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Abstract

This study attempts to examine the empirical relationship between trade and total factor productivity (TFP) in the agricultural sector using both cross -sectiona;- (across nine agricultural commodities); and time -series analysis. The Error Correction Model of ordinary least square (OLS) results from the cross -sectional analysis confirm that export shares and capital formation were found to be positive and significant; whereas, import shares and real exchange rate were found to be related negatively. However, the net effect of export and import shares had a positive effect. This implies that trade liberalisation causes productivity gains. Moreover, the time -series analysis goes in the same direction as the cross -sectional results, showing that there is a robust relationship among TFP, degree of openness, and capital formation. Whereas, debt was found to be inversely related, this implies that agricultural industries / farmers lack debt management skills.

Key words: TFP, OLS, Trade liberalisation or degree of openness and capital formation

INTRODUCTION

South Africa is the industrial giant of sub-Saharan Africa. A challenge facing the nation of South Africa is to ensure that agriculture continues to contribute to the national policy objectives of economic growth. In addition to the needs of the nation, agriculture is critical to South Africa's rural population. It is a major source of food and household income in rural areas.

According to the National Department of Agriculture (2005), agriculture is regarded as one of the means to reduce poverty, firstly through its contribution to total GDP and employment, and secondly because its 240 000 small farmers provide a livelihood to more than 1 million family members and to another 500 000 occasional workers. Furthermore, there are an estimated 3 million farmers, mostly in the communal areas of the former homelands, who produce food primarily to meet their families' needs and almost all of the productive and social activities of rural towns and service centres are dependent on primary agriculture and related activities (DoA, 2005). In addition, agriculture utilises the largest portion of South Africa's land and therefore forms the backbone of the rural economy. It is therefore clear that agriculture is regarded as one of the means through which Government can reach its growth objectives as articulated in the Integrated Rural Development Strategy and ASGISA.

Over the past decade, major changes in the agricultural business environment have taken place. These changes have affected agriculturalists and others who are either directly or indirectly involved in agricultural activities. The introduction of free trade has resulted in price fluctuations, which brought about a whole new dimension of risk. South Africa's agriculturalists were not always prepared to manage the resulting external competition (Taljaard, 2007).

In the 1960s and 1970s, African countries have been very sceptical about the virtues of free trade. Since the late 1980s, they have shown more interest in multilateral trade as well as negotiations. This reflects the combined effect of the following three factors, namely: dissatisfaction with the slow pace of regional integration; the belief that trade (if well managed), could play a critical role in confronting the development challenges facing the continent, and lastly, the widespread view that multilateral trade could promote as well as spur regional integration efforts. By increasing competition, multilateral trade liberalisation could force African governments to intensify regional integration efforts so as to reduce transactions costs through the development of regional infrastructure (Economic Commission for Africa (ECA), 2004).

During the last decade trade policy in South Africa has undergone several changes. These changes include multilateral reductions in tariffs and subsidies through the country's World Trade Organization (WTO) commitments, the signing of Free Trade Agreements (FTAs) and more recently, negotiations around future commitments to liberalisation both at multilateral level as well as regional level. These simultaneous developments have had an important influence on both *de facto* protections in the South African economy, as well as on welfare improvement (Organisation on Economic Co-Operation and Development (OECD), 2006).

The opening of the agricultural sector placed South Africa among the world's leading exporters of agro-food products such as wine, fresh fruit and sugar. The country is also an important trader in the African region. The beginning of the current decade witnessed particularly strong agricultural export oriented growth. South Africa's agricultural export revenues reached almost 9% of the total value of national exports. Europe is by far the largest destination, absorbing almost one-half of the country's agricultural exports (OECD, 2006). Agricultural imports are also growing, accounting for 5-6% of total annual imports since 2000 (OECD, 2006). However, Coetzee (2008) indicated that the current export trend shows that the capacity is declining, whereas import is growing tremendously. South Africa is to become a net importer of major food items.

