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Exports, capital formation and economic growth in South Africa

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Abstract

In South Africa the export sector is frequently accorded a special role in encouraging faster economic growth. Nonetheless, a question that remains unresolved is whether higher export growth indeed leads to higher economic growth and what particular role exports may play within the overall economic growth process of the country. This study applies Johansen's cointegration procedure, impulse response functions, variance decomposition analysis and Granger causality tests to shed light on the channels through which export growth may impact South Africa's economic growth rate. Quarterly time series data ranging from 1975q1 to 2012q4 is employed in the study's empirical tests. The results support the notion that the role of exports lies in their ability to encourage investment and capital formation. While export growth directly supports higher economic growth in the short-run, the long-term effect was found to lie in supporting faster capital formation, and in turn, significantly increasing economic growth. Overall, a strategy of export-led growth that does not explicitly emphasize the export-capital-growth connection is likely to fall short of reflecting the dynamics contained within the exports-growth relationship in South Africa.

Keywords: Exports; Economic growth; South Africa.

1. Introduction

Export promotion is widely regarded as a key potential driver of economic growth in South Africa as part of policy frameworks such as the New Growth Path (NGP), the National Development Plan (NDP) and industrial policy

documents including the 2014 Industrial Policy Action Plan (DTI, 2014). Export oriented growth has been pursued gradually from 1972 and markedly since South Africa's offer to the 1994 Uruguay Round, replacing the previously dominant strategy of import-substitution industrialisation (Cassim, Onyango and van Seventer, 2004, p.7; Patel, 2010). Similar to the NGP, the NDP views export promotion via the development of competitive infrastructure, expertise, and market access as an opportunity to raise the level of economic growth and the share of employment in tradable activities through the transition towards a more diversified industrial base (NPC, 2011, pp. 106-7).

Recent empirical studies on South Africa, which are discussed in Section 2.2 below, mostly supports the theory that higher export growth is associated with higher economic growth. Both uni- and bidirectional Granger causality between exports and economic growth have been found. The question that has remained unresolved, however, is how exports support economic growth, in particular whether its role within the growth process is that of an "exogenous forcing variable or an endogenous responding variable" (Srinivasan, 2001, p. 8).

This research finds that exports support economic growth mainly through their ability to stimulate investment and capital formation. The rest of the paper is organised as follows: Section 2 covers the literature review; Section 3 explains the data used in the study, while Section 4 deals with the model specification. Section 5 covers the methodology, followed by the results in Section 5. Section 6 concludes.

2. Literature review

2.1. Theoretical background

Classical Economics (Smith and Ricardo in particular) provided the bedrock ideas that allowed for the possibility of mutual gains from trade contributing to higher economic growth, laying the foundations for subsequent investigations of the links between exports and economic growth (Myint, 1958, p. 318). In the tradition of Smith's (1776, p. 413) theory that openness to trade encourages the accumulation of wealth, neoclassical economists have since emphasised the role of exports in driving higher economic growth (Srinivasan, 2001, p. 7). It is thought that the exposure to large foreign markets leads to an improved allocation of given resources in accordance with comparative advantage – an idea regularly associated with David Ricardo (Ram, 1985, p. 415; Szentes, 2005, p. 147). Thus, the expansion of export industries leads to increases in total factor productivity (TFP) by shifting resources from sectors of low-productivity to sectors of

higher productivity (Yaghmaian and Ghorashi, 1995, p. 39). Trade and growth economists within a neoclassical supply side framework have put forward a variety of reasons why export expansion is beneficial to economic growth and many link it to Smith's productivity theory. This warrants the inclusion of exports as an additional variable in a neoclassical production function-type relationship (Michalopoulos and Jay, 1973, p. 4). In the standard neoclassical growth model, if marginal productivity rises as a result of technological progress for example, then a sustained increase in output is possible Solow (1956).

Econometric evidence tends to support the contention that foreign and domestic investment is positively related to export expansion and openness to trade (see, for example: Culem, 1988; Sharma, Nayagam and Chung, 2012). Indeed, the export-investment relationship tends to hold empirically, particularly when export expansion is centred on manufacturing goods (Ibarra, 2010, p. 439). In general, 'export-led investment' may play an important role in an economy's growth process. The idea that export-expansion could promote faster economic growth by triggering the necessary investments in technological improvements, which result from pressures of international competition, is well documented in studies of export-led growth (Balassa, 1978, p. 181; Bhagwati, 2007, pp. 63-4).

Neo-Classical Economics use a supply-side production function approach to link exports to economic growth (Michalopoulos and Jay, 1973, p. 4). Growth in exports increase aggregate output for a given level of capital and labour through improvements in factor productivity (Ram, 1985, p. 418). Other than capital and labour, such production functions typically also include explanatory variables such as domestic and foreign investment (Balassa, 1978, p. 185). Sustained growth is illustrated by a shift upwards of the production function and a shift rightwards of the aggregate supply curve, resulting in an increase in output (Dutt, 2005, p. 100; Michalopoulos and Jay, 1973, p. 2; Myint, 1987, p. 118). New growth models aim to improve the applicability of the basic neoclassical model by including a number of endogenous explanatory variables, particularly human capital (Romer, 1986; Marin, 1992, p. 678).

In contrast to the above, the demand-side theories (which are not covered in detail here), such as the Kaldorian Growth Model, link exports and growth via the demand for exports and balance of payments constraints. It is argued that the growth of autonomous demand determines the long-run rate of output. In the open economy the main aggregate demand factor that will fundamentally determine the growth of demand and therefore overall growth will emanate from outside the region, in other words, demand for exports is the key driver of

economic growth (Chenery, 1960; de Melo and Robinson, 1992; Harrod, 1933; Prebisch, 1950). Within the demand-side approach, Thirlwall's Law (2011, pp. 307-11) claims that due to foreign exchange being an important constraint on growth for many developing countries, better export performance through a rising demand for it and a reduced income elasticity of demand for imports can help such countries improve their growth performance (see also Hussain, 2006, p. 40). It follows that economic policy can make the case for a stronger focus on manufacturing exports to support economic growth from both supply-and demand side perspectives.

Another relevant development within the field of export-led studies is the increased interest in firm-level analyses. One of the central models to new trade theory showed that a country that opens up to trade will find that only the productive firms stay in the market, whereas the least productive ones are forced to exit (Melitz, 2003, p. 1695).

2.2. Recent empirical studies on South Africa

The empirical testing of the export-led growth hypothesis has resulted in a substantial body of literature. Similar to this research, the production function approach has predominated. Space permitting, this section is focused only on the recent South African studies. The most recent South African empirical studies include Ziramba (2011), who analysed whether causality exists between the components of exports and real GDP from 1960q1 to 2008q3. Evidence of export-led growth was detected in the case of merchandise exports, whereas no evidence of Granger causality in either direction was found for net gold exports. Rangasamy's (2009, p. 613) results suggested unidirectional Granger causality running from exports to economic growth for the period 1975q1 to 2007q3. Notably, non-primary exports were found to support economic growth more strongly than primary exports.

