Chapter 5

A South African export model

Trade equations are one of the older, and more rewarding, parts of empirical economics. Numerous standard trade equations relating the volume of exports or imports to relative prices and to levels of activity have been estimated over the past 20 or so years (Bayoumi, 1999: 2).

5.1 Introduction

This chapter develops an export model and presents empirical estimations of both the export functions and export prices for South Africa's various manufacturing industries. It builds on Chapter 3 that gave an exposition of the formal theories of trade and proposed a typology to classify sectors for appropriate policy development and implementation. The proposed export model for South Africa draws on this theory and on certain unique characteristics of the South African economy as indicated in Chapter 2. To deduce the factors driving South African exports, both the foreign demand for South African products and the ability and willingness of local producers to supply foreign markets, need to be assessed. Factors such as sanctions, incentives, the oil price, transport costs, the gold price (to determine the impact of Dutch-disease), technology dummies, cost of capital, trade policy, the relative productivity of labour and unit labour costs are tested.

Prices and relative prices play an important role in determining export volumes. Rather than only using inverted supply-derived prices, a neoclassical framework is used. Since this approach is based on the profit-maximising decision-making process of the firm, it provides policy-makers with richer information, particularly on the supply-side of the economy.

The point of departure is to develop, estimate and validate applicable equations for export volumes and prices of the South African manufacturing sector. However, to verify the plausibility and provide further evidence for policy-makers, the dynamic response properties of the model are investigated by applying exogenous shock to the long-run variables separately. The response characteristics show the adjustment path after the initial shock.

Therefore the purpose of this chapter is to:

1. Review previous empirical research on export supply and demand equations;
2. Identify and review data to be used in a model;
3. Identify theoretical determinants of South African export prices;

4. Identify factors peculiar to South African exports;
5. Estimate the impact of the identified variables on South African exports; and
6. Investigate the response properties of the model.

Although examples of international empirical literature on import and export elasticities abound, these studies tend to estimate aggregate elasticities and ignore individual sectors or industries. Therefore, the focus will be on the development of a disaggregated export model rather than a general aggregated trade model that includes imports.

It is essential that policy-makers know and understand the causes of comparative advantage and particularly the determinants of exports at a sectoral or industrial level, so that "one-size-fits-all" prescriptions can be avoided and instruments can be designed to maximise export growth and optimise the returns on public resources. Armed with the knowledge of the determinants of trade, the elasticities, and the impact each variable has on export volumes; policy-makers can formulate "tailor-made" policies that will have the optimum impact on national goals.

5.2 Theoretical framework: export model

Although domestic and global markets become indistinguishable from each other as globalisation progresses, there are certain drivers that influence the way economic agents allocate resources to the international market. However, it is becoming increasingly difficult to distinguish between the various factors that influence domestic from global activities. International trade is therefore a process by which local and foreign economic agents make decisions about the consumption of alternative goods and services (from various sources) and firms make decisions about how and what to produce for the various markets.

Although the focus of this study is on South African exports, it draws from literature that tends to focus on trade (both imports and exports). Two general trade models, the imperfect substitutes and perfect substitutes models, dominate empirical literature and although ostensibly disparate when analysing aggregate trade, once disaggregated they are complementary. The perfect substitutes models assume perfect substitutability between domestic and export products, while the imperfect substitutes model more realistically enables domestic and export prices to differ from one another (Goldstein & Khan, 1986).

5.2.1 The perfect substitutes model

The perfect substitutes model is briefly considered because, although the South African export basket has changed over the past decade, some of its exports still fit this description.[1] Typically, this model uses excess demand and excess supply rather than separate import demand and export supply functions. Once transport costs, tariffs and other frictions are removed, and all prices are expressed in a common currency, there is only one price. A producer will only affect the world price, *ceteris paribus*, to the extent it can affect world supply and demand. In other words, a country's ability to influence world prices depends on its share of world consumption, its share of world production, and its own price elasticities of demand and supply.

The simple perfect substitutes model is given by the demand and supply conditions in a country (South Africa) during a period t [2]:

$$X^d_{sait} = f(\overset{(+)}{P_{wit}} * e_t, \overset{(+)}{Y_{wt}} * e_t), \quad \text{.......} \quad (1)$$

where:

- X^d_{sait} is the demand for South African exports;
- P_{wit} is the world price of the commodity;
- e_t is the exchange rate; and
- Y_{wt} is world income[3] (expressed in domestic currency).

and $X^s_{sait} = f(\overset{(+)}{PX_{sait}} * (1 + S_t), \overset{(-)}{P_{sait}})$; .... (2)

where:

- X^s_{sait} is the supply of South African exports
- $P_{it}X_{sait}$ is the income received by South African manufactures and augmented by subsidies;
- S_t is the subsidy; and
- P_{sait} is the domestic price of the commodity.

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1 Many of South Africa's homogeneous goods (e.g. gold, coal, pig-iron, aluminium billets etc) are traded on organised commodity markets and demand and supply do not necessarily depend on domestic and foreign price differentials. Techniques in collecting price data vary and substitutability may be underestimated. (Using various classification systems (e.g. Lall, 2000) products can be classified according to their tariff classifications making it possible to identify perfect substitutes)

2 The expected sign of the coefficient is indicated above the variable in parenthesis (+) and (-).

3 Total world income or a weighted average can be used.

excess demand is give as $I_{sait} = D_{sait} - S_{sait}$ .... (3)

where

- I_{sait} is the import quantity demanded by South Africans;
- D_{sait} is the domestic demand; and
- S_{sait} is the quantity of the commodity produced by South Africans.

and excess supply is $X_{sait} = S_{sait} - D_{sait}$ .... (4)

where

- X_{sait} is the export quantity supplied by South Africans;
- D_{sait} is the domestic demand; and
- S_{sait} is the quantity of the commodity produced by South Africans.

when $P_t I_{it} = P_{it} = P_t X_{it} = e_t * P_{wt}$ .... (5)

where

- P_t is the price level;
- I_{it} is the import quantity demanded by South Africans;
- P_{it} is cost of imports;
- X_{it} is the South African export volume;
- e_t is the exchange rate; and
- P_{wt} is the world price.

World equilibrium demand and supply conditions are:

$$D_{wt} = \sum_{i=1}^{m} D_{it} \quad (6)$$

and $S_{wt} = \sum_{i=1}^{m} S_{it}$ .... (7)

where $D_{wt} = S_{wt}$ .... (8)

5.2.2 The imperfect substitutes model

Imports or exports are seldom perfect substitutes. If domestic and foreign goods were perfect substitutes, and produced under constant or decreasing costs, countries would specialise and there would be no intra-industry trade (IIT) (Magee, 1975). As pointed out in Chapter 4 the proportion of IIT of total trade is growing. Further, Goldstein and Khan (1986) show that except for the standard commodity products (such as wheat or copper), no "law of one price" holds.

Murata *et al.,* (2000) state that by their nature exports are demand based, and *ceteris paribus*, the long-term export demand function shows the relation between the export price and the quantity demanded. Therefore, the conventional practices in specifying Marshallian-type export demand equations are to include the price and an income variable representing the budget constraint in the target markets. The volume exported is determined largely by the quantity demanded by foreigners. Nevertheless, a country needs to have supply capacity to export. The export supply and demand factors are discussed below.

(i) Export supply

The behavioural relationships that influence the quantity South African producers will supply to the international market are complicated. The standard micro-economic supply curve plots the relationship between the price and the quantity producers are willing to supply. The shape of this curve is determined by technology, input costs and government regulations. Supply relationships have typically been handled by assuming that the export supply price elasticities facing any individual country are infinite (Magee, 1972; Mutti, 1979). The export supply curve will be influenced by the relative price, rather than simply the export price – the greater the difference in relative export and domestic price, the greater the willingness to pursue and supply foreign markets.

Since the Reynders' Commission in the 1970s, the government has, for many reasons, tried to influence producers to export more. Instruments have ranged from various financial inducements to moral suasion. The main subsidies that have been available to exporters over the past twenty years are the A and B Schemes (1982-1990) that focused on compensating for the cost increasing effects of trade policies, and GEIS (1990-1997) that provided inducement to export goods based on the impact of real exchange rate, value of local content and whether it was a final product. Other subsidies, such as various regional or spatial incentives were available, and although they did reduce costs, were not targeted at the export market. (Grants were also made available for certain categories of research and development. These did have an impact on export supply and will be discussed below.)

