Wages, productivity and export performance in South Africa: A dynamic panel analysis.

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Abstract

This paper focuses on the changing cost competitiveness of South African labour at a sectoral level and the effect this has had on export performance since the 1970s. We compare Relative Unit Labour Costs (RULC) across a wide range of countries and find that South Africa is cost competitiveness vis-à-vis developed economies, but not vis-à-vis developing economies. Labour cost competitiveness has improved during the 1990s, but much of this has been brought about by the substantial depreciation of the currency. RULC have a significant impact on export performance in the long run. A 1 % rise in RULC reduces real exports by between 1.64 % and 2.32 % in the long run. Improvements in relative productivity boost exports while rising relative wages reduce exports.

I. Introduction

With the end of Apartheid and the new government, South Africa's trade policy regime has shifted in the 1990s from one of import substitution towards one of export orientation. This process has taken the form of an accelerated tariff liberalisation program since 1994, the adoption of export orientation policies that ranged from direct support (GEIS) to marketing related assistance, and a macroeconomic strategy (GEAR) that was explicitly expected to transform South Africa into a "competitive, outward orientated economy" (GEAR, 1996).

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The successes of these policies in South Africa have been mixed. While export growth has risen, this has not been significantly greater than other dynamic emerging economies. Import penetration, particularly within labour intensive sectors, has also risen, raising questions about the cost competitiveness of domestic labour. Finally, employment has continued to fall, despite the recovery in output growth. Although the evidence suggests that this is not due to trade (Edwards, 2000, Fedderke *et al*. 1999), the public perception of the correlation between tariff liberalisation and continued losses in employment make this a contentious debate. This paper extends this debate and focuses on the changing cost competitiveness of South African labour and the effect this has had on South African export performance.

As the South African economy liberalises its trading regime, the ability of domestic producers to effectively participate in the global economy will increasingly be defined by their cost or price competitiveness vis-à-vis the rest of the world. This importance placed on international competitiveness has given rise to a wide literature covering a diverse range of competitiveness measures. In South Africa these include real effective exchange rates (IMF, 1998, Kahn, 1998, Tsikata, 1999, and Golub, 2000), unit labour costs (Nordas, 1996, and Golub, 2000), revealed comparative advantage measures (Edwards, Mlangeni, Van Seventer, 2000, and Valentine and Krasnik, 2000) and other composite measures. Two conclusions generally arise from these analyses. First, South Africa is competitive in natural resource abundant products. Second, the competitiveness of South African production has improved during the 1990s.

There are a number of shortcomings in the debate on competitiveness in South Africa. Firstly, the debate has primarily focussed on the correct measurement of competitiveness indicators (IMF, 1998, and Kahn, 1998), rather than the extent to which improvements in competitiveness as outlined by these indicators explain trade flows. The work on real effective exchange rates (REER) by Tsikata (1999) and Golub (2000) are amongst the exceptions. There is, however, still scope for an analysis of competitiveness and trade flows at the sectoral level.

Secondly, the bulk of the work has treated manufacturing as an aggregated sector. This tends to hide much of the variation in competitiveness at the sectoral level. International trade theory predicts non-uniform effects on the competitiveness of manufacturing arising from trade liberalisation.[1] Thus, it is not evident which sectors are driving the improvements in relative labour cost competitiveness shown by Golub (2000) during the 1990s. Analyses of unit labour costs in South Africa at the sectoral level are unfortunately not widely available. One sectoral level study by Nordas (1996) compares relative unit labour costs between SA and USA and finds that South Africa is competitive in medium wage, low technology and resource intensive industries. No link to the structure of bilateral trade flows between SA and USA was made. Further, the analysis uses data from the early 1990s making extrapolation to recent years tenuous.

[1] If all trade is intra-industry trade, then a uniform impact is possible.

Thirdly, most analyses of competitiveness fail to consider regional differences in competitiveness. As is clearly shown in the relative wage & productivity comparisons of Golub (2000), the competitiveness of South African manufactures varies according to region. South Africa is shown to have a relative labour cost advantage vis-à-vis developed countries, but not vis-à-vis many developing countries. Further insight into the regional competitiveness of South African production could be gained through a sectoral breakdown of competitiveness according to regions. We may find that South Africa is competitive in the production of relatively high-tech products with respect to developing countries. On the other hand, South Africa's comparative advantage with respect to developed countries may be in low-tech (low wage, low productivity) sectors.

This paper extends the initial work by Golub (2000) on the competitiveness of South African production in various dimensions. The paper extends Golub's (2000) analysis of RULC, relative productivity and relative wages in aggregate manufacturing to the sectoral level. Greater emphasis is also placed on the relationship between labour cost competitiveness and the structure and performance of South African exports over time. In doing so the paper draws upon the extensive literature dealing with the estimation of export demand and supply functions. This leads to the inclusion of other variables such as capacity utilisation and world income into the analysis. Finally, we use dynamic panel estimation techniques to determine the long run relationship between labour cost competitiveness and export performance.

The structure of the paper is as follows: Section II presents the analytical framework for analysing productivity, cost competitiveness and their relationship to trade flows. Section III specifies the functions that are to be estimated while Section IV discusses the econometric methodology. Section V briefly discusses the data and provides a preliminary analysis of export performance and RULC. Section VI and VII presents the cross-sector and time series results, respectively. Finally, Section VIII concludes.

II. Analytical Framework

Golub (2000) presented a framework based on international comparisons of unit labour costs for analysing international competitiveness. This framework is particularly useful in the South African context where labour costs are a central point of contention. Here we review this framework, with more attention to the implications for the sectoral pattern of trade.

Unit labour cost is the cost of labour per unit of output, i.e. the ratio of wages to productivity. In addition to its clear intuitive appeal, relative unit labour cost is the key relative price in a Ricardian model of trade. Furthermore, in a world where capital is mobile and production is footloose between countries, it is the relative price of non-tradable *inputs*, notably labour, rather than *outputs* that matters. Further, technological advancements have enabled the fragmentation of the production process into smaller distinct steps, the physical location of which can be spread around the globe without losing control of the production process (Gourevitch et al. 2000). In this milieu labour costs have become an important determinant in the location of these production processes. For example, much of the assembly of consumer electronics has shifted to low wage, labour intensive economies within the South East Asian region.

It is therefore of interest to compare both levels and rates of change of labour costs and labour productivity between countries. For these reasons and others, Turner and Van't Dack (1992) and Turner and Golub's (1997) surveys of the literature conclude that relative unit labour costs in manufacturing are the best single indicator of competitiveness. Where data are available, Hinkle and Nsengiyumba (1999) also endorse the use of unit labour costs, both for analysis of levels and rates of change of competitiveness.

At a disaggregated level, the Ricardian model provides an appealing framework for the analysis of trade flows (see Carlin *et al* (2001), Golub (1994) and Golub and Hsieh (2000) for further discussion). This model provides an integrated framework for understanding the macro- and microeconomic factors determining trade flows, as most elegantly shown in Dornbusch, Fischer and Samuelson (1977) (DFS). The basic idea is that relative unit labour cost is influenced both by sector-specific variables (productivity and wages) as well as the real exchange rate.[2] On a micro level, the Ricardian model has both advantages and disadvantages compared to the Heckscher-Ohlin-Samuelson (HOS) model, in which comparative advantage is derived from factor endowments. The main advantage is that the Ricardian model allows for technological differences between countries, which in practice seem very significant. There are large and persistent gaps in labour and total factor productivity by industry across countries (e.g. Harrigan 1999). Moreover, the HOS model has received lukewarm empirical support (Bowen, Leamer, and Sveikauskas, 1987). It has recently been shown that a key reason for the failure of the HOS model is the failure to incorporate international differences in technology and that when such differences are allowed for the HOS model improves (Trefler 1995, Davis and Weinstein 1998). The main disadvantage of the Ricardian model is that it implies that countries specialise completely in tradable goods production. In practice, import-competing industries contract but rarely disappear completely in the face of foreign competition. To allow for incomplete specialisation in a Ricardian context, one would have to introduce other considerations, such as differentiated products. Also, unit labour cost may be an imperfect gauge of competitiveness if quality differences are not measured accurately or if labour is not the only non-tradable factor of production.