Furthermore, support for the export-led growth strategy was derived from Cipamba's (2013) Granger causality tests in a multivariate VAR framework, which established bidirectional causality between exports and economic growth for the period 1970q1 to 2012q4. Chang, Simo-Kengne and Gupta (2013) conducted an investigation at provincial level for the period 1995-2011 and detected evidence of export-led growth and bidirectional causality in the case of Mpumalanga and Gauteng respectively. Ajmi, Aye, Balcilar and Gupta (2013) found no evidence of linear causality between exports and GDP for the period 1911 to 2011. Only when applying nonlinear methods, Ajmi *et al.* (2013) detected

evidence of unidirectional causality running from GDP to exports for the test based on Hiemstra and Jones (1994) and bidirectional causality based on the test proposed by Diks and Panchenko (2005). These studies have therefore produced somewhat mixed results and given the strategic role awarded to exports in South Africa's current macroeconomic policies, the dynamics of exports in the growth process warrant more empirical research.

For the bigger Southern African region, and more generally in support of the theoretical link between trade, productivity gains and growth as contained in the neoclassical production function model, Habiyaremye's (2013) research using Botswana data shows that imported machines have increased manufacturing productivity 1 – 2 years following the investment.

3. The data

The quarterly time series data required to estimate the production function type model were drawn from the South African Reserve Bank and Thomson Reuters DataStream for the period 1975q1 to 2012q4. The data is at constant prices with 2005 as the base year. Gross Domestic Expenditure (GDE) has been used as a proxy for economic activity, which allows for an assessment of the exports-output link beyond merely the analysis of a national accounting identity in which exports form part of GDP (Rangasamy, 2009, p. 607). Capital formation (a key variable in the model below) is specified as total fixed capital formation/GDP (GFCF/GDP). Labour is proxied by total employment. Figure 1 shows GDE and total exports, while Figure 2 portrays GDE and capital formation. Both graphs show signs of positive associations between the variables, particularly after 2000, which seems to suggest that evidence of an export-growth nexus may be present in South Africa.

FIGURE 1: GROSS DOMESTIC EXPENDITURE AND EXPORTS IN SOUTH AFRICA, PERCENTAGE

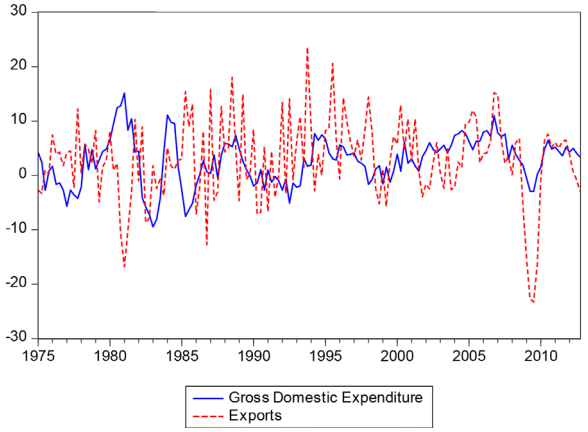
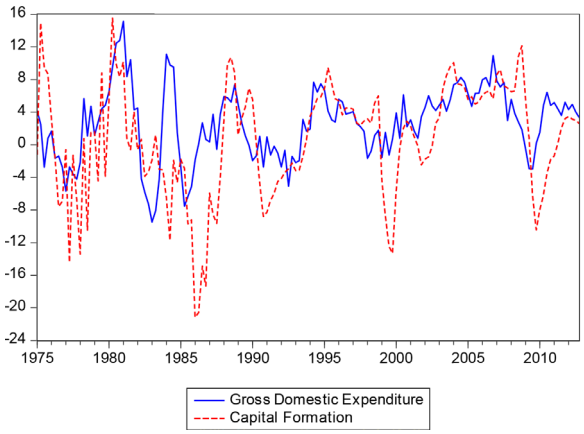


FIGURE 2: GROSS DOMESTIC EXPENDITURE AND CAPITAL FORMATION IN SOUTH AFRICA, PERCENTAGE CHANGE PER ANNUM



4. Model specification

What follows is a production function-type model of exports and economic growth[1].

4.1. Economic growth

Given that export production is often treated as similar to a production input, Ram (1985, p. 417) proposes that the aggregate production function would simply take the form:

$$Y = f(L, K, X) \tag{1}$$

where Y is aggregate real output, L is labour input, K is capital input, and X is exports. When specified in terms of growth rates (indicated by dots), Equation 1 becomes:

$$\dot{Y} = \beta_0 + \beta_1 \dot{L} + \beta_2 \dot{K} + \beta_3 \dot{X} \tag{1a}$$

where β_1, β_2, β_3 are the elasticities of output with respect to the factor inputs L, K and X.

Since the rate of change of capital input is difficult to determine, Ram (1985, p. 417) proposes replacing K by the more available variable $^{\Delta K}/_{Y}$, which reflects the investment-income ratio:

$$\dot{Y} = \beta_0 + \beta_1 \dot{L} + \frac{\partial Y}{\partial K} \times \frac{K}{Y} \times \frac{dK}{K} + \beta_3 \dot{X} \tag{1b}$$

[1] See Balassa (1978); Ghorashi (1995); Ram (1985); Tyler (1981); and more recently Awokuse (2003); Cipamba (2013); Narayan et al. (2007); Yaghmaian and Ghorashi (1995) and Siliverstovs and Herzer (2006).

or replacing *dK* by *I*,

$$\dot{Y} = \beta_0 + \beta_1 \dot{L} + \alpha_2 \frac{I}{Y} + \beta_3 \dot{X} \tag{1c}$$

where α_2 is the marginal physical product of capital. The effects that export growth has on economic production can therefore be analysed by estimating the coefficient of $\dot{X}$.

In another approach, but along similar lines, Cipamba (2013, p. 6) uses a production function model drawn from Herzer *et al*. (2006):

$$Y = Af(L, K) \tag{2}$$

In Cobb Douglas form:

$$Y_t = AK_t^{\beta} L_t^{\gamma} e^{\varepsilon_t} \tag{2a}$$

A represents total factor productivity (*TFP*). The successful expansion of trade activities, including exports and imports, can raise *TFP* through technological spill-over effects and a rising share of capital goods in imports. This mirrors the arguments of several authors going back to Smith (1776) for example, but continues to be relevant in recent studies such as Ibarra (2010). *A* is therefore assumed to capture the productivity gains derived from exporting and importing and can be modelled as a function of both exports (*X*) and imports (*M*):

$$A = \varphi X_t^{\partial} M_t^{\theta} \tag{3}$$

Substituting Equation 3 into Equation 2a:

$$Y_t = \varphi X_t^{\partial} M_t^{\theta} K_t^{\beta} L_t^{\gamma} e^{\varepsilon_t} \tag{3a}$$

and taking logarithms, derive the following linear form of the model:

$$lnY_t = ln\varphi + \partial lnX_t + \theta lnM_t + \beta lnK_t + \gamma lnL_t + \varepsilon_t \tag{3b}$$

$$\alpha = ln\varphi \tag{3c}$$

$$lnY_t = \alpha + \beta lnK_t + \gamma lnL_t + \delta lnX_t + \theta lnM_t + \epsilon_t \tag{4}$$

where α is a constant, the coefficients β, γ, δ and θ are elasticities of production with respect to *K*, *L*, *X* and *M*, and ε_t is the stochastic error term that captures the impact of all other explanatory factors. The national accounting identity of output already includes exports as a component thereof, so the automatic positive correlation between exports and output that would arise could be misinterpreted as improvements in productivity, so GDP net of exports or NY= Y-X is used (Cipamba, 2013, p. 7; Herzer *et al.*, 2006, p. 12; Rangasamy, 2009, p. 607). Therefore:Table 1 indicates that liquidity as measured by the value of

$$lnNY_t = \alpha + \beta lnK_t + \gamma lnL_t + \delta lnX_t + \theta lnM_t + \epsilon_t \quad (4a)$$

Equation 4a forms the basis of the more detailed model specification used in this paper.