The quantity supplied by South African producers to foreign markets is therefore a positive function of the own export price and negative function of the price of domestic goods of the exporting country (Goldstein & Khan, 1986) and the export supply function is given by:

$$X^s_{sait} = f(\overset{(-)}{P_{sait}}, (1+\overset{(+)}{S_{sait}}) * P_{saixt}) \quad \text{.......} \quad (9)$$

where:

- X^s_{sait} is the South African export supply of sector *i*;
- P_{sait} is the domestic price of sector *i*;
- S_{sait} is the subsidy applicable on products from sector *i;* and
- P_{saixt} is the export price of sector *i.*

This specification assumes infinite export supply. There are also possible simultaneity bias, potential endogeneity and contemporaneous feedback. These problems are dealt with below.

Various factors, including trade policies, have played a role in shaping South African export supply. Following on evidence presented in Chapters 2 and 3, firm interviews, and previous econometric evidence, exporting represented a marginal activity for South African enterprises. Domestic demand should have a negative effect on exports of manufactured goods. This "vent-for-surplus" view of exporting is not surprising since a large share of its manufactured exports consist of scale intensive natural resource goods and South Africa has a relatively large domestic market.

Therefore, in addition to standard export supply specifications, capacity utilisation as a term for domestic demand is included.

$$X^s_{sait} = f(\overset{(-)}{P_{sait}}, (1+\overset{(+)}{S_{sait}}) * P_{saixt}, \overset{(-)}{CAP_{it}}) \quad \text{.......} \quad (10)$$

where:

- X^s_{sait} is South African export supply of sector *i*;
- P_{sait} is the domestic price of sector *i*;
- S_{sait} is the subsidy applicable on products from sector *i;*
- P_{saixt} is the export price of sector *i;* and
- CAP_{it} is the use of capacity in that particular sector.

The impact of various political events, especially sanctions, has been influential. Although there is good reason to assume that products manufactured in South Africa are heterogeneous, it is assumed in this model that products within each sector are homogeneous. For regressions with long-term cointegrating relationships, the model assumes homogeneity and postulates that both income and export price elasticities are constant overtime.

Technology shifts the supply curve to the right. Although exporters tend to acquire new technology faster than suppliers exclusively serving the local market, spillover effects ensure that any technological advances would apply to both the domestic and foreign markets. Nevertheless, unless the technology is so advanced and can be considered a world leader, any innovation or technological advances would serve to benefit both local and foreign markets and would not be considered a reason for producers to shift resources to the export market. Similarly, any reduction in input costs, although shifting the supply curve to the right, would not influence the firm's allocation between the export and domestic market.

$$X^{s}_{sait} = f(\overset{(-)}{P}_{sait}, (1+\overset{(+)}{S}_{sait}) * P_{saixt}, \overset{(+)}{Tech}_{it}) \quad \text{.......} \quad (11)$$

where:

- X^{s}_{sait} is the export volume of sector *i* from South Africa;
- P_{sait} is the domestic price of sector *i*;
- S_{sait} is the subsidy applicable on products from sector *i;*
- P_{saixt} is the export price of sector *i;* and
- $Tech_{it}$ is a series constructed to indicate technological progress in sector *i.*

Besides variable costs such as additional transport and duties, a firm makes certain investments to enter the foreign market. Sunk costs include the initial market research and product modifications to meet foreign market requirements and regulations. These costs cannot be recovered. Therefore, once a foreign market has been established, the price rather than the relative difference is important. In other words local price should not play such an important role and is expected to have a very small coefficient or to be statistically insignificant.

(ii) Export demand

Drawing on standard demand and supply theory, price (relative price) and income are the main determinants of the quantity traded. Following Goldstein and Khan (1986), the demand for South African exports in the long run for a given sector is given by:

$$X^{d}_{sai} = f(\overset{(+)}{Y_{wt}} * e_t, \overset{(-)}{P_{sai}}, \overset{(+)}{P_{wit}} * e_t) \qquad (12)$$

where:

- X^{d}_{sai} is the export demand for South African product from sector *i;*
- Y_{wt} is the income for the rest of the world;
- P_{wit} is the world price for the rest of the world for sector *i;*
- e_t is the exchange rate; and
- P_{sai} is the price of all domestically produced goods for South Africa for sector *i.*

Income elasticities and cross-price elasticities of demand should be positive, while own-price elasticities of demand are negative. Assuming no money illusion, homogeneity of the demand function is expressed by dividing the right-hand side of the equation by P_{sai}, expressing exports as a function of the real income and the relative price of exports.

Tsikata (1999) adapted this to include real effective exchange rate:

$$x^{d}_{sait} = f(\overset{+}{y_{wt}}, \overset{-}{p_{saxit}}, \overset{+}{reer_{sat}}) \qquad (13)$$

where[4]:

- x^{d}_{sai} is export demand for South African product from sector *i*;
- y_{wt} is the real income for the rest of the world;
- p_{saxit} is the South African export (rand) price for sector *i;* and
- $reer_{sat}$ is the real effective exchange rate for South Africa.

(iii) Case studies

Although there has been some empirical research in South Africa, few studies have attempted to estimate export elasticities on a sectoral level. The following research has been done:

- Bhorat (1998) - seven manufacturing sub-sectors' elasticities;
- Fallon and Da Silva (1994) - export elasticities for total manufacturing;
- Golub (2000) - export demand equation for total manufacturing and total manufacturing plus agriculture;

[4] The use of lower case indicates that the variables have been converted to natural logs.

- Gumede (2003) – 27 manufacturing sub-sectors' elasticities;
- Naude (2000) - aggregate export supply function; and
- Tsikata (1999) - export elasticities for total manufacturing.

The main result from most of these empirical studies is that export elasticities, especially price elasticities, are generally small and often statistically insignificant.

(iv) Problems with the export demand models

The model implicitly assumes that a countries export supply passively responds to changes in the level of foreign demand and therefore the price elasticity of supply extends to infinity. This reasoning can be justified with either spare capacity or increasing returns to scale are experienced by the industry. Therefore export demand models are subject to simultancity bias or an omitted-variable bias (Johnston, 1984: 256-61). This problem can however be overcome by employing simultaneous equations or estimating export determination models.

Export determination models are best described as a combination of an export demand and an export supply model brought together in a single, reduced-form. This can then be estimated using OLS and error correction techniques. The simultancity bias can be assumed away on the grounds that the markets are oligopolistic. Specifically this would occur when prices are sticky in the short term and therefore do not respond to random volume fluctuations (King 1997: 85). Edwards and Willcox (2004: 6) show that South African exporters are indeed price takers in international markets. They conclude that export growth is driven by the profitability of export supply rather than price competitiveness relative to foreign suppliers.

The impact of prices and income on the volume of exports, although interesting, does not provide the critical information necessary to inform policy formulation. Because of its relative size, South African policy has a negligible impact on foreign prices and even less on foreign income. Therefore, despite the small elasticities expected, policy will have to focus on South African export prices. Prices are affected directly through subsidies such as GEIS, or indirectly through labour, trade, monetary or fiscal policy.

Based on this theory the next section proposes an export model (prices and volume) for South Africa.

5.3 An export model for total aggregated South African exports

Prices and foreign demand play an important role in determining South African export volumes. To overcome the problem with reliable price data, Tsikata (1999: 65) estimated reduced form of the export demand and supply equations, implying an inverted supply price. As Edwards and Willcox (2004) show export growth is determined by the profitability of export supply rather than relative prices. Therefore, rather than only using inverted supply derived export prices in a deterministic model describe above, this section proposes that a neoclassical framework be used. This approach is based on the profit-maximising decision-making process of the firm. It therefore provides policy-makers with richer information, particularly on the supply-side of the economy.

This section analyses the determinants firstly of South African export prices and then its export volumes. Using the coefficients derived from these stochastic equations, a model is constructed and used to show the impact of shocks on the variables. This process will be followed firstly for the total aggregated South African export sector and repeated for the manufacturing sector. Finally the coefficients for each industrial sector are reported.

With imperfect market competition, in a neoclassical profit-maximising framework, firms set prices as a mark-up on the marginal cost of production (Layard & Nickell, 1985, 1986; and Nickell, 1988). These are proxied by average or unit costs (Burda & Wyplosz, 1993: 256). Long-run production or value-added prices can therefore be estimated as:

$$P_{saxit} = f\left(\overset{+}{W}_{it}, \overset{-}{prod}_{it}, \overset{+}{r}_{t}\right) \qquad (14)$$

where:

- P_{saxit} is the South African export price for sector *i;*
- W_{it} is the nominal wage rate per worker;
- $prod_{it}$ is labour productivity; and
- r_t is the nominal user-cost-of-capital.