South Africa has undertaken several major economic reforms and, among these, import liberalisation was a principal component. This reform, along with complementary changes in industrial policy and technology, was aimed at making South African industries more efficient, updating technology and competitiveness (Jonsson and Subramanian, 2001).

Given the fact that the main objective of import liberalisation was to improve industrial productivity, it is appropriate to ask how much import liberalisation has contributed to economic growth, better productivity and the improved performance of agricultural industries.

This study attempts to examine the impact of trade liberalisation on agricultural total factor productivity (TFP), in particular the case of South Africa. More specifically, the empirical relationship between trade and TFP is examined. The hypothesis is that enhanced trade liberalisation in recent years has improved agricultural industries' efficiency.

The study is timely from a policy perspective, as trade liberalisation constitutes part of the crucial policy element in the government's efforts to boost the underlying supply capacity of the economy in light of the variation in trade policy orientation, and different degrees of trade openness, combined with the South African external sanction experience and recent trade liberalisation. This case study can analyse the problems more comprehensively.

EFFECT OF IMPORT LIBERALISATION AND CHANNELS TO FOSTER ECONOMIC GROWTH

There are persuasive theoretical arguments for contemplating the positive effect of import liberalisation on agricultural productivity. However, this view or hypothesis does not constitute unequivocal empirical support. A number of empirical studies from developing countries (e.g. Das, 2002; Dollar, 1992; Goldar & Kumari, 2003; Ojo & Oshikoja, 1994), in which econometric models have been estimated to assess the effect of import liberalisation on industrial productivity, have found a significant and favourable effect. However, others have found no significant effect, while others still have found an adverse effect of import liberalisation on productivity.

Some researchers have suggested that developing countries' trade policy for development should be based on import substitution. Contrary to this, Vamvakidis' (1999) study shows that growth prospects for developing countries are greatly enhanced through an export-oriented trade regime (Vamvakidis, 1999). However, the question as to whether trade liberalisation increases productivity remains unanswered. Trade liberalisation might not provide uniform incentives to all countries but it is accepted as a favourable productivity channel. Goldar and Kumari (2003) categorise the channels as follows:

- Import liberalisation provides industrial firms with greater and cheaper access to imported capital and intermediate goods (embodying advanced technology);
- Greater availability of imported intermediate goods enables the industry to adopt better productivity and technological methods;
- Increased competitive pressure makes industrial units more efficient in their resource usage (i.e. through better organisation of production, improved managerial efficiency, effective utilisation of labour, better capacity utilisation, etc.);
- Increased competitive pressure could be coupled with expanded opportunities for importing technology and capital goods ;
- The competitive environment forces inefficient industries to be closed down, resulting in an improvement in the average level of efficiency of various industries; and
- Greater access to imported inputs and more realistic exchange rates associated with a liberalised trade regime enable better competitiveness.

During the past three decades open economies have grown much faster than economies with high protection. In addition, some of the economies that have followed import substitution policies experienced economic crisis and collapsed during the 1980s and 1990s (Vamvakidis,

1999). Studies on open -economy growth show that the trade features that best foster economic growth are technology and investment.

The technology category has been supported mainly by Bassanini, Scarpetta and Visco (2000), De Long (1996), De Loo and Soete (1999) and Vamvakidis (1999), who highlight four benefits:

- An enlarged international market provides technological spillover effects;
- Economies categorised as open markets have led to an economy -of -scale advantage, by encouraging research and development in the sector;
- An enlarged international market provides greater productivity from the adoption of new technology over time; and
- An open market avoids replication of research and development efforts .

The second category, however, argues that investment is the main link between trade and growth. Miller and Tsoukis (2001) present three reasons to explain why investment fosters trade:

- The traded sector is more capital intensive than the non-traded sector;
- The production of investment goods uses imported intermediates; and
- Competition in the international market regarding machinery and capital equipment lowers the price of capital.