In addition to the variables in Equation 4a, two key developments are expected to have had a substantial impact on South Africa's economic growth path. The model takes into account the inclusion of South Africa in the world community that followed with the transition to democracy and which was consolidated with the first democratic elections held in April 1994. The dummy variable D_{1994} will take the value of 0 prior to and including 1994q1 and 1 thereafter. Another dummy (D_{CRISIS}) will be included to control for the dampening impact of the global financial crisis of 2008 on South African economic growth. The dummy D_{CRISIS} will take a value of 0 prior to 2008q3 and a value of 1 thereafter. Furthermore, the dummy variables D_{1994} and D_{CRISIS} will be included in the model as exogenous factors, since they are both determined outside the multivariate model.

South African export demand is also a function of world income (WY), which as an exogenous factor, will be proxied by US GDP growth. A factor traditionally associated with South African growth is world commodity prices, but US GDP growth is preferred as Arora and Bhundia (2003) found that the increased diversification of the South African economy after 1994 (which meant a lesser reliance on primary exports), has resulted in a diminished correlation between South Africa's growth rate and world commodity prices.

In contrast to Rangasamy's (2009) study, which included the variables economic growth (net of exports), exports and terms of trade, or Cipamba's (2013) which included economic growth, capital, labour, exports and imports, this paper models economic growth by including the following variables:

$$Y = f(K, L, X, M, WY, D_{1994}, D_{CRISIS}) \quad (5)$$

In log-linear form, Equation (5) becomes:

$$lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnL_t + \beta_3 lnX_t + \beta_4 lnM_t + \beta_5 lnWY_t + \beta_6 D_{1994\,t} + \beta_7 D_{CRISIS_t} + \varepsilon_t \quad (5a)$$

All coefficients are elasticities, hence β_1, β_2, β_3, β_4, and β_5 show the elasticity of economic output to capital input, labour input, exports, imports and world income respectively. Finally, β_0 is a constant and ε_t is a stochastic error term.

4.2. Export growth

Export growth is modelled by four endogenous variables, namely economic growth, capital formation, imports and the real effective exchange rate (REER),

as well as the above three exogenous variables, namely world income and the dummy variables D_{1994}, and D_{CRISIS}):

$$X = f(Y, K, REER, M, WY, D_{1994}, D_{CRISIS}) \quad (6)$$

Economic output is a domestic demand factor that is generally expected to have a negative impact on exports (Dodaro, 1991, p. 1159). Secondly, a positive connection between export growth and capital formation seems to exist as shown by Figure 1 and 2, but requires further investigation. As noted above, the export sector may benefit from imported capital and intermediate products, hence the inclusion of imports (Sharma, 2003, p. 442). In order to increase the predictive power of the model, the real effective exchange rate (REER) is also included, as as well as world income (WY), as a factor influencing the demand for South African exports and proxied by US GDP growth (Herrerias and Orts, 2010, p. 46).

Transforming Equation 6 in log-linear form:

$$lnX_t = \beta_0 + \beta_1 lnY + \beta_2 lnK + \beta_3 lnREER_t + \beta_4 lnM_t + \beta_5 lnWY_t + \beta_6 D_{1994\,t} + \beta_7 D_{CRISIS\,t} + \varepsilon_t \quad (7)$$

5. Econometric methodology

Johansen's (1988, 1991) cointegration procedure is appropriate to estimate the number of co-integrating relations among the variables in a system, as well as analysing the relationships they share with each other (Fedderke and Schaling, 2005, p. 86). The Kwiatkowski–Phillips–Schmidt–Shin (KPSS), Augmented Dickey–Fuller (ADF) and Elliott-Rothenberg-Stock (ERS) tests are used to test whether all variables included in the model are stationary. The first step is to specify and estimate a VAR(k) model for the vector z_t, where k is the number of variables (Zivot and Wang, 2003, p. 440). This produces a k-dimensional VAR:

$$z_t = A_1 z_{t-1} + \cdots + A_m z_{t-m} + \mu + \delta_t \quad (8)$$

where m denotes the lag length, μ contains deterministic terms and δ is a Gaussian error term.

From Equation 8, a VECM specification can be derived:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k+1} + \mu + \delta_t \quad (9)$$

where μ and r_i ..., r_k, are allowed to vary without restrictions, z_t denotes the variables included, and δ_t is a normally distributed error term (Simleit *et al.*, 2011, p. 11).

The presence of r cointegrating relationships amounts to the hypothesis that:

$$H_1(r): \Pi = \alpha\beta' \tag{10}$$

where Π is $p \times p$, and α and β are $p \times r$ matrices of full rank.

According to Johansen (1995, p. 89), the advantage of the parametrisation shown in Equation 11 below is the interpretation of the coefficients - the effect of the levels is isolated in the matrix $\alpha\beta^1$ and r_i ..., r_k depict the short-run dynamics of the process:

$$\Delta z_t = \alpha\beta' z_{t-k+1} + \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \mu + \delta_t \tag{11}$$

The cointegration procedure applies two likelihood ratio (LR) test statistics to establish the rank of the Π matrix, namely the trace (λ_{trace}) and maximum eigenvalue (λ_{max}) statistics. Exact identification requires the imposition of restrictions on the cointegrating equations. Hence, for the expectation that $r = 2$, four restrictions are necessary (Johansen, 1995, p. 72). Furthermore, WY, D_{1994} and D_{CRISIS} are included in the model as weakly exogenous variables (Herrerias and Orts, 2010, p. 42; Tang and Ravin, 2013, p. 5). The model specified in Equation 12 below reflects the VECM, estimated with a constant only, to model the export-growth relationship in South Africa:

$$\Pi z_{t-k+1} = \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \\ \alpha_{61} & \alpha_{62} \end{pmatrix} \begin{pmatrix} 1 & +\beta_{12} & +\beta_{13} & +\beta_{14} & 0 & +\beta_{16} \\ -\beta_{21} & 1 & +\beta_{23} & +\beta_{24} & +\beta_{25} & 0 \end{pmatrix} \begin{pmatrix} Y \\ X \\ K \\ M \\ REER \\ L \end{pmatrix}_{t-k+1} \tag{12}$$

For the first cointegrating equation, normalisation is done on GDE, whereas export growth is normalised on in the second cointegrating equation. Based on the findings from the literature in Section 4 above, two zero restrictions are imposed with β_{15} and β_{26} set equal to zero, leading to the exclusion of the real effective exchange rate in the first cointegrating relationship and labour in the second cointegrating relationship. Given the inclusion of economic growth, export growth, capital formation, labour, import growth and the real effective exchange rate within the multivariate framework, and the preceding theoretical and empirical analyses of particularly relevant variables to include in both cointegrating relationships, the real effective exchange rate and labour in the first and second cointegrating relationships respectively are less significant for the determination of the dependent variables and are therefore excluded in the long-run estimations.