In addition, a measure for capacity utilisation, *caput,* can be included in the short-run to capture potential domestic demand pressures. This can also be used as an indicator of the vent-for-surplus theory discussed above.

The unit labour cost (ulc) is calculated for the South African economy, each sector. This includes both wage rates and productivity. Although implicitly, productivity captures technological progress and labour skills, the impact of the availability of various categories of labour skills and technology can be tested separately.

The nominal user-cost-of-capital (ucc) has to be inferred. Using Hall and Jorgenson (1967) it can be derived as follows (Du Toit, 1999: A16):

$$ucc_t = p_k\left(\frac{i_t - \delta_t}{1 - t_t}\right) \quad (15)$$

where:

- ucc_t is the user-cost-of-capital for South African producers;
- i_t is the interest rate;
- p_k is the price of capital;
- δ_t is the rate of depreciation; and
- t_t is the tax rate.[5]

Since exporters have access to international finance, this variable has been adapted to include international interest rates. Therefore i_t index is determined from a weighted average using 80 per cent South African interest rates and 20 per cent from libor (London interbank lending rate).

With the specifications based on a mark-up pricing in a profit maximising framework and from the discussion above, the export production price index is given by:

$$p_{xit} = f(\overset{+}{ucc_t}, \overset{+}{ulc_{it}}) \quad (16)$$

where:

- p_{xit} is the South African export price;
- ucc_t is the user-cost-of-capital applicable to South African exporters; and
- ulc_{it} is the unit labour cost.

This only gives the supply side determinants and does not include factors that also affected South African export prices such as sanctions. Nor does it include world demand factors. A dummy variable, *wdem*, was created to capture world demand. (See Appendix 10).

$$p_{xit} = f(\overset{+}{ucc_t}, \overset{+}{ulc_{it}}, \overset{+}{wdem_t}, d\_\overset{-}{sanc_t}) \quad (17)$$

where:

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[5] Although exporters have access to preferential interest rates through off-shore markets (Gouws and Bothma, 2002), international interest rates (that are generally lower than those in South Africa) did not prove to be significant. This was confirmed in discussions with exporters who were reluctant to borrow off-shore because of volatile exchange rates and exchange control regulations.

- ucc_t is the user-cost-of-capital;
- ulc_{it} is the unit labour cost per sector or industry;
- $wdem_t$ is a dummy to represent world demand; and
- d_sanc_t is a dummy to represent the periods when South African exporters were subject to sanctions.

Trade policy too, has a cost implication and as has been discussed can lead to an anti-export bias. Trade policy can be proxied by implicit tariff (collection ratio) or the effective rate of protection. The following equation is estimated to determine the export production price index:

$$p_{xit} = f(\overset{+}{ucc_t}, \overset{+}{ulc_{it}}, \overset{+}{wdem_t}, d\_\overset{-}{sanc_t}, \overset{-}{erp_{it}}) \text{ .... } (18)$$

where:

- p_{xit} is the export price per industry;
- ucc_t is the user-cost-of-capital;
- ulc_{it} is the unit labour cost per sector or industry;
- $wdem_t$ is a dummy to represent world demand;
- d_sanc_t is a dummy to represent the periods when South African exporters were subject to sanctions; and
- erp_{it} is the effective rate of protection.

The anti-export bias was also calculated and used to determine the impact that trade policy has had on South African export prices. The anti-export bias is a result of tariffs that has caused high effective rates of protection and also made the domestic market more attractive than international markets. The anti-export bias can is calculated as follows (Kuhn & Jansen, 1997):

$$AEB = \frac{(1+ERP)}{(1+XRP)} \text{ .... } (19)$$

where:

- AEB is the anti-export bias;
- ERP is the effective rate of protection; and
- XRP is export rate of protection.

The calculation of the effective rate of protection and export rate of protection is discussed in Chapter 4 and Appendix 3.

$$p_{xit} = f(\overset{+}{ucc_t}, \overset{+}{ulc_{it}}, \overset{+}{wdem_t}, d\_\overset{-}{sanc_t}, \overset{-}{aeb_{it}}) \quad (20)$$

where:

- p_{xit} is the export price per industry;
- ucc_t is the user-cost-of-capital;
- ulc_{it} is the unit labour cost per sector or industry;
- $wdem_t$ is a dummy to represent world demand;
- d_sanc_t is a dummy to represent the periods when South African exporters were subject to sanctions; and
- aeb_{it} is the anti-export bias.

5.4 Estimation results

A number of models can be estimated from the discussion above. Each model has a contribution to make in the investigation of the determinants of exports. Certain determinants are of academic interest, while others are crucially important from a policy perspective. Groups that determine international trade policy can be sorted into three categories: domestic, trade partners and bi- or multilateral arrangements. The South African government has direct control over its own domestic policies and plays a role in bi- or multilateral negotiations and fora. Notwithstanding the rules-based international trade regime, South Africa has virtually no control over its trading partners' policies.

A synopsis of the methodology and the data-generating processes is given, however these are reported in greater detail in Appendix 11. Appendices 12 and 13 present an explanatory list and graphical representation of the variables used in both the long-run cointegration and short-run error correction models.

5.4.1 Models estimated

The following sections empirically verify (or refute) the models discussed above. The model comprises of two behavioural equations: export price and export volume. All other explanatory variables are taken to be exogenous. In most cases the models is estimated for South Africa's total aggregated exports, the manufacturing sector and also for the various industries. Various tests are applied to ensure the robustness of the estimations. The stochastic equations are solved and then various scenarios are applied to simulate policy measures.

5.4.2 Estimation technique

There are a number of econometric procedures, each with its limitations[6], that can be used to estimate economic relationships. However, a fundamental assumption of regression analysis is that the right-hand side variables are uncorrelated with the disturbance term. If this assumption is violated, ordinary least squares (OLS) are biased and inconsistent. The finding that many macro time series may contain a unit root has spurred the development of the theory of non-stationary time series analysis. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. The purpose of the cointegration test is to determine whether a group of non-stationary series are cointegrated or not, and therefore, whether the estimated residual is stationary or not.

The empirical estimations employ the Engle and Yoo (1991) three-step estimation procedure. Essentially the methodology determines the long-run cointegrating relationship through the testing of stationarity of the residuals, employing the Augmented Dickey-Fuller test (first-step). If, after comparing the test statistic with the calculated p per cent critical value using surface response analysis (MacKinnon, 1991: 273-75), the null hypothesis of no cointegration can be rejected, and an error correction model (ECM) can be estimated (second-step). The ECM contains the long-run cointegration equation in the form of the stationary residual from the long-run relationship, lagged by one period (the error correction mechanism) and the short-run dynamic structure of the system adjusting toward the long-run equilibrium. All non-stationary variables, including the dependant variable, are differenced to ensure they are stationary. Since all the variables are stationary, the classical assumptions hold and the standard tests can be used to test for normality, serial correlation, misspecification and Homoskedasticity (this procedure is more fully described in Appendix 11).

Since all variables are estimated in log format (except where indicated), the coefficients can be interpreted as the elasticity of the variable concerned.

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[6] Despite these limitations, single equation estimation is still widely used by practitioners (see Bank of England (2000)). The limitations are discussed in Appendix 11.

5.4.3 Export price for total aggregated South African exports

This section describes the process of estimating the South African export price - focussing on input costs (labour and capital). This model will then be expanded to include other determinants such as the anti-export bias.

(i) The theoretical model

Following the theoretical discussion above, the following equation is used to estimate export prices:

$$p_{xsa} = \beta_{sa1} ucc_{sa} + \beta_{sa2} ulc_{sa} + \varepsilon \qquad (21)$$

where:

- p_{xsa} is the South African export price;
- *ucc* is the user-cost-of-capital; and
- *ulc* is the unit labour cost.

(ii) The data

The user-cost-of-capital, as discussed above, is calculated using the following identity:

$$ucc_t = p_k \left(\frac{i_t - \delta_t}{1 - t_t} \right) \qquad (22)$$

where:

- ucc_t is the user-cost-of-capital for South African producers;
- i_t is the interest rate;
- p_k is the price of capital;
- δ_t is the rate of depreciation; and
- t_t is the tax rate.