Ojo and Oshikoja (1994) support the above argument by presenting neoclassical growth models in which the domestic production process uses investment as primary input. Their model shows that trade liberalisation fosters economic growth through a rise in imports of capital goods. Moreover, empirical evidence by Ashipala and Haimbodi (2003) and Ramirez (1998) supports the argument that investment fosters economic growth through its positive impact on trade.

It might, however, not be an either/or situation, as there is common consensus in the current research that both categories are key for economic growth (whatever their sequence), and empirically it is very difficult to disentangle the effects of investment and technology, since most investment incorporates new technology and most new technology results in more investment (Vamvakidis, 1999).

Both models would support a country opening up free trade without any discrimination, and not with a few neighbouring countries only, while still intervening to distort trade with the rest of the world (Vamvakidis, 1999). Nonetheless, more research on the theoretical links of regional integration with growth would help considerably in designing trade policy.

REVIEW OF PREVIOUS RESEARCH

In theoretical models, information on the impact of trade liberalisation on agricultural growth is either absent or ambiguous. In a conventional neoclassical growth model, trade does not affect the equilibrium or steady-state rate of output growth, because, by assumption, growth is determined by an exogenously given technological progress (Dixon, 2003). In sector growth models, trade policy does affect the allocation of resources and, thus, the steady-state level of savings and capital accumulation. This may have a once -off effect on the steady-state level of

output (which can be positive or negative depending on how savings and capital accumulation are affected by trade policy), but not on the rate of growth. Nevertheless, even in the neoclassical model, trade policy may have a transitional growth effect on the economy as it converges toward the steady state (Dixon, 2003).

The empirical evidence on trade and economic growth has two distinct strands. The first and perhaps largest body of research is based on cross-country studies (e.g. Dollar, 1992; Sachs & Warner, 1995; Ben-David, 1993; Edwards, 1998; Coe, Helpman & Hoffmaister, 1997). These studies have focused either on the direct impact of trade on growth (the first three studies) or on TFP (the last two studies) but all of these studies reach the broad conclusion that increased trade has a positive impact on economic growth. These studies have since been critically reviewed by Rodrik (1998) and Rodriguez and Rodrik (1999), who call their results into question.

The critique comprises the following elements: Firstly, is it really a meaningful question to ask whether outcomes or liberal trade policy help economic growth?. Moreover, the question continues to remain unanswered, because the trade outcome approach suffers from conceptual and empirical shortcomings, including the endogeneity of outcomes, -failure to specify the mechanism through which exports and imports affect growth, and measurement problems. Secondly, recent prominent studies do not incontrovertibly support the positive relationship between trade policy and growth, because of difficulties either in measuring trade policy or in picking up other effects (such as macroeconomic stability) (Dollar, 1992). Moreover, Sachs and Warner (1995) and Edwards (1998) questioned the robustness accuracy of using dummies to represent the effects of macroeconomic stability as alternative specifications.

The second strand in the empirical research comprises intra-country studies based on either plant or industry level (see e.g. Harrison, 1994). The results of this strand indicate that the causal link between trade and TFP is less evident in the data. For example, Harrison (1994) finds that; TFP growth and trade policy orientation do not appear to be correlated at industry level; a correlation can be detected when TFP is measured appropriately by taking into account the biases emanating from the presence of non -constant returns to scale and imperfect competition. Johansen (1988) suggests that while efficiency and trade orientation are correlated, the causation appears to run from the former to the latter in the sense that efficient firms tend to self-select export markets rather than openness, leading to increased efficiency. One of the few papers that examine the empirical relationship between trade and growth from a time-series perspective is Coe and Moghadam's (1993) study on France. They found a robust long-run relationship among growth, factor inputs, and openness (which is intended to capture the effects of TFP).

The lack of a strong theoretical framework for trade liberalisation and TFP and the puzzling empirical evidence is a call for further research. This study, therefore, examines the determinants in TFP in the case of the South African agricultural industry using both cross - sectional and time -series analysis. The hypothesis is that TFP is positively related to trade liberalisation.

