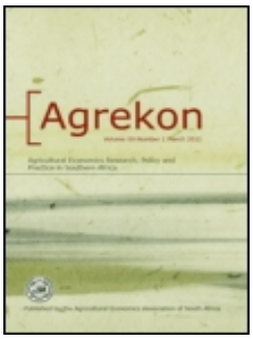

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ESTABLISHING THE LINKAGES BETWEEN THE SOUTH AFRICAN AGRICULTURAL TRADE BALANCE AND MACROECONOMIC INDICATORS

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ABSTRACT

This paper investigates the long-run and short-run linkages between macroeconomic fundamentals, agricultural variables and the South African agricultural trade balance, using co-integration analysis and a vector error-correction model with yearly data from 1980 to 2011. The literature review shows that these linkages have not been empirically established for South Africa, despite the relative importance thereof in the policy process. The findings reveal that in the long run, the exchange rate, agricultural price, agricultural production and disposable income all have a significant impact on trade balance. The joint short-run dynamic impact of the lagged trade balance, lagged agricultural production, lagged exchange rate, domestic price and agricultural production explains the changes in the South African agricultural trade balance.

Keywords: agricultural trade balance, macroeconomic fundamentals, co-integration analysis, vector error-correction model

JEL CLASSIFICATION

C50, Q17

1 INTRODUCTION

Amidst the gradual trade reform process within the South African economy in the 1990s, the South African government's endorsement of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994 has manifested itself in, inter alia, the phasing out of subsidies and the replacement of qualitative barriers with tariffs and reduced tariffs (Swanepoel, Coetzee and Gwarada 1997). Trade as a share of output has risen, with both imports and exports contributing to this increase (Mabugu 2005). Trade reform, along with other incentives, critically influences the way in which resources are reallocated from one sector of the

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economy to another (Cassim 2003). Any decisions to further liberalise trade and reduce tariffs will be extremely important for policymakers and interest groups with an interest in agriculture. Thus, the impact of other factors exogenous to the agricultural sector should be taken into consideration in such decisions.

South Africa has traditionally been a net exporter of primary agricultural products, and this trade surplus helps to offset a portion of the non-farm trade deficit. Employment resulting from agricultural exports includes direct farm employment and non-farm-related employment (eg food processing, trade, transportation and other services). The jobs resulting from agricultural exports reflect the output that is stimulated as farmers purchase inputs for production and as agricultural commodities are harvested, transported and stored. The outputs and job-creation opportunities related to agricultural exports are spread across the supporting sectors of the economy.

Macroeconomic variables (exchange rate and disposable income) and agricultural variables (price and agricultural production) are commonly perceived as factors that can influence agricultural trade. For example, appreciation of the rand may drive up the prices of agricultural goods and thus dampen exports, while an increase in disposable income may boost purchasing power and lead to an increase in imports and an associated decrease in trade surplus. It is therefore important to understand the dynamic interrelationship between macroeconomic variables and agricultural trade balance, since gaining an understanding of these dynamic interactions may provide an explanation of fluctuations in trade balance, while also guiding policymakers in agricultural policy formation.

Within the agricultural trade literature, the relationship between macroeconomic variables (exchange rate and disposable income) and agricultural trade balance has not been extensively explored in relation to South African agriculture. Macroeconomic disturbances and their links to the agriculture sector are central for policy developments leading to direct government intervention in the agriculture sector. Brownson, Vincent, Emmanuel and Etim (2012) argued that the resilience of the agricultural sector depends largely on the level of economic growth in the country which is largely hinged on the stability of some key macroeconomic variables.

Thus, this study aims to establish the dynamic relationship between South African agricultural trade balance, agricultural productivity and some key macroeconomic variables. Such a relationship is momentous and is a reliable tool needed to accelerate productivity in the agricultural sector. These linkages were mostly unanswered and less considered by policy makers in South Africa. The answer to this question will help to understand macroeconomic variables linkages with agricultural trade balance and to determine whether policy makers have to be concerned with the response of agricultural trade balance and also contribute to the literature of South African agricultural trade.