The data used to calculate the user-cost-of-capital was obtained from the South African Reserve Bank's *Quarterly Bulletin* and the IMF's *International Financial Statistics*.

The unit labour cost measures the average cost of producing one unit of output. Unit labour cost is equal to wage rate or earnings per worker (w) times the number of workers (N) divided by the output produced by the workers (Q):

$$ulc = \frac{(w * n)}{q} \qquad (23)$$

where:

- w is the wage rate;
- n represent the number of employees; and
- q represents output.

The unit labour cost was obtained from the Quantec's South African standardised industry output structure database for each of the sectors and industries.

(iii) Total South African aggregate export price – estimation results of cointegration equation

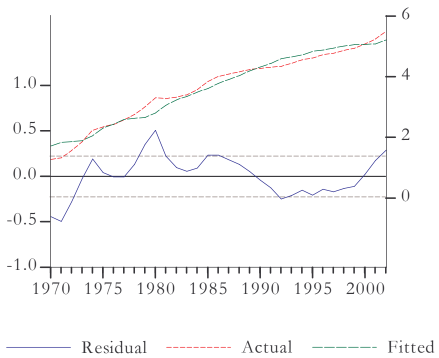
The first step in the Engle and Yoo (1991) three-step equation technique is employed to test whether the set of variables in the empirical model are cointegrated.

Table 1 Cointegration equation: South African aggregate export price

Dependent Variable: Export price		
Method: Least Squares		
Sample: 1970 2002		
Included observations: 33		
Variable	Coefficient	Std. Error
User-cost-of-capital	**0,223980	0,043927
Unit labour cost	**0,727885	0,080954
R-squared		0,965004
Adjusted R-squared		0,963875

*(**) Significant at a 5(1) per cent level.

Figure 1 Residuals, actual and fitted values of the South African aggregate export price



The results of the estimation are reported in Table 1. The null hypothesis of no cointegration can be rejected after comparing the Engle-Granger test statistic (-3,612371) with the MacKinnon[7] and the specified cointegration augmented Dickey-Fuller critical values (-3,174765) respectively.

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[7] Critical values for the relevant response surfaces for any number of regressors (excluding any constant and trend components, $1 \leq n \leq 6$, can be calculated as $C(p) = \phi_\infty + \phi_1 T^{-1} + \phi 2T^{-2}$, where C($p$) is the p per cent critical value (Mac Kinnon, 1991).

This points to stationary residuals and indicates cointegrated variables. Figure 1 represents a plot of the residuals as well as the actual and fitted dependent variable.

A number of problems related to a single equation approach towards modelling the static long-run equilibrium relationship and the dynamic short-run properties of the underlying data generating process. These are discussed in Appendix 11. Despite these limitations, single equation estimation is still widely used by practitioners (see Bank of England (2000)).

As expected from the theory, both the user-cost-of-capital and the labour costs have an influence on the South African export price. However, labour costs have a bigger coefficient and therefore have a more prominent role in determining export prices. This has important policy implications that will be discussed in Chapter 8.

(iv) South African export price - estimation results of error correction model (ECM)

The short-run dynamics can be estimated, using the second stage of the Engle and Yoo procedure after the long-run cointegration relationship has been determined. This estimation captures the dynamic adjustment process to the long-run equilibrium. The estimation results of the ECM are reported in Table 2 together with the residuals in Figure 2.

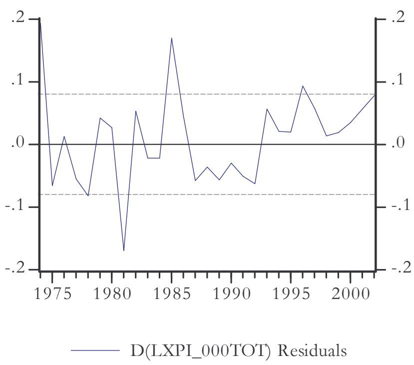
Table 2 Error correction model: South African export price

Dependent Variable: ∈ export price
Method: Least Squares
Sample (adjusted): 1972 2002
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error
Residual (-1)	0,599798	0.223188
∈ user-cost-of-capital(-3)	*0,259443	0.092174
∈ gold price (-1)	0,160270	0.084551
∈ unit labour cost(-2)	*0,523607	0.177444
R-squared		0,319329
Adjusted R-squared		0,237649

*(**) Significant at a 5(1) per cent level.

Figure 2 Residuals of South African export price



In the short term, the South African export price is not only influenced by the user-cost-of-capital and labour costs, but also by the price of gold. The full impact of a change in the price of labour and especially a change in the user-cost-of-capital is felt a few months after the exogenous shock. Interestingly, there is a "crowding-out" effect when the price of gold increases. Labour and capital are drawn out of other sectors into gold-production. This causes shortages, which in turn increase other prices, including export prices.

(v) Diagnostic testing

The export price function was subjected to rigorous diagnostic testing.

Table 3 Diagnostic test: South African export prices

Purpose of the test	Test	d.f.	Test statistic	Probability
Normality	Jarque-Bera	JB(2)	0,887686	0,641566
Homoskedasticity	ARCH LM	$nR^2(1)$	0,316495	0,573722
Homoskedasticity	White	$nR^2(10)$	10,64985	0,222339
Serial correlation	Breusch-Godfrey	$nR^2(2)$	0,000000	1,000000
Serial correlation	Lunq Box Q	Q(12)	5,7329	0,454
Misspecification	Ramsey Reset	LR(2)	0,111715	0,894781
Parameter stability	Recursive estimate	Indicative of stability		

Since all the variables in the ECM are stationary, the assumptions of the classical regression analysis are met, and the standard diagnostic tests can be used to determine which variable to include in the ECM. These are reported in Table 3 indicating that all the statistical tests are satisfactory.

(vi) Cointegration correction and adjusted coefficients

The final step of the Engel and Yoo (1991) technique described in Appendix 11 is applied to adjust the coefficients and *t*-statistics. Summaries of these results are reported in Table 4 and Table 5.

Table 4 Engel and Yoo third-step estimation: South African export price

Dependent Variable: Residual term from the ECM
Method: Least Squares
Sample (adjusted): 1972 2002
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error
-0,160281*user-cost-of-capital	0,050625	0,038481
-0,160281*unit labour cost	-0,097317	0,070375
R-squared		0,065788
Adjusted R-squared		0,033574

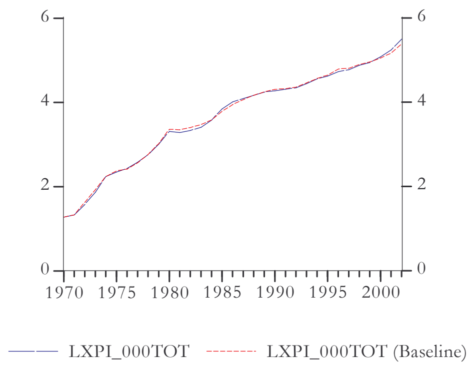
These results are used to determine coefficients and t-statistics that are closer to their true values.

Table 5 Cointegration correction: South African export price

Variable	Coefficient	t-Statistic
User-cost-of-capital	0,223545	5,088905
Unit labour cost	0,729079	9,006505

A dynamic simulation of the South African export price model yields the overall fit as show in Figure 3.

Figure 3 Actual and baseline values of the South African export price



The estimated function is statistically well-behaved and stable. Furthermore, the estimated South African export price is consistent with *a priori* theoretical specifications made in the proceeding sections. Nevertheless, the importance of the unit labour costs in determining the South African export price is salient.

5.4.4 Export volume for total aggregated South African

This section reports the determinants of South African export volume.

(i) The theoretical model

The export function based on real values is explained in this section. The equation therefore to be estimated is:

$$X_{sa} = \alpha + \overset{(-)}{\beta_1} p_{sax} + \overset{(+)}{\beta_2} y + \overset{(-)}{\beta_3} sanc + \beta_4 \overset{(-)}{D}\_80 + \varepsilon \quad \text{.......} \quad (24)$$

where:

- X_{sa} is the South African export volume;
- p_{sax} is the South African export price;
- y is the income of South Africa's trading partners;
- *sanc* is a dummy to measure the impact of sanctions imposed on South Africa during the 1980s; and
- *D_80* is a dummy to measure the impact of gold price shocks.