Let a_i represent the unit labour requirement (the inverse of productivity), for sector *i*:

$$(1) \qquad a_i = \frac{L_i}{Q_i} \ ,$$

where Q is value-added, and L is labour employment. Marginal productivity and hence a_i are assumed to be constant with respect to variations in L_i.

Let w denote the wage and e the exchange rate between home and foreign currencies. If labour is the only factor of production (or that other factor costs do not differ across countries), home (South African) average costs of production are equal to unit labour costs $w_i.a_i$. Expressed in domestic currency, foreign unit labour cost is $e.w_i^*.a_i^*$. International competitiveness in sector i then depends on relative unit labour cost (RULC$_i$):

[2] Most expositions of the Ricardian model assume perfectly competitive labor markets and hence a uniform wage rate across sectors. But this assumption is easily relaxed in empirical work.

(2) $$\text{RULC}_i = \frac{a_i w_i}{a_i * w_i * e}.$$

Alternatively, equation (2) can be written

(3) $$\text{RULC}_i = \frac{a_i}{a_i *} \cdot \frac{w_i}{w_i * e}.$$

Equation (3) illustrates the decomposition of relative unit labour costs into relative productivity and relative wages converted into a common currency. Thus South Africa's competitiveness vis-à-vis other countries could improve when some combination of the following conditions hold: 1) labour productivity in South Africa rises relative to other countries, 2) South Africa's relative wages fall, or 3) the rand depreciates. As South African cost competitiveness improves, exports are predicted to increase and imports decline for the affected sectors. [3] Notice that the exchange rate affects all sectors simultaneously, while the competitiveness of each individual sector also depends on wages and productivity in that sector vis-à-vis other countries.

The home country will have an absolute advantage in good *i* when $\text{RULC}_i > 1$, i.e., South African unit labour costs are below those of its trading partners, or equivalently when relative South African productivity exceeds relative the relative South African relative wage, measured in a common currency, i.e.,

(4) $$\frac{a_i *}{a_i} > \frac{w_i}{w*_i e}.$$

This model implies both cross-section and time-series relations between RULC and trade flows. Declines in RULC over time are predicted to raise export volumes and lower import volumes. We can also assess South African comparative advantage by comparing RULC across industries. Those industries with lowest RULC are predicted to have the largest export shares and net exports.

Our empirical analysis will examine both levels and changes over time in relative productivity, relative wages, and unit labour costs and their effects on the composition and time pattern of trade flows.

III. Estimating the relationship between RULC and export performance

RULC and the structure of trade

Much of the empirical literature analysing the relationship between RULC and export performance has focussed on cross sectoral data for a given year. These papers in effect

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[3] Strictly speaking, in a Ricardian setting, countries will specialize completely in those sectors in which they have comparative advantage, and an improvement in RULC will only affect trade flows if it causes RULC to fall from above 1.0 to below 1.0. In practice, however, because of product differentiation and other discrepancies from the model, countries do not specialize completely and the response to changes in RULC is likely to be smoother. See Golub and Hsieh (2000) for further discussion.

test whether indicators of sectoral export performance are negatively correlated with RULC for that given year. Various specifications of the function have been used. MacDougall (1951) and Stern (1962), in their studies on US-UK trade, analyse the relationship between total export ratios, relative labour productivity and/or relative unit labour costs. Balassa (1963), also focuses on US-UK trade, but critiques the use of total trade on the grounds that bilateral trade between the countries is strongly affected by the relative size of US and UK tariff barriers.[4] He uses exports to third markets instead, but the use of this has been questioned by Golub and Hsieh (2000). Golub and Hsieh (2000) more appropriately uses bilateral trade flows as the dependent variable and relative productivity and relative unit labour costs as explanatory variables. All these results show a consistently positive and significant correlation between relative productivity and exports.

Drawing on the Ricardo theory and international literature the following cross section equations estimating the relationship between RULC and export performance across sectors can be defined:

(5a) $\text{Log}(X_{isa}/X_{ij}) = \alpha_{saj1} + \beta_{saj1}\text{logRULC}_{isaj} + \varepsilon_{isaj1}$

(5b) $\text{Log}(X_{isaj}/M_{isaj}) = \alpha_{saj2} + \beta_{saj2}\text{logRULC}_{isaj} + \varepsilon_{isaj2}$

(5c) $\text{Log}(X_{isaj}/M_{isaj}) = \alpha_{saj3} + \beta_{saj3}\text{logRelProd}_{isaj} + \beta_{saj3}\text{logRelWage}_{isaj} + \varepsilon_{isaj3}$

(5d) $\text{Log}(X_{isaj}) = \alpha_{saj4} + \beta_{saj4}\text{logRULC}_{isaj} + \varepsilon_{isaj4}$

(5e) $\text{Log}(X_{isaj}) = \alpha_{saj5} + \beta_{saj5}\text{logRelProd}_{isaj} + \beta_{saj5}\text{logRelWage}_{isaj} + \varepsilon_{isaj5}$

X_{isa} is total South African exports of commodity i, X_{ij} is total country j exports of commodity i, X_{isaj} and M_{isaj} are exports and imports of commodity i to and from country j, and $RULC_{isaj}$, $RelProd_{isaj}$ and $RelWage_{isaj}$ are unit labour costs, labour productivity and wages in South Africa over those of country j. Equation (5a) uses the ratio of total exports as the dependent variable and is similar to the approach by MacDougall (1951) and Stern (1963). Equations (5b) and (5c) follow Golub and Hsieh (2000) and use bilateral trade balances as the dependent variable. In equations (5d) and (5e) the emphasis is on the structure of exports and not net trade, and real bilateral exports are used as the dependent variable.

RULC and exports over time

These specifications are cross-sectional in nature and analyse whether for a particular time period sectors with high RULC are also sectors with low exports. Cross-section regressions do not directly analyse the relationship between changes in RULC and export performance within a particular sector over time.

There is substantial evidence that exports are influenced by RULC over time. Golub (1994) applies the Ricardo model to export patterns of the G7 using time series

[4] MacDougall (1951) also identified this as a reason for the low import content of consumption within these countries.

regressions, cross section regressions and panel data regressions. In his regressions sectoral trade balances are used as the dependent variable and unit labour costs as the independent variable. His results suggest that changes over time of sectoral trade balances are quite well explained by the evolution of unit labour costs, but the levels of these balances are sometimes difficult to reconcile with the levels of unit labour costs. His results are particularly strong for the US and Japan. The time series analysis performs better than the cross-section analysis.

Golub and Hsieh (2000) assess the Ricardian theory of comparative advantage using cross-section seemingly unrelated regressions. Their focus is on the US vis-à-vis a number of OECD countries. They also uses a variety of PPP indicator to deflate output and find that the results are sensitive to the choice of PPP measure. R^2 values are low indicating that the model is not very good at explaining all cross-section trade flows.

The poor explanatory power of the results suggest the importance of other variables in explaining export performance. Carlin *et al*. (2001) use panel data techniques to analyse the impact of RULC on the share composition of OECD exports. They also include other economic, technological and institutional features of economies into their regressions in an attempt to explain export shares. They find that rising RULC, rising relative wages, declining relative productivity and an appreciating currency negatively affect the share of a country's exports in total OECD exports. They also find that investment rates and institutional features of the countries such as schooling, TFP growth and the structure of corporate ownership play an import role in explaining export performance over time.

One critique of Carlin *et al*. (2001) is that they are essentially estimating export demand functions without considering export supply (a fault they recognise). As result, their model implicitly assumes an infinitely elastic supply function which biases the estimated coefficients downwards.

The importance of these other variables suggests that the Ricardo model alone is too simplistic to fully explain export performance. Further, in estimating the impact of RULC on exports, it is important to consider export supply. In this section the literature on export demand functions is used to specify a functional form that includes both demand and supply side variables that affect export performance.

The standard export model, as discussed by Goldstein and Khan (1985), can be represented as a system of equations dealing with export supply (X^s) and export demand (X^d) equations[5]

(6a) $X^d = f(Y^*, Px, P^*)$, $f_1, f_3 > 0, f_2 < 0$
(6b) $X^s = g(Px(1+s), P)$, $g_1 > 0, g_2 < 0$
(6c) $X^s = X^d$

[5] This model is an imperfect substitutes model where imperfect substitutability between domestic and export products enables domestic and export prices to differ from one another (Goldstein and Khan, 1985).