The reasons for these restrictions stem from the theoretical production function model framework utilised in the study (see equations 1-4), in which *K*, *L*, *X* and *M* are key variables. The identification requirement of a zero restriction on the first cointegrating vector would thus imply that, in order to remain consistent with the theoretical framework, these four variables should not be excluded; hence the restriction of REER to zero. In the literature reported in Section 4 above, moreover, it was also found that the real effective exchange rate was rarely included as a determinant of economic growth in existing studies on the topic (Rangasamy, 2009; Cipamba, 2013). Similarly, employment could be considered less important for export growth, since the other variables within the model were explicitly emphasised in existing studies on the determinants of export growth, whereas employment rarely featured in such estimations of export growth.

6. Estimation results

6.1. Univariate characteristics of the data

Table 1 summarises the results of the unit root tests for all variables in log form. The unit root tests show that all variables are stationary at first differences. Predicated on the assumption that all variables are I(1), the next section proceeds with Johansen's method (Enders, 2004, p. 362).

Table 1: Summary of Unit Root Test Results

Series	KPSS test statistics		ADF test statistics		ERS test statistics	
	Level	1st Difference	Level	1st Difference	Level	1st Difference
Economic growth	0.308***	0.046	-1.083	-6.902***	42.527	1.771***
Capital formation	0.325***	0.066	-0.964	-14.057***	45.188	3.906***
Employment	0.239***	0.074	-1.436	-11.980***	21.817	1.233***
Export growth	0.192**	0.037	-2.142	-12.982***	11.555	0.938***
Import growth	0.302***	0.053	-2.821	-14.519***	27.626	1.294***
Real effective exchange rate	1.049***	0.032	-1.771	-6.091***	9.282	0.621***
World income	0.188**	0.068	-1.341	- 8.465***	19.862	1.402***

Notes: The KPSS (1992) 1% critical value = 0.216, the MacKinnon (1996) 1% critical value for the ADF test = -4.020 and the ERS (1996) 1% critical value = 4.150. For KPSS, the null hypothesis is that the series is stationary. For ADF and ERS, the null hypothesis is that the series contains a unit root. *** and ** indicate significance at the 1% and 5% levels, respectively.

6.2. Johansen VECM estimation

(i) Lag length selection

The Akaike (AIC), Schwartz (SIC) and Hannan-Quinn (HQ) information criteria indicated that two lags are optimal, with preliminary tests for autocorrelation indicating that only from three lags and higher the degree of autocorrelation falls to desirable levels. Increasing the number of lags to three instead of two lags lead to a notable improvement in the degree of autocorrelation, but caused only a negligible increase in the information criteria, as shown in Table 2. Hence, based on autocorrelation tests and the information criteria shown below, it was decided that three lags would be most appropriate for the unrestricted VAR estimation.

Table 2: Summary of Lag Order Selection Information Criteria

Lags	AIC	SC	HQ	LR
1	-23.946	-22.709*	-23.443	1324.499
2	-24.360*	-22.380	-23.556*	117.026
3	-24.313	-21.590	-23.207	55.205
4	-24.290	-20.825	-22.882	55.382
5	-24.291	-20.084	-22.582	55.101*

Notes: AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion, LR: sequential modified LR test statistic (each test at 5% level)

(ii) Testing for the rank

The results of both rank tests in Table 3 indicate the presence of two cointegrating vectors.

Table 3: Johansen Cointegration Test (Max-eigen value and trace statistics)

Null Hypothesis	Trace Statistic ( )	5% Critical Value	P-value	Max-Eigenvalue Statistic $\xi(r)$	5% Critical Value	P-value
$r = 0$	159.305*	117.708	0.000	58.679*	44.497	0.001
$r \leq 1$	100.625*	88.803	0.005	45.274*	38.331	0.006
$r \leq 2$	55.350	63.876	0.211	27.199	32.118	0.177
$r \leq 3$	28.150	42.915	0.613	18.443	25.823	0.3442

Notes: r is the number of cointegrating vectors under the null hypothesis of no cointegration. *indicates the rejection of the null hypothesis of no cointegration at the 5% level of significance.

(iii) VECM results

(a) Long-run equilibrium relationships

The results shown in Equations 13 and 14 below provide the long-run relationships for the two cointegrating vectors, with *t*-statistics shown in parentheses below the respective coefficients:

$$lnY = 0.350lnK + 0.270lnL - 0.156lnX + 0.103lnM \quad (13)$$

$$(-5.360) \quad (-4.605) \quad (1.686) \quad (1.619)$$

$$lnX = -1.128lnY + 0.689lnK - 0.297lnREER + 0.166lnM \quad (14)$$

$$(6.966) \quad (-7.991) \quad (4.100) \quad (2.558)$$

$$LM \sim \chi^2(2) = 37.103 \ (p\text{-value} = 0.418)$$

The individual coefficients of the equilibrium relationship for economic growth (Equation 13) suggest that economic growth shares a significant positive long-term relationship with capital formation and labour. Employment and economic growth are also positively linked in the long-run, as expected. Interestingly, export- and import growth are both insignificant in explaining economic growth, with the exports coefficient showing a negative sign – contrary to *a priori* expectations. It is likely that, had GDP been used as dependent variable, exports growth would share a more pronounced positive relationship with

economic growth. However, the results show that at least when GDE is used as the proxy for economic growth, which excludes the tradable sector in its calculation, the remaining impact of exports on economic growth in the long-run is not significant. At first glance, therefore, it seems that higher exports do not support economic growth, at least in the long-run, beyond constituting a positive component within the accounting identity of GDP when it is used as a measure for economic growth instead. Nonetheless, it is important also to consider the short-term influence of exports within the model as well as to analyse impulse response functions and Granger causality tests for a more complete impression of the role of exports within the economic growth process in South Africa.

Equation 14, which is based on the export growth model (equation 6) and the literature supporting it in Section 4.2 above, reflects the second cointegrating relationship, where exports growth shares a significant positive long-run relationship with capital formation and import growth, and a significant negative long-run relationship with economic growth and the real effective exchange rate. As expected, higher domestic growth represents a demand factor that has the effect of diverting production output towards domestic consumption and away from the export sector. As already mentioned, a highly significant, positive long-run relationship can be detected between exports growth and capital formation. Furthermore, the above results show a negative elasticity of exports with respect to the real effective exchange rate, suggesting that a real appreciation of the Rand adversely affects South African exports in the long-run. Furthermore, an increase in import growth is associated with a rise in exports in the long-run, holding all else constant. These results conform to *a priori* theoretical and empirical expectations.

(b) Short-run dynamics

The estimates of the short-run dynamics for economic growth, export growth and import growth are shown by Equation 15, 16 and 17 respectively.

