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How Do South African Exports Respond to Price and Exchange Rate Changes? An Econometric Analysis of the Manufacturing Sector

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EXECUTIVE SUMMARY

This paper examines the response of South African manufacturing production to changes in prices and exchange rates. A restricted profit function is used to model the behaviour of the manufacturing sector, as well as a number of manufacturing sub-sectors, and of the agricultural and coal mining sectors. Labour and intermediate imports are treated as variable inputs into the productions process. Capital is treated as a fixed input. Outputs of the production process are goods for the domestic market and exports. Using estimates derived from the restricted profit function, both price and exchange rate elasticities are calculated.

There are a number of key findings:
- For the manufacturing sector as a whole, prices do determine output supply and input demand. This is the case for most manufacturing sub-sectors and agricultural production.
- Manufacturing export supply is very inelastic with respect to export prices, as well as domestic prices and import prices and wages. This means that price changes have a very small impact on the amount of exports supplied.
- Changes in the price of intermediate imports or the price of domestic goods have a larger impact on the quantity of exports supplied than do changes in the price of exports.
- Like export supply, domestic output supply is also very inelastic.
- In most sectors exports and domestic output are compliments. This suggests that an increase in domestic price increases export supply and *vice versa*.
- Both domestic supply and exports respond negatively to an exchange rate devaluation. We suggest that this is the result of the increase in the price of intermediate imports caused by a devaluation. The magnitude of this reaction has decreased since 1994.
- A 25% devaluation in the nominal effective exchange rate of the Rand (a devaluation similar to that experienced at the end of 2001) causes a 2 percent decrease in total manufactured exports and a 5 percent contraction in domestic supply. However, a number of sectors benefit from this depreciation. The electrical, radio and TV and transport sectors expand exports by between 4 and 5 percent in response to this devaluation. Domestic supply falls in all these sectors.
- The results of our estimations suggest three areas particularly relevant for policies designed to increase export supply and labour demand (and consequently decrease unemployment):
- Firstly, domestic prices (the price the producer receives in the domestic market) are one of the most important determinants of both export supply and labour demand. Policies which increase these prices will boost exports and the demand for labour. Policies which aim to increase firm efficiency, stimulate domestic demand, or decrease taxes should do this.
- Secondly, the price of intermediate imports has the largest effect on the quantity of exports produced. A decrease in this price through a reduction in tariffs would increase the quantity of exports and domestic goods produced. It would also increase labour demand.

- Thirdly, an exchange rate depreciation has a negative impact on exports. In order to overcome this firms need to export more. The export market provides a mechanism for firms to hedge their exposure, because of imported intermediate goods, to exchange rate movements.

1. INTRODUCTION

In an increasingly globalised world, manufacturing exports are an important component of South African economic policy. For those active in designing policy it is important to understand how these exports respond to price and exchange rate changes. Knowing the magnitude of the response (or elasticity) of export quantity to price changes helps to identify potentially successful policies. For example, if exports are unresponsive to price changes (or inelastic), then policies which target prices in an attempt to encourage exports will fail to achieve their goal.

In this paper the responses of export and domestic supply, and imported input and labour demand to changes in their own price, as well as to changes in the prices of the other inputs and outputs are examined. Supply and demand responses to changes in the nominal exchange rate are also considered. This is done for the manufacturing sector in total as well as a number of manufacturing sub-sectors, the coal mining sector and the agricultural produce sector.

This paper attempts to answer a number of questions:

1. Do prices matter for export supply, domestic supply, labour demand and intermediate imports?
2. If they do, what are the magnitudes of the supply and demand responses (elasticities) to own price changes, as well as to other input or output price changes?
3. Are outputs (goods for the domestic market and goods for the export market) substitutes or compliments?
4. Are inputs (labour and intermediate imports) substitutes or compliments?
5. What are the magnitudes of the supply and demand responses (elasticities) to nominal exchange rate changes?
6. Have responses to price and/or exchange rate changes changed since the end of apartheid, the repeal of sanctions in the early 1990's and recent trade liberalisation?
7. What are the likely effects of the depreciation of the Rand in late 2001?

To answer these questions an integrated production or restricted profit function approach is used. This assumes that exports and domestic goods are outputs of the production process, and that labour and imported intermediate goods are variable inputs into this process. Capital is a fixed input. A brief description of this model is provided in section 2, as well as an explanation of the estimation procedure and the calculations of the price and exchange rate elasticities. The technical details are described in the appendices. In section 3 South Africa's past export performance and the performance of the manufacturing sub-sectors as well as the agricultural and coal mining sectors is reviewed. Section 4 presents the results of our calculations of price and exchange rate elasticities. In section 5 the results of a number of simulations of changes in the exchange rate are presented. Section 6 discusses policy implications and concludes.

2. MODEL ESTIMATION[1]

The analysis in this paper is based on an integrated production or restricted profit function approach. It follows work by Burgess (1974), Kohli (1978) and Diewert and Morrison (1988). Lawrence and van der Westhuizen (1990) have applied this technique to the South African economy as a whole for the period 1974-1987.

The restricted profit function approach assumes firms are profit-maximisers and operate under conditions of perfect competition. Firms choose an optimum output and input mix based on a vector of (exogenous) international and domestic prices. In this model outputs are goods for the domestic market and export goods. Inputs are labour and imported intermediate goods. The assumption of exogenous prices means that firms are price takers in the input and output markets, and in the domestic and international markets. The capital accumulation process is not modelled. Instead the capital stock is assumed exogenous. The set of production possibilities is allowed to change with time as a result of technical progress.

It can be shown that differentiating the restricted profit function with respect to prices produces a system of input demand and output supply equations. In order to estimate this system a functional form needs to be imposed on the restricted profit function. A Generalised McFadden functional form developed by Diewert and Wales (1987) is used. This allows price elasticities to change over time. Furthermore, the Generalised McFadden functional form is chosen because it allows the curvature conditions, imposed by our theoretical model, to be tested. If these conditions do not hold, they may be easily imposed.

Constant returns to scale are assumed as there is evidence that these exist at the firm-level for South Africa (Rankin, 2002). This simplifies estimation and allows profits, outputs and inputs to be expressed per unit of capital.

The following system of input demand and output supply equations results:

$$q^d = \frac{\partial \pi}{\partial P^d} = b_d + b_{dd}\frac{P^d}{w^l} + b_{dx}\frac{P^e}{w^l} + b_{dm}\frac{w^m}{w^l} + b_{dt}t + \gamma_d t^2 \qquad (1)$$

$$q^x = \frac{\partial \pi}{\partial P^e} = b_x + b_{xx}\frac{P^e}{w^l} + b_{dx}\frac{P^d}{w^l} + b_{xm}\frac{w^m}{w^l} + b_{xt}t + \gamma_x t^2 \qquad (2)$$

$$q^l = \frac{\partial \pi}{\partial w^l} = b_l - \frac{1}{2}\left[b_{dd}\frac{P^{d2}}{w^{l2}} + b_{xx}\frac{P^{e2}}{w^{l2}} + b_{mm}\frac{w^{m2}}{w^{l2}}\right] - \left[b_{dx}\frac{P^d P^e}{w^{l2}} + b_{dm}\frac{P^d w^m}{w^{l2}} + b_{xm}\frac{P^e w^m}{w^{l2}}\right] + b_{lt}t + \gamma_l t^2 \qquad (3)$$

[1] In order to make this section as accessible as possible most technical discussion of the modelling procedure, the estimation process and calculations have been placed in the appendices. However, it still remains fairly technical. Readers not wishing to get bogged down in (some) technical details may skip to section three.

$$q^m = \frac{\partial \boldsymbol{p}}{\partial w^m} = b_m + b_{mm}\frac{w^m}{w^l} + b_{dm}\frac{P^d}{w^l} + b_{xm}\frac{P^e}{w^l} + b_{mt}t + g_m t^2 \qquad 4$$

Where:
q^d is the quantity of domestic goods per unit of capital;
q^x is the quantity of exports per unit of capital;
q^l is (minus) the quantity of labour per unit of capital;
q^m is (minus) the quantity of intermediate imports per unit of capital into the production process;
P^d is the price of domestic goods;
P^e is the price of exports;
w^m is the price of intermediate imports;
w^l is the price of labour; and
t is a technical progress or time term.

These equations express quantities as functions of relative prices, as well as a technological progress term that is allowed to vary (hence the squared term). Furthermore, one good – labour – (which all prices are relative to) has an asymmetrical role in the system.

A Full Information Maximum Likelihood (FIML) method is used for estimation. A number of tests of cross-equation symmetry and equality as well as a test of whether prices are significant and whether the technical progress terms are significant, are run. A check is done to ascertain whether the curvature conditions satisfy the theory. If not, a correction suggested by Wiley, Schmidt and Bramble (1973) is imposed.

The coefficient estimates obtained from this system are used to calculate price elasticities as well as exchange rate elasticities.

Price elasticities are calculated as:

$$E_{ij} = (p_j / q_i)(\partial q_i / \partial p_j) \qquad 5$$

In our model this becomes:

$$E_{ij} = (p_j / q_i)(b_{ij} / p_4) \text{ for } i, j = 1,2,3 \qquad 6$$

$$E_{i4} = (p_4 / q_i)(-\sum_{j=1}^{3} b_{ij} p_j / p_4^{\,2}) \text{ for } i = 1,2,3 \qquad 7$$

$$E_{4i} = (p_i / q_4)(-\sum_{j=1}^{3} b_{ij} p_j / p_4^{\,2}) \text{ i=1,2,3} \qquad 8$$

$$E_{44} = (p_4 / q_4)(\sum_{i=1}^{3}\sum_{j=1}^{3} b_{ij} p_i p_j / p_4^{\,3}) \qquad 9$$

Where the subscript 4 refers to the term in the denominator (wages). Quantities are measured per unit capital.

To determine the impact of exchange rates on the system, import and export price changes are expressed as the product of world prices and the nominal effective exchange rate. This does not change the setup of the system, as producers still

respond to the price they receive (the domestic price), but this allows for the impact of changes in the exchange rate to be isolated. This means differentiating the system with respect to the exchange rate (*e*). Exchange rate elasticities are expressed as:

$$E_{de} = \left(\frac{e}{q^d}\right)\left(\frac{\partial q^d}{\partial e}\middle| P^d, w^l\right) = \left(\frac{e}{q^d}\right)\left(b_{dx}\frac{P^{we}}{w^l} + b_{dm}\frac{w^{wm}}{w^l}\right) \quad 10$$

$$E_{xe} = \left(\frac{e}{q^x}\right)\left(\frac{\partial q^x}{\partial e}\middle| P^d, w^l\right) = \left(\frac{e}{q^x}\right)\left(b_{xx}\frac{P^{we}}{w^l} + b_{xm}\frac{w^{wm}}{w^l}\right) \quad 11$$

$$\begin{aligned} E_{le} &= \left(\frac{e}{q^l}\right)\left(\frac{\partial q^l}{\partial e}\middle| P^d, w^l\right) \\ &= \left(\frac{e}{q^l}\right)\left(-b_{xx}\frac{eP^{we2}}{w^{l2}} - b_{mm}\frac{ew^{wm2}}{w^{l2}} - b_{dx}\frac{P^d P^{we}}{w^{l2}} - b_{dm}\frac{P^d w^{wm}}{w^{l2}} - 2b_{xm}\frac{eP^{we}w^{wm}}{w^{l2}}\right) \end{aligned} \quad 12$$

$$E_{me} = \left(\frac{e}{q^m}\right)\left(\frac{\partial q^m}{\partial e}\middle| P^d, w^l\right) = \left(\frac{e}{q^m}\right)\left(b_{mm}\frac{w^{wm}}{w^l} + b_{xm}\frac{P^{we}}{w^l}\right) \quad 13$$

This partial differentiation holds domestic prices and wages constant. This is a potentially serious limitation because it fails to pick up the impact of a change in exchange rate on domestic prices, which in turn would have an impact on all other input and output quantities. It also fails to pick up the impact of changes of factor demands and output supplies, caused by exchange rate changes, on wages. This is not corrected for on this paper.