Y^*, P^*, P, Px, and s are foreign income, foreign domestic price, domestic price, domestic price of exports and subsidies, respectively. Export demand is positively affected by foreign income (Y^*) and the price of competing foreign goods (P^*), but is negatively affected by the domestic price of exports (Px).

On the supply side domestic firms produce export products if the return to export production rises via a rise in the price of exports or export subsidies, s, but declines if the price of domestic competing goods rise. Often variables to account for trends and cyclical effects are included in the export supply equations. Trend income or trend export variables are included to capture advances in non-price based elements of competitiveness such as infrastructure, total factor productivity and factor supplies that are correlated with rising levels of real aggregate output. Capacity utilisation is also included to capture cyclical effects of domestic demand. As Goldstein and Khan (1985: 1061) note, "*…when domestic demand pressure increases, selling in the home market becomes more profitable than selling abroad, and … this effect is not fully captured by movements in the ratio of domestic to export prices*".

The model is an imperfect substitutes model where imperfect substitutability between domestic and export products enables domestic and export prices to differ from one another (Goldstein and Khan, 1985). This assumption differs from the strict Ricardian assumption of perfect substitutability. Nevertheless, in specifying relative prices as functions of unit labour costs we are able to capture the essence of the Ricardo model.

The world demand for South Africa's exports of sector i in period t is specified in log-linear form as[6]

(7) $$\log X_{it}^{d} = b_0 + b_1 \log\left[\frac{P_x}{ULC^*}\right]_{it} + b_2 \log Y_t^*$$

where X_{it}^{d} is quantity of exports P_{xit} is price of exports, ULC_{it}^* is unit labour cost of foreign firm and Y_t^* is real income of South Africa's trading partners.[7] This model assumes a perfectly competitive market in which labour is the only factor of production. The domestic price of a product, P, thus equals ULC.[8] Different demand elasticities in the home and export market, different cost structures for home and export production, market distortions and product differentiation give rise to differences in export and domestic prices (Goldstein and Khan, 1985). Because the variables are in logs, the coefficients represent elasticities, the expected signs of which are:

$b_1 < 0$; $b_2 > 0$ (although if the product is inferior then we may find $b_2 < 0$)[9].

[6] Khan and Ross (1977) find that the log-linear specification performs better than a standard linear function.

[7] A common b_1 is assumed as it is generally assumed that the demand function is homogenous of degree zero in prices, i.e. a doubling of P_x and of ULC^* has no effect on demand as relative prices have not changed.

[8] It is possible to incorporate other costs, or mark-ups, which raise the market price above ULC by a constant fraction λ, i.e. $P = lULC$, without affecting the results.

[9] Wood (1995) finds a negative coefficient in his estimation for some sectors in South Africa.

Thus a decline in price competitiveness of South Africa arising from an increase rise in export price or a decline in foreign domestic price (*ULC**) reduces export demand.

The export supply function of sector *i* in period *t* is specified in log-linear form as[10]

(8) $$\log X_{it}^{s} = a_0 + a_1 \log\left[\frac{P_x}{ULC}\right]_{it} + a_2 \log CU_{it}$$

where CU_{it} represents capacity utilization and ULC_{it} represents the domestic price, proxied by unit labour costs in South Africa. Products for domestic consumption or export markets are substitute products. A rise in P_x or a decline in domestic price (*ULC*) raises the relative profitability of export causing a shift of resources into export producing sectors. If *ULC* also serves as a proxy for overall production costs, the decline in *ULC* will also reflect a reduction in the cost of producing exports. Capacity utilisation has been included to capture the cyclical impact of domestic demand on export behaviour. In South Africa this variable is expected to capture the impact of the volatile domestic demand conditions during periods of political upheaval. As domestic demand declined firms turned to the export market as a 'vent-for-surplus'. Not included in the equation is a variable to capture domestic production that is generally included to proxy a country's capacity to produce (Goldstein and Khan, 1978). The expected signs of the elasticities are:

$a_1 > 0$, $a_2 < 0$.

Data constraints, particularly the lack of export prices at a sectoral level, frequently prohibit the estimation of both export demand and supply functions simultaneously. The system of equations is then frequently solved for the two endogenous variables *X* and *Px* to obtain the reduced form equations. This is the approach followed here.

Imposing the equilibrium condition, $X^s = X^d = X$, the two equations solve for the two endogenous variables *X* and *Px*. If equation (8) is normalised for the price of exports, *Px*, and then substituted into equation (7) we obtain the reduced form equations

(9) $$\log X_{it} = \left(1 - \frac{b_1}{a_1}\right)^{-1}\left[(b_0 - \frac{b_1 a_0}{a_1}) + b_1 \log RULC_{it} - \frac{b_1 a_2}{a_1}\log CU_{it} + b_2 \log Y_t^*\right]$$

where $RULC_{it} = \frac{ULC_{it}}{ULCi_t *}$. This equation can be further refined by decomposing the log of $RULC_{it}$ into its constituent parts: relative wages, relative productivity and exchange rates. The log of RULC in equation (3) can be written as

(10) $$\log RULC_{it} = \log\left(\frac{a}{a*}\right)_{it} + \log\left(\frac{w}{w*}\right)_{it} + \log\left(\frac{1}{e_{R/For}}\right)_{it}$$

where a and a^* reflect labour requirements per unit real output in domestic and foreign industries, respectively, w and w^* reflect domestic and foreign wage per worker, respectively, and $e_{R/For}$ is the Rand value of foreign currency. The first variable on the right hand side measures the productivity of foreign workers relative to South African workers while the second measures the relative wage of South African workers compared to foreign workers. Thus a 10 % rise in RULC can be brought about by either a 10 % rise in relative productivity of foreign workers, a 10 % rise in the relative wage of South African workers or a 10 % appreciation of the currency. This relationship can be tested directly by substituting equation (10) into regression equation (9).

Given the signs of the structural parameters in the export supply and demand functions the expected signs of the reduced form equation (9) coefficients are as follows

	RULC	Rel $Prod_{SA}$	Rel $wage_{SA}$	$e_{R/For}$	CU	Y^*
Equation (9)	-				-	+
+ Equation (10)		+	-	+	-	+

Note, however, that these are not necessarily estimates of the structural coefficients in the export demand equation (7). To obtain these it is necessary to estimate the export demand and supply equations simultaneously, or in the case of fully identified equations these can be 'retrieved' from the reduced form coefficient estimates directly.

Frequently studies ignore the export supply equation and estimate the export demand function in equation (7) directly. The problem with this approach is that these models implicitly assume infinitely elastic export supply or stable demand functions with a supply function that shifts around it (Goldstein and Khan, 1985; Riedel, 1988). The estimates for b_1 and b_2 are interpreted as elasticities, but because these are weighted averages of the true demand and supply elasticities they tend to be biased downwards (Goldstein and Khan, 1985). More problematic is the correlation between the endogenous variable on the right hand side and the error terms in the regression as these violate the conditions for OLS and will yield inconsistent estimates (Gujarati, 1995). Nevertheless, because these models have dominated research in this area, and particularly research in South Africa, it is useful to estimate the export demand function (7), if only for comparative purposes.

IV. Econometric Methodology

The availability of repeated observations between 1970-98 for 24 industrial sectors suggests the use of panel data estimation techniques to identify the relationships between export performance and RULC. We draw upon Pesaran and Smith (1995) and Pesaran *et al.* (1999) to estimate dynamic versions of the export functions.

[10] A problem with this functional form is that it fails to take into account possible interdependence between capacity utilisation and export performance (Balassa, 1979).

The advantage of using panel data estimation techniques is that if the data generating processes in the different sectors share common features, then combining the data will improve the efficiency of estimation of the parameters (Smith, 2001: 8). Further, because sector specific effects (or time specific effects) are easily incorporated into panel data models, the effect of omitted variable bias is reduced (Hsiao, 1986: 3). Finally, in the process of pooling the data problems arising from spurious coefficients between *I(1)* variables is attenuated allowing a consistent estimate of the parameter to be obtained (Smith, 2001).