From this point onwards, the paper is organised as follows: section 2 is a synopsis of South Africa's agricultural trade performance, section 3 contains a review of the relevant literature on macroeconomic variables and agricultural trade balance, section 4 presents the data used for the purposes of the study, section 5 explains the methodology employed for the analysis, section 6 presents and discusses the empirical results and the final section (section 7) concludes with a summary of the paper and an outline of the policy implications.

2 SYNOPSIS OF SOUTH AFRICA'S AGRICULTURAL TRADE PERFORMANCE

For more than three decades, South Africa has been a net exporter of primary agricultural products. During the period 2009/10 to 2010/11, the value of South Africa's agricultural exports increased by 6.9 percent from R44.469 billion to R47.561 billion, while the estimated value of agricultural product imports over that same period increased by 14.3 percent, from R33.946 billion to R38.815 billion (DAFF 2011). As a result, agricultural trade surplus reached a record high of R13.615 billion in 2010, a 55 percent increase over the trade surplus in 2000. Figure 1 illustrates that from the fourth quarter of 2008 to the fourth quarter of 2010, South Africa's exports of primary agricultural products exceeded its imports. The figure reveals that between the third and fourth quarters of 2010, there was a significant decline in exports of primary agricultural products from R7.5 billion to R4.2 billion, with a slight increase in primary agricultural product imports during the same period. As a result, the primary product trade surplus declined from R5.2 billion to R2.2 billion.

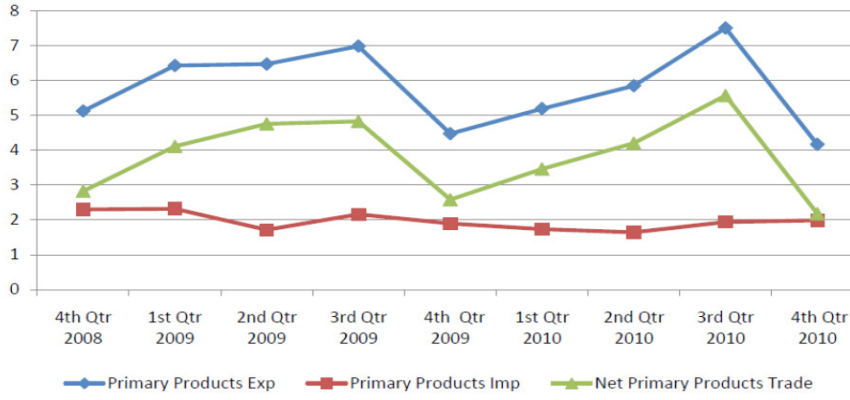

Figure 1: South African trade in primary agricultural products
Source: DAFF (2012)

The country maintained a net exporter status in terms of primary agricultural products between 1998 and 2005, thereafter becoming a net importer until 2010. Notwithstanding the recovery experienced in the second quarter of 2010, primary agricultural exports in general continued to fall short of imports, with the gap widening even further during the third and fourth quarters of 2010 (DAFF 2011). Variations in primary agricultural exports and imports are largely influenced by the seasonal nature of agricultural production. Figure 2 illustrates the trend of total agricultural exports exceeding imports, largely due to the fact that South Africa has been able to maintain its net export status for primary agricultural products over recent decades, far exceeding imports in this regard. However, it is worth noting that South Africa is a net importer of processed agricultural products.

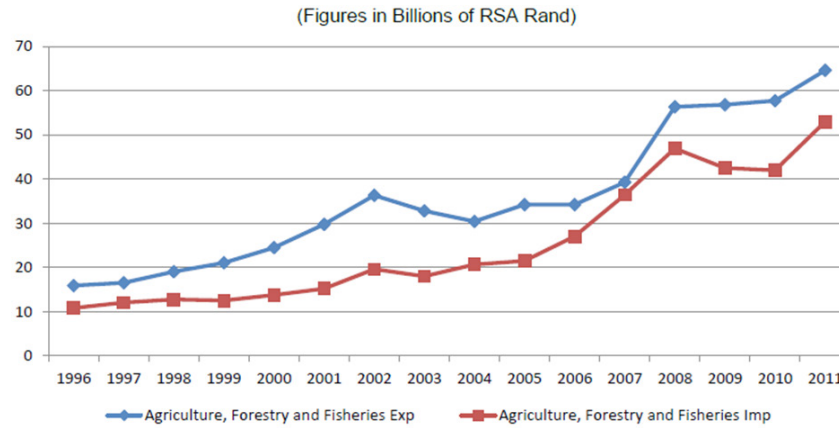

Figure 2: South African agricultural exports and imports
Source: DAFF (2012)

Overall, South Africa remains a net exporter of primary agricultural products. It is against this backdrop that the differentials of South African agricultural exports and imports over the past two decades are explored.