3. PAST EXPORT PERFORMANCE

Over the past three decades real South African manufacturing production has grow almost continuously. At the end of 2001 real total output (the sum of exports and domestic output) was more than double its value in 1970. As figure 1 illustrates the most rapid period of growth occurred in the late seventies, driven by growth in real domestic output, and corresponding with the dramatic increase in the gold price during this period. This higher level of output for the domestic market was sustained until 1984 but fell in 1985 and 1986, the years which correspond to the implementation of widespread economic sanctions.[2]

Since 1986 most of the increase in total output has been as a result of an increase in exports. Real exports have increased in value every year since 1981. The most rapid increase in exports was directly after the transition to a democratic South Africa. During the period from 1994 to 1996 real exports increased by almost 50%.

[2] This fall off in total output was probably not solely the result of economic sanctions, but also of the debt default of 1985, the associated balance of payments constraints and the ongoing political unrest.

In the late nineties and early naughties total manufacturing output has increased at a faster rate than much of the period. This has been a result of both an increase in production for the domestic market as well as export growth.

The third series graphed in figure 1 is the real capital stock. Like total output this grew during the early seventies, and grew more rapidly in the late seventies and early eighties. With the restriction on foreign investment, that coincided with sanctions, the capital stock declined and only reached pre-sanctions levels in 1991.

Figure 1: Real Manufacturing Output and the Capital Stock.

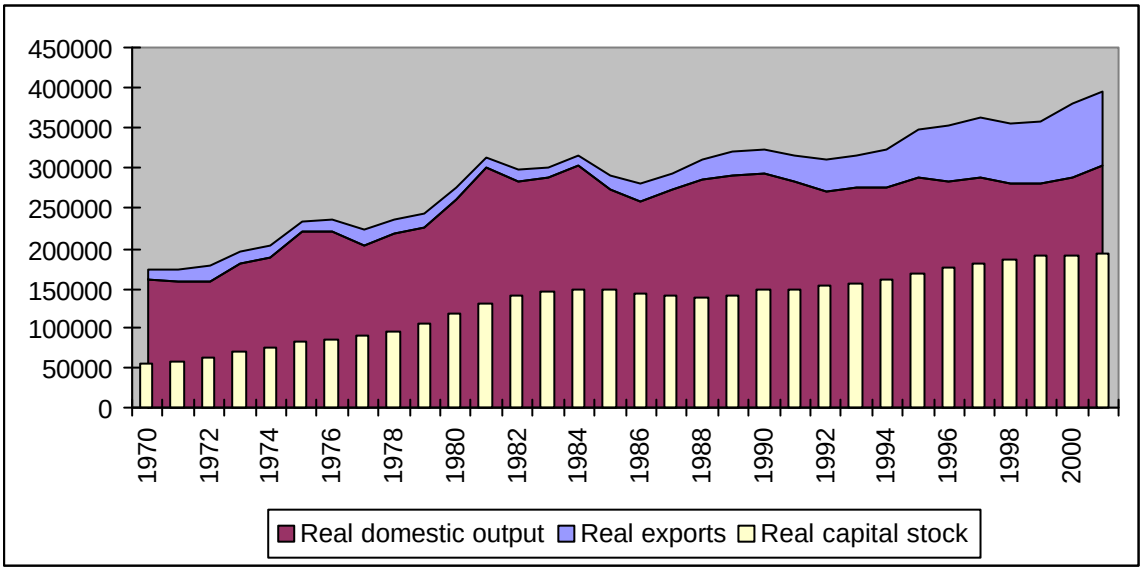
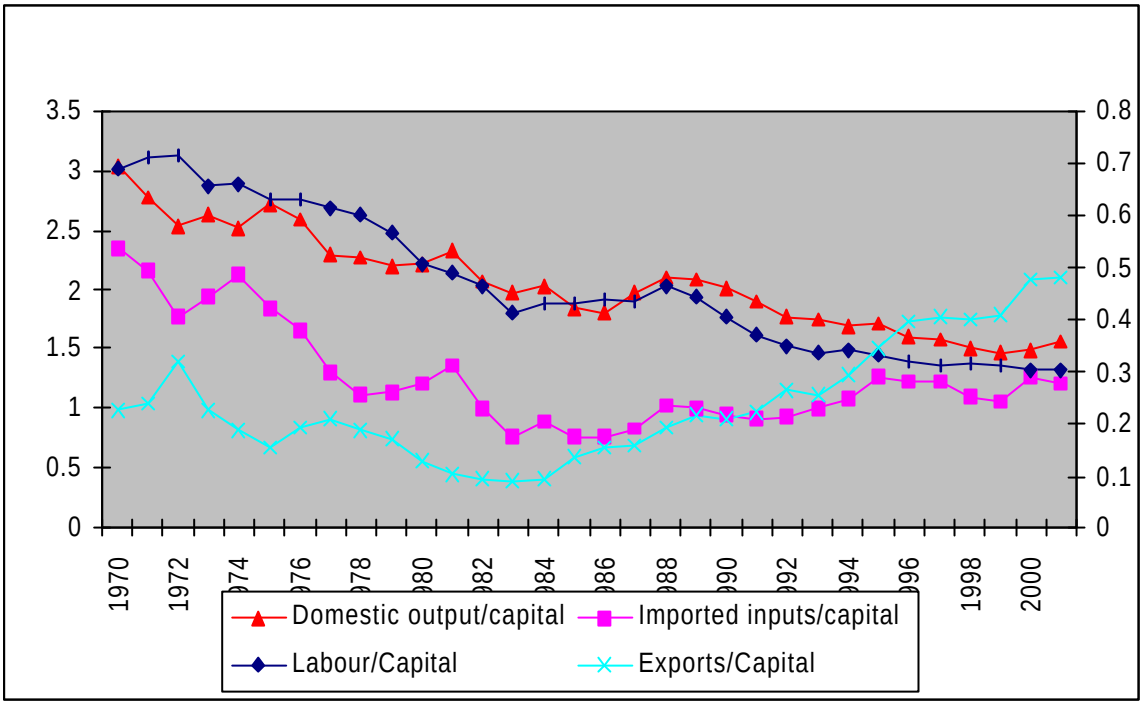


Figure 2 expresses outputs and inputs as a ratio to the capital stock. Over the period domestic output has become less capital intensive. The amount of exports per unit of capital increases dramatically after the mid 80's. This is a puzzle given that this period coincided with economic sanctions. One lkely answer may be that firms were forced to export because they required essential intermediate imports to produce for the domestic market. Exports would have provided the foreign currency to pay for these.

On the input side, the ratio of labour to capital has behaved in a similar way to the ratio of domestic output to capital. This suggests that labour is strongly related to the quantity of domestic output. Closer analysis suggests that the labour intensity of domestic output has declined by about 6% during this period. The ratio of imported intermediate inputs to capital declined in the first half of the period but has increased slightly since the mid-80's.

Figure 2. Output and Inputs as a Ratio to Capital



Note: Domestic output to capital is graphed on the left hand axis. All other series are graphed on the right hand axis.

Figure 3 graphs prices in relation to wages. Domestic output and capital prices follow a very similar pattern. A similar observation can be made for intermediate imports and export prices. This suggests that export and import prices are mostly determined by the exchange rate.

Figure 3. Output and Input Prices

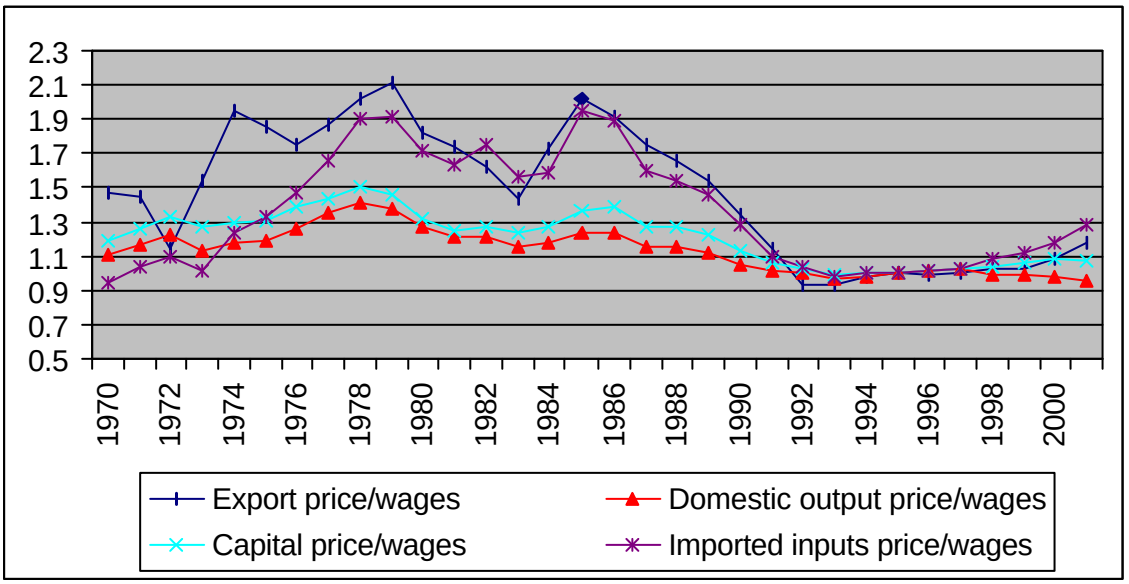
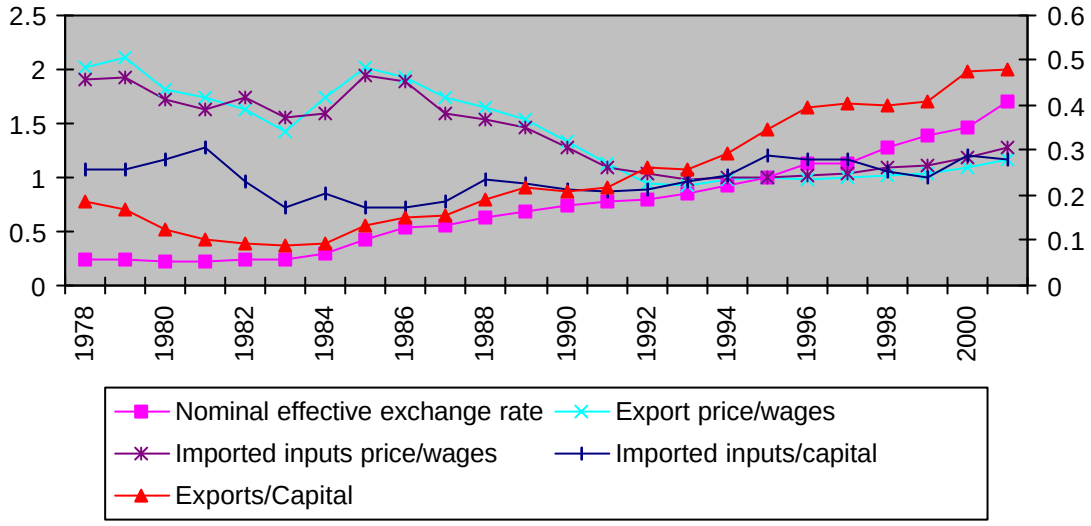


Figure 4 graphs, on different axes, the relationship between exports and imports per unit of capital and the nominal effective exchange rate. This exchange rate is

calculated as a trade-weighted index of the exchange rates of South Africa's major trading partners. It seems that exports and the exchange rate are very closely related. The relationship between imports and the exchange rate is less clear.