In Equation 15 the coefficient of ECT(1) is -0.220, which is significant at the 1% level of significance, suggesting that about 22% of the discrepancy between long-term and short-term economic growth is corrected each quarter. It is particularly noteworthy that a change in exports in the previous quarter has a significant positive impact on economic growth in the following quarter. While the long-run relationship between economic growth and exports growth could not be established from Equation 13, in the short-run a positive relationship between the two variables can be detected. Furthermore, the exogenous variables

D_{1994}, D_{CRISIS} and WY are all significant at least at the 5% level. The positive coefficient of D_{1994} suggests that economic growth has been higher post-1994 than before democracy. Furthermore, the positive sign of D_{CRISIS} suggests that South Africa's economy has been able to weather the global economic turbulence triggered by the world-wide crisis of 2008 surprisingly well. Finally, contrary to *a priori* expectations, the coefficient of WY is negative.

$$\Delta Y_t = -0.220ECT(1) + 0.155ECT(2) + 0.583\Delta Y_{t-1} + 0.259\Delta Y_{t-2} - 0.048\Delta K_{t-1} - 0.031\Delta K_{t-2}$$
$$(-4.473) \quad (3.842) \quad (3.672) \quad (1.429) \quad (-1.081) \quad (-0.718)$$
$$- 0.019\Delta L_{t-1} + 0.035\Delta L_{t-2} + 0.126\Delta X_{t-1} + 0.041\Delta X_{t-2} - 0.128\Delta M_{t-1} - 0.025\Delta M_{t-2} - 0.012\Delta REER_{t-1}$$
$$(-0.456) \quad (0.867) \quad (2.669) \quad (0.896) \quad (-3.030) \quad (-0.558) \quad (-0.511)$$
$$+ 0.051\Delta REER_{t-2} + 0.013D_{1994} + 0.015D_{CRISIS} - 0.069WY + 0.619 + \mu_t$$
$$(0.051) \quad (2.268) \quad (2.636) \quad (-3.101) \quad (3.090)$$

$$Adj.\ R^2 = 0.356 \qquad (15)$$

In Equation 16 the ECT(2) coefficient of -0.523 indicates that 52.3% of the discrepancy between long-term and short-term exports growth will be corrected each quarter. Furthermore, economic growth lagged one quarter has a positive impact on exports growth at least in the short-run, but only at the 10% level. The exogenous variable WY is significant at the 1% level and suggests that in the short-run an increase in world income leads to an increase in exports growth, *ceteris paribus*. Thus, a significant positive link between South Africa's export performance and world income can be detected that indicates that higher exports are dependent on buoyant demand from abroad. Furthermore, the impact of the global recession and consequent European sovereign debt crisis had a significant negative impact on South African export performance.

$$\Delta X_t = 0.284ECT(1) - 0.523ECT(2) + 1.554\Delta Y_{t-1} + 0.686\Delta Y_{t-2} - 0.084\Delta K_{t-1} - 0.143\Delta K_{t-2}$$
$$(1.548) \quad (-3.493) \quad (1.954) \quad (1.016) \quad (-0.504) \quad (-0.877)$$
$$- 0.075\Delta L_{t-1} - 0.030\Delta L_{t-2} - 0.082\Delta X_{t-1} - 0.021\Delta X_{t-2} - 0.149\Delta M_{t-1} + 0.029\Delta M_{t-2} + 0.119\Delta REER_{t-1}$$
$$(-0.494) \quad (-0.202) \quad (-0.468) \quad (-0.127) \quad (-0.943) \quad (0.174) \quad (1.329)$$
$$+ 0.105\Delta REER_{t-2} - 0.034D_{1994} - 0.076D_{CRISIS} + 0.296WY - 2.667 + \mu_t$$
$$(1.169) \quad (-1.585) \quad (-3.644) \quad (3.582) \quad (-3.580)$$

$$Adj.\ R^2 = 0.278 \qquad (16)$$

The error correction model for import growth is shown by Equation 17, where roughly 76% in the discrepancy between short-term and long-term import growth will be corrected in one quarter. A number of short-run variables show high individual significances, warranting a more in depth analysis of the import growth error correction model. It can be seen, for example, that higher economic growth lagged one and two quarters has a significant positive impact on import growth. Perhaps surprisingly, capital formation shares a negative short-run relationship with import growth at one and two lags at the 5% level of significance. Furthermore, a rise in export growth in the previous quarter leads to an increase in import growth. While the real effective exchange rate in the previous quarter has no notable impact on import growth, at two lags it becomes significant at the 1% level, such that an appreciation in the real effective exchange rate leads to an increase in import growth two quarters later, holding all else constant.

$$\Delta M_t = -0{,}761 ECT(1) + 0.326 ECT(2) + 3.012\Delta Y_{t-1} + 1.753\Delta Y_{t-2} - 0.357\Delta K_{t-1} - 0.330\Delta K_{t-2}$$
$$\textit{(-4.849)} \qquad \textit{(2.543)} \qquad \textit{(5.955)} \qquad \textit{(3.034)} \qquad \textit{(-2.505)} \qquad \textit{(-2.367)}$$
$$- 0.150\Delta L_{t-1} + 0{,}019\Delta L_{t-2} + 0.300\Delta X_{t-1} + 0.080\Delta X_{t-2} - 0.807\Delta M_{t-1} - 0.182\Delta M_{t-2}$$
$$\textit{(-1.144)} \qquad \textit{(0.150)} \qquad \textit{(1.960)} \qquad \textit{(0.549)} \qquad \textit{(-5.971)} \qquad \textit{(-1.290)}$$
$$- 0.015\Delta REER_{t-1} + 0.241\Delta REER_{t-2} + 0{,}003 D_{1994} + 0.011 D_{CRISIS} - 0.065 WY + 0.572 + \mu_t$$
$$\textit{(-0.195)} \qquad \textit{(3.145)} \qquad \textit{(0.146)} \qquad \textit{(0.610)} \qquad \textit{(-0.920)} \qquad \textit{(0.898)}$$
$$\textit{Adj. } R^2 = 0.463 \qquad (17)$$

Moreover, when analysing the ECM for employment (results not shown), it is interesting to note that increases in export growth have a significant positive impact on labour growth in South Africa. Furthermore, the impact of the exogenous variables D_{CRISIS} and WY on employment is significant at the 1% level. The great recession and the European sovereign debt crisis that followed had a significant negative impact on employment in South Africa, and improvements in world income have a significant positive impact on employment, at least in the short-run.

(iv) Impulse response functions

Figure 3 shows the impulse response functions related to the export-capital-growth connections as generated from the VAR results. Figure 3 a) shows that a one standard deviation shock to exports leads to a positive shock in economic growth, which first spikes up to quarter three, and then starts to fall towards zero, stabilising at a slightly higher level from lag twenty onwards. This implies

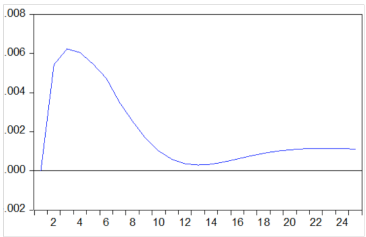
that while in the long-run the effect of a shock to exports dies out to some extent, in the short-run the positive shock to economic growth is notable.

Economic growth also responds notably to a shock to capital formation (Figure 3 b). While at first there is a spike downwards, economic growth recovers from quarter two onwards and then keeps rising until stabilising at a significantly higher level from about quarter fifteen onwards. Perhaps it is not surprising then, that the long-term coefficients shown in Equation 13 reflect a significant positive long-term effect of economic growth to a rise in capital formation, but not to a rise in export growth. While the impulse response functions suggest that the response of economic growth to a shock in exports dissipates fairly quickly, the positive response to a shock in capital formation remains evident even in the long-run.