Drawing on equation (9) we assume that the long run export function is given by

(11) $$X_{it} = q_{0i} + q_{1i} RULC_{it} + q_{2i} Y^{*}_{it} + q_{3i} CU_{it} + m_{it}$$

where X_{it} is the logarithm of export demand, $RULC_{it}$ is the log of relative unit labour cost (a proxy for relative prices), $Y_{it}*$ is log of real foreign income and CU_{it} is logarithm of capacity utilisation. $i = 1,\dots,N$, stand for industrial sectors and $t = 1,2,\dots.T$, stand for time periods. The expected signs of the long run coefficients are

$q_{1i} < 0$, $q_{2i} > 0$ and $q_{2i} < 0$.

Often the presence of adjustment costs and incomplete information induces a lag in the response of demand to changes in the exogenous variable. This adjustment process is frequently introduced by imposing various distributed lag structures on the model. A common approach in the estimation of export demand equations is the use of the Partial Adjustment Model (PAM) where the actual change in exports in time period *t* equals a fraction of the desired change in exports.[11] Polynomial distributed lag structures and alternative dynamic specifications have also been used.[12] To estimate the long run properties of this model we utilise a general first order ARDL(1,1,1,1) which nests a number of alternative restricted models, of which the PAM is one. The ARDL(1,1,1,1) export model is:

(16) $$X_{it} = a_i + l_i X_{i,t-1} + g_{1i} RULC_{it} + g_{2i} RULC_{i,t-1} + g_{3i} Y^{*}_{it} + g_{4i} Y^{*}_{i,t-1} + g_{5i} CU_{it} + g_{6i} CU_{i,t-1} + e_{it}$$

where a_i denotes the sector specific effect which can be either fixed or random. e_{it} is the remainder disturbances which is IID$(0,\sigma^2)$ and independent of a_i and the explanatory variables.

The ARDL(1,1,1,1) can be reparametised as an error correction model

(13) $$\Delta X_{it} = f_i (X_{i,t-1} - q_{0i} - q_{1i} RULC_{i,t-1} - q_{2i} Y^{*}_{i,t-1} - q_{3i} CU_{i,t-1}) + g_{1i} \Delta RULC_{it} + g_{3i} \Delta Y^{*}_{it} + g_{5i} \Delta CU_{it} + e_{it}$$

where

(14) $$q_{0i} = \frac{a_i}{1 - l_i}, \quad q_{1i} = \frac{g_{1i} + g_{2i}}{1 - l_i}, \quad q_{2i} = \frac{g_{3i} + g_{4i}}{1 - l_i}, \quad q_{3i} = \frac{g_{5i} + g_{6i}}{1 - l_i}, \quad f_i = -(1 - l_i) \cdot$$

f_i is the error correction coefficient and measures the speed of adjustment towards long run equilibrium. The larger the value the greater the convergence to long run equilibrium. For stability we require $f_i < 0$.

[11] Note that the PAM assumes a geometrically declining lag structure. The model also assumes that the lag in the response of exports is the same irrespective of whether the change in exports is due to changes in world income or prices (Goldstein and Khan, 1985).

[12] See Goldstein and Khan (1985) and Marquez and McNeilly (1988).

Pesaran and Smith (1995) identify a number of procedures for estimating the average long run coefficients and emphasise the potential inconsistencies arising from using these under different conditions of heterogeneity across sectors. One approach is to use the dynamic fixed effects (DFE) estimator which pools all the data and assumes homogeneity for all parameters except for the sector fixed effects (α_i).[13] In this model $\lambda_i = \lambda$ and $\gamma_{ki} = \gamma_k$. for all $i = 1,2,\ldots N$ and $k = 1,\ldots 5$. The average long run coefficients are calculated from the estimates of these coefficients

(15) $$\hat{\theta}_1 = \frac{\hat{\gamma}_1 + \hat{\gamma}_2}{1-\hat{\lambda}}, \quad \hat{\theta}_2 = \frac{\hat{\gamma}_3 + \hat{\gamma}_4}{1-\hat{\lambda}}, \quad \hat{\theta}_3 = \frac{\hat{\gamma}_5 + \hat{\gamma}_6}{1-\hat{\lambda}}.$$

One problem with estimating this using OLS is that the lagged dependent variable $X_{i,t-1}$ is correlated with the fixed effect α_i. This renders the OLS estimator biased and inconsistent (Baltagi, 2001). This problem is not solved by the Within transformation, which eliminates the sector specific effects, as by construction the transformed lagged dependent variable is correlated with the transformed error term. The effect is to bias the estimated coefficient of the lagged dependent variable upwards (Hsiao, 1986). However, the bias of the within estimator is of order (1/T) and the inconsistency disappears as T $\to \infty$.

The dynamic fixed effects estimator will also only give consistent estimates of the average long run coefficients for large *T* and *N* so long as homogeneity holds across sectors. If the true model is represented by equation (12) and the true coefficients differ across sectors, then the fixed effects estimator gives inconsistent estimates of the coefficients (Pesaran and Smith, 1995; Smith, 2001). When the coefficients vary across sectors and the regressors are serially correlated, assuming homogeneity induces serial correlation in the errors. These in turn are not independent of the lagged dependent variable and give rise to inconsistent estimates, even if $T \to \infty$ (Pesaran and Smith, 1995). Pesaran and Smith (1995: 80) use a number of examples to show that when coefficients differ across sectors pooling of data can give "*potentially highly misleading estimates of the coefficients*". This is problematic as when tested the equality of coefficients over groups is frequently rejected (see Baltagi and Griffin, 1997).

A more appropriate approach in this case is to use the Mean Group Estimator (MG) of Pesaran and Smith (1995). Equation (12) is estimated separately for each sector and the long run coefficients are computed as averages of the individual sector coefficients.

For example, the long run elasticities for RULC, Y* and CU for each industry *i* are defined as

(16) $$\hat{\theta}_{1i} = \frac{\hat{\gamma}_{1i} + \hat{\gamma}_{2i}}{1-\hat{\lambda}_i}, \quad \hat{\theta}_{2i} = \frac{\hat{\gamma}_{3i} + \hat{\gamma}_{4i}}{1-\hat{\lambda}_i}, \quad \hat{\theta}_{3i} = \frac{\hat{\gamma}_{5i} + \hat{\gamma}_{6i}}{1-\hat{\lambda}_i}.$$

The Mean Group Estimator for each variable is then computed as[14]

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[13] It is also possible to assume $\alpha_i = \alpha$ for a common constant across all sectors and $\alpha_i = \alpha_1 + \eta_{1i}$ for sector specific effects with a random component η_{1i}.

[14] The long run relationship can also be estimated by $\theta_k = \dfrac{\bar{\gamma}_k}{1-\bar{\lambda}_k}$ where $\bar{\gamma}_k = \sum_{i=1}^{N} \gamma_{ki} / N$ and $\bar{\lambda} = \sum_{i=1}^{N} \lambda_{ki} / N$.

(17) $$\hat{q}_1 = \sum_{i=1}^{N} \hat{q}_{1i} / N, \quad \hat{q}_2 = \sum_{i=1}^{N} \hat{q}_{2i} / N, \quad \hat{q}_3 = \sum_{i=1}^{N} \hat{q}_{3i} / N, \quad \hat{f} = \sum_{i=1}^{N} \hat{f}_i / N \cdot$$

As shown by Pesaran and Smith (1995) these averages are consistent estimates of the parameters for large *T*. If *T* is small, the existence of a lagged dependent variable will cause the estimates of f_i to underestimate their true value. Because a separate equation for each sector is estimated it is possible to use different ARDL specifications in each case. This is particularly useful when the short run dynamics differ from sector to sector. As is evident in the examples of Pesaran *et al.* (1999) the choice of lag structure appears to be more important when *T* is small.

In cases where some coefficients are equal across sectors, the MG estimator will provide consistent, but inefficient estimates of the long run coefficients. Pesaran *et al.* (1999) suggest that frequently the long run effects are homogenous and propose a Pooled Mean Group (PMG) estimator that constrains the long run coefficients to be the same for each sector, i.e.