METHODOLOGY AND DATA

This study follows the general modelling of Jonsson and Subramaniam (2001) to test the relationship between trade and TFP. Dummy variables have been included to capture the impact of trade agreements. As stated earlier, this section uses both cross-sectional and time -

series data. For cross-sectional analysis, data was pooled from 1995 to 2002 in respect of nine South African agricultural commodities (these are: sorghum, wheat, dry beans, soybeans, oats, groundnuts, sugar, maize and beef).

The cross-sectional model is specified as follows:

$$\mathbf{TFP} = \mathbf{f}(\mathbf{export_share, import_share, CFC, PP, RER, SADC \text{ and } EU})$$

Where: TFP is defined as the ratio of total production to area planted;

Export_share is the ratio of total export to production (in volume);

Import_share is the ratio of total import to domestic consumption (in volume);

CFC is the ratio of capital formation to agricultural GDP (in current price);

PPI is producer price index;

RER is real exchange rate; and;

SADC and EU represent the dummy variables for SADC and EU trade agreements respectively.

To analyse the dynamic relationship between TFP and openness (the study used time-series data) the model is specified as follows:

$$\mathbf{TPF} = \mathbf{f}(\mathbf{Open, CFC, DEBT})$$

The data set of the time-series was examined for the period 1970 – 2005. TFP was calculated as the real agricultural GDP divided by consumer price index (CPI).

The variable **Open** is defined as the ratio of real imports and real exports to real GDP (this is a proxy for the state of South African trade openness). The use of this variable might be open to criticism and might only measure an outcome, and thus may not have policy implications. The preferred estimation strategy is to view and use direct measures of trade policy. However, it is difficult to compute a reliable series of “trade policy” over the sample period, especially due to the pervasiveness of non-tariff barriers (Jonsson & Subramaniam, 2001).

The variable **CFC** is defined as the total investment in equipment and machinery divided by agricultural GDP since time-series data for R&D in South Africa is not easily available. However, following on the findings of De Long and Summers (1991) (in Jonsson & Subramaniam, 2001), this study uses the share of investment in equipment and machinery to the total agricultural GDP as the proxy for technology adoption. Insofar as South Africa does not undertake significant amounts of R&D activity in agriculture, the study assumes the bulk of R&D to be embodied in capital formation, especially that imported from abroad. By looking at total investment in machinery and equipment, the specification implicitly aggregates R&D undertaken at home and abroad and assumes that the two have similar effects on TFP. An alternative approach that could have disentangled the effects of foreign and domestic R&D would have been to use separate measures for domestic and imported capital goods (Jonsson & Subramaniam, 2001).

The last variable in this section is **DEBT**, included to capture the financial crisis in the agricultural industry, and defined as the total debt in agriculture relative to agricultural GDP.

To apply the above -mentioned method, secondary data has been used from sources such as the South African Reserve Bank (SARB), Statistics South Africa (SSA), the International Trade Centre (ITC), and the Food and Agricultural Organisation (FAO).

RESULTS AND DISCUSSION

CROSS -SECTIONAL EVIDENCE

In this section, the method explained in the methodology section is applied. Results pertaining to the impact of trade liberalisation on TFP with other key determinants, across 9 different agricultural commodities are reported. The data observed was pooled from the period 1995 to 2005.

The overall explanatory power is at 77 percent. With the exception of PPI (not significant and not reported – see Table 1), all other variables were found to be statistically significant at the specified level of significance.

Table 1: Determinants of TFP (pooled results: 1995 - 2005), ordinary least square (OLS)

Dependent variable	TFP	
Independent variable	Estimated coefficient	T-ratio
Export_share	0.045	2.9***
Import_share	-0.035	-4.6*
CFC	0.04	2.3**
PPI	0.032	0.44
RER	-0.012	-6.12*
SADC	0.045	1.13**
EU	0.013	2.9***
C	4.2	
R-sq	0.77	
Adj R-sq	0.65	
Number of observations	99	

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

Table 1 shows that export_share was found to be positive and significant at 10 percent. This implies that export is linked directly to productivity, and that higher export_share performance might encourage high investment growth and capital accumulation, leading to better factor productivity growth.