FIGURE 3: IMPULSE RESPONSE FUNCTIONS AND THE EXPORT-CAPITAL-GROWTH CONNECTION

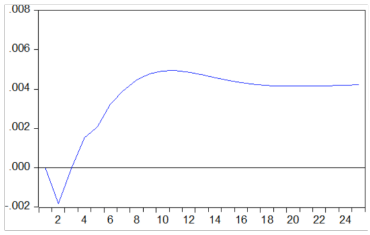
Response of economic growth to a one standard deviation shock to export growth

a)



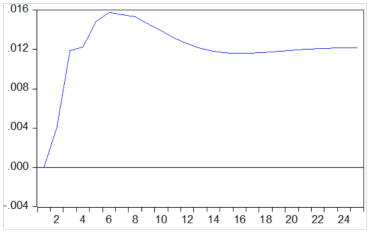
Response of economic growth to a one standard deviation shock to capital formation

b)



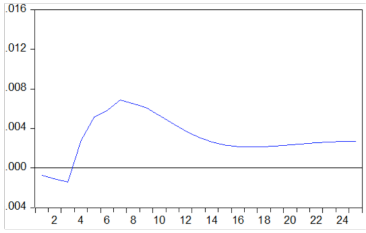
Response of capital formation to a one standard deviation shock to export growth

c)



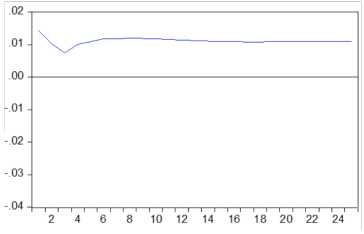
Response of capital formation to a one standard deviation shock to economic growth

d)



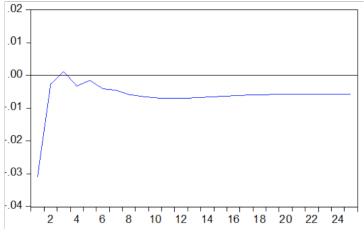
Response of export growth to a one standard deviation shock to capital formation

e)



Response of export growth to a one standard deviation shock to economic growth

f)



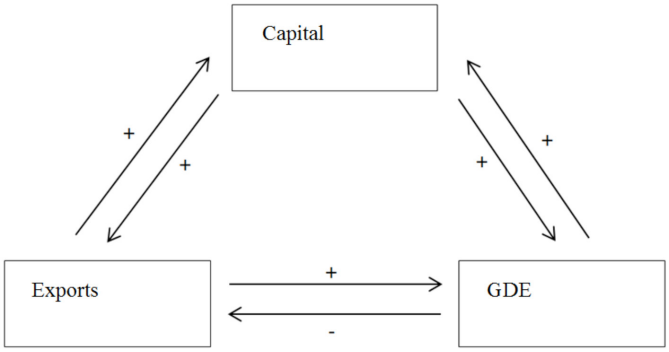
The role of exports may also be better understood when looking at the response of capital formation to a shock to export growth. Figure 3 c) shows that capital formation responds positively by spiking steeply up to quarter six and then stabilising at a notably higher level from quarter fifteen onwards. Interestingly, Figure 3d) indicates that a shock to economic growth leads to a more dampened response from capital formation than a shock to export growth does. A shock to economic growth at first leads to a negative response in capital formation up to quarter three. This response then reverses, peaking at higher levels in quarter seven and then stabilises at a slightly higher level from quarter fifteen onwards.

Figure 3 e) and f) reflect how export growth responds to shocks in capital formation and economic growth respectively. A shock to capital formation leads to a positive response in exports growth that stabilises at a higher level from quarter six. On the other hand, a shock to economic growth translates into a significant negative spike in export growth, which starts to recover from quarter one, although exports growth stabilises at a visibly lower level from quarter ten onwards.

Overall, the impulse response functions highlight what the short-run VECM analysis already showed to some extent. The role of exports in supporting economic growth and capital formation is particularly visible in the short-run. Moreover, although the encouraging role exports may play in supporting economic growth is not lasting enough to be captured by the long-run relationship of Equation 13, the impulse response functions and short-run coefficients do suggest that exports are relevant for economic growth in South Africa. This is particularly true when including the impact of capital formation.

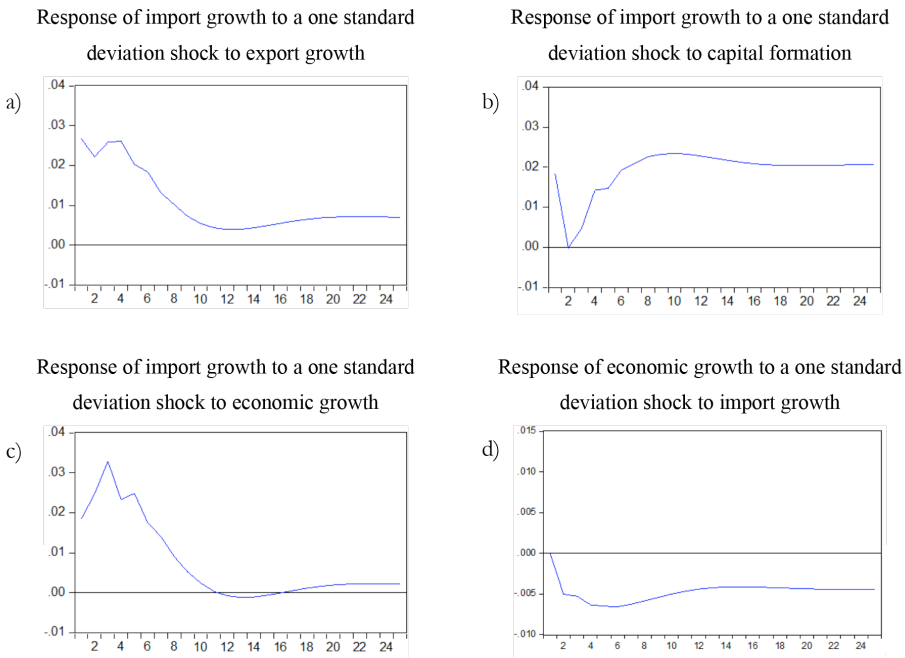
Figure 4 has been generated from the above results and summarises the findings. Capital formation responds positively to a shock in exports, and economic growth responds positively to a shock in capital formation. While the positive impact of economic growth to a shock in exports is only visible in the short-run, the positive connection between exports-capital-growth is supported by both the long-run cointegrating relationships as well as the short-run coefficients and impulse responses.

FIGURE 4: SUMMARY OF RESULTS - THE EXPORTS-CAPITAL-GROWTH CONNECTION



Therefore, as the results and Figure 4 suggest, when exports growth works through the Therefore, as the results of Figure 4 suggest, when exports growth works through the intermediary, namely capital formation, higher exports is likely to have a significant positive impact on economic growth. When assessed on its own, the insignificant long-run coefficient for exports in Equation 13 could yield misleading conclusions. It is thus important to emphasise the role of capital formation within the model of export-led growth in South Africa to gain a more differentiated understanding of the inter-connections and transmissions that are active in the South African economy.