(ii) The data

The export price data was obtained from Quantec's South African standardised industry output structure database for each of the sectors and industries. It is calculated from the Producer Price Indices (PPIs, P0142.1 from Stats SA). These are available in three different versions: PPI of South African consumption (domestically produced output excluding exports but including imports); PPI of South African output (domestically produced output including exports and excluding imports); and PPI of South African output for SA consumption (domestically produced output excluding exports). Combining these PPIs allows for "raw" PPIs for exports and imports to be derived. Comparing the "PPI for South African output for South African consumption" with the "PPI for South African consumption" allows for the derivation of the "PPI for imports." Comparing the newly derived "PPI for imports" with the "PPI of South African consumption" allows for the "PPI for exports" to be derived. The income variable was tested for total world income (from the World Bank), for the OECD countries (from the OECD) and a weighted average calculated using the South African Reserve Bank's weights used to calculate the real effective exchange rate. The best fit was achieved using the data obtained from the OECD. Two dummy variables, one for sanctions (1985 to 1992), and another for 1980 when the gold price increased are included in the cointegration equation.

(iii) Total South African aggregate export volume – estimation results of the cointegrated equation

Using the log of real South African exports and regressing it against the log of OECD income expressed in South African rand, the export price, gold price and a sanctions dummy variable is given in Table 6.

Comparing the Engle-Granger test statistic of -4,374543 with the MacKinnon and specific cointegration augmented Dickey-Fuller critical values respectively, resulted in the rejection of the null of cointegration in favour of stationary residuals and cointegrated variables. The residuals are plotted in Figure 4.

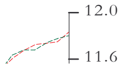
Table 6 Cointegration equation: South African aggregate export volume

Figure 4 Residuals, actual and fitted values of the South African aggregate export volume

Dependent Variable: Export volume
Sample: 1970 2002
Included observations: 33

Variable	Coefficient	Std. Error
Export price	-0,08888	0,02323
OECD income	0,38103	0,03
Gold price shocks	0,17901	0,04444
Sanctions dummy	-0,08871	0,01976
C	10,0641	0,05632
R-squared		0,974311
Adjusted R-squared		0,970642

As expected, the volume of exports is determined by export prices and the income of trading partners. As with other



pected, the volume of exports is determined by export prices and the income of trading partners. As with other studies discussed above, the coefficient for the export price is low, although it is negative as is predicted. The income of our trading partners is positive and also has a larger coefficient than for export price. The impact of sanctions was significant.

hort-run dynamics: error correction model

(iv) The short-run dynamics: error correction model

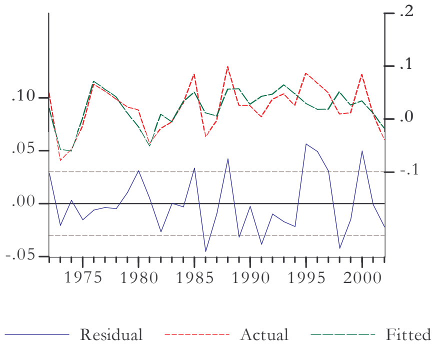
After the long-run cointegration relationship has been determined, the error correction mechanism the long-run cointegration relationship has been determined, the error correction mechanism (second stage of the Engel and Yoo procedure) can be estimated. Using the equilibrium error (residual terms) with other variables, the ECM captures the short-run or dynamic adjustments to the long-run equilibrium.

Table 7 Error correction model: South African aggregate export volume

Figure 5 Residuals, actual and fitted values of the South African aggregate export volume (first difference)

Dependent Variable: ∈ export volume
Method: Least Squares
Date: 08/09/04 Time: 13:50
Sample (adjusted): 1972 2002
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error
Residual (-1)	-0,392056	0,144859
∈ export price (-1)	-0,280667	0,061390
∈ OECD income	0,108168	0,058813
Capacity utilisation	0,012539	0,002775
D_80(-2)	-0,077621	0,025544
R-squared		0,599128
Adjusted R-squared		0,537456



he short run, the volume of South African exports is determined by the export price and the

In the short run, the volume of South African exports is determined by the export price and the e short run, the volume of South African exports is determined by the export price and the trading partner's income. Apart form the long-run explanatory variables; the degree of capacity utilisation was included. This shows the relevance of the vent-for-surplus theory.

(v) Diagnostic testing

The export function was submitted to rigorous diagnostic validation. The diagnostic test results are reported in Table 8 below.

Table 8 Diagnostic tests: South African aggregate export volume

Purpose of the test	Test	d.f.	Test statistic	Probability
Normality	Jarque-Bera	JB(2)	1,648104	0,438651
Homoskedasticity	ARCH LM	$nR^2(1)$	0,306270	0,579978
Homoskedasticity	White	$nR^2(10)$	7,583620	0,669435
Serial correlation	Breusch-Godfrey	$nR^2(2)$	2,674893	0,262515
Serial correlation	Lunq Box Q	Q(12)	5,863800	0,439000
Misspecification	Ramsey Reset	LR(2)	0,517608	0,602447
Parameter stability	Recursive estimate	Indicative of stability		

Since all the variables in the ECM are stationary, the assumptions of classical regression analysis are fulfilled. Standard diagnostic tests can therefore be used to determine which variables should be included in the final specification (Harris 1995: 24). The diagnostic tests results reported indicate that the function passes all the statistical diagnostic tests.

(vi) Cointegration correction and adjusted coefficients

The third step of the Engle and Yoo technique (Appendix 11) is applied to adjust the coefficients estimated in the first step. The results are reported in Table 9 and Table 10 below.

Table 9 Engle and Yoo third-step estimation: South African aggregate export volume

Dependent Variable: RRX_000TOT_EC
Method: Least Squares
Sample (adjusted): 1974 2000
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic
-0,392055863769794*export price	-0,07524	0,0501398	-1,50051
-0,392055863769794*OECD income	0,237101	0,1265562	1,873486
-0,392055863769794*D_80	-0,00287	0,084699	-0,03386
-0,392055863769794*D_8692	-0,00021	0,0397663	-0,00536
C	-2,26153	0,0397663	-0,00536
R-squared	0,360491		
Adjusted R-squared	0,337601		
Durbin-Watson stat	2,015969		

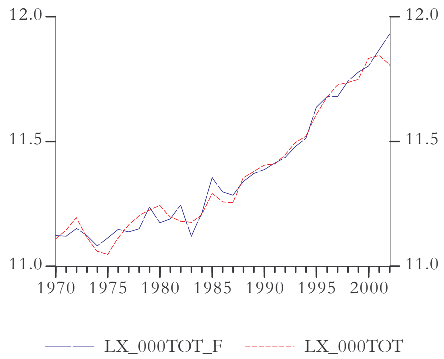
These coefficients are used to correct the long-run coefficients and the t-Statistics.

Table 10 Cointegration correction: South African aggregate export volume

Variable	Coefficient	t-Statistic
Export price	-0,16411	-5,326825
OECD income	0,61813	14,572817
D_80	0,17613	3,994299
D_8692	-0,08892	-4,494826
C	7,80253	178,693660

Using these estimates, the actual and fitted values are plotted in Figure 6. From visual inspection the estimated equation represents a good fit of the actual data. This is particularly true for the late 1980s and 1990s.

Figure 6 Actual and fitted values of the South African aggregate export volume



(vii) Discussion of the results

The income elasticity is less than one, indicating that although South Africa benefits from an increase in its trading partners' income, it is losing market share. For the total economy, both the long- and short-run export price elasticities are negative as expected, but small. Following the discussions in Chapter 3, it is difficult to draw policy conclusions. The size of the coefficient of the price variable is rather small and macro policy measures aimed at improving South Africa's competitiveness by reducing its export price are therefore less likely to succeed. Products are heterogeneous and should be analysed separately. However, the next section does attempts to determine economy-wide policy implications. As expected the sanction variables are negative while the income of South Africa's trading partners is positive. The impact of sanctions, although statistically significant did not influence export volumes (although sanctions did have an impact on export prices).

The model's dynamic simulation properties were investigated and tested for stability and robustness. The model is then extended to estimate the impact of various policy measures. These are reported in the next section.

5.4.5 Extending the model to include trade policy and anti-export bias

Since the purpose of this study is to identify the critical policy issues the impair export growth and development, the model discussed above is elaborated to include the impact of trade policy and particularly the anti-export bias that is created by it.