(18) $$\hat{q}_1 = q_{1i}, \quad \hat{q}_2 = q_{2i}, \quad \hat{q}_3 = q_{3i} \quad \text{for } i = 1,2,\ldots N.$$

The short run coefficients, the *g*'s, are allowed vary across sectors. The PMG estimator for the short run coefficient, g_1, is

(19) $$\hat{g}_1 = \sum_{i=1}^{N} \tilde{g}_{1i} / N$$

where $\tilde{g}_{1i}$ is the coefficient for sector *i* computed by the pooled maximum likelihood estimation. The PMG estimators for g_2 to g_6 are calculated in a similar manner. A further benefit of the PMG over the MG is that it appears to be less sensitive to outliers, a common problem with the MG estimator (Pesaran *et al.*, 1999). It also appears to be relatively robust to choice of lag order.

A final approach to estimating the average long run relationship is to average the data over time and then estimate cross-section regressions on group means. Pesaran and Smith (1995) show that for large *N* and *T* the cross-section estimator will give consistent estimates of the average long run coefficient even if the coefficients differ randomly across sectors. Strict exogeneity of the regressors is required. In this approach the following function is estimated

(20) $$\bar{X}_{it} = q_{0i} + q_1 \overline{RULC}_t + q_2 \bar{Y}_t^* + q_3 \overline{CU}_i + \bar{e}_i$$

where $\overline{RULC}_i = \sum_t RULC_{it} / T_i$, $\overline{CU}_i = \sum_t CU_{it} / T_i$, $\bar{Y}_i^* = \sum_t \bar{Y}_{it}^* / T_i$ and $\bar{e}_i = \sum_t e_{it} / T_i$.

We present the results of the Dynamic Fixed Effects estimator. To cater for problems associated with heterogeneity across sectors the Mean Group estimates are also presented. Finally, the cross section equations (5a-e) are estimated for a number of sub-periods between 1970-98. As noted by Pesaran and Smith (1995) the cross section regression can provide consistent estimates of the long run relationship between RULC, relative productivity, relative wages and export performance. The estimation over various periods will enable an analysis of the stability of the relationship over time.

V. Data and preliminary analysis of exports and RULC

The calculation of RULC, relative wages and relative productivity for the vast range of countries and sectors against which South Africa is compared is a data intensive process. This section briefly outlines the data sources and some of the changes made to the data in cases of missing values and clear inconsistencies.

Data

As shown by Golub (2000) South African labour cost competitiveness of aggregate manufacturing differs across developed and developing economies. These differences in competitiveness may be more stark once industrial sectors are introduced as standard trade theory predicts that countries will specialise in particular products. To identify sectoral competitiveness across countries a range of developed and developing countries were selected according to the availability of consistent data. After eliminating countries with incomplete data, 9 developed countries and 10 developing countries were chosen. The developed countries are Canada, France, Hong Kong, Italy, Japan, Netherlands, Spain, United Kingdom and USA. The developing countries are: Chile, Hungary, India, Kenya, Korea, Mexico, Poland, Singapore, Turkey and Zimbabwe. These countries cover most geographic regions with at least one developed country selected from Europe, North America and the East. Complete data were not available for Australia or New Zealand. Developing countries were selected from South America (Chile), the South East Asian region, Eastern Europe and Africa. Although these countries have been classified as developing, they show substantial differences in level of development.

For the purpose of the study two consistent data sets were constructed. A large panel data set consisting of 27 sectors (Appendix Table B.1) between 1970-98 for all countries. Three sectors, tobacco (314), petroleum refineries (353) and miscellaneous petroleum products (354) were dropped as the data were either missing or highly irregular. The analysis is thus based on 24 industrial sectors. An aggregated data set was also constructed using all countries other than Mexico for which a complete balanced data set was not available. All variables were aggregated using share of total group trade (exports + imports) as weights. The data used to construct the panel data sets were obtained from various sources. Further details of the data sources and the construction of the relevant variables are provided in the appendix.

Preliminary Analysis of Export Performance and RULC

Table 1 and 2 present average relative wages and relative productivity during the 1970s, 1980s and 1990s for developing and developed countries, respectively. RULC vis-à-vis these regions during these periods are presented in Figure 1. In this figure sectors with RULC exceeding 1 reflect South African sectors with relatively high labour costs of production.

These results substantially extend the work of Golub (2000) who compared RULC, relative wages and relative productivity for aggregate manufacturing with a number of developed and developing economies. The results are largely consistent with his work. RULC have improved substantially since the 1970s relative to both developed and developing economies. The improvement in competitiveness is widespread with RULC declining in most industrial sectors since the 1970s.

Much of the improvement in competitiveness has been brought about by substantial depreciations in the currency during the mid 1980s and the late 1990s, although more so vis-à-vis developed economies during the latter period. In all sectors average relative wages compared to developed countries were lower in the 1990s than in the 1970s. Compared to developing countries average relative wages were lower in 17 of the 25 sectors, with much of the decline occurring during the 1980s.

During the 1990s improved relative labour productivity also lowered RULC. Between the 1980s and 1990s average relative labour productivity vis-à-vis developing and developed countries rose in 15 and 14 sectors, respectively. Some of this is due to capital labour substitution during the 1990s (Golub and Edwards, 2002).

As found by Golub (2000) South Africa is relatively more competitive compared to developed countries than developing countries. South African labour is more productive than labour in developing countries, but wages are substantially higher resulting in a RULC value greater than 1 for most sectors. Average RULC vis-à-vis developing countries exceeded 1 for 22 of the 25 sectors during the 1990s. Compared to developed economies South Africa was not competitive in 16 of the 25 sectors over the same period. Care must be taken in the interpretation of these level results as they are strongly influenced by the PPP deflator used (see Appendix). Nevertheless, the results suggest large differences in competitiveness across regions.

The sectoral ranking of South African industries according to RULC is similar across developed and developing countries. The Spearman's rank correlation coefficients, which capture the similarity in the ranking of sectors, exceeded 0.5 for all periods. During the 1990s South Africa's labour cost competitiveness was extremely low in beverages, other chemicals, non-electrical machinery & equipment and electrical machinery. South Africa had a comparative advantage in leather products, glass & products, non-ferrous metals, and other manufacturing.

There is no clear pattern of competitiveness over the years. The ranking of sectors according to RULC changed substantially between the 1970s and the 1990s. The Spearman's rank correlation coefficient of 0.567 is obtained when the average sectoral rankings of RULC in the 1970s are correlated with those in the 1980s. This falls to -0.083 when the ranking of sectors during the 1970s are compared with those in the 1990s. The poor correlation in rankings is largely due to substantial structural changes in RULC during the 1990s. This is reflected in the low Spearman's rank correlation coefficient (0.294) between the 1980s and the 1990s.

Table 1
Average relative wages and relative productivity by sector vis-à-vis developing countries

	1970-79	1980-89	1990-98	1970-79	1980-89	1990-98
		Relative wage			**Relative productivity**	

Total manufacturing (1)	3.58	3.00	3.32	2.15	1.98	2.31
Food products	3.34	3.97	6.02	2.93	3.09	3.82
Beverages	3.96	3.80	3.51	1.29	1.96	1.65
Textiles	2.40	1.95	2.04	1.51	1.55	1.43
Wearing apparel	2.33	1.66	1.72	1.00	0.85	1.03
Leather products	3.70	2.27	2.95	2.15	2.12	2.89
Footwear	2.86	1.47	1.04	1.40	0.84	1.35
Wood products	1.38	1.41	1.16	0.66	0.85	0.77
Furniture	3.29	2.57	1.94	1.45	1.53	1.67
Paper & products	3.59	3.26	3.00	1.89	2.56	2.14
Printing & publishing	4.05	4.63	6.98	6.32	3.94	3.99
Industrial chemicals	4.54	3.85	4.93	2.54	2.34	3.49
Other chemicals	3.23	4.47	4.86	1.53	2.59	2.23
Rubber products	3.91	2.47	2.11	1.67	1.36	1.21
Plastic products	3.40	2.55	2.32	1.40	1.13	1.16
Pottery & china	2.60	2.02	1.39	1.77	1.49	0.72
Glass & products	2.54	2.67	3.45	1.67	2.56	2.55
Other non-metallic	2.26	2.16	2.56	1.12	1.54	1.22
Iron & steel	3.85	3.47	5.67	2.58	2.57	3.54
Non-ferrous metals	1.88	1.67	2.72	0.99	1.78	2.98
Fabricated metal	3.71	3.44	3.47	2.56	2.01	2.01
Machinery	7.52	6.02	6.54	4.07	3.49	3.71
Machinery, electric	4.73	3.07	1.44	2.16	1.46	0.62
Transport equipment	4.52	3.98	4.32	4.64	2.58	4.92
Professional & scientific	3.60	3.07	2.57	1.77	1.57	2.52
Other manufacturing	5.33	2.22	2.25	2.25	1.21	2.43