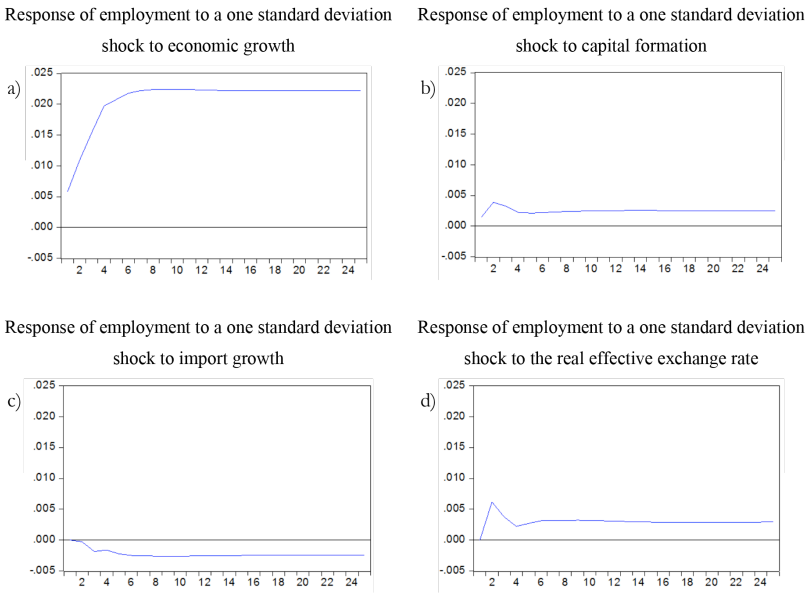
FIGURE 5: IMPULSE RESPONSE FUNCTIONS AND THE LINK TO THIRLWALL'S LAW



The impulse response functions derived from the multivariate model of Equation 12 also offer some insights into the question whether exports may play a role in easing possible balance of payments constraints on economic growth in South Africa. As Figure 5 a) shows, a positive shock to export growth leads to a notable positive response in import growth that is particularly strong for the first seven to eight quarters after the initial shock, and then stabilises at a slightly higher level from quarter twelve onwards. It is likely that export earnings provide funds for higher imports (income-induced import effect). Figure 5 b) shows that a shock to capital formation leads to an immediate positive shock to import growth, which then falls to zero in quarter two. Import growth then recovers and stabilises at a higher level from quarter nine onwards. As noted earlier, the positive response of imports to a shock in capital formation is likely linked to the high proportion of capital goods in the import basket.

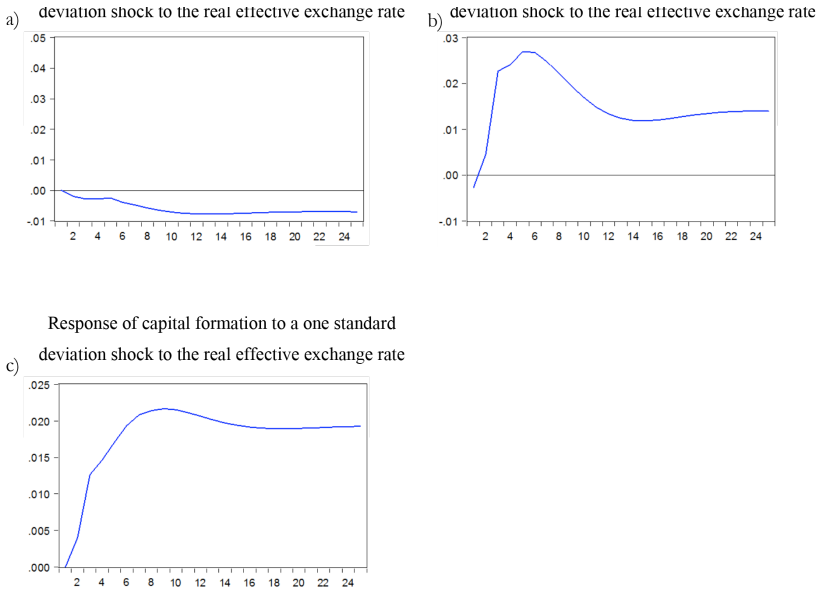
Figure 5 c) reflects that a positive shock to economic growth leads to a significant positive spike in import growth peaking at quarter three, declining towards zero between quarter four to twelve thereafter. From quarter twenty onwards, import growth stabilises at a slightly higher level, although it is almost zero. From the above results as portrayed in Figure 5, and as expected, import growth responds positively to an increase in income in the economy, however this impact dissipates over time. Finally, Figure 5 d) indicates that a positive shock to import growth leads to a negative response in economic growth, with economic growth stabilising at a slightly lower level from quarter thirteen onwards. A short-run negative influence of import growth on economic growth is also shown by the short-run coefficient of import growth lagged one quarter in Equation 15. Although in the long-run imports do not share a significant relationship with economic growth, in the short-term a negative connection between the two variables can be detected. From the results in Figure 5, higher domestic income stimulates higher import growth and imports play a role in supressing higher economic growth.

FIGURE 6: RESPONSE OF EMPLOYMENT TO SHOCKS IN ECONOMIC GROWTH, CAPITAL FORMATION, IMPORT GROWTH AND THE REAL EFFECTIVE EXCHANGE RATE



The impulse response functions shown in Figure 6 reflect the response of employment to shocks in economic growth, capital formation, import growth and the real effective exchange rate respectively. Labour responds positively to a shock to economic growth (Figure 6 a)). Furthermore, that response is sustained, stabilising at a higher level from quarter seven onwards. Employment also responds positively to a one standard deviation increase in capital formation (Figure 6 b)) and appreciation of the real effective exchange rate (Figure 6 c)), stabilising at a slightly higher level from quarter six onwards in both cases, although the initial response of employment is relatively small. Figure 6 c) suggests that a shock to import growth leads to a slightly negative response in employment that stabilises at a lower level from quarter six onwards. Employment therefore responds positively to an upward shock to economic growth, capital formation and export growth. On the other hand, employment suffers as a result of a positive shock to import growth.

FIGURE 7: RESPONSE OF EXPORT GROWTH, IMPORT GROWTH AND CAPITAL FORMATION TO A ONE STANDARD DEVIATION SHOCK IN THE REAL EFFECTIVE EXCHANGE RATE



The impulse response functions shown in Figure 7 reflect how export growth, import growth and capital formation respond to a shock in the real effective exchange rate. As expected, export growth declines in response to a shock (appreciation) in the real effective exchange rate, with export growth stabilising at a lower level from quarter twelve onwards. Import growth, on the other hand, responds positively to an appreciation in the real effective exchange rate, spiking after six quarters and then stabilising at a significantly higher level from quarter twenty onwards. This corresponds to the results of the short-run VECM, where the appreciation of the real effective exchange rate at two lags was found to have a significant positive impact on import growth. As Figure 7 c) shows, capital formation responds positively to a shock in the real effective exchange rate, stabilising at a higher level from quarter sixteen onwards. The impulse response functions discussed above behave as expected and provide support from the short-run VECM results discussed above.

(v) Variance decompositions

The variance decompositions are shown in Table 4. As the variance decomposition of economic growth demonstrates, changes in the economic growth rate are mostly due to its own innovations. Nonetheless, in period 5 innovations to export growth explain 8.6% of the movements in economic growth. This influence declines towards period 20, implying that a long-run impact of export growth

on economic growth is limited, as already discussed above. Furthermore, import growth shares a larger proportion of the movements in economic growth that are due to its shocks than export growth. For example in period 5, 10.9% of movements in economic growth are explained by shocks to import growth. The impact of import growth on economic growth hence exceeds that of export growth. This would suggest that for the tradable sector in South Africa to be able to support higher economic growth, the growth rate of exports has to exceed that of imports, given that import growth has a negative impact on economic growth as shown by Equation 15 and Figure 5.