On the other hand, import_share was found to be negative and statistically significant at the specified level (see Table 1). This might indicate that there is a high level of external competition, creating pressure on domestic agricultural industries to keep costs low, which restricts the economy -of -scale advantage. Generally, taking these two key determinants into account, the effect of openness was positive, and trade liberalisation created a net positive effect to TFP. For example, further increasing export_shares by 10 percent led to a 0.45% improvement in TFP. Similarly, a 10 percent increase in import_shares led to a 0.35% decline

in TFP, However, the agricultural sector still needs the support of all stakeholders to ensure a better contribution, and continuous research is important within this era of globalisation.

Empirical studies on international trade theory, show that growth in export shares is a good indicator of what is stimulating production across the economy through technological spillovers and other externalities. On the other hand, exports might create externalities for the following reasons: (i) exposure to international markets calls for increased efficiency, which provides incentives for product and process innovation, (ii) increases in specialisation allow for economies of scale, and (iii) larger exports will contribute to the stock of knowledge and human capital accumulation in the economy (Goldar & Kumari, 2003). Thus, generally speaking, as can be seen from the analysis of Table 1, South African agricultural industries have showed a net benefit from the growth in export and import shares. This might indicate economy-wide productivity gains, leading to increased land and labour productivity. This in turn reduces the price of food for rural communities.

The third key determinant of TFP in this section is producer price index (PPI), which was found to be positive, but not sufficiently significant to report (see Table 1). The fourth key determinant of TFP is the ratio of capital formation to GDP (CFC)- which was found to be positive and significant (at 5 percent significance level). This implies that TFP has increased as a result of capital formation.

Goldar and Kumari (2003) showed in their study, that trade liberalisation gives industries better access to imported inputs, the adoption of technology and a stable exchange rate. The export-oriented trade policy also provides an opportunity to learn better management practices. However, the direct impact of real exchange rate (RER) on this study (see Table 1) was found to be negative and statistically significant in terms of influencing TFP. This implies that, even though South African agriculture showed a net benefit from trade liberalisation, somehow the results indicate that the external competition might have created pressure on domestic agricultural industries to keep costs low, which restricts the economy -of -scale advantage. The rand market devaluation also contributed to the decline in the agricultural sector's contribution to the economy.

The dummy variables for SADC and EU trade liberalisation of the regions appear to be important variables in explaining TFP. The dummy variables for the SADC and EU were found to be significant at 5 and 10 percent respectively (see Table 1). The results show that the SADC agreement has magnified the effect in explaining TFP. The estimated coefficients of both were found to be 0.045 and 0.013 respectively. This implies that, by keeping other variables constant, a further 10-percent increase in trade to SADC or EU regions led to a 0.45% and 0.13% improvement in TFP respectively, which is a good indicator that, during this era of trade liberalisation, the SADC region was an efficient market for South African agricultural industries. This might be due to cheaper transportation costs, relatively better infrastructure, and a similar industrialisation level in the region, contributing to higher intra -trade levels in the region.

One must, however, caution against inferences regarding the dummy variable for the EU. The relatively smaller elasticity responsiveness of the EU dummy variable might have resulted from the exclusion of beef, sugar and maize from the agreement, or it might imply that products/commodities that have preferential access to the EU are unable to explain TFP.

TIME -SERIES EVIDENCE

This section provides time-series results that corroborate the cross-sectional evidence. In this section, the necessary statistical test and the long-term relationship among the variables are estimated. This section consists of three subsections: The first two subsections deal with stationary and integration tests, while the third section deals with the model estimation.

STATIONARITY TEST (UNIT ROOT TESTS)

Previous studies have indicated that time -series data, be it monthly, quarterly or annual, is likely to be nonstationary (see e.g. Bakucs & Ferto, 2005; Cho, Kim & 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 whether the variables are trend stationary.