Figure 4. Imports, Exports and the Exchange Rate



Note: Import and export prices and the nominal exchange rate are graphed on the left hand axis. Export and imported quantities are graphed on the right hand axis.

3.1 Coal mining, agriculture, and manufacturing sub-sectors

The responsiveness of a number of manufacturing sub-sectors to price and exchange rate changes are also considered. The manufacturing sector is broken down into 9 sub-sectors. These are:

- food, beverages and tobacco (food);
- textiles, clothing and leather (textiles);
- wood and paper, publishing and printing (wood and paper);
- petroleum products, chemicals, rubber and plastics (chemicals);
- other non-metallic mineral products (non-metals);
- metals, metal products, machinery and equipment (metals);
- electrical machinery and apparatus (electrical);
- radio, TV, instruments, watches and clocks (radio and TV);
- transport equipment (transport).

Other manufacturing is excluded. Figure 5 gives an indication of the proportion of real total output for the various sub-sectors. The composition of manufacturing output has remained fairly constant over the period. The most noticeable change has been an increase in the size of the chemical sector and a decrease in the relative size of the metal sector.

Figure 5. Real Total Manufacturing Output by Sector

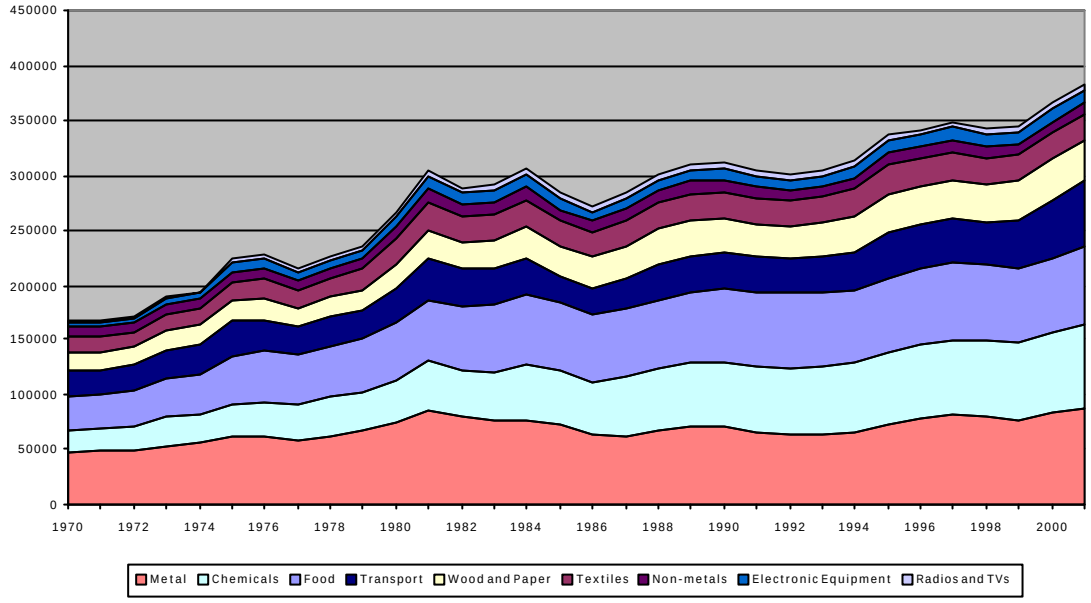


Figure 6 graphs real exports. Total manufacturing exports have increased dramatically since the mid-80's, mainly as the result of increases in the metal and chemical sectors. Since 1990 exports from the transport sector have increased in proportion to other sectors. The share of exports from the food sector has decreased over the period.

Figure 6. Real Exports by Sector

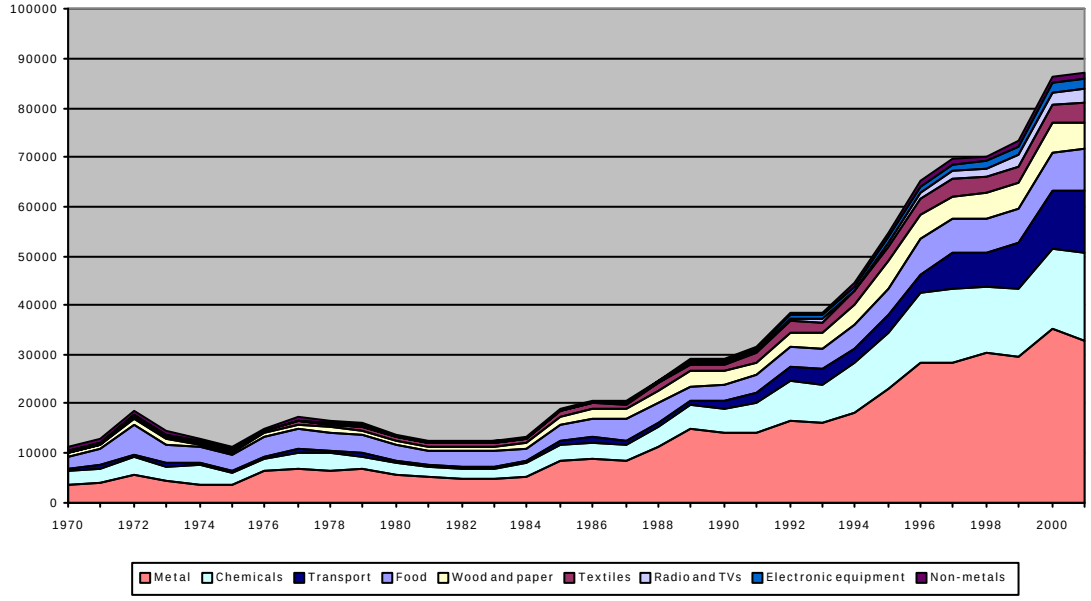
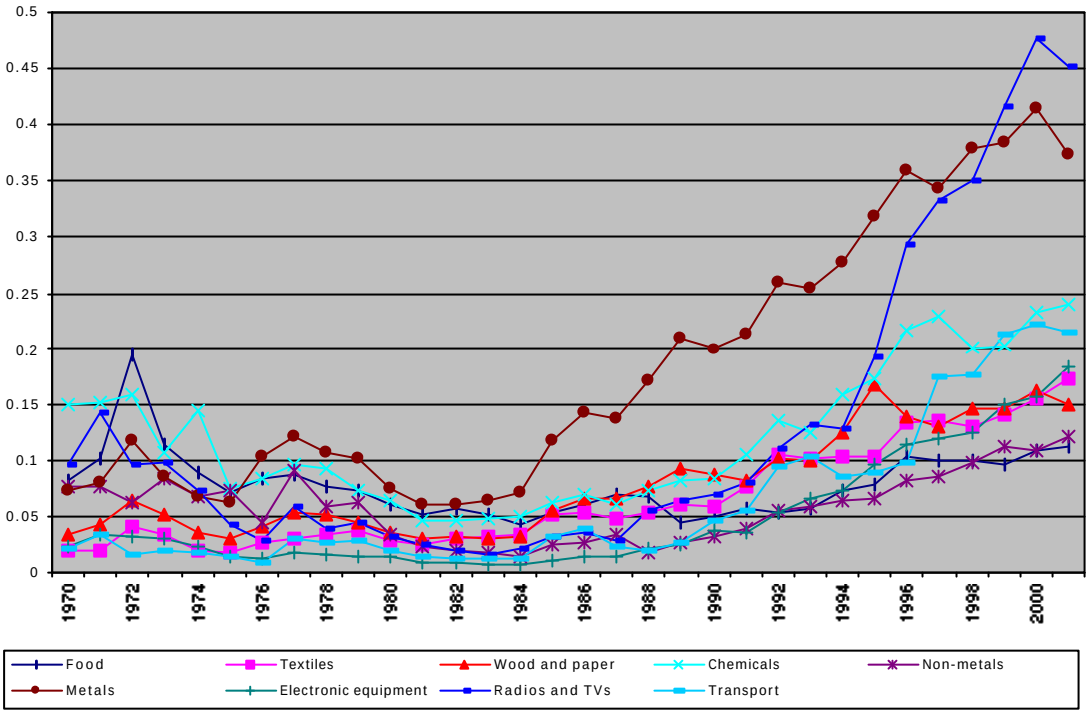


Figure 7 considers the ratio of exports to total output. Since 1984, this has increased for all sectors. The metal, and, radio and TV sectors were the most export intensive in 2001. Both these sectors have increased their export intensity during the latter half of

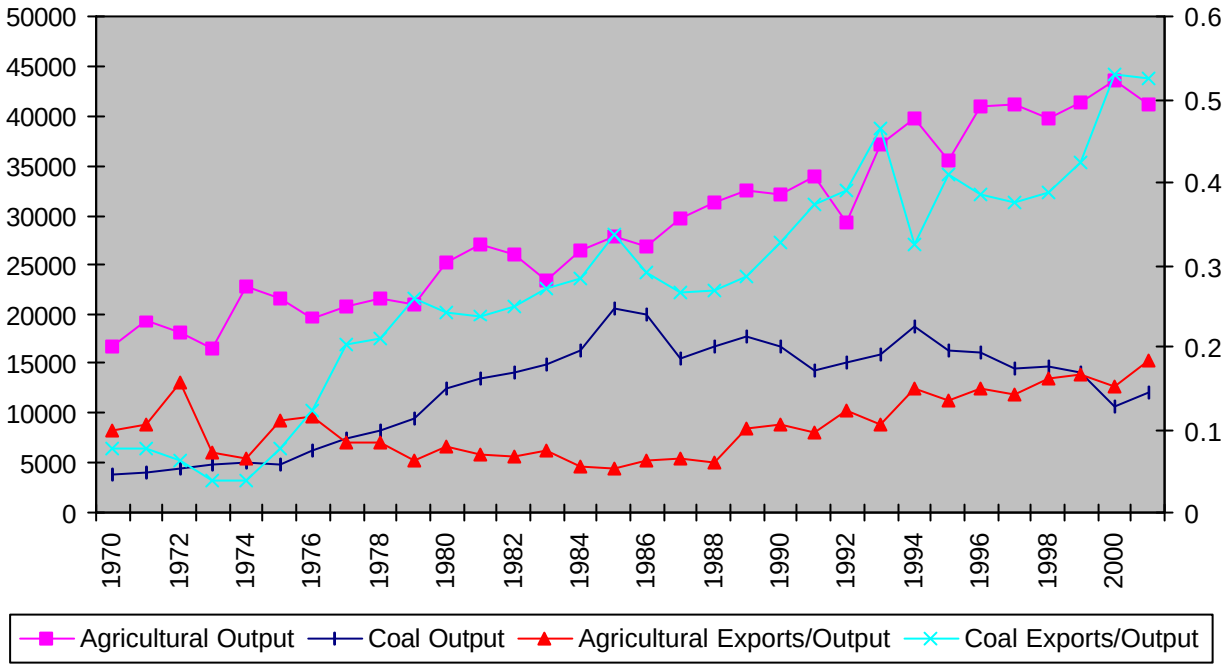
the period. This has been most spectacular for the radio and TV sector. The ratio of exports to domestic output in this sector has increased almost fourfold between 1994 and 2001.

Figure 7. Exports as a Percentage of Total Output, by Sector



In addition to the various manufacturing sub-sectors, we also attempt to model the agricultural and coal sectors. Since 1970, agricultural output has more than doubled in real terms. However, the ratio of agricultural exports to output was fairly constant between 1970 and 1989. Since then, this ratio has also doubled. Although the coal mining sector is smaller in value than agriculture, it exports over half its production. This ratio has increased from less than 10% in 1970 to over 50% in 2001. Coal output however, grew until the mid-80's and has been slowly declining since then.

Figure 8: Agriculture and Coal Output, and the Ratio of Exports to Output



Note: Agricultural and coal output are graphed on the left-hand axis. Ratios of exports to outputs are graphed on the right-hand axis.

4. RESULTS

The model is estimated for total manufacturing, as well as for the various sub-sectors and for agricultural production and coal mining. Tests are carried out on the model to test whether the model explains the observed behaviour for each sector or sub-sector. A more specific test on whether prices matter for determining quantities is also carried out.

The only sub-sector for which the model fits the data badly is the wood and paper sub-sector. The particular difficulty with this sector is the domestic supply equation.

Prices matter as a group for all sectors and sub-sectors, except coal mining, chemicals and non-metals.[3] These results suggest that in these sectors prices are not important in determining export and domestic output supply and imported inputs and labour demand. Further results for each of these sectors, nor for the wood and paper sector, are not reported.

The coefficient estimates obtained from the systems estimation are used to calculate the responsiveness, or elasticities, of output supply and input demand to price changes. A value greater than one suggests that quantities are elastic – a one percent increase in price results in a greater than one percent increase in quantity. Values

[3] A test for whether technical progress matters is also carried out. For all sectors it does.

close to zero suggest that quantities are not very responsive to price changes – they are inelastic.
Tables 1 – 4 present resultant changes in export and output supply, labour and intermediate import demand to a one percent change in output and input prices. These are estimates for 2001.

Table 1: Export supply elasticities for 2001.

	Elasticity of export supply to the price of:			
	exports	Domestic goods	Imported intermediate goods	Labour
Agriculture	**0.002**	**-0.008**	**-0.009**	**0.015**
- change since 1994	0.000	0.000	-0.002	0.002
Food	**0.077**	**0.061**	**0.021**	**-0.159**
- change since 1994	-0.020	-0.031	-0.005	0.056
Textiles	**0.048**	**0.207**	**-0.177**	**-0.078**
- change since 1994	-0.011	-0.103	0.028	0.086
Metals	**0.156**	**0.056**	**-0.225**	**0.013**
- change since 1994	-0.006	-0.034	0.051	-0.011
Electrical	**0.103**	**0.358**	**-0.012**	**-0.450**
- change since 1994	-0.132	-0.549	0.007	0.674
Radio and TV	**0.127**	**-0.123**	**-0.070**	**0.067**
- change since 1994	-0.219	0.351	0.144	-0.275
Transport	**0.072**	**-0.078**	**0.076**	**-0.070**
- change since 1994	-0.094	0.137	-0.034	-0.010
Total Manufactured	**0.159**	**0.276**	**-0.312**	**-0.122**
- change since 1994	-0.058	-0.190	0.087	0.160

Note: The change in elasticity is calculated as the value in 2001 minus the value in 1994. Thus if the elasticity in 2001 is positive, a negative change indicates that the elasticity was higher in 1994. If the elasticity in 2001 is negative, a negative change indicates that the elasticity was less negative in 1994, i.e. an increase in elasticity.

As Table 1 illustrates the overwhelming result is that exports are very inelastic, to all prices. A one percent increase in export prices causes, at most across all sectors, a 0.16 percent increase in export supply. This is for total manufacturing. In all sectors this responsiveness has declined since 1994. The least responsive sector is the agricultural sector where a change in export prices has little impact on export supply. Export supply for many sectors is more responsive to the price of domestic output than the price of exports. This is particularly the case in the textile sector – exports are four times more responsive to domestic prices than their own – and the electrical sector – exports are three times more responsive to domestic prices than their own. In both these sectors domestic and export supply are compliments and elasticities have fallen since 1994. Exports and domestic output are compliments for total manufacturing. An increase in the price of domestic goods results in an increase in the supply of exports. This will be discussed more fully later.

For most sectors export supply responds negatively to an increase in the price of intermediate imports. The exception to this is the food and the transport sectors. For

the manufacturing sectors as a whole, exports respond more strongly to changes in the price of intermediate imports than to other prices.

The electrical sector is the most sensitive sector to changes in wages. A one percent increase in wages causes almost half a percent decrease in exports. The least sensitive sectors to wage changes are the agricultural and metals sectors.

For the manufacturing sector as a whole, export supply has become less responsive to input and output price changes since 1994. This is the case in all sectors except agriculture and transport.

Table 2: Domestic supply elasticities for 2001.

	Elasticity of domestic supply to the price of:			
	exports	Domestic goods	Imported intermediate goods	labour
Agriculture	**-0.002**	**0.007**	**0.008**	**-0.013**
- change since 1994	0.000	0.001	0.003	-0.004
Food	**0.009**	**0.089**	**-0.110**	**0.012**
- change since 1994	0.002	0.006	-0.026	0.018
Textiles	**0.052**	**0.236**	**-0.169**	**-0.119**
- change since 1994	0.016	0.041	-0.061	0.003
Metals	**0.051**	**0.018**	**-0.073**	**0.004**
- change since 1994	0.017	-0.001	-0.016	-0.001
Electrical	**0.088**	**0.810**	**-0.374**	**-0.525**
- change since 1994	0.017	0.084	-0.157	0.056
Radio and TV	**-0.147**	**0.689**	**-0.290**	**-0.253**
- change since 1994	-0.075	0.215	-0.132	-0.008
Transport	**-0.026**	**0.511**	**-0.290**	**-0.194**
- change since 1994	-0.006	0.032	-0.147	0.121
Total Manufactured	**0.104**	**0.183**	**-0.196**	**-0.091**
- change since 1994	0.025	0.011	-0.056	0.021

Note: The change in elasticity is calculated as the value in 2001 minus the value in 1994. Thus if the elasticity in 2001 is positive, a negative change indicates that the elasticity was higher in 1994. If the elasticity in 2001 is negative, a negative change indicates that the elasticity was less negative in 1994, i.e. an increase in elasticity.

In all sectors, except metals, the elasticity of domestic supply to its own price is greater than the elasticity of export supply to its own price. The electrical, radio and TV, and transport sectors are the most sensitive to domestic prices. In all sectors, except metals, this responsiveness has increased since 1994. The responsiveness of domestic output to export prices is very low in all sectors.

In all cases, except agriculture, an increase in the price of imports results in a decrease in domestic supply. This response is again largest in the electrical, radio and TV, and transport sectors. These elasticities have grown since 1994. As with export supply, domestic supply in the electrical sector is the most responsive to wage changes. An increase in wages of one percent results in a half a percent decrease in domestic output. Other negative responses by domestic supply to wage changes occur in the

agricultural, textiles, radio and TV, transport and total manufacturing sectors. In general these relationships have not changed by much since 1994.

Table 3: Labour demand elasticities for 2001.

	Elasticity of labour demand to the price of:			
	exports	Domestic goods	Imported intermediate goods	labour
Agriculture	**-0.015**	**0.065**	**0.068**	**-0.118**
- change since 1994	-0.003	0.019	0.032	-0.048
Food	**0.204**	**-0.102**	**0.419**	**-0.521**
- change since 1994	0.060	-0.155	0.288	-0.192
Textiles	**0.069**	**0.422**	**0.013**	**-0.503**
- change since 1994	-0.011	-0.104	0.116	-0.001
Metals	**-0.043**	**-0.016**	**0.063**	**-0.004**
- change since 1994	-0.009	0.003	0.005	0.001
Electrical	**0.192**	**0.908**	**-0.195**	**-0.905**
- change since 1994	0.019	-0.228	0.038	0.171
Radio and TV	**-0.166**	**0.528**	**-0.157**	**-0.205**
- change since 1994	0.068	-0.579	0.121	0.390
Transport	**0.192**	**1.576**	**0.696**	**-2.464**
- change since 1994	0.150	-0.714	0.999	-0.434
Total Manufactured	**0.228**	**0.452**	**-0.239**	**-0.441**
- change since 1994	-0.009	-0.101	0.078	0.032

Note: The change in elasticity is calculated as the value in 2001 minus the value in 1994. Thus if the elasticity in 2001 is positive, a negative change indicates that the elasticity was higher in 1994. If the elasticity in 2001 is negative, a negative change indicates that the elasticity was less negative in 1994, i.e. an increase in elasticity.

The elasticity of labour demand to its own price is the most sensitive in the transport sector. A one percent increase in wages results in a 2.5 percent decrease in labour demanded. This sensitivity has increased since 1994. In all other sectors this relationship is not as large but in many it is larger than 0.5. In all sectors, except for electrical, radio and TV, and total manufacturing labour and intermediate imports are substitutes. This relationship is the strongest in the transport and food sectors and has become stronger since 1994.

The elasticity of labour demand to the price of domestic goods is largest in the transport sector. A one percent increase in domestic prices in this sector results in an increase in labour demand by 1.6 percent. The sector with the largest elasticity with respect to export prices is total manufacturing. A one percent increase in the export price of manufactured goods would result in an increase in labour demand by 0.23 percent.

Table 4: Import demand elasticities for 2001.

	Elasticity of import demand to the price of:			
	exports	Domestic goods	Imported intermediate goods	labour
Agriculture	**0.017**	**-0.072**	**-0.075**	**0.130**
- change since 1994	-0.006	0.011	-0.010	0.005
Food	**-0.034**	**1.173**	**-1.669**	**0.531**
- change since 1994	-0.005	-0.018	-0.288	0.311
Textiles	**0.221**	**0.845**	**-1.085**	**0.019**
- change since 1994	0.066	0.130	-0.373	0.176
Metals	**0.635**	**0.228**	**-0.918**	**0.055**
- change since 1994	0.062	-0.090	0.059	-0.032
Electrical	**0.018**	**2.367**	**-1.671**	**-0.713**
- change since 1994	0.004	0.393	-0.769	0.371
Radio and TV	**0.162**	**0.560**	**-0.577**	**-0.146**
- change since 1994	0.015	-0.156	0.007	0.134
Transport	**-0.077**	**0.866**	**-1.046**	**0.256**
- change since 1994	-0.022	0.122	-0.574	0.474
Total Manufactured	**0.493**	**0.820**	**-1.111**	**-0.202**
- change since 1994	0.031	-0.132	-0.133	0.235

Note: The change in elasticity is calculated as the value in 2001 minus the value in 1994. Thus if the elasticity in 2001 is positive, a negative change indicates that the elasticity was higher in 1994. If the elasticity in 2001 is negative, a negative change indicates that the elasticity was less negative in 1994, i.e. an increase in elasticity.

The elasticity of import demand to import prices is greater than one for the majority of sectors considered and has increased since 1994 for most sectors. In the food, textiles, electrical, transport and total manufacturing sectors a one percent increase in import price results in a decrease in import demand by more than one percent. This indicates that in these sectors imports are very sensitive to import prices. The magnitude of the import demand response to wages is far less for all sectors. This magnitude is greatest for the electrical sector (-0.71) and the food sector (0.53).

Import demand is very sensitive to the price of domestic goods in the electrical and food sectors. A one percent increase in the price of domestic goods results in a 2.4 percent increase in import demand in the electrical sector and a 1.2 percent increase in import demand in the food sector. Although these values are less than one for the other sectors, many of them have values close to unity. Import demand is most sensitive to export price in the metals sector. For total manufacturing a one percent increase in export prices results in a half a percent increase in import demand.

Table 5: Complementarities and substitutability of outputs and inputs

	exports and domestic supply	Intermediate imports and labour
Agriculture	Substitutes	Substitutes
Food	Compliments	Substitutes
Textiles	Compliments	Substitutes
Metals	Compliments	Substitutes
Electrical	Compliments	Compliments
Radio and TV	Substitutes	Compliments
Transport	Substitutes	Substitutes
Total Manufactured	Compliments	Compliments

In most cases exports and domestic output are complements. This suggests that an increase in the price of one leads to an increase in production of that good as well as the other. The exceptions to this are the agriculture sector as well as the radio and TV and transport sub-sectors. In these sectors an increase in the price of one good results in a shift of production away from the other good towards the good experiencing a price increase.

On the input side intermediate imports and labour are mostly substitutes – an increase in price of one causes an increase of the quantity demanded of the other. In the electrical, radio and TV and total manufacturing sectors inputs are compliments and thus an increase in the price of one would lead to a reduction in demand for both goods.

4.1 Exchange rate elasticities

Next, the response of outputs and inputs to nominal effective exchange rate changes are calculated. The nominal effective exchange rate is the weighted exchange rate of the Rand to the exchange rates of South Africa's major trading partners. A depreciation is represented as an increase in this rate. As mentioned earlier, the impact of exchange rate changes is isolated by holding prices of domestic output and labour, and world price of exports and intermediate imports constant. This method fails to capture the impact of exchange rate changes on domestic prices and wages – these are assumed exogenous – and thus the impact of these changes on quantities. This is a potentially serious limitation, but one we do not correct at this stage.[4]

Table 6 presents exchange rate elasticities for the various sub-sectors. Two things are striking in these results. Firstly, the supply side is very inelastic. This links with the findings that the supply-side is very price inelastic. The second striking feature is that in many sectors exports respond negatively to a devaluation. This is startling since one would expect a depreciation to increase the incentive to export (the domestic export supply price). A possible explanation for this finding is that a depreciation causes intermediate import costs to increase by more than it causes export revenue to increase. Given that domestic supply faces similar rising costs and thus contracts, that domestic output and exports are complements in many sectors, and that domestic

[4] The first step in correcting this would be to model domestic demand.

supply dominates exports in all sectors, this would cause exports to contract. This would be exacerbated if some intermediate imports were essential in the production process.

Table 6: Exchange Rate elasticties

	Exports	Domestic Supply	Imports	Labour
Agriculture				
2001	-0.007	0.006	-0.058	0.053
- change since 1994	-0.002	0.003	-0.016	0.029
Food				
2001	0.098	-0.101	-1.704	0.623
- change since 1994	-0.025	-0.024	-0.293	0.347
Textiles				
2001	-0.130	-0.118	-0.864	0.082
- change since 1994	0.017	-0.044	-0.306	0.105
Metals				
2001	-0.070	-0.023	-0.283	-0.919
- change since 1994	0.045	0.001	0.122	-0.36
Electrical				
2001	0.091	-0.285	-1.653	-0.003
- change since 1994	-0.125	-0.14	-0.764	0.057
Radio and TV				
2001	0.057	-0.437	-0.415	-0.323
- change since 1994	-0.075	-0.207	0.023	0.189
Transport				
2001	0.148	-0.316	-1.122	0.888
- change since 1994	-0.128	-0.153	-0.596	1.149
Total Manufacturing				
2001	-0.154	-0.092	-0.618	-0.012
- change since 1994	0.030	-0.031	-0.102	0.069

Note: The change in elasticity is calculated as the value in 2001 minus the value in 1994. Thus if the elasticity in 2001 is positive, a negative change indicates that the elasticity was higher in 1994. If the elasticity in 2001 is negative, a negative change indicates that the elasticity was less negative in 1994, i.e. an increase in elasticity.

For total manufacturing the response of exports to the exchange rate has decreased since 1994. This indicates that exports respond less negatively to an exchange rate depreciation than they did in 1994. Exports have become less responsive to exchange rate changes in all sectors except agriculture. In all sectors except textiles and radio and TVs imports have become much more responsive with regards to exchange rate changes.

5. SIMULATION RESULTS OF A DEPRECIATION

The estimated exchange rate elasticities as well as the coefficient estimates from our model, are used to investigate the implications of changes in the nominal exchange rate. These simulations are estimated for 2002. This model allows for output

quantities to change over time, independently of price changes, and thus, as column three illustrates, exports and domestic output quantities change even with no depreciation. The change in exports is largest for the textile sector – our model predicts a 3.2% increase in export supply in 2002. Domestic output supply is predicted to change the most in the metals sector. The model predicts a 4% decrease in domestic supply for this sector.

A simulation in which a 25% depreciation of the nominal exchange rate is assumed is run next. 25% is close to the actual nominal depreciation which occurred in the last months of 2001 and the first few months of 2002. The simulation predicts this depreciation to benefit the exports of the electrical, radio and TV, and transport sectors the most. These exports are predicted to increase by between 4 and 5 percent. It is only total manufacturing for which the model predicts a drop in exports. In this scenario domestic output is forecast to decline in all sectors except agriculture.

A simulation in which the Rand depreciates by 50% is also run. This larger depreciation causes a further expansion in agricultural exports, as well as exports from the food, electrical, radio and TV, and transport sectors. Domestic output supply is predicted to further contract for all sectors except agriculture.

The last scenario investigates the response to a 25% appreciation in the Rand. This appreciation would cause exports to expand in the agricultural, textiles, metals and total manufacturing sectors. The amount of domestic supply produced would increase relative to the no change scenario for all sectors except agriculture.

Table 7: Simulation results for 2002 (% Change in output)

	25% Appreciation	No Change	25% Depreciation	50% Depreciation
Agriculture				
Exports	0.024	0.022	0.020	0.018
Domestic Output	0.020	0.021	0.023	0.024
Intermediate imports	0.036	0.021	0.007	-0.008
Labour	0.005	0.018	0.032	0.045
Food				
Exports	-0.033	-0.009	0.016	0.040
Domestic Output	0.013	-0.012	-0.037	-0.063
Intermediate imports	0.396	-0.030	-0.456	-0.882
Labour	-0.182	-0.027	0.129	0.285
Textiles				
Exports	0.065	0.032	0.000	-0.033
Domestic Output	0.047	0.017	-0.012	-0.042
Intermediate imports	0.242	0.026	-0.190	-0.406
Labour	-0.002	0.019	0.039	0.060
Metals				
Exports	0.043	0.026	0.008	-0.009
Domestic Output	-0.035	-0.041	-0.046	-0.052
Intermediate imports	0.055	-0.016	-0.087	-0.157
Labour	0.172	-0.058	-0.288	-0.518
Electrical				
Exports	0.000	0.023	0.045	0.068
Domestic Output	0.078	0.007	-0.064	-0.135

Intermediate imports	0.424	0.010	-0.403	-0.816
Labour	-0.400	-0.401	-0.401	-0.402
Radio and TV				
Exports	0.013	0.027	0.041	0.056
Domestic Output	0.127	0.018	-0.092	-0.201
Intermediate imports	0.129	0.025	-0.079	-0.182
Labour	0.116	0.036	-0.045	-0.126
Transport				
Exports	-0.026	0.011	0.048	0.085
Domestic Output	0.049	-0.030	-0.109	-0.188
Intermediate imports	0.272	-0.009	-0.289	-0.570
Labour	-0.276	-0.054	0.168	0.390
Total Manufactured				
Exports	0.057	0.018	-0.020	-0.059
Domestic Output	-0.002	-0.025	-0.048	-0.071
Intermediate imports	0.142	-0.012	-0.167	-0.321
Labour	-0.028	-0.031	-0.034	-0.037

These simulation results suggest that the largest effect on the demand for imports of a 25 percent depreciation will be in the food and electrical sectors. A depreciation of this magnitude should cause a contraction in demand of between 40 and 50 percent. All sectors, except agriculture, experience a contraction in demand in this scenario.

In the 25 percent depreciation scenario labour demand contracts the most in the electrical sector. However, this contraction is driven by changes in the production structure, as can be seen by comparing this scenario with the others, rather than by changes in the exchange rate. The metal sector is also forecast to experience a large contraction in labour demand as a result of this depreciation. The largest increase in labour demand is predicted to be in the food and transport sectors. These increases are predicted to be 13 percent and 17 percent respectively. Labour demand in the manufacturing sector as a whole is predicted to contract by 3 percent.

6. CONCLUSION AND POLICY DISCUSSION

In this paper an attempt has been made to quantify the impact of price and exchange rate changes on the supply of exports and domestic output and the demand for labour and intermediate imports. A model, representative of the manufacturing sector, as well as various manufacturing sub-sectors and the agricultural and coal mining sectors, was constructed. This was done using a restricted profit function.

Tests were carried out on whether input and output prices significantly affect the supply of outputs and the demand for inputs. Prices are significant in all sectors except the coal mining sector, and the chemical and non-metal sub-sectors. It was also found that this model is not a good representation of the wood and paper sub-sector. This suggests that it is factors other than price which determine output supply and input demand in these sectors. The coefficient estimates obtained from the model were used to calculate price and exchange rate elasticities. In most cases output and

input quantities are not very responsive to prices. For the manufacturing sector as a whole the supply of exports is more responsive to the price of intermediate imports and domestic goods than to its own price. In many sectors the domestic and international markets are compliments. The demand for intermediate imports has the highest elasticities of all. Import demand is very sensitive to its own price.

Since 1994, the own price elasticity of exports has declined in all sectors indicating that exports are less responsive to price changes now than they were at the end of apartheid. The own price elasticity of import demand has increased since 1994 for most sectors. This suggests that South African manufacturers are better able to adjust their demand for imported intermediate goods when prices change than they were in 1994. This may be a result of tariff reduction, and a drop in import prices which facilitates an increase in import intensity, as well as integration into the world economy.

Turning to policy issues, there are a number of results from this paper relevant to export promotion. These include:

1. Real exports have undergone sustained growth since 1981. The most rapid increase in this growth was between 1994 and 1996.
2. Exports are generally unresponsive to their own price. This responsiveness has declined since 1994. They are more responsive to the price of intermediate imports and domestic goods.
3. Domestic output supply and export supply are compliments.
4. Exchange rate changes have a limited impact on export supply. This impact is negative.

These results suggest that the real export supply by South African manufacturing firms is growing, not as a result of price changes, but rather because of the changing structure of the South African economy. Policy that targets export prices will have little impact on export supply. This may be because South African manufacturers are not well integrated into export markets, or their products are price inelastic. More effective policies to increase export supply should target intermediate imports and domestic demand. A continued reduction in import tariffs, and thus a reduction in import price, will have beneficial consequences for both domestic and export supply. Policies that raise domestic producer prices, *ceteris paribus*, will also have a beneficial impact on both domestic and export supply.[5] Ways to do this would be to stimulate domestic demand, increase the efficiency of production, or reduce taxes on producers. These policy conclusions emphasis that domestic market considerations are a vital part of trade policy.

The results in this paper suggest that exchange rate depreciation is not helpful in stimulating export supply. Although, depreciation benefits certain sectors, it actually reduces the total amount exported by the manufacturing sector. It is likely that as more producers become exporters or existing exporters export more, the detrimental effects of a depreciation will decline. It is thus important to encourage producers to

[5] It must be borne in mind that these are the prices that the producer receives for his goods and excludes charges such as taxes. Although an increase in tax would increase producer prices, it would not increase the amount the producer receives and thus not have the desired effect.

enter the export market, and to encourage exporters to expand their activities. Not only do exports offer the opportunity to increase revenue but more importantly, as highlighted in this paper, they provide a mechanism to hedge against import price increases. This has important ramifications in the domestic market. Events such as the depreciation of the Rand in late 2002 provide an opportunity to highlight, to both producers and the public, the importance of exports.

Although promoting exports is an important policy, the most pressing economic challenge in South Africa is to create employment and stimulate labour demand. This has not been the focus of this paper, but our results suggest some relevant policy implications. Our results suggest that the price of domestic goods is the most important price determining labour demand. Thus, policies that stimulate domestic producer prices, such as stimulating domestic demand, increasing efficiency and the reduction of import prices, will have positive implications for labour demand. The responsiveness of labour demand to wages is of a similar magnitude to the response to domestic price. Labour demand responds negatively to wage demands and thus wage increases in general are likely to have detrimental effects on labour demand. This is particularly the case in sectors such as transport. However, in the metals sector, there is scope for wages to increase with little detriment to labour demand and output.

Promoting exports and stimulating labour demand require related policies. This paper highlights three policy areas which do both. Firstly, domestic market policies which would increase domestic output and consequently export supply and labour demand. These policies could take the form of stimulating domestic demand and/or increasing efficiency. Secondly, a reduction in import prices, through a reduction in tariffs, which would increase domestic output, exports and labour demand. Thirdly, an exchange rate depreciation does not benefit exports in general. Given that the Rand floats freely, and likely future depreciations in the currency, there is thus a pressing need to encourage more producers to enter the export market, and to convince those already exporting to increase their export intensity. This would allow producers to hedge against exchange rate depreciations. Policies which target these three issues are key for promoting exports and stimulating labour demand.

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APPENDIX A: MODEL STRUCTURE

We assume firms are profit-maximisers and operate under conditions of perfect competition. Firms choose an optimum output and input mix based on a vector of (exogenous) international and domestic prices and a stock of factor endowments. This implicitly assumes that firms are price takers in the input and output markets, and in the international and domestic markets. We do not attempt to model the capital accumulation process. Instead the capital stock is assumed exogenous.

The technology available is represented by a production possibilities set $S_t \equiv \{(x, K^t, t)\}$, where $x \equiv (x_1, ..., x_N)$ is an N-dimensional vector of both domestic and international net outputs (if $x_n < 0$, then good n is an input), and $K^t \equiv (K_1^t, ..., K_J^t)$ is a nonnegative J-dimensional vector of capital stocks utilised by the private sector in period t. The production possibilities set S is allowed to change over time due to technical progress t. We let $p^t \equiv (p_1^t, ..., p_N^t)$ be the positive vector of prices faced by domestic producers in period t. During each time period firms maximise profit, $Ð^t$, by choosing the levels of inputs and outputs, x^t, given the price levels, p^t, of these inputs and outputs, and the capital stock, K^t. The chosen input-output mix must be part of the production possibilities set, S^t. The restricted profit function is thus: (Diewert and Morrison, 1988):

$$\Pi^t(p^t, K^t, t) \equiv \max_x \left\{ p^t.x : (x, K^t, t) \in S^t \right\} \qquad A1$$

From Hotelling's Lemma[6] the economy's observed net output (both domestic and international) vector is equal to the vector of the derivatives of the restricted profit function with respect to the components of p^t (if these derivatives exist); that is,

$$x^t = \nabla_p \Pi^t(p^t, w^t, K^t, t), \qquad A2$$

where ∇ is the vector differential operator. Thus $\nabla_p \Pi^t(p^t, w^t, K^t, t)$ is the vector of first-order derivatives of $Ð$ with respect to the components of p.

These net output and input vectors are explicitly based on short-run decisions because they are conditional on fixed stock levels of capital.

Functional forms

In order not to place limitations on the partial elasticities of outputs and inputs we need to estimate a flexible functional form. We use a Generalised McFadden (GM) functional form proposed by Diewert and Wales (1987). This allows us to easily check that the correct curvature conditions hold and to impose these if necessary.

The Generalised McFadden functional form can be represented as:

[6] differentiating the profit function with respect to the prices gives the output supply and input demand functions.

$$\Pi^1(p,K,t) \equiv g^1(p)K + \sum_{i=1}^{N} b_{ii}\, p_i K + \sum_{i=1}^{N} b_i\, p_i + \sum_{i=1}^{N} b_{it} p_i\, tK$$
$$+ b_t(\sum_{i=1}^{N} \alpha_i\, p_i)t + b_{KK}(\sum_{i=1}^{N} \beta_i\, p_i)^2 + b_{tt}(\sum_{i=1}^{N} \gamma_i\, p_i)t^2 K \qquad \text{A3}$$

where

$$g^1(p) = \frac{1}{2}\, p_1^{-1} \sum_{i=2}^{N}\sum_{j=2}^{N} c_{ij} p_i p_j \quad \text{where } c_{ij} = c_{ji} \text{ for } 2 \le i, j \le N \qquad A4$$

We impose constant returns to scale, given that some evidence exists that this is the case for South African firms (Rankin, 2002). This constraint is equivalent to: $\gamma^T p^* \neq 0$, and $b_i = 0, b_t = 0, b_{KK} = 0$ for $i = 1,..., N$.

The model that we construct has two outputs – domestic output and exports – and two variable inputs – labour and intermediate imported goods which enter into the manufacturing process. The capital stock is assumed exogenous. We allow for technical progress through a quadratic expression of time.

We divide the Generalised McFadden function through by capital (this assumes constant returns to scale). The LHS is thus profit per unit capital. Our model is thus represented:

$$\begin{aligned} p\left(P_t^d, P_t^e, w_t^l, w_t^m, t\right) &= b_d P_t^d + b_x P_t^e + b_l w_t^l + b_m w_t^m \\ &+ b_{dt} P_t^d t + b_{xt} P_t^e t + b_{lt} w_t^l t + b_{mt} w_t^m t \\ &+ \gamma_d P_t^d t^2 + \gamma_x P_t^e t^2 + \gamma_l w_t^l t^2 + \gamma_m w_t^m t^2 \\ &+ \frac{1}{2} b_{dd} \frac{\left(P_t^d\right)^2}{w_t^l} + \frac{1}{2} b_{xx} \frac{\left(P_t^e\right)^2}{w_t^l} + \frac{1}{2} b_{mm} \frac{\left(w_t^m\right)^2}{w_t^l} \\ &+ b_{dx}\left(\frac{P_t^d P_t^e}{w_t^l}\right) + b_{dm}\left(\frac{P_t^d w_t^m}{w_t^l}\right) + b_{xm}\left(\frac{P_t^e w_t^m}{w_t^l}\right) \end{aligned} \qquad 14$$

Where:
P_t^d is domestic prices;
P_t^e is export prices;
w_t^m is intermediate import prices;
w_t^l is wages; and
t represents technological change.

As explained above we need to choose a good to be the asymmetrical term. As exports are the variable we are most interested in it is logical to choose one of the other goods for the asymmetric term. We are also particularly interested in the behaviour of domestic output and intermediate imports and eliminate these as possibilities. We thus choose wages.

From Hotelling's Lemma, differentiating this profit function with respect to prices yields the output supply functions (for exports and domestic output) and input demand functions (for labour, intermediate imports).
These are:

$$q^d = \frac{\partial \boldsymbol{p}}{\partial P^d} = b_d + b_{dd}\frac{P^d}{w^l} + b_{dx}\frac{P^e}{w^l} + b_{dm}\frac{w^m}{w^l} + b_{dt}t + \boldsymbol{g}_d t^2 \qquad 15$$

$$q^x = \frac{\partial \boldsymbol{p}}{\partial P^e} = b_x + b_{xx}\frac{P^e}{w^l} + b_{dx}\frac{P^d}{w^l} + b_{xm}\frac{w^m}{w^l} + b_{xt}t + \boldsymbol{g}_x t^2 \qquad A5$$

$$q^l = \frac{\partial \boldsymbol{p}}{\partial w^l} = b_l - \frac{1}{2}[b_{dd}\frac{P^{d2}}{w^{l2}} + b_{xx}\frac{P^{e2}}{w^{l2}} + b_{mm}\frac{w^{m2}}{w^{l2}}]$$
$$-[b_{dx}\frac{P^d P^e}{w^{l2}} + b_{dm}\frac{P^d w^m}{w^{l2}} + b_{xm}\frac{P^e w^m}{w^{l2}}] \qquad 16$$
$$+b_{lt}t + \boldsymbol{g}_l t^2$$

$$q^m = \frac{\partial \boldsymbol{p}}{\partial w^m} = b_m + b_{mm}\frac{w^m}{w^l} + b_{dm}\frac{P^d}{w^l} + b_{xm}\frac{P^e}{w^l} + b_{mt}t + \boldsymbol{g}_m t^2 \qquad A6$$

Where:
q^d is the quantity of domestic goods per unit of capital;
q^x is the quantity of exports per unit of capital;
q^l is (minus) the quantity of labour per unit of capital; and
q^m is (minus) the quantity of intermediate imports per unit of capital into the production process.

Diewert and Wales (1987) demonstrate that it is easy to check whether the correct curvature conditions hold. These required curvature conditions arise from the assumption that profit is convex in prices. It is simply a matter of checking whether the matrix: $\begin{pmatrix} b_{xx} & b_{xd} & b_{xm} \\ b_{dx} & b_{dd} & b_{dm} \\ b_{mx} & b_{md} & b_{mm} \end{pmatrix}$ where $b_{ij} = b_{ji}$, 17
is positive semi-definite.
This can be done by checking that there are no negative eigenvalues. If the correct curvature conditions do not hold Diewert and Wales demonstrate that a legitimate technique to use to impose the correct curvature conditions is that of Wiley, Schmidt and Bramble (1973). This entails replacing the matrix of quadratic terms $B = [b_{ij}]$ with the product of a lower triangular matrix and its transpose:

$B = CC^T$ where $C = [c_{ij}]$ and $c_{ij} = 0$ for $i < j$.

We can thus impose the correct curvature conditions on the function by representing B as:

$$B = \begin{pmatrix} c_{11}^{\ 2} & c_{11}c_{12} & c_{11}c_{13} \\ c_{11}c_{12} & c_{12}^{\ 2} + c_{22}^{\ 2} & c_{12}c_{13} + c_{22}c_{23} \\ c_{11}c_{13} & c_{12}c_{13} + c_{22}c_{23} & c_{13}^{\ 2} + c_{23}^{\ 2} + c_{33}^{\ 2} \end{pmatrix} \qquad A7$$

APPENDIX B: ESTIMATION RESULTS

Table B1: Uncorrected and Corrected Estimates (Total Manufacturing)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.1559**	0.0373	4.18	0.0003	**0.1576**
b_{xt}	**-0.0190**	0.0055	-3.45	0.0018	**-0.0209**
$\tilde{a}_x$	**0.0009**	0.0002	4.22	0.0002	**0.0009**
b_d	**2.6786**	0.3305	8.11	<.0001	**2.5689**
b_{dt}	**-0.0589**	0.0263	-2.24	0.0334	**-0.0556**
$\tilde{a}_d$	**0.0006**	0.0008	0.76	0.4555	**0.0005**
b_m	**-0.3496**	0.1190	-2.94	0.0065	**-0.3390**
b_{mt}	**0.0244**	0.0104	2.35	0.0259	**0.0232**
$\tilde{a}_m$	**-0.0006**	0.0003	-1.94	0.0622	**-0.0006**
b_l	**-0.6262**	0.1143	-5.48	<.0001	**-0.5663**
b_{lt}	**0.0187**	0.0049	3.78	0.0008	**0.0192**
$\tilde{a}_l$	**-0.0002**	0.0001	-1.55	0.1344	**-0.0003**
b_{xx}	**0.0164**	0.0549	0.3	0.7677	**0.0649**
b_{xd}	**0.2077**	0.0615	3.38	0.0022	**0.1382**
b_{xm}	**-0.1238**	0.0417	-2.97	0.0062	**-0.1171**
b_{dd}	**0.0913**	0.3255	0.28	0.7813	**0.2985**
b_{dm}	**-0.2077**	0.1422	-1.46	0.1555	**-0.2385**
b_{mm}	**0.2259**	0.0787	2.87	0.0079	**0.2415**
R^2 values					
Exports	0.935				0.923
Domestic Output	0.930				0.929
Intermediate imports	0.938				0.938
Wages	0.968				0.972
Log likelihood	267.63				264.59
Number of observations	32				

Table B2: Uncorrected and Corrected Estimates (Agriculture Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.0673**	0.0141	4.78	<.0001	**0.0616**
b_{xt}	**-0.0064**	0.0016	-4.13	0.0003	**-0.0061**
$\tilde{a}_x$	**0.0003**	0.0000	6.42	<.0001	**0.0003**
b_d	**0.3127**	0.0582	5.38	<.0001	**0.3250**
b_{dt}	**0.0032**	0.0063	0.5	0.6198	**0.0032**
$\tilde{a}_d$	**0.0004**	0.0002	2.42	0.022	**0.0004**
b_m	**-0.0269**	0.0058	-4.67	<.0001	**-0.0256**
b_{mt}	**0.0022**	0.0011	2.04	0.051	**0.0021**
$\tilde{a}_m$	**-0.0001**	0.0000	-4.07	0.0003	**-0.0001**
b_l	**-0.0954**	0.0179	-5.33	<.0001	**-0.0956**
b_{lt}	**0.0030**	0.0012	2.49	0.0197	**0.0028**
$\tilde{a}_l$	**-0.0002**	0.0001	-3.51	0.0017	**-0.0002**
b_{xx}	**-0.0038**	0.0085	-0.44	0.6608	**0.0003**
b_{xd}	**-0.0073**	0.0250	-0.29	0.7713	**-0.0011**
b_{xm}	**0.0037**	0.0056	0.66	0.5171	**-0.0008**
b_{dd}	**0.0539**	0.0950	0.57	0.5747	**0.0044**
b_{dm}	**-0.0055**	0.0132	-0.42	0.6773	**0.0032**
b_{mm}	**0.0016**	0.0031	0.54	0.5967	**0.0023**
R^2 values					
Exports	0.946				0.943
Domestic Output	0.929				0.921
Intermediate imports	0.912				0.929
Wages	0.938				0.923
Log likelihood	400.11				394.98
Wald test on price*	27.98				
[Prob]	<.0001				
Wald test on time**	803.61				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B3: Uncorrected and Corrected Estimates (Coal Mining Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**-0.2096**	0.3944	-0.53	0.5994	**-0.2109**
b_{xt}	**0.1014**	0.0302	3.36	0.0023	**0.1005**
$\tilde{a}_x$	**-0.0028**	0.0010	-2.9	0.0072	**-0.0028**
b_d	**3.0927**	1.1143	2.78	0.0097	**3.2696**
b_{dt}	**-0.0359**	0.0984	-0.36	0.7184	**-0.0460**
$\tilde{a}_d$	**-0.0018**	0.0035	-0.51	0.6138	**-0.0015**
b_m	**-0.1031**	0.1936	-0.53	0.5987	**-0.1121**
b_{mt}	**-0.0314**	0.0140	-2.25	0.0328	**-0.0299**
$\tilde{a}_m$	**0.0010**	0.0004	2.29	0.03	**0.0009**
b_l	**-1.3147**	0.5692	-2.31	0.0291	**-1.4018**
b_{lt}	**0.0792**	0.0498	1.59	0.1242	**0.0869**
$\tilde{a}_l$	**-0.0013**	0.0017	-0.74	0.4667	**-0.0015**
b_{xx}	**0.0780**	0.1281	0.61	0.5479	**0.0926**
b_{xd}	**-0.0219**	0.3673	-0.06	0.9528	**-0.0276**
b_{xm}	**0.0601**	0.0513	1.17	0.2521	**0.0454**
b_{dd}	**0.1686**	0.9787	0.17	0.8645	**0.0082**
b_{dm}	**-0.0307**	0.1855	-0.17	0.8696	**-0.0135**
b_{mm}	**0.0105**	0.0827	0.13	0.8995	**0.0223**
R^2 values					
Exports	0.7534				0.7522
Domestic Output	0.8568				0.8589
Intermediate imports	0.7399				0.7497
Wages	0.9066				0.9015
Log likelihood	107.3354				106.9504
Wald test on price*	4.43				
[Prob]	0.6181				
Wald test on time**	76.92				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B4: Uncorrected and Corrected Estimates (Food Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.4667**	0.0514	9.08	<.0001	**0.4399**
b_{xt}	**-0.0363**	0.0114	-3.19	0.0035	**-0.0324**
$\tilde{a}_x$	**0.0009**	0.0004	2.15	0.0401	**0.0009**
b_d	**3.1188**	0.2222	14.04	<.0001	**3.0631**
b_{dt}	**0.0725**	0.0268	2.7	0.0115	**0.0661**
$\tilde{a}_d$	**-0.0031**	0.0009	-3.48	0.0016	**-0.0029**
b_m	**-0.4173**	0.0650	-6.41	<.0001	**-0.4045**
b_{mt}	**0.0144**	0.0095	1.51	0.1422	**0.0153**
$\tilde{a}_m$	**-0.0003**	0.0003	-1.1	0.2807	**-0.0003**
b_l	**-0.4390**	0.0894	-4.91	<.0001	**-0.3825**
b_{lt}	**-0.0031**	0.0084	-0.37	0.714	**-0.0027**
$\tilde{a}_l$	**0.0003**	0.0002	1.26	0.2202	**0.0003**
b_{xx}	**-0.0619**	0.0592	-1.05	0.3045	**0.0207**
b_{xd}	**0.1472**	0.1011	1.46	0.1567	**0.0199**
b_{xm}	**-0.0133**	0.0545	-0.24	0.8092	**0.0054**
b_{dd}	**-0.0592**	0.2033	-0.29	0.7733	**0.2317**
b_{dm}	**-0.1753**	0.1213	-1.45	0.1598	**-0.2227**
b_{mm}	**0.2372**	0.1208	1.96	0.0601	**0.2456**
R^2 values					
Exports	0.935				0.923
Domestic Output	0.930				0.929
Intermediate imports	0.938				0.938
Wages	0.968				0.972
Log likelihood	267.63				
Wald test on price*	26.13				
[Prob]	0.0002				
Wald test on time**	112.88				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B5: Uncorrected and Corrected Estimates (Textile Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**-0.1566**	0.1408	-1.11	0.2756	**-0.0330**
b_{xt}	**-0.0080**	0.0062	-1.3	0.2058	**-0.0106**
$\tilde{a}_x$	**0.0012**	0.0002	5.55	<.0001	**0.0013**
b_d	**2.0335**	0.8078	2.52	0.0178	**1.7957**
b_{dt}	**0.2061**	0.0327	6.3	<.0001	**0.2107**
$\tilde{a}_d$	**-0.0037**	0.0011	-3.52	0.0015	**-0.0039**
b_m	**-0.2269**	0.2323	-0.98	0.3371	**-0.2550**
b_{mt}	**-0.0036**	0.0081	-0.44	0.6652	**-0.0033**
$\tilde{a}_m$	**-0.0005**	0.0002	-1.94	0.0627	**-0.0005**
b_l	**-0.3934**	0.3310	-1.19	0.2454	**-0.3270**
b_{lt}	**-0.0381**	0.0101	-3.78	0.0008	**-0.0399**
$\tilde{a}_l$	**0.0005**	0.0003	1.6	0.1219	**0.0005**
b_{xx}	**-0.0982**	0.1740	-0.56	0.577	**0.0427**
b_{xd}	**0.4727**	0.2007	2.36	0.026	**0.2241**
b_{xm}	**-0.1178**	0.1602	-0.74	0.4685	**-0.1510**
b_{dd}	**0.7649**	0.7794	0.98	0.3351	**1.2302**
b_{dm}	**-0.7434**	0.3715	-2	0.0555	**-0.6944**
b_{mm}	**0.6849**	0.2182	3.14	0.0041	**0.7022**
R^2 values					
Exports	0.9822				0.9765
Domestic Output	0.868				0.8747
Intermediate imports	0.908				0.9064
Wages	0.8483				0.8469
Log likelihood	157.07				153.38
Wald test on price*	19.39				
[Prob]	0.0036				
Wald test on time**	458.18				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B6: Uncorrected and Corrected Estimates (Wood and Paper Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.0856**	0.1554	0.55	0.5859	**0.0993**
b_{xt}	**0.0082**	0.0161	0.51	0.6119	**0.0042**
$\tilde{a}_x$	**0.0003**	0.0005	0.57	0.5734	**0.0004**
b_d	**1.8544**	0.8556	2.17	0.0389	**1.8316**
b_{dt}	**0.0045**	0.1037	0.04	0.9654	**0.0114**
$\tilde{a}_d$	**0.0001**	0.0030	0.03	0.9744	**-0.0002**
b_m	**-0.4469**	0.1684	-2.65	0.013	**-0.4312**
b_{mt}	**0.0131**	0.0116	1.13	0.2686	**0.0130**
$\tilde{a}_m$	**-0.0005**	0.0003	-1.55	0.1324	**-0.0005**
b_l	**-0.5367**	0.2653	-2.02	0.0535	**-0.5363**
b_{lt}	**0.0383**	0.0353	1.08	0.2884	**0.0370**
$\tilde{a}_l$	**-0.0009**	0.0011	-0.83	0.4129	**-0.0008**
b_{xx}	**-0.0440**	0.0921	-0.48	0.637	**0.0573**
b_{xd}	**0.1646**	0.1675	0.98	0.3347	**0.0133**
b_{xm}	**-0.1763**	0.0533	-3.31	0.0027	**-0.1665**
b_{dd}	**0.7434**	0.5690	1.31	0.2023	**0.9760**
b_{dm}	**-0.1431**	0.1751	-0.82	0.4209	**-0.1700**
b_{mm}	**0.4997**	0.1369	3.65	0.0011	**0.5015**
R^2 values					
Exports	0.8392				0.7774
Domestic Output	-0.1218				-0.0284
Intermediate imports	0.7488				0.7518
Wages	0.793				0.7944
Log likelihood	154.81				152.20
Wald test on price*	42.06				
[Prob]	<.0001				
Wald test on time**	268.18				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B7: Uncorrected and Corrected Estimates (Chemical Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.2833**	0.1041	2.72	0.011	**0.2972**
b_{xt}	**-0.0299**	0.0084	-3.55	0.0014	**-0.0332**
$\tilde{a}_x$	**0.0009**	0.0002	3.64	0.0011	**0.0010**
b_d	**2.1650**	0.3486	6.21	<.0001	**1.9775**
b_{dt}	**-0.1174**	0.0576	-2.04	0.0512	**-0.0968**
$\tilde{a}_d$	**0.0025**	0.0021	1.16	0.2556	**0.0018**
b_m	**-0.6064**	0.2487	-2.44	0.0214	**-0.5068**
b_{mt}	**0.0465**	0.0286	1.63	0.1147	**0.0342**
$\tilde{a}_m$	**-0.0011**	0.0010	-1.14	0.2633	**-0.0007**
b_l	**-0.4028**	0.0806	-5	<.0001	**-0.3591**
b_{lt}	**0.0240**	0.0090	2.67	0.0128	**0.0220**
$\tilde{a}_l$	**-0.0005**	0.0003	-1.85	0.0757	**-0.0005**
b_{xx}	**-0.0062**	0.1696	-0.04	0.971	**0.0540**
b_{xd}	**0.1230**	0.1658	0.74	0.4643	**0.0764**
b_{xm}	**-0.0599**	0.2414	-0.25	0.8058	**-0.0788**
b_{dd}	**-0.3043**	0.3318	-0.92	0.3672	**0.1084**
b_{dm}	**0.1300**	0.3338	0.39	0.6999	**-0.1106**
b_{mm}	**-0.0707**	0.4146	-0.17	0.8659	**0.1230**
R^2 values					
Exports	0.8601				0.8347
Domestic Output	0.659				0.6861
Intermediate imports	0.5469				0.5763
Wages	0.7488				0.7389
Log likelihood	226.64				219.79
Wald test on price*	9.23				
[Prob]	0.1608				
Wald test on time**	90.56				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B8: Uncorrected and Corrected Estimates (Non-metals Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.2699**	0.0799	3.38	0.0022	**0.2695**
b_{xt}	**-0.0234**	0.0062	-3.75	0.0008	**-0.0234**
$\tilde{a}_x$	**0.0007**	0.0002	3.16	0.0038	**0.0007**
b_d	**1.4547**	0.6654	2.19	0.0373	**1.4515**
b_{dt}	**-0.0571**	0.0408	-1.4	0.1734	**-0.0569**
$\tilde{a}_d$	**0.0012**	0.0012	0.94	0.3547	**0.0012**
b_m	**-0.3010**	0.2907	-1.04	0.3094	**-0.2991**
b_{mt}	**0.0291**	0.0206	1.41	0.1691	**0.0290**
$\tilde{a}_m$	**-0.0007**	0.0007	-1.05	0.3005	**-0.0007**
b_l	**-0.4470**	0.2422	-1.85	0.0764	**-0.4460**
b_{lt}	**0.0206**	0.0173	1.19	0.2462	**0.0205**
$\tilde{a}_l$	**-0.0003**	0.0005	-0.65	0.5195	**-0.0003**
b_{xx}	**0.0181**	0.0309	0.58	0.5641	**0.0183**
b_{xd}	**-0.0896**	0.1083	-0.83	0.4154	**-0.0890**
b_{xm}	**0.0254**	0.0668	0.38	0.7074	**0.0248**
b_{dd}	**0.9298**	0.8018	1.16	0.2563	**0.9354**
b_{dm}	**-0.2493**	0.4089	-0.61	0.5471	**-0.2528**
b_{mm}	**0.0661**	0.2435	0.27	0.7883	**0.0684**
R^2 values					
Exports	0.8308				0.8308
Domestic Output	0.6675				0.6679
Intermediate imports	0.6746				0.6747
Wages	0.8378				0.8378
Log likelihood	219.00				219.00
Wald test on price*	9.58				
[Prob]	0.1434				
Wald test on time**	69.41				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B9: Uncorrected and Corrected Estimates (Metal Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**0.1763**	0.0867	2.03	0.0517	**0.1911**
b_{xt}	**-0.0020**	0.0089	-0.23	0.8225	**-0.0040**
$\tilde{a}_x$	**0.0005**	0.0003	1.86	0.0731	**0.0006**
b_d	**2.2141**	0.3583	6.18	<.0001	**2.1644**
b_{dt}	**-0.0312**	0.0273	-1.14	0.2634	**-0.0282**
$\tilde{a}_d$	**-0.0003**	0.0010	-0.31	0.7551	**-0.0004**
b_m	**-0.3957**	0.0944	-4.19	0.0003	**-0.3964**
b_{mt}	**0.0173**	0.0045	3.88	0.0006	**0.0171**
$\tilde{a}_m$	**-0.0004**	0.0002	-2.55	0.0165	**-0.0004**
b_l	**-0.7349**	0.1685	-4.36	0.0002	**-0.7144**
b_{lt}	**0.0181**	0.0078	2.34	0.0275	**0.0183**
$\tilde{a}_l$	**-0.0001**	0.0003	-0.35	0.7281	**-0.0001**
b_{xx}	**0.0323**	0.0727	0.44	0.6599	**0.0695**
b_{xd}	**0.1037**	0.0864	1.2	0.2401	**0.0378**
b_{xm}	**-0.1218**	0.0470	-2.59	0.0152	**-0.1144**
b_{dd}	**-0.1088**	0.2676	-0.41	0.6876	**0.0206**
b_{dm}	**-0.0549**	0.0818	-0.67	0.5076	**-0.0622**
b_{mm}	**0.1897**	0.0507	3.74	0.0009	**0.1882**
R^2 values					
Exports	0.921				0.9102
Domestic Output	0.7742				0.7711
Intermediate imports	0.796				0.7965
Wages	0.9117				0.912
Log likelihood	219.32				218.05
Wald test on price*	33.98				
[Prob]	<.0001				
Wald test on time**	160.38				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B10: Uncorrected and Corrected Estimates (Electrical Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**-0.0535**	0.0931	-0.57	0.5704	**-0.0668**
b_{xt}	**-0.0359**	0.0030	-11.98	<.0001	**-0.0387**
$\tilde{a}_x$	**0.0016**	0.0001	15.34	<.0001	**0.0017**
b_d	**1.2291**	1.0024	1.23	0.2303	**1.1465**
b_{dt}	**0.0088**	0.1108	0.08	0.9371	**0.0115**
$\tilde{a}_d$	**0.0005**	0.0036	0.14	0.887	**0.0004**
b_m	**-0.1675**	0.1521	-1.1	0.2802	**-0.1405**
b_{mt}	**0.0243**	0.0152	1.6	0.1211	**0.0258**
$\tilde{a}_m$	**-0.0009**	0.0006	-1.54	0.1346	**-0.0009**
b_l	**-0.0973**	0.3930	-0.25	0.8064	**-0.0635**
b_{lt}	**0.0278**	0.0361	0.77	0.4479	**0.0266**
$\tilde{a}_l$	**-0.0018**	0.0011	-1.74	0.0933	**-0.0018**
b_{xx}	**-0.0791**	0.0838	-0.94	0.3537	**0.0702**
b_{xd}	**0.3447**	0.2340	1.47	0.1523	**0.2692**
b_{xm}	**0.0846**	0.1025	0.83	0.4163	**-0.0060**
b_{dd}	**2.5430**	0.8249	3.08	0.0047	**2.7108**
b_{dm}	**-0.8857**	0.2083	-4.25	0.0002	**-0.8623**
b_{mm}	**0.3665**	0.1544	2.37	0.025	**0.4203**
R^2 values					
Exports	0.9901				0.9857
Domestic Output	0.5367				0.5391
Intermediate imports	0.6802				0.6897
Wages	0.9504				0.95
Log likelihood	155.87				152.32
Wald test on price*	92.13				
[Prob]	<.0001				
Wald test on time**	479.42				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B11: Uncorrected and Corrected Estimates (Radio and TV Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|	**Corrected WSB Estimate**
b_x	**1.0633**	0.7482	1.42	0.1663	**1.0236**
b_{xt}	**-0.1359**	0.0343	-3.96	0.0005	**-0.1378**
$\tilde{a}_x$	**0.0061**	0.0009	7.11	<.0001	**0.0061**
b_d	**0.0111**	0.6460	0.02	0.9865	**-0.0079**
b_{dt}	**0.4196**	0.0780	5.38	<.0001	**0.4199**
$\tilde{a}_d$	**-0.0112**	0.0027	-4.21	0.0002	**-0.0112**
b_m	**-0.4239**	0.8009	-0.53	0.6007	**-0.4006**
b_{mt}	**0.0063**	0.0387	0.16	0.8719	**0.0070**
$\tilde{a}_m$	**-0.0011**	0.0011	-0.94	0.3568	**-0.0011**
b_l	**-0.0352**	0.2002	-0.18	0.8618	**-0.0204**
b_{lt}	**-0.0083**	0.0226	-0.37	0.7154	**-0.0076**
$\tilde{a}_l$	**-0.0008**	0.0006	-1.22	0.2316	**-0.0008**
b_{xx}	**0.1808**	1.5612	0.12	0.9086	**0.2958**
b_{xd}	**-0.4022**	1.3745	-0.29	0.7721	**-0.4130**
b_{xm}	**-0.1404**	1.4268	-0.1	0.9223	**-0.1880**
b_{dd}	**2.7601**	1.3510	2.04	0.0509	**2.7957**
b_{dm}	**-0.9281**	0.8884	-1.04	0.3054	**-0.9350**
b_{mm}	**0.7414**	1.3179	0.56	0.5784	**0.7657**
R^2 values					
Exports	0.9397				0.9405
Domestic Output	0.6921				0.6915
Intermediate imports	0.7672				0.7669
Wages	0.898				0.8968
Log likelihood	50.08				50.01
Wald test on price*	16.97				
[Prob]	0.0094				
Wald test on time**	337.90				
[Prob]	<.0001				
Number of observations	32				

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

Table B12: Uncorrected Estimates (Transport Sector)

Parameter	**Uncorrected Estimate**	Approx Std Err	t Value	Approx Pr > |t|
b_x	**0.2417**	0.1290	1.87	0.0714
b_{xt}	**-0.0509**	0.0105	-4.83	<.0001
$\tilde{a}_x$	**0.0023**	0.0003	6.97	<.0001
b_d	**5.1402**	1.5548	3.31	0.0026
b_{dt}	**-0.0634**	0.1383	-0.46	0.6501
$\tilde{a}_d$	**-0.0007**	0.0041	-0.18	0.8571
b_m	**-1.0315**	0.2693	-3.83	0.0007
b_{mt}	**0.0521**	0.0246	2.12	0.0434
$\tilde{a}_m$	**-0.0014**	0.0008	-1.7	0.0998
b_l	**-0.6665**	0.4485	-1.49	0.1492
b_{lt}	**0.0089**	0.0305	0.29	0.772
$\tilde{a}_l$	**0.0005**	0.0008	0.64	0.5279
b_{xx}	**0.0617**	0.0837	0.74	0.4673
b_{xd}	**-0.0824**	0.1571	-0.52	0.604
b_{xm}	**0.0413**	0.0801	0.52	0.6103
b_{dd}	**1.9593**	0.8635	2.27	0.0315
b_{dm}	**-0.5734**	0.2532	-2.26	0.0318
b_{mm}	**0.3567**	0.1150	3.1	0.0045
R^2 values				
Exports	0.9456			
Domestic Output	0.638			
Intermediate imports	0.7403			
Wages	0.8987			
Log likelihood	100.29			
Wald test on price*	20.58			
[Prob]	0.0022			
Wald test on time**	557.81			
[Prob]	<.0001			
Number of observations	32			

Note: * This is the adjusted Wald test of the null: $b_{xx}=b_{xd}=b_{xm}=b_{dd}=b_{dm}=b_{mm}=0$.

** This is the adjusted Wald test of the null: $b_{xt}=\tilde{a}_x=b_{dt}=\tilde{a}_t=b_{mt}=\tilde{a}_m=b_{lt}=\tilde{a}_l=0$.

The uncorrected estimates satisfy the curvature conditions and so no corrected estimates are reported.