Notes: (1) Unweighted average

Table 2

Average relative wages and relative productivity by sector vis-à-vis developed countries

	1970-79	**1980-89**	**1990-98**	**1970-79**	**1980-89**	**1990-98**
	Relative wage			**Relative productivity**		
Total manufacturing (1)	0.57	0.44	0.35	0.40	0.36	0.40
Food products	0.32	0.28	0.25	0.26	0.22	0.22
Beverages	0.55	0.42	0.35	0.29	0.29	0.31
Textiles	0.48	0.40	0.30	0.35	0.34	0.30
Wearing apparel	0.45	0.34	0.31	0.20	0.22	0.26
Leather products	0.55	0.35	0.26	0.30	0.33	0.43
Footwear	0.55	0.37	0.30	0.30	0.26	0.39
Wood products	0.25	0.23	0.19	0.17	0.19	0.17
Furniture	0.54	0.40	0.27	0.22	0.26	0.27
Paper & products	0.53	0.46	0.32	0.44	0.46	0.36
Printing & publishing	0.55	0.44	0.40	0.31	0.30	0.30
Industrial chemicals	0.69	0.48	0.40	0.52	0.38	0.42
Other chemicals	0.49	0.57	0.38	0.34	0.40	0.30
Rubber products	0.65	0.47	0.38	0.50	0.42	0.38
Plastic products	0.55	0.44	0.32	0.28	0.32	0.35
Pottery & china	0.46	0.39	0.25	0.41	0.37	0.30
Glass & products	0.41	0.37	0.36	0.34	0.39	0.48

Other non-metallic	0.36	0.29	0.25	0.24	0.22	0.24
Iron & steel	0.62	0.50	0.54	0.74	0.52	0.60
Non-ferrous metals	0.44	0.35	0.39	0.52	0.55	0.91
Fabricated metal	0.55	0.49	0.37	0.42	0.38	0.40
Machinery	1.21	0.91	0.61	0.87	0.62	0.61
Machinery, electric	0.91	0.69	0.30	0.59	0.51	0.23
Transport equipment	0.53	0.44	0.35	0.38	0.35	0.33
Professional & scientific	0.60	0.50	0.31	0.51	0.34	0.39
Other manufacturing	0.92	0.50	0.50	0.60	0.36	0.98

Notes: (1) Unweighted average

To explore the relationship between RULC and export performance Figure 2 presents scatter plot diagrams between average RULC and average real exports for all decades since 1970. A scatter plot between RULC and real exports as a share of output (export orientation) during the 1990s is also presented. Figure 2 displays a clear relationship between RULC and real exports during the 1970s and 1980s. Sectors with high RULC exported less than sectors with low RULC. During the 1990s, however, no relationship between RULC and real exports is evident. If one uses net exports or export orientation rather than average real exports the expected negative relationship is found in all periods. This is shown in the in the diagram in the fourth quadrant of Figure 2.

The data appears consistent with predictions made by the Ricardo model. Net exports and export orientation are negatively related to RULC during all periods. Real exports are negatively related to RULC during the 1970s and 1980s. In the following section these relationships are explored further using more rigorous econometric techniques.

VI. Cross Section Results

The cross-section estimations (equations 5a-e) that have traditionally been used to assess the Ricardo theory are first presented. We follow Pesaran and Smith (1995) and estimate cross-section regressions on group means to obtain the average long run coefficient. The cross-section equations were estimated using both the aggregated and disaggregated panel data sets. In the disaggregated case the equations were estimated for each country separately.

Aggregated Panel Data Results

Because the aggregated data set covered the period 1970-98, it was possible to estimate the impact of RULC on the export performance across sectors for a number of sub-periods. For brevity only the aggregated panel data set results analysing the structure of South African exports (equation 5d and e) are presented here, although reference will be made to alternative results where appropriate. These results are presented in Table 3.

Looking first at the 1970-98 results, it is evident that RULC is significant in explaining the structure of South African real exports. 20 % of the variation between sectors is explained by RULC and this rises to 51 % when RULC is broken up into relative productivity and relative wages. The RULC coefficient is negative and significant indicating that sectors with high RULC export less than sectors with low RULC.[15] The coefficient is, however, extremely large and suggests that on average a 1 % rise in RULC reduces real exports by –4.66 % in the long run.

The coefficients for relative wages and relative productivity are of the expected sign and are both significant. Sectors with low relative wages and/or high relative labour productivity export more. The absolute value of these coefficients are not significantly different from each other and a percentage rise in relative productivity or a percentage decline in relative wages have the same impact on exports. This is expected as these changes affect RULC equally. Like the coefficient on RULC coefficients on relative wages and relative productivity are extremely large and possibly reflect some bias in the estimation.

The analysis of sub-periods suggests that the influence of relative unit labour costs on the structure of exports has diminished over time. During the periods 1970-79 and 1980-89 RULC, relative wages, and relative labour productivity were significant in explaining the structure of exports. However, during the 1990s these variables are incorrectly signed and fail to explain the structure of trade as shown by the low F-statistic. This is consistent with the cross-section diagrams of RULC and real exports in Figure 2, but is inconsistent with the negative relationship between RULC and exports as a share of output. Cross sector regressions using exports as a share of output as the dependent variable find a significant relationship for 1990-94 and 1995-98, but only for the coefficient on RULC.[16] The coefficients on relative productivity and relative wage are insignificantly different from zero. The weaker results during the 1990s suggest that other factors not related to labour costs are becoming more important in influencing the sectoral composition of South African exports. Possible causes of the weaker results during the 1990s are discussed in the following section.

Disaggregated Data Results

More detailed insight in the structure of trade vis-à-vis trading partners can be obtained by repeating the cross section regressions for each country. Data limitations, however, constrained the number of possible export functions that could be estimated for developing countries. Cross-section regressions were estimated for developed countries using real bilateral exports (equation 5d and 5e), bilateral net exports (equation 5b and 5c) and the ratio of total South African exports to total foreign country exports (equation 5a) as the dependent variable. Bilateral trade data for developing countries was not available prior to 1988 limiting the estimated export function to equation (5a) for these countries. Although bilateral HS trade data were available for developing countries after 1988, the results using this data were poor, as were the case for most estimates during the 1990s. For complete coverage of all countries the results using the log of total exports ratio (Xisa/Xij) as the dependent variable (equation 5a) are presented in Table 4. These

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[15] The coefficients are significantly higher than those found by Golub and Hsieh (2000).
[16] A coefficient of -1.66 is obtained for the 1990s. This is significant at the 5% level.

estimates are thus similar to the original research by MacDougall (1951) and Stern (1962).

Two sets of cross section regression results are presented for the periods 1980-89 and 1990-98. The first regressions (columns 1 & 4) have RULC as the explanatory variable. In the second regressions (columns 2 & 5) RULC is replaced with relative wage and relative productivity. For illustrative purposes only the significant coefficients of each country specific regression are presented in Table 4. Empty cells reflect coefficients insignificantly different from zero.

Looking first at the developed country results it is clear that the relationship between relative exports and RULC was stronger during the 1980s than the 1990s. For the 1980s period the coefficients on RULC are negative and significant for 6 out of 8 countries. None of these are significant in the 1990s. The poor results during the 1990s are also evident when using relative wages and productivity. Relative wages appear to have a greater impact on exports than relative productivity. For all countries for which significant results emerged the coefficient on relative wages exceeded that of relative productivity. The difference, however, is not significantly different from zero.

The results for developing countries were weaker than those for developed countries, although when significant (at or below the 10 % level) these were mostly of the correct sign.[17] The coefficient on relative wages in Zimbabwe and Poland were incorrectly signed. This may reflect relatively high exports of high wage-high productivity goods by South Africa to these developing countries. Tsikata (1999) shows that the structure of South African exports is relatively capital and human capital intensive when compared to other middle income countries. Some of this is explained by the regional comparative advantage South Africa has in the production and export of high-tech products to neighbouring countries.