Following the above technique for the standard practice of unit root tests in the literature, both the level and first difference of each data series were tested. The results are presented in Table 2.

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, which corresponds to the highest (absolute value) Akaike information criterion (AIC).

From Table 2 the absolute values of the ADF test in levels shows that it is statistically lower than the 95 percent critical value. This suggests that the null hypothesis of the unit root is not rejected and none of these variables are (trend) stationary in levels at a 5 percent significance level. Each series was differenced and the ADF test performed. The results show that the unit root null hypothesis is rejected at a 5 percent significance level (see Table 2).

Table 2: ADF test results – with and without trend

Variable	Specification	In levels			Differenced		
		Lags	Critical value	Test statistics	Lags	Critical value	Test statistics
lnTFP	Constant only	2	-2.9591	-2.4038	1	-2.9627	-5.4294
	Constant and trend	2	-3.5948	-3.5615	1	-3.5671	-5.325
lnOpen	Constant only	4	-2.9591	-1.8097	4	-2.9627	-5.7812
	Constant and trend	4	-3.5615	-1.7976	4	-3.5671	-5.7802
lnDebt	Constant only	1	-2.9591	-2.0519	1	-2.9627	-4.0596
	Constant and trend	1	-3.5615	-2.9352	1	-3.5671	-4.0148
lnCFC	Constant only	1	-2.9591	-1.5124	2	-2.9627	-4.4552
	Constant and trend	2	3.7196	-2.6095	2	-3.5671	-4.3715

95% critical value for the augmented Dickey-Fuller statistic

The results show that all the series tested are not stationary in (log) levels, but at 5 percent significance level after being differenced once. All the series are therefore assumed to be integrated of order one, fulfilling a necessary condition for a co-integration test.

CO-INTEGRATION TEST

To test co-integration, Johansen (1990) proposes two statistics that can be used to evaluate the rank of the coefficient matrix, or the number of co-integrating relationships. The one used here is the likelihood ratio test of the null hypothesis, i.e. that the number of co-integrating vectors is r versus the alternative $r+1$ vector. In this case, the null hypothesis is the number of co-integrating vectors equals 0.

Table 3 shows that likelihood ratio (LR) statistics are below their corresponding coefficients of the critical value, thus co-integration between the variables pairs is unlikely. The Johansen tests reject the hypothesis at 5 percent (1 percent) significance level LR (see Table 3). The results show clearly that there is no long-term co-integrating vector among the variables: TFP, Open, CFC and DEBT.

Table 3: Co-integration analysis of TFP, OPEN, CFC and DEBT

Test assumption: No deterministic trend in the data					
Series: TFP OPEN CFC DEBT					
Lags interval: 1 to 1					
		Likelihood	5 Percent	1 Percent	Hypothesised
Rank	Eigen Value	Ratio	Critical Value	Critical Value	No. of CE(s)
R= 0	0.523564	38.26830	39.89	45.58	None
R<= 1	0.211567	13.05993	24.31	29.75	At most 1

R<= 2	0.106587	4.977856	12.53	16.31	At most 2
R<=3	0.033140	1.145842	3.84	6.51	At most 3
*(**) denotes rejection of the hypothesis at 5% (1%) significance level					
LR- rejects any co-integration at 5% significance level					

Table 3 shows that co-integration tests were conducted with the assumption that no deterministic trend in the data had been preformed, proving that there is no long-term relationship; the necessary condition to use OLS regression was done.

TIME SERIES MODEL ESTIMATION

In this section the results of the relationship between TFP and trade liberalisation are reported. The overall explanatory power is at 74 percent. All variables were found to be statistically significant at the specified level of significance.