(i) South African exports and trade policy - the theoretical model

Many policy-makers have advocated export promotion arguing that they bring about increased levels of economic growth and development. Since the 1970s there has been the realisation that production for the domestic market was not translating into high and sustained economic growth and South Africa attempted to switch from an inward- looking economy. Typically manufacturing enterprises viewed production for the domestic market as more profitable than for exports. Exporting was a vent-for-surplus activity, when the domestic market could not absorb manufacturing output. The manufacturing sector exhibited a strong anti-export bias.

The City of Cape Town (2000) undertook a survey among its exporters and found that imported components are an important part of South African exports. Thirty per cent of exporting companies reported that imported goods made up at least 25 per cent of the total cost of at least one of the products that they produced. They also found that although the majority of companies do not import components directly, nevertheless direct participation in importing increases with export commitment. The anti-export bias works through the price mechanism and arising from the discussion above the following equation is used:

$$p_{xsa} = \beta_1 ucc_{sa} + \beta_2 ulc_{sa} + \beta_3 aeb_{sa} + \varepsilon \quad (25)$$

where:

- p_{sax} is the South African export price;
- *ucc* is the user-cost-of-capital;
- *ulc* is the unit labour cost; and
- *aeb* is the anti-export bias.

(ii) The data

Although there are various techniques and data that can be used to calculate these three variables, the actual customs collected was used and then expressed as a tariff rate. Since there have been various rebates and drawbacks introduced since 1970, the actual collections represent a more accurate picture of the nominal protection offered to industrialists than the tariff rate. The imports and customs collections were obtained from Quantec. The value added and the intermediary inputs (at domestic and world prices) were calculated using input-output analysis[8]. The AEB, ERP, and XRP are graphically presented for each sector and industry in Appendix 13.

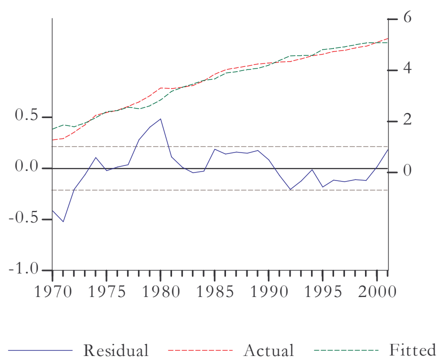
(iii) The estimation results of the cointegrated equation

The first step of the Engel and Yoo three-step estimation technique is utilised to test whether the set of variables specified in the empirical model is cointegrated. In other words if the anti-export bias is included, does the combination of variables provide a long-run equilibrium relationship? The results of the cointegration equation are reported in Table 11 while the residuals, actual and fitted values of the South African aggregate export price are plotted in Figure 7.

Table 11 Cointegration equation: South African aggregate export price

Dependent Variable: Export price		
Method: Least Squares		
Sample (adjusted): 1970 2001		
Included observations: 32 after adjustments		
Variable	Coefficient	Std. Error
Unit-cost-of-capital	0,339223	0.068402
Unit labour cost	0,574424	0.102782
Anti-export bias	8,972868	4.876854
R-squared		0,967978
Adjusted R-squared		0,965770

Figure 7 Residuals, actual and fitted values of the South African aggregate export price



After comparing the Engle-Granger test statistic of -3,765846 with the computed MacKinnon and the specified cointegration ADF critical values (-3,643483), it is concluded that the residuals are stationary and the variables are cointegrated.

(iv) The short-run dynamics: error correction model

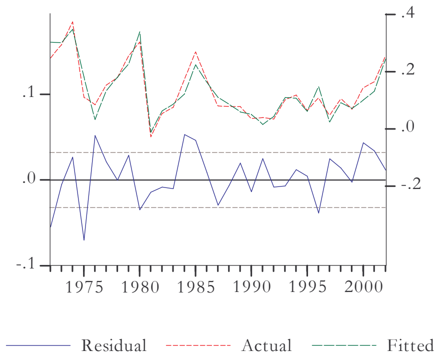
The short-run dynamics are estimated using the procedure used above and described in detail in Appendix 11. The results are given in Table 12.

[8] The 1993 Input-output table was used for all calculations based on the assumption that the underlying economic structure remained unchanged.

Table 12 Error correction model: South African aggregate export price

Dependent Variable: ∈export price		
Method: Least Squares		
Date: 08/15/04 Time: 13:37		
Sample (adjusted): 1972 2002		
Included observations: 31 after adjustments		
Variable	Coefficient	Std. Error
Residual (-1)	-0.138015	0.035468
∈ export price (-1)	0.203349	0.077286
∈ gold price	0.453782	0.035319
∈ unit labour cost	0.385988	0.094374
D_DROUGHT	-0.040109	0.017606
R-squared		0.902679
Adjusted R-squared		0.887706

Figure 8 Residuals, actual and fitted values of the South African aggregate export price (first difference)



(v) Diagnostic testing

Again the export price function was subjected to rigorous diagnostic tests, reported in Table 13.

Table 13 Diagnostic tests: South African aggregate export price

Purpose of the test	Test	d.f.	Test statistic	Probability
Normality	Jarque-Bera	JB(2)	0.733275	0.693061
Homoskedasticity	ARCH LM	$nR^2(1)$	1.512440	0.218767
Homoskedasticity	White	$nR^2(10)$	9.983934	0.351787
Serial correlation	Breusch-Godfrey	$nR^2(2)$	0.579925	0.748292
Serial correlation	Lunq Box Q	Q(12)	6.7686	0.343
Misspecification	Ramsey Reset	LR(2)	0.522327	0.599728
Parameter stability	Recursive estimate	Indicative of stability		

Since all the variables in the ECM specified above are stationary, the assumptions of classical regression analysis are fulfilled and the standard diagnostic tests applied can be used to determine which variables can be included. The results indicate that the function passes all the statistical diagnostic tests.

Since the residual variable (RRXP_000TOT(-1)) has a low coefficient, the adjustment that can be made to the cointegrating equation is small. The third step of the Engel and Yoo procedure is skipped. The next section describes the dynamic simulation.

(vi) Dynamic simulation: response properties the model

If the anti-export bias is reduced by 10 per cent, the volume of exports increases. This is shown in Figure 9 and 27 below. The actual increase in the volume of exports is very small but nevertheless shows that protection in fact has had an impact on South African exports.

Figure 9 Correction path of the South African aggregate export price with a 10% reduction in the anti-export bias

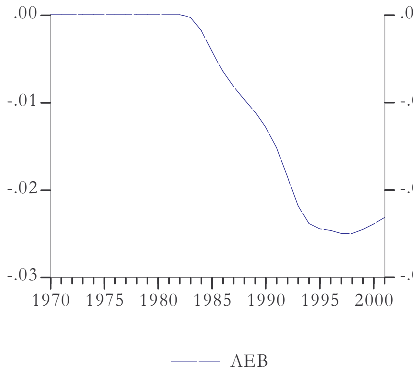
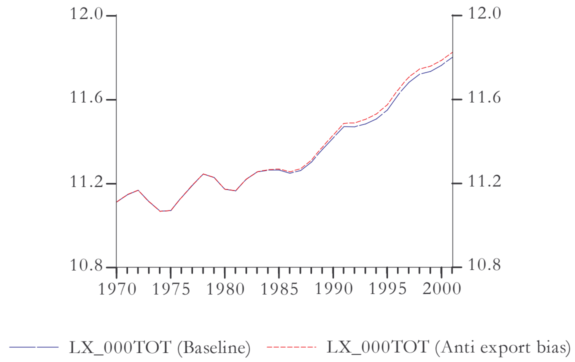


Figure 10 Dynamic adjustment in South African aggregate export price with a 10% reduction in the anti-export bias



Clearly by reducing the increased costs associated with tariff protection on imported inputs and by removing the incentive to serve the domestic market by making it more profitable, export volumes do increase. The effects of liberalisation are reflected in the growth of exports. This is confirmed by Fedderke and Vaze (2000) who too suggest that despite the general pessimism brought about by liberalisation, trade liberalisation in South Africa has had the effect of improved export performance (at least in some sectors).

5.5 South Africa's aggregated total manufactured exports

The same model and technique is applied to the manufacturing sector. The following is a summary of the estimations of South African export price and export volume equations. The cointegrated equation for the manufacturing sector's results is given in Table 14.