3 REVIEW OF RELEVANT LITERATURE

Many scholars have investigated the relationship between macroeconomic variables and agricultural trade, but there is little literature available on the subject of macroeconomic variables such as exchange rate volatility, interest rates and agricultural trade relationships in South Africa. The direct effect of macroeconomic variables on the South African agricultural trade balance has thus far received little attention.

Several studies have shown that the exchange rate has a negative impact on exports, as it imposes costs on risk-averse entrepreneurs, who generally favour domestic rather than foreign trade (Byrne, Darby and MacDonald 2008; Côté 1994). Schuh (1974) argued that changes in the exchange rate play an important role that for the most part has been ignored, and that an adequate understanding of the performance of the agricultural sector cannot be gained without a more ample consideration of the exchange rate. This argument contends that the exchange rate is an exogenous variable affecting trade. Chambers (1981) and Chambers and Just (1979) provided empirical evidence of the exchange rate as an exogenous variable, while other studies (Collins, Meyers and Bredahl 1980; Bordo 1980) established that exchange rate movements have little effect on the variability of real commodity prices.

Baek and Koo (2008) investigated the short-run and long-run relationships between agricultural trade balance and domestic macroeconomic aggregates and agricultural variables in the United States of America (USA), using the Johansen co-integration analysis. Their results revealed that in the long run, the exchange rate, agricultural price and disposable income are weak exogenous variables in the USA's agricultural sector, but with a significant effect on agricultural trade balance. The authors argued that the combined short-run dynamic effects of the exchange rate, agricultural price and production, along with disposable income, jointly explain the changes in the USA's agricultural trade balance.

In international trade research, the emphasis was traditionally placed on price elasticity. Over time, however, income elasticity came to be considered as equally important, especially in a growing economy (Houthakker and Magee 1969). Johnson (1958) pointed out that under certain conditions, the direction in which the trade balance moves over time depends critically on a country's income elasticity of demand for imports and on the rest of the world's income elasticity of demand for that country's exports. Where the income elasticity of demand for a country's imports is higher than the foreign income elasticity of demand for its exports, that country will experience more rapid growth in imports than in exports, as well as deterioration of its trade balance and eventual pressure on its exchange rate. However, for the agricultural sector, variations in agricultural income and exports are influenced by movements in agricultural prices (Kwon and Koo 2009).

A study conducted in Tunisia by Gil, Ben Kaabia and Chebbi (2009) found that responses to agricultural exports are greater if generated by exchange rate movements than by price movements. This shows that macroeconomic variables are important and should be taken into consideration in agricultural policy formulation (Chebbi 2010). The authors also found significant government intervention in the agricultural product price response to macroeconomic shocks in Tunisia.

Few studies have been conducted on the effects of macroeconomic variables on agriculture in South Africa specifically. Kargbo (2006) investigated the supply and demand relationships for agricultural trade flows in South Africa using the vector error-correction model, finding a strong link between exchange rates, prices and other variables in the economy. The author argued that real exchange rate volatility has a negative impact on South African agricultural exports and imports. According to Dushmanitch and Darroch (1990) the problem of farm debt in South Africa, along with interest rate variability and depreciation of the rand exchange rate, point to the importance of the effect of monetary policy on the South African agricultural sector.

4 DATA USED

This study made use of data related to South African agricultural exports and imports, macroeconomic variables such as disposable income and exchange rate, as well as agricultural variables (agricultural price and production), according to an annual time series from 1980 to 2011. Data on South African agricultural exports and imports, the producer price index for agricultural products and the aggregate agricultural gross domestic product (GDP) was gathered from the Department of Agriculture, Forestry and Fisheries (DAFF 2012). Data on the exchange rate and disposable income per capita was collected from the South African Reserve Bank (2012). Data on agricultural exports and imports was used for purposes of calculating the trade balance.