TABLE 4: VARIANCE DECOMPOSITIONS

Variance Decomposition of Economic Growth						
Period	**LNGDE**	**LNK**	**LNL**	**LNX**	**LNM**	**LNREER**
5	60.273	0.637	5.134	8.592	10.906	14.455
10	45.528	3.124	14.102	5.451	12.124	19.669
20	37.874	5.663	20.688	3.454	12.051	20.267
Variance Decomposition of Capital Formation						
Period	**LNGDE**	**LNK**	**LNL**	**LNX**	**LNM**	**LNREER**
5	1.153	58.246	0.297	16.206	4.944	19.151
10	2.433	41.372	2.203	17.810	7.958	28.221
20	1.502	41.306	3.834	15.161	8.114	30.083
Variance Decomposition of Employment						
Period	**LNGDE**	**LNK**	**LNL**	**LNX**	**LNM**	**LNREER**
5	24.970	0.776	72.680	0.008	0.315	1.248
10	34.552	0.616	63.331	0.006	0.531	0.961
20	38.544	0.583	59.472	0.018	0.597	0.782
Variance Decomposition of Export Growth						
Period	**LNGDE**	**LNK**	**LNL**	**LNX**	**LNM**	**LNREER**
5	19.305	11.738	1.139	67.092	0.171	0.552
10	15.633	17.950	1.002	62.597	0.203	2.611
20	13.090	21.586	1.521	57.247	0.403	6.150
Variance Decomposition of Import Growth						
Period	**LNGDE**	**LNK**	**LNL**	**LNX**	**LNM**	**LNREER**
5	31.141	7.605	6.221	28.880	8.112	18.042
10	19.407	16.257	18.754	18.620	4.604	22.354
20	12.131	24.698	25.507	12.557	5.224	19.881

The variance decomposition of import growth suggests that a notable income-induced import effect can be detected, since at 5 quarters 31.1% of changes in import growth are explained by innovations to economic growth in South Africa. This would have implications for the economy's ability to maintain balance of payments equilibrium during phases of accelerated economic growth.

The variance decomposition of capital formation reflects that capital is not only explained by its own innovations, but also by innovations to export growth. In period 5, 16.2% of changes in capital formation are explained by export growth. This is an effect that remains at levels around 15% even up to period 20. Export growth, in turn, is explained to a large extent by innovations to capital formation. The proportion of change in exports explained by shocks to capital formation increases over time, reaching 21.6% in period 20. These results support the idea that exports and capital formation are closely linked. Furthermore, it is also noteworthy that the real effective exchange rate explains a large portion of capital formation, which reaches 30.1% in period 20. This supports the findings of Figure 7.

Furthermore, the single most important factor that impacts employment, apart from its own innovations, are shocks to economic growth. In period 20, for example, shocks to economic growth explain 38.5% of movements in employment. Although the largest proportion of movements in the various endogenous variables is due to their own variations as expected, in a number of cases, the shocks from other variables within the model also share a large fraction of these movements.

Interestingly, the proportion of movement in economic growth due to the real effective exchange rate (a zero restriction variable in the first cointegrating equation of the model) is increasing until it explains 20.27% of the variation after 20 periods. It would therefore be revealing to compare the findings from this research with those resulting from an alternative specification.

(vi) Causality tests

The results of VEC Granger Causality/Block Exogeneity Wald tests are given in Table 5. All variables included were significant at least at the 10% level of significance.

TABLE 5: SUMMARY OF VEC GRANGER CAUSALITY/BLOCK EXOGENEITY WALD TESTS

Dependent variable	Excluded variable	Chi-square	p-value
Economic growth	Export growth	7.152	0.028
	Import growth	9.317	0.009
	Real effective exchange rate	4.819	0.090
Capital formation	Export growth	4.937	0.084
Export growth	Economic growth	5.094	0.078
Employment	Real effective exchange rate	11.918	0.002
	Export growth	4.776	0.091
Import growth	Economic growth	46.880	0.000
	Capital formation	10.487	0.005
	Real effective exchange rate	10.022	0.006

The Granger causality results mirror to a large extent the short-run relationships between the variables derived from the short-run VECM and the impulse responses. For example, exports, imports and the real effective exchange rate Granger cause economic growth at the 5%, 1% and 10% level respectively. Export growth Granger causes capital formation, while economic growth Granger causes export growth. The real effective exchange rate and export growth both Granger cause employment at the 1% and 10% level respectively. Finally, economic growth, capital formation and changes in the real effective exchange rate all Granger cause import growth at the 1% significance level.

(vii) Weak exogeneity

A test for weak exogeneity on the coefficients of economic growth and exports is critical in order to assure the validity of the VECM model, as well as all consequent causality tests and innovation accounting techniques. Table 6 shows a summary of the weak exogeneity tests for the main variables of interest, namely economic growth and exports. Both variables were found to be endogenous, as the null hypothesis of weak exogeneity is rejected at the 1% level in both cases. Hence, both economic growth and exports form part of the long-run equilibrium relationships between the cointegrated variables.

Table 6: Summary of Weak Exogeneity Tests

	Economic growth	**Export growth**
Restriction	$\alpha_{11} = 0$	$\alpha_{22} = 0$
Chi-square(1)	11.758	8.388
Probability	0.000	0.003

6. Conclusion

Both exports and economic activity have a significant positive association with an increase in capital (both in the long- and short-run), but when exports work through capital, higher exports is likely to have a significant positive impact on economic performance.

Capital has a significant positive long-run association with both GDE and exports respectively. Moreover, the short-run VECM shows that capital has a positive impact on GDE at one lag. The results therefore not only suggest the presence of a capital-output connection, but also that exports play a role in supporting the accumulation of capital stock. The impulse response functions indicate that a shock to exports is associated with an improvement in capital; the variance decompositions showed that changes in capital are to a large extent explained by shocks from exports, and the Granger causality tests indicate that exports Granger-causes capital. Hence, it is possible that exports stimulate growth in capital stock, which in turn is associated with better economic performance. This finding supports the well-documented notion that export expansion could promote higher economic output by triggering the required investments in technological improvements, resulting from pressures of international competition.

The more exports are directed towards supporting capital formation, the more it may indirectly support economic growth. Furthermore, there is evidence pointing to the presence of a virtuous export-capital cycle, since a higher rate of investment in physical capital also leads to improved export performance. This suggests that the success of the export sector depends on the amount of fixed investment spending in the South African economy and that the export-capital connection is the key to export-led growth. Moreover, policy should take a two-pronged approach emphasising the interdependence and potential for symbiosis between both macroeconomic variables.

The positive relationship between exports and GDE in the short-run supports the notion that export growth promotes higher economic growth rates in South Africa. This would suggest that policymakers should focus on raising the export growth rate in South Africa as a precondition for higher economic growth. The results suggest furthermore that South Africa's export sector without significant investment growth will struggle to compete successfully in the global market.

Significant potential benefits could arise from explicitly coordinating policies that link and simultaneously drive export expansion and investment in some sectors due to the anticipated positive feedback effects between the two. Such policies could be used to capitalise on the virtuous cycle that exists between exports and fixed capital that in turn raises economic growth in South Africa. In other words, for higher economic growth to be viable in the long-run, it is imperative that the link between exports and fixed investment is emphasised – as only through the positive relationship between exports and fixed investment will the positive influence on economic growth be maximised.

As a recommendation for further research, the degree of variation in GDE explained by the real effective exchange rate suggests some potential role for the latter in explaining movements in economic growth. Necessitated by identification restrictions, in this study the real effective exchange rate was excluded from the long-run component of the GDE relationship, though not from the exports growth equation, in order to remain consistent with the theoretical framework, previous research, and principal focus of this study. Nevertheless, within an appropriate theoretical framework, future research could examine this potential dynamic of the export-growth relationship.

Biographical notes

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