Table 14 Cointegration equation: South Africa's aggregated total manufactured exports

Variable	Coefficient
Cost of capital	0,447251
Unit labour cost	0,340219
C	-0,160487

Comparing the Engle-Granger test statistic of -4,208039 with the MacKinnon and specific cointegration augmented Dickey-Fuller critical values respectively, resulted in the acceptance of the null of cointegration in favour of stationary residuals and cointegrated variables.

Johansen

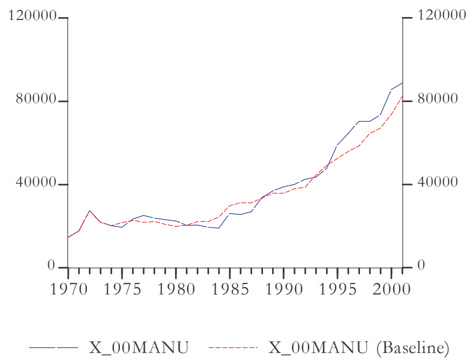
The short-run dynamics are estimated using the second stage of the Engel and Yoo technique and the resultant error correction model is given in Table 15.

Table 15 Error correction model: South Africa's aggregated total manufactured exports

Variable	Coefficient
Residual (-1)	-0,386899
∈ unit labour cost(-2)	-0,467894
∈ user –cost-of-capital (-4)	0,186074
C	0,137479

The actual export volumes are plotted against the estimated volumes in Figure 11.

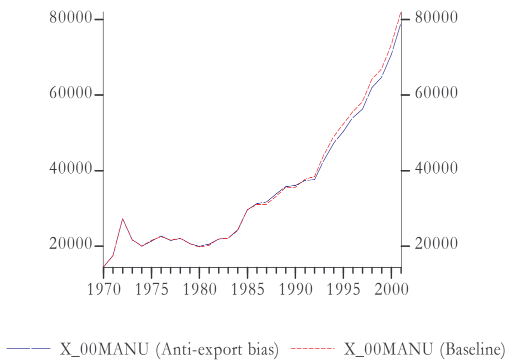
Figure 11 Actual and estimated of South African aggregated total manufactured exports



(i) Trade policy and anti export bias

South Africa imports a significant portion of its intermediate inputs; a lowering of import tariffs enhances competitiveness by reducing input costs. This is confirmed by Tsikata (1999) who found that a 1 per cent reduction in tariffs results in an 0,86 per cent long-run increase in manufactured exports and concluded that the anti-export bias introduced by protection declines when protection is lowered.

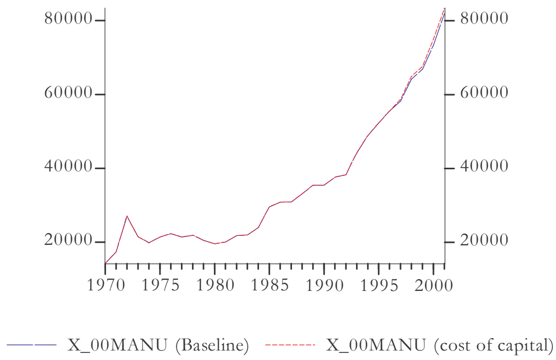
Figure 12 Correction path of the South African aggregate export volume with a 10% reduction in the anti-export bias



(ii) User-cost-of-capital

User-cost-of-capital was shocked and reduced by 10 per cent from 1995. The impact on export volumes is shown diagrammatically in Figure 13.

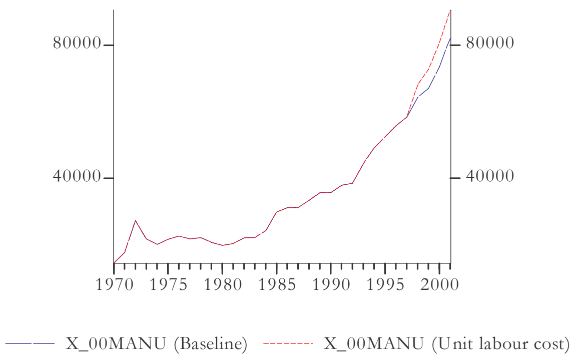
Figure 13 Dynamic adjustment in South African aggregate exports with a 10% reduction in the user-cost-of-capital



(iii) Unit labour cost

Unit labour costs were shocked and reduced by 10 per cent from 1995. The impact on export volumes is shown diagrammatically in Figure 14.

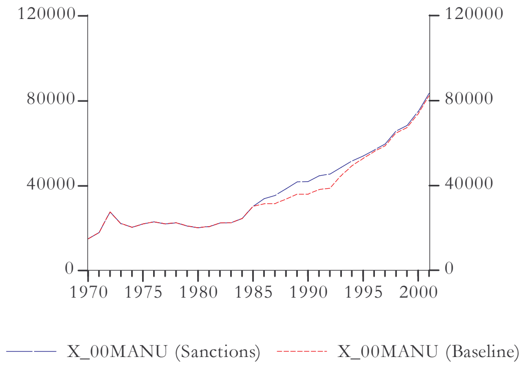
Figure 14 Dynamic adjustment in South African aggregate exports with a 10% reduction in the unit labour costs



(iv) Sanctions

As expected the impact of sanctions was evident from 1985. Even though many prohibitions were lifted during 1990 and 1991, the effect remained until 1996. Although the graph below shows the impact that sanctions had on export volumes, the prices of South African goods were also negatively affected.

Figure 15 Estimated South Africa's trade volumes without sanctions



5.6 South Africa's manufactured exports per industry

Chapters 3 and 4 highlight the importance of disaggregating trade to ascertain what the determinants of trade are. This section reports a synopsis of these determinants and only reports the models with the best theoretical and statistical fit. The other models that were estimated are reported in Appendices 14 and 15.

5.6.1 Export prices – per South African industrial sector

(i) Function estimated

Imported inputs are an important component of South Africa's cost structure and the effective rate of protection (erp) is included in the regression. Similarly, technical progress can also impact the production price. The model estimated is:

$$p_{saxi} = \alpha + \overset{+}{\beta_1}(ucc) + \overset{+}{\beta_2}ulc_i + \overset{+}{\beta_3}wdem + \overset{-}{\beta_4}erp_i + \overset{-}{\beta_5}tech_i + \overset{-}{\beta_6}d\_sanc + \varepsilon \quad \text{.........} (26)$$

Sectoral data on research and development was not available. Although technology is implicitly included in the *ulc* variable, a separate technology dummy was created (see Appendix 10 for full description) and tested to measure the influence of technology on export prices. The econometric estimations and statistical tests results are given in Appendix 14. The table below summarises the coefficients for their determinants.

The first step of the Engel and Yoo (1991) procedure was applied to the various models described above for each of the manufacturing sectors. The Johansen test was also applied to verify cointegration. As can be expected, cointegration was not achieved for all sectors despite various models being used. These results cannot be interpreted since spurious results occur. The comprehensive results are reported in Appendix 15, while the summary results are presented in Tables 32a and 32b below.

(ii) The estimation results of the cointegration equation

Table 16a Determinants of export prices

	Total	Manufacturing	Food	Beverages	Tobacco	Textiles	Clothing	Leather	Foot	Wood	Paper	Print	Basic Chemicals	Other Chemicals
LUCC	-0,01	*	0,924	*	0,428	0,586	*	0,152	*	*	0,292	1,085	0,479	0,494
LWPROD	1,782		0,641		-0,36	0,755		-0,69			0,400	-0,87	0,583	0,295
WDEM	0,006		0,002		0,019	0,005		-0,01			-0,00	0,013	-0,00	0,011
TECH	0,894		0,346					2,133			1,543		1,296	0,433
SANC	-0,11		-0,28					-0,88			-0,35		-0,79	-0,70
R-squared	0,944		0,784		0,889	0,637		0,937			0,740	0,524	0,916	0,979
Adj R-squared	0,939		0,764		0,884	0,621		0,931			0,716	0,503	0,909	0,977
Engle-Granger	-4,45		-4,07		-4,76	-4,44		-3,97			-4,13	-3,85	-4,79	-6,17

* indicates sectors where variables were not cointegrated.