Trade balance is measured as the ratio of export value to import value (X/M). There are several reasons for using such a ratio, one of which is the fact that ratios are not sensitive to the units of measurement, particularly when in a logarithmic form, and therefore this particular ratio can be interpreted as the real trade balance (Boyd, Caporale and Smith, 2001). Ratios also narrow the range of the variable to make it less susceptible to outliers or extreme observations (Wooldridge 2000). The producer price index for agricultural products was used as a proxy for aggregate South African agricultural price, while the aggregate agricultural GDP was used as a proxy for agricultural production.

5 METHODOLOGY

5.1 Development of the econometric model

Following the procedure used by Baek and Koo (2008), a dynamic relationship between the South African agricultural trade balance and macroeconomic aggregates and agricultural variables was specified as:

$$TB = g(P, AP, DI, EX) \quad (1)$$

where *TB* is trade balance, *P* is agricultural price, *AP* is agricultural production, *DI* is disposable income, and *EX* is the exchange rate.

To capture the long-run relationship among variables in equation 1, the Johansen maximum likelihood estimation procedure was specified, in terms of which the co-integrated vector autoregression (VAR) model is depicted as follows:

$$\Delta X_t = \alpha_0 + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{P-1} \Delta Z_{t-p+1} + \Pi Z_{t-p} + \nu_t \quad (2)$$

where X_t is a (5 x 1) column vector of endogenous variables that are integrated of order I(1), Δ is the difference operator, $\Gamma_1 \ldots \Gamma_{k-1}$ are the coefficient matrices of short-term dynamics, $\Pi = -(I - \Pi_1 + \ldots + \Pi_k)$ are the matrix of long-run coefficients, α_o is a vector of constant, and $\mathcal{V}_t$ is a vector of error terms.

Granger's representation theorem affirms that if matrix Π has reduced rank r < k co-integration vectors present, then Π can be decomposed into a matrix of loading coefficients α and a matrix of co-integrating vector β; that is, $\Pi = \alpha\beta'$. Here, *r* is the number of co-integrating relations, β is a (*k* x *r*) matrix representing the co-integrating vectors that are commonly interpreted as meaningful long-run equilibrium relations between the Z_t variables, and α is a (k x *r*) matrix representing the speed of adjustment to equilibrium. The number of co-integrating vectors – the rank of Π – in the model is determined by a likelihood ratio test. Therefore, under the I(1) hypothesis, the co-integrated VAR model is formulated for the short-run dynamic model as:

$$\Delta X_t = \alpha_0 + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{P-1} \Delta Z_{t-p+1} + \alpha(\beta' X_{t-1}) + \nu_t \quad (3)$$

Where $\beta' X_{t-1}$ is a measure of the error or deviation from the equilibrium, which is stationary due to the series being co-integrated. Since the variables are co-integrated, the Vector Error Correction (VEC) model incorporates both short-run and long-run effects, meaning that if the long-run equilibrium holds, then $\beta' X_{t-1} = 0$. At disequilibrium, the term $\beta' X_{t-1}$ is not equal to zero and measures the distance of the system from equilibrium during time *t*. Thus, an estimate of α_o provides information on the speed of adjustment, which implies how the variable X_t changes in response to disequilibrium.

5.2 Time series properties of the variables

The first requirement of a co-integration test is that selected variables must be non-stationary. Unit root tests are important in examining the stationarity of a time series, since a non-stationary regressor invalidates many standard empirical results and thus requires special treatment (Kwiatkowski, Phillips, Schmidt and

Shin 1992). The existence of a unit root for this study was therefore determined using the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979, 1981), with the results presented in table 1.

Table 1: Results of ADF unit root test

Variable	Level	First difference	Lag
TB	-0.26	-1.72*	1
AP	-1.67	-3.34*	3
P	-0.80	-1.92*	2
EXR	-0.37	-0.96*	1
DI	-0.35	-1.41*	2

*Denotes rejection of the null hypotheses of a unit root (ADF test) at the 5 percent significance level. *TB, AP, P, EXR* and *DI* represent South African agricultural trade balance, agricultural production, exchange rate and disposable income respectively.