A clear result from the disaggregated and the aggregated analysis is that the importance of RULC, relative wages and relative productivity in explaining the level of real exports across sectors has diminished during the 1990s. Yet, as is shown in Figure 2 RULC are still important in determining the export orientation of South African industry. Sectors with high RULC tend to export low shares of their output, even in the 1990s.

There are a number of possible reasons for the poor results during the 1990s. The 1990s were a period characterised by significant structural breaks such as the ending of sanctions, the election of a new government, a new macroeconomic policy, new labour legislation and the initiation of tariff liberalisation. The significant structural changes

[17] One reason for the weaker results is that the dependent variable is the ratio of total country exports according to sector and not bilateral exports according to sector. According to the Ricardo model trade between similar countries is expected to be low. Because bilateral trade is small between South Africa and most other developing countries, changes in RULC vis-à-vis these countries will not have a substantial direct affect on total SA exports. Changes in RULC will, however, affect comp etitiveness in third countries which, depending on the substitutability of exports, will affect the ratio of total exports. Because other factors (market access agreements, product differentiation) also affect exports, these products are unlikely to be perfect substitutes; hence the relatively poor results for developing countries.

during the 1990s have already been seen in the declining rank order correlation coefficients for RULC between the 1970s, 1980s and 1990s. The impact of these structural breaks may affect exports in a way that is not necessarily related to RULC. For example, the reintegration of South Africa into the world economy since 1994 led to rapid increases in exports to various regions. Some of this export growth is due to increased market access and not changes in labour cost competitiveness. Structural changes in the economy have also affected RULC across sectors. This has been shown by the poor Spearman's rank correlation coefficients between the 1980s and 1990s. Thus changes in the sectoral structure of exports and RULC may obscure the long run relationship between the two. As shown by Pesaran and Smith (1995) the cross-section estimator is biased for low *T*. The 1990s may be too short a period for the cross-section estimator to give an unbiased estimate of the average long run coefficient, particularly given the substantial changes in the policy environment.

Non-traditional exports have also grown rapidly during the 1990s and have increased the diversity of South Africa's export bundle (Black and Kahn, 1998). Because these changes are not adequately captured in the broad industrial categories used within this analysis, potential relationships between trade and RULC will be obscured.

Finally, the decline in importance of RULC may also reflect the rising importance of human capital and technology in determining export competitiveness. Edwards (2001) shows a positive relationship between skill intensity and export growth between 1993-97, some of which is due to growth of non-traditional exports, particularly to neighbouring countries. Using a factor classification system Edwards and Schoer (2001) and Lewis (2001) also show a bias in South African exports of technology intensive and human capital intensive sectors that has continued into the late 1990s. This bias may reflect a shift in competitiveness and trade away from natural resource and labour intensive products towards more technology and skill intensive products. The use of microelectronics and automation processes in production, the development of new products and production processes through innovation and R&D and the provision of after sales service are increasingly being seen as important determinants of competitiveness. This is the view that lies behind the recent Department of Trade and Industries (DTI) industrial strategy framework document (DTI, 2001).

To conclude, the cross section results provide substantial support for the Ricardian theory prior to 1990. During this period, sectors characterised by high RULC or high relative wages and low relative productivity exported significantly less than sectors with low RULC or low relative wages and high relative productivity. When using the aggregated data set, the impact on exports of a 1 % rise in relative productivity appears to have the same impact as a 1 % decline in relative wages. In contrast the country specific regressions suggest that relative wages have a greater impact. Since 1990 the evidence is weaker, particularly at the country level. Significant structural breaks, the role of innovation and technology in competitiveness, and rising diversity of exports within industrial sector classifications may give rise to the weaker relationship between RULC and export levels. Unit labour costs are, however, still significant in explaining the degree to which a firm is export orientated. Further evidence is provided in the time-series analysis.

VII. Time Series Results

In this section the time series results are presented. The reduced form equation (9) derived from the export demand and supply of equations is estimated. Although the estimated coefficients for world income and relative prices in the reduced form equation (9) do not necessarily represent income and price elasticities of export demand, they give insight into the relationship between exports and these variables. An export demand function similar to equation (7), but where P_x/P^* is proxied by RULC, is also estimated. This function implicitly assumes an infinite export supply elasticity. Both these equations were also estimated with RULC substituted by relative productivity, relative wage and exchange rates.

The export functions were estimated using the large disaggregated and the aggregated panel data sets. The latter is more appropriate for the dynamic estimates as it covers the period 1970-98 providing a larger sample for the estimation of the 'within sector' variation (as is done by the fixed effects estimator). Within the *aggregated* panel data set weighted averages of the exogenous variables were constructed for developed and developing countries within the sample. The equations were estimated for these broad regions separately. The export functions were also estimated for the following manufacturing sub-categories: natural resource intensive, labour intensive, chemical intensive and machinery & metal products sectors. This may overcome problems of inconsistent estimates if the slope coefficients differ across sectors. As these manufacturing sub-sectors are more homogenous than the entire sample, the relationship between the exogenous variables and export performance is expected to similar.

To determine the impact of relative wages and relative productivity on exports the equations were re-estimated using the aggregated panel with RULC replaced by these variables. Because country specific relative wages and nominal exchange rates are not measured in the same units, it is not possible to create weighted averages of these.[18] Relative wages were first converted to a common currency and a weighted average of indices created from these (1987=100) was constructed using share world trade (exports + imports) in total sample trade as weights. A one percent rise in relative wage can thus be brought about by a 1 % rise in nominal wages in South Africa or by a 1 % appreciation of the Rand with respect to all currencies. It is not possible to separate out which of these effects is more important. Both the MG and DFE estimators were used to determine the average long run coefficients.

[18] Carlin *et al*. (2001) in their study of OECD constructed weighted relative wage and exchange rate indices from nominal wage and nominal exchange rate indices. Although they sum variables in different units, this is unlikely to be too great a problem in a sample of countries with similar inflation rates. Given the broader coverage of this paper as well as the inclusion of high inflation economies, it is not possible to pursue a similar approach here.

The large *disaggregated* panel was also used to estimate export functions for the entire sample as well as for specific countries. Only the DFE estimator is used where a fixed effect is imposed for each sector within each country. The fixed effects capture any country and sector specific effects that are constant over time. Unlike the aggregated panel data set it was possible to estimate country export functions with relative wages in local currency units, relative productivity and nominal exchange rates separately. This should give insight into the relative importance of each of these in influencing export performance.

Aggregated Panel Data Results

Table 5 presents the DFE and MG estimates of the average long run coefficients of the various export functions using the aggregated panel data set (1970-98). The export demand function (equation 7) and the reduced form export function (equation 9) are estimated using the DFE estimator. We assume the dynamic process is characterised by a first order ARDL model in each case. The average long run coefficients in the reduced form export function are also estimated using the MG estimator. In addition, a simple Partial Adjustment Model (PAM) where a single lagged dependent variable is included in the regressors is estimated. The PAM has been the standard approach to modelling dynamics in export functions (see Goldstein and Khan, 1985) and was also used in our earlier paper (Edwards and Golub, 2002). The short run coefficients for the dynamic fixed effects regressions are presented in appendix Tables A1. The sector level results used to estimate the average long run relationships using the MG estimator are presented in appendix Tables A2 and A3.

As shown in Table 5 the average long run coefficients are of the expected sign for all variables in all the regressions. RULC, relative wages and capacity utilisation negatively affect exports. In contrast relative productivity and world income positively affect exports. In calculating the MG estimates the iron & steel and rubber sectors were excluded. The individual regressions for these sectors gave extremely large long run coefficients which resulted in a substantial bias in the MG estimate of the average long run coefficient. The extreme impact of outliers on the MG estimates has also been found by Pesaran *et al.* (1999).

The average long run coefficients of the export demand function (column 1 & 2) and the reduced form export function (column 3 & 4) are similar although the former generally exceeds the latter. Given the similarity in results the reduced form equation is focussed on as it provides further insight into the role of capacity utilisation on exports.

A comparison of the two estimators shows that the DFE estimated coefficients generally exceed those of the MG estimator. This suggests the existence of heterogeneity in the response of sectors to changes in labour cost competitiveness. Pesaran and Smith (1995: 86) note the existence of parameter heterogeneity biases the DFE estimated lagged dependent variable upwards which tends to overestimate the long run effects compared to the MG estimator. The upward bias in the lagged dependent variable is shown by the very slow adjustment to the long run equilibrium in the DFE results (ecm = -0.13) compared to the MG results (ecm = - 0.34). Similar biases were found by Baltagi and Griffin (1997) who estimate the demand for gasoline, Pesaran and Smith (1995) who estimate labour demand functions and Pesaran *et al.* (1999) who estimate a consumption function.