Table 32b Determinants of export prices (continued)

	Petro	Rubber	Plastic	Glass	Non-Metal Products	Iron	Non-Ferrous Metal	Metal	Machinery	Electric Machinery	Motor Vehicles	Transport	Furniture	Other
LUCC	2,057	0,291	0,627	0,253	*	0,224	1,968	0,862	0,465	0,500	0,353	0,748	0,553	0,166
LWPROD	-0,77	-0,96	-0,68	-0,46		-0,27	-0,33	-0,42	-0,24	-0,59	-1,10	-0,02	0,148	0,160
WDEM		0,002	0,006	-0,00		0,010		-0,00	-0,00	-0,00	-0,00	0,018	0,005	-0,01
TECH		1,825	0,944	1,343				1,330	1,821	1,643	2,435		0,734	1,782
SANC		-0,05	-0,43	0,299				-0,41	-0,40	-0,54	0,378		-1,57	-0,11
ERP_TOT						30,00								
R-squared	0,304	0,981	0,972	0,640		0,829	0,098	0,935	0,976	0,949	0,968	0,730	0,977	0,533
Adj R-squared	0,289	0,980	0,969	0,607		0,815	0,079	0,928	0,974	0,944	0,965	0,718	0,975	0,490
Engle-Granger	-4,03	-5,97	-6,03	-4,31		-5,03	-3,84	-4,11	-7,10	-5,20	-4,86	-4,85	-3,93	-5,40

* indicates sectors where variables were not cointegrated.

(iii) Discussion of the results

Cointegrating equations could not be found for the beverages, clothing, footwear, wood, and non-metal products sectors, and are not reported here. Iron was only cointegrated when the effective rate of protection was included. The equation for the non-ferrous metal sector cointegrated but with a very low R-squared that was not sufficiently improved even using the third step of the Engel and Yoo procedure.

The short-run dynamics: error correction model (ECM) and diagnostic validation is reported in Appendix 15.

5.6.2 Export volume – per South African industrial sector

(i) Function estimated

Despite not being able to build and ECM for the aggregated manufacturing sector, various industries were estimated. Following the discussion above, the export demand and export supply functions are estimated. The first sectoral export demand model to be estimated is:

$$x_{sai} = \alpha + \overset{+}{\beta_1} p_i^* + \overset{-}{\beta_2} p_{saxi} + \overset{+}{\beta_3} y_{oecd} + \varepsilon \quad \text{.......} \quad (27)$$

where:

- x_{sa} is the represent the South African exports per sector;
- p^* and p_{sax} are the world and South African prices for each sector; and
- y_{oecd} represents the income of South Africa's trading partners (OECD countries).

(ii) Data

Relative prices are important. However, world prices (P^*) per sector are difficult to obtain. This is especially when trying to obtain prices that match the South African export basket. Therefore, proxies are used. These are calculated from price data per product collected by the IMF, import price data collected by the US and South African producer price index's import component.

These are reported below together with the Engle Granger test statistic. The leather, footwear, basic chemicals, glass, non-metallic products and the motor vehicle sectors are not cointegrated. Although their coefficients and test statistics are reported, they may be spurious and should not be interpreted.

Table 17a Real exports per sector with world prices

	FOOD	BEVERAGES	TOBACCO	TEXTILES	CLOTHING	LEATHER	FOOT	WOOD	PAPER
C	-3,667	-14,85**	-11,1*	-4,477**	3,758	-11,20**	-28,05**	-3,47**	-2,115
income	0,485**	0,818**	0,815*	0,581**	-0,132	0,803**	2,083**	0,323**	-0,334*
world price	-0,016	-1,81**	0,297	-0,129	0,861**	-0,743**	-4,634**	0,151	0,005
export price	-0,41**	2,475**	-0,626	-0,551*	-0,688*	0,562*	3,086**	-0,191	-0,181
R-squared	0,752	0,929	0,698	0,583	0,85	0,891	0,853	0,732	0,565
Engle-Granger	-3.351	-4.4224	-6.7713	-3.8428	-5.7393	-3.3444	-3.3099	-4.7235	-4.0725

Table 33b Real exports per sector with world prices (continued)

	PRINT	PETRO	BASIC CHEMICALS	OTHER CHEMICALS	RUBBER	PLASTIC	GLASS	NON-METAL PRODUCTS	IRON
C	4,668	4,225	-5,727**	-8,877**	-10,66**	-12,23**	-3,536**	-11,42**	-0,184
income	-0,414	-0,259	0,58**	0,634**	0,864**	0,68**	0,344**	0,757**	-0,225
world price	0,954	-0,201	-0,455	-0,471*	-0,825**	-0,653**	-0,018	-0,388	-0,035
export price	-0,069	-0,868	1,779*	0,549	-0,299	1,13**	-1,402*	4,47*	-0,034
R-squared	0,657	0,334	0,86	0,917	0,96	0,954	0,783	0,839	0,645
Engle-Granger	-5,0401	-6,3065	-2,3612	-3,9080	-4,6338	-6,0070	-3,0267	-2,5589	-4,502

Table 33c Real exports per sector with world prices (continued)

	NONFERROUS METAL	METAL	MACHINERY	ELECTRIC MACHINERY	MOTOR VEHICLES	TRANSPORT	FURNITURE	OTHER
C	-1,588	-8,211**	-10,26**	-5,785	-9,807**	-10,77**	-25,84**	3,599
income	0,409**	0,591**	0,796**	0,221	0,743**	0,83**	2,063**	-0,169
world price	0,761**	0,268**	-0,587*	-0,162	-0,44	-1,229*	-3,058**	-0,185
export price	-1,311**	-0,125	-0,434	1,08*	-0,354	0,934*	1,37**	0,611
R-squared	0,612	0,9	0,958	0,927	0,931	0,858	0,962	0,239
Engle-Granger	-4,0966	-3,4137	-5,1615	-4,4953	-3,3187	-6,9442	-5,4378	-6,2315

*(**) Significant at a 5(1) per cent level. (At a 5(1) per cent significance level the MacKinnon critical values are –3.60(-4.38) when a trend and a constant are included (ϑϑ), and –3.00(-3.75) when only a constant is included (ϑ:), and –1.95(-2.66) when neither is included (ϑ). The standard normal critical value is –1.708(-2.485).)

(iii) Discussion of the results

With the exception of the furniture sector, the income elasticity is less than one, indicating that sectors are losing market share. The clothing, iron and other manufactured products sectors with negative income elasticities but are not statistically significant.

The beverages, other chemical, rubber, plastic, machinery and furniture sectors have negative and significant world price elasticities. It would be expected that when competitors increase their prices, South African exports would increase. Clearly South African exporters in these sectors are operating in markets with differentiated products and price is not necessarily relevant. This is confirmed when the export price elasticities are analysed. The beverages, other chemical and plastic sectors have elasticities that are positive and significant. In other words, their exports increase as their prices increase. Beverages have a high elasticity of almost 2,5, indicating that their exports increase by 2,5 per cent for each 1 per cent increase in prices. This sector includes wine, where branding is very important. Besides the electrical machinery sector, that also has a positive export price elasticity, all other sectors that are significant, have negative coefficients.

5.7 Conclusion

This chapter reviewed previous research on export supply and demand equations, identified factors peculiar to South African exports and the determinants of South African export prices. It also identified and reviewed data used in a model. In this study, the impact of changes in output on export has been analysed in a time series context. The analysis was undertaken for total exports, the manufacturing sector and at individual industry level. Both the long-term and short-term models behave as expected. Importantly sectors respond differently to the variables. Policy-makers therefore should not use the same instruments to achieve their objectives.

Focusing on the South African export market, both the foreign demand for South African products and the determinants of the South African export price were considered. Globalisation and the increased international competitiveness have made export sensitive to costs. Although export elasticities are generally small and insignificant, implying that exports are not fully responsive to changes in economic activity and relative prices. Therefore, policy should aim at strengthening the responsiveness of these sectors. Information and access to alternative suppliers have made price important. Products have become more sophisticated and competition is often based on quality differences. This implies that relative costs are less significant. South African firms can compete on product differentiation rather than on price. Quality and specific features are therefore important.

The problematic nature of most estimates can be attributed to a few data points, given that the time-series techniques applied require many more data points. Pooling of sectors provides a remedy to that problem. Pooled regression results are more robust. For instance, a total pool of manufacturing sectors gives expected signs, at least for the long-run regression. Although these results will be discussed fully in Chapter 8, from the analysis it is clear that there are peculiarities that make analysis different in South Africa from other countries. Most important is the impact of sanctions. It appears that sanctions had an important impact on export prices. In order to retain export share, South African exporters had to sell at a discount. Normally, lower prices would have translated into additional export volume but that was not the case during the sanctions period.