The results presented in Table 1 show that at the different levels, all variables are non-stationary or have a unit root, while all variables are stationary at first difference. Determining the lag length for the VAR model before applying the Johansen co-integration test is essential, due to the sensitivity to changes in lag length (Maddala and Kim 1998). By means of the Akaike Information Criterion, the appropriate lag length for the VAR model was confirmed as being three, and therefore three lags ($k = 3$) were used for the co-integration analysis. For systems with lagged dependent variables, the serial correlation of the residuals must be examined, and in this case the Lagrange Multiplier test was employed for this purpose, resulting in a finding of no serial correlation among the variables.

5.3 Johansen co-integration test

This section reports on the process of testing for the stationarity of the linear relationship amongst the variables in order to determine whether the variables are co-integrated (Johansen 1988 and 1992). For the purposes of this study, the approach described by Johansen (1995) was adopted, with trace statistics being used to determine the co-integrating rank, ie the number of co-integrating vectors. The results of the co-integration test are presented in table 2.

Table 2: Results of Johansen co-integration test (trace test)

Null hypothesis	Eigenvalue	Trace statistic	5% critical value
H_0: r = 0	0.691 695	71.790 50	69.818 89*
H_0: r ≤ 1	0.467 540	37.667 20	47.856 13
H_0: r ≤ 2	0.329 116	19.390 04	29.797 07
H_0: r ≤ 3	0.167 527	7.814 424	15.494 71
H_0: r ≤ 4	0.082 505	2.497 136	3.8414 66

* denotes rejection of the null hypotheses at the 5 percent significance level

As shown in table 2, the trace test indicated at least more than one co-integrating equation at the 5 percent level. The existence of co-integration implies that the variables in the system have a stable long-run equilibrium relationship(s) to which they return after short-run deviations.

6 EMPIRICAL RESULTS AND DISCUSSION

Having established the time series properties of the data, the number of co-integrating equations and the lag length of the VAR model, the next step was to estimate both the long-run and short-run equations, as shown in equations 2 and 3 above, thus producing the results for the long-run and short-run elasticities. The results for the long-run elasticities are presented in table 3.

Table 3: Co-integrating equation showing long-run elasticities

Variable	Coefficient	t statistic
ΔAP_t	0.812 0*	2.790 1
ΔP_t	-0.720 9**	-1.842 4
ΔDI_t	-0.077 3**	-2.254 6
$\Delta EXRt$	-0.446 9*	-2.165 1
Constant	-47.151 7	

*, **denote significance at 5 percent and 10 percent respectively

The results show South African agricultural trade balance as having a negative long-run relationship with exchange rate movements. These results provide evidence that the depreciation of the South African rand is associated with an increase in agricultural exports, thereby improving trade balance in the long run. A depreciation of the rand spurs greater demand for South African primary agricultural products in the international market, thereby leading to an increase in exports. These results are consistent with the finding of Ozturk and Kalyoncu (2009), ie that the exchange rate has a significantly negative effect on trade. With trade balance having a negative long-run relationship with disposable income, this implies that an increase in disposable income would lead to an increase in South African imports due to the increased purchasing power of South African consumers, thus leading to a trade deficit. Agricultural imports react more quickly to shocks than domestic production.

The results point to a positive long-run relationship between trade balance and aggregate agricultural production (agricultural GDP), explaining why an increase in South African agricultural production results in an increase in exportable agricultural products and an improvement in trade surplus. Moreover, there is evidence of a negative long-run relationship between the South African agricultural trade balance and domestic price. A negative long-run relationship between trade balance and domestic price implies that an increase in South African agricultural product prices would cause a decrease in exports and an increase in imports, thereby worsening the agricultural trade surplus situation. According to Asfaha and Jooste (2007), relative changes in agricultural prices can influence farmers in terms of their investment decisions, productivity and income.

The short-run relationship between the agricultural trade balance and the stated explanatory variables was estimated using the VEC model, with the short-term dynamics of the variables in the system being influenced by the deviation from equilibrium. The results of the short-run elasticities are presented in table 4.