Table 4: Relationship between TFP and trade liberalisation – Log OLS (from 1970 to 2005)

Independent variable	Estimated coefficient	T-ratio
DOPEN	0.034733	1.93**
DCFC	0.0919	1.38***
DDEBT	-0.328	-8.54*
C	-0.0135	
R ²	0.74	
Adjusted R ²	0.71	
Durbin Watson stat	1.55	
No. observation	35	

* ** and *** denote significant at the 1, 5 and 10 percent levels respectively

Table 4 indicates that all three variables are individually non-stationary; the coefficients of the estimated variables have the expected signs: TFP was positively related to OPEN and CFC, whereas DEBT related negatively.

The time-series evidence goes in the same direction as the cross-sectional results: there exists a robust relationship among TFP, the degree of openness (measured as imports plus exports over GDP), and the share of machinery and equipment investment (measured capital formation relative to GDP). In addition, annual growth in TFP is positively (and significantly) related to contemporaneous changes in openness and investment in equipment and machinery. Whereas debt was found to be inversely related to TFP, this implies that increasing debt further causes temporary deviations in TFP to decline. The quantitative effects seem to be quite large: the estimated coefficients indicate that a 10 percentage point increase in debt is associated with a decline in TFP by about 3 percent. Similarly, an increase in the share of machinery and equipment investment and openness of 10 percentage points is associated with a TFP increase of about 0.9 and 0.3 percent respectively.

CONCLUSIONS

The proposition that trade liberalisation is beneficial to dynamic efficiency (and not just to static economic welfare) is theoretically ambiguous and the empirical evidence supporting it has been questioned. This study has tested this proposition for South Africa using a cross

sectional approach covering nine agricultural commodities for the period 1995–2005, when South Africa witnessed major trade reform, and an aggregate time-series approach (covering the period 1970–2005). Both approaches validate the above proposition with a high degree of statistical reliability. The results obtained in this paper indicate that trade liberalisation has contributed significantly to augmenting South Africa's growth potential via its impact on TFP.

From cross-sectional analyses (paragraph 5.1) it is shown that all variables, with the exception of PPI, were found to be statistically significant at 10 percent test level. The OLS results confirm that TFP was negatively affected by import_share and real exchange rate. This implies that generally, the agricultural sector needs support from all stakeholders to enable it to make a better contribution.

The variables export_share and CFC were found to be positive and significant (at 10 and 5 percent significance level) respectively. As Goldar and Kumari (2003) indicate in their study, trade liberalisation increases efficiency, allows specialisation and innovation, and moreover contributes to the stock of capital formation, knowledge and human capital in the agricultural economy. Thus, the rate of export growth will cause economy-wide productivity gains.

The dummy variables for the SADC and EU regions appeared to be important variables in explaining TFP and were found to be significant (at 5 and 10 percent significance levels). The SADC agreement was found to have a magnified effect in explaining TFP in comparison with the EU. This implies that the SADC region is an efficient market for South African agricultural industries. This might be due to cheaper transportation costs, relatively better infrastructure, and the similar industrialisation capacity level of the region.

One must, however, caution against inferences regarding the dummy variable for the EU. The relatively smaller elasticity response of the EU might have resulted from the exclusion of beef, sugar and maize from the agreement, or might imply that those agricultural products/commodities that have preferential access to the EU have no influence when it comes to improving TFP.

The time -series analysis (paragraph 5.2) results regarding the joint importance of the openness and technology variables draws attention to two key and complementary channels of influence on the economy's productivity. While R&D, as embodied in investment in machinery and equipment, augments productivity, it also appears to be important in providing an open or liberal environment in which the gains from R&D can be maximised. A policy corollary of this finding could be that emphasis on increasing an economy's access to foreign capital goods by, selectively liberalising imports of capital goods might be insufficient to harness the benefits from technology absorption. By the same token, the results suggest that openness needs to be complemented by appropriate avenues for the creation and absorption of technology. The burden of debt needs to be revised in such a way that it can improve productivity. Moreover, this also implies that South African farmers/agricultural industries need support from all stakeholders to improve the contribution of the sector, and continuous research is also important

While the study finds the results in this paper encouraging, there remains considerable scope for refining and deepening the research agenda.

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