RULC have a significant impact on export performance in the long run. A 1 % rise in RULC reduces real exports by between 1.64 % and 2.32 % in the long run. This reflects a far greater responsiveness to RULC changes than is found by Golub (2000) for aggregate manufacturing in South Africa.

Relative wages and relative productivity are also shown to be important determinants of export competitiveness. The results of export demand and reduced form equations using relative wages and relative productivity as explanatory variables are shown in column (2), column (4) and column (7). The bias of the DFE estimator appears to be substantial as shown in the greater long run impacts estimated using this estimator. A 1 % rise in relative productivity raises real exports by 1.31 % and 1.9 % in the long run. Relative wages appear to have a more significant impact with a 1 % rise in relative wages reducing exports by between 1.52 % and 3.04 % in the long run. Either a rise in nominal wages or an appreciation of the domestic currency can induce a rise in relative wages. it is not possible to estimate the impact of nominal wage and exchange rate changes separately using the aggregated data set.

World income has the correct sign with an average long run income elasticity of between 1.65 to 2.37. These values are similar to those found in the international survey by Goldstein and Khan (1985), but exceed those found by Golub (2000) and Golub and Ceglowski (2001). They find income elasticities for aggregate manufacturing exports ranging between 0.67 and 1.64 in their estimates with RULC as the relative price variable. The long run relationship also exceed those found by Fallon and Pereira de Silva (1993) and Tsikata (1999).

Capacity utilisation has the expected negative sign, but the long run coefficient appears exaggerated (3.63 to 7.18). Tsikata (1999) for example finds that capacity utilisation has no effect on exports while Fallon and Pereira de Silva (1993) find that a 1 % rise in capacity utilisation reduces export orientation by up to –2.24 %. The relatively high value may reflect the use of the export market by South African firms as a vent-for-surplus as domestic demand declines. Finally, sanctions reduced real exports by between 0.2 and 0.4 % between 1985 and 1993, a result also found by Tsikata (1999).

Other variables were also included in the analysis. Following Carlin *et al.* (2001) investment in machinery and equipment as a share of the total capital stock of machinery and equipment was included as an exogenous variable. This variable was used as a proxy for innovation, R&D and embodied technological change. No significant results were found. Effective rates of protection according to sector were obtained from Fedderke and Vase (2001) and included as explanatory variables. Declines in effective protection are expected to capture reductions in the anti-export bias. Unlike Tsikata (1999), who found a negative relationship, no significant results were found. Insufficient data and the exclusion of non-tariff protection in calculating these effective rates of protection are likely to partly explain the poor results.

Sector Specific Results

In the process of estimating the average long run coefficients using the MG estimator the reduced form export function was estimated for each sector. The long run coefficients and the error correction term for each sector are presented in Appendix Tables A2 and A3. Care must be taken in interpreting these as the correct procedure outlined by Pesaran and Smith (1995) and Pesaran and Shin (1996) for testing for the existence of long run relationships and the subsequent estimation thereof using a correctly specified ARDL model has not been followed. However, as in Pesaran, Shin and Smith (1999) the sector specific results are still presented. In the analysis that follows the results of the estimations with RULC as the explanatory variable are emphasised. The results in Table A3 are qualitatively similar.

The results are mixed. For a long run relationship to exist the error correction coefficient $f_i \neq 0$. This is less than zero for all but the iron & steel industry, although only significantly so for 14 of the 25 sectors. Sectors displaying rapid convergence to the long run equilibrium ($f_i \leq -0.5$) were paper products, printing & publishing, transport and professional and scientific equipment.[19]

The long run elasticity for RULC is correctly signed for 17 of the 24 sectors and significant in 8 of them. The largest significant coefficient is for furniture (-7.26) and the lowest is –1.57 for paper products. Labour intensive sectors appear most affected by RULC with 4 of the 6 labour-intensive sectors displaying negative coefficients. These are leather products, wearing apparel, wood products and furniture. Relative wages appear to drive this relationship with these sectors displaying large negative long run coefficients for this variable (Table A3). No coefficients for RULC were significant in chemical intensive sectors. Of the remaining sectors, significant and negative results were found for food, paper products, professional and scientific equipment and other manufacturing. As found by Goldstein and Khan (1985) the elasticities of sub-sectors generally exceed those for manufacturing as a whole.

Capacity utilisation is correctly signed in 18 sectors, but only 2 of these were significantly different from zero. World Value added is correctly signed for 19 of the sector regressions with 10 of these significant at the 10 % level. Sanctions were significant and negative for only 3 sectors although 15 of the sectors had the correct sign.

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[19] Evidence of serial correlation is found in 6 sectors (beverages, Leather, non-electrical machinery, transport and other manufactures). Heteroskedasticity is found in beverages, furniture, industrial chemicals, non-ferrous metal, glass products, electrical machinery, transport and professional and scientific equipment sectors. The functional form of 2 sectors are found to be mis-specified (transport and wood products). The individual estimates may be biased because of omitted variables and measurement errors that are correlated with the regressors. The pooled estimates will be appropriate so long as the bias inducing correlations are not systematic.

The sector specific estimates displayed wide variability in the long and short run coefficients. Wide dispersion of estimates were also found in the comparative estimator studies of Baltagi and Griffin (1997), Pesaran and Smith (1995) and Pesaran *et al*. (1999). The variability of the sector specific regressions questions the reliability of the MG estimator. Further, Baltagi and Griffin (1997: 313) argue that the MG estimator substantially underestimates the coefficients, while the pooled estimators (of which the DFE is one) provide more plausible estimates.

Nevertheless, the wide variation in the individual sector estimates suggests that the common coefficient imposed on all sectors by the DFE estimator may be extreme. To test for the possible biases arising from parameter heterogeneity export functions were estimated for a number of broadly defined manufacturing sub-sectors: natural resource intensive, labour intensive, chemicals and machinery & metal products (see Table B1 for a sectoral breakdown of these categories).[20] It is expected that the slope estimates for the sub-sectors will be more similar to each other, thus overcoming some of the problems associated with the parameter homogeneity assumptions of the DFE estimator. The DFE estimates of the long run coefficients are presented in Table 6.

We find that export performance of labour intensive and chemical sectors are strongly influenced by labour costs of production. The long run impact of a 1 % rise in RULC is a reduction in real exports of more than 2.5 % in each case. The decline in exports of natural resource intensive and machinery and metal products sectors is between 1.3 % and 1.5 %. Improvements in relative productivity increase exports while increases in relative wages reduce export competitiveness for all broadly defined sub-sectors. Long run export performance is more affected by changes in relative wages than relative productivity for all but the natural resource intensive sub-sector. Labour intensive and chemical sector exports are particularly strongly affected by rising relative wages with coefficients in excess of –3. Capacity utilisation and changes in world income affect exports of all broad sub-categories in the expected way, although the affect of these variables on machinery & metal product sectors is small. This sector, however, shows a much quicker convergence to the long run equilibrium in response to shocks than the other sectors.

Region Specific Results

As shown in the preliminary analysis RULC, relative wages and relative productivity differ according to region. Trade flows also differ according to region with South Africa exporting relatively skill intensive products to developing countries and less skill intensive products to developed countries (IMF, 1998, Edwards and Schoer, 2001). In this section we analyse whether the relationship between labour cost competitiveness and

[20] We tested for homogeneity of the slope coefficients using the Chow test (see Baltagi, 2001: 53 and Hsiao, 1986: 12-16). Slope homogeneity with all sectors pooled was rejected. For the broadly defined manufacturing sectors, slope homogeneity was rejected for all but the chemical sectors. These tests are only valid if the errors in each individual regression are iid with mean zero and constant variance. These conditions do not hold in some cases, rendering the test statistic invalid. They have not been emphasised as result.

export performance differs according to region. Unfortunately bilateral trade data from 1970 is not available for the set of countries. However, South African exports to developed countries is available from the Canadian World Trade Analyzer whose data is originally based on the UN Comtrade data