Table 4: VEC estimates showing short-run elasticities

Variable	Coefficient	t-value
Error correction	-0.616 3	-3.253 5*
Constant	-0.762 7	2.886 1*
Trend	-0.368 8	-4.722 0*
ΔTB_{t-1}	-1.574 9	-3.352 3*
ΔTB_{t-2}	-0.951 8	2.171 5*
ΔAP_{t-1}	1.594 6	2.811 5*
ΔAP_{t-2}	1.866 6	2.909 2*
ΔP_{t-1}	-2.920 9	-4.162 0*
ΔP_{t-3}	-3.191 9	-3.111 2*
ΔEXR_{t-3}	-1.877 4	-2.422 0*
ΔDI_{t-3}	-2.523 6	-1.927 5*

*indicates significance at 5 percent

The coefficient of the error-correction term for trade balance is statistically significant at the 5 percent level and negative as expected, thus supporting the validity of the equilibrium relationship between variables in the long-run equations (table 4). From the results, it is evident that approximately 62 percent of the proportion of disequilibrium in the agricultural trade balance during the previous period is corrected within one year, implying that it takes less than two years to correct long-run disequilibria.

Coefficients of lagged variables in the model show short-run dynamics of dependent variables. The coefficients are relatively great, indicating a rapid adjustment process, with an indication of the proportion of disequilibrium that is corrected each year. Trade balance is negatively correlated with lagged trade balance, price, disposable income and exchange rate, but positively correlated with agricultural production. The results reveal the significant short-run dynamic effect of agricultural production on trade balance, which is also affected by lagged changes in agricultural production.

7 SUMMARY AND IMPLICATIONS

The main objective of this study is to establish the dynamic relationship between South African agricultural trade balance, agricultural productivity and some key macroeconomic variables using co-integration and a VEC model, with yearly data spanning the period 1980 to 2011. The methodological approach used based on the co-integration analysis allow us to examine long-run equilibrium relationships

as well as short-run dynamics. The long-run analysis is usually associated with structural relationships and it is in this context that theoretical restrictions are tested. Short-run analysis is also important for policy analysis as it gives an indication of the magnitude and time path of the reaction of economic variables to deviations from long-run relationships.

The error correction term is negative and significant for South African agricultural trade balance in the VEC model, confirming the existence of a long-run equilibrium relationship among variables. The VEC model shows that exchange rate has a significant impact on South African trade in the short run. The study also found that agricultural price and disposable income have a significant impact on trade in the short run, thus corroborating the findings of Kargbo (2006), who argued that real prices, exchange rates and domestic prices are major determinants of agricultural trade flows in South Africa.

One vital implication of this study's findings is that exchange rate movements can alter relative prices and affect agricultural trade balance, over both the short and long run. The short-run trade effects are not straightforward, as they are likely to depend on specific characteristics of the economy, including the currency in which domestic producers invoice their products and the structure of trade. A weaker exchange rate will shift relative prices in favour of agriculture in the long run. In a study by Orden (2010), he maintained that the recent boom in the USA's agricultural prices and net farm income occurred in the presence of a weak dollar and low interest rates. From this inference, it is suggested that government policy be directed at sustaining the depreciation of the rand as this could have a favourable impact on agricultural policy reform.

The long-run coefficient of domestic prices is negative, showing that rising domestic prices lead to a reduction in agricultural exports. According to Goldstein and Kahn (1985), rising domestic prices reduce the profitability of production for export markets relative to domestic markets, thus causing a shift in resources away from export production. This study found that the South African agricultural sector is competitive, with prices that are more flexible than those in non-agricultural sectors. In the short run, expansionary monetary policy would favour the agricultural sector, but in the long run may have an adverse effect on stability.

Disposable income and the exchange rate are generally seen as convenient tools for measuring the strength of the economy (for example, an increase in disposable income serving to stimulate agricultural imports and diminish agricultural trade surplus). This means that policy must be geared towards favouring agricultural exports, since this would have a more direct impact on the economy by generating employment within the agricultural sector. Macroeconomic variables therefore play an important role in explaining commodity prices. This will probably continue to be the case in an increasingly global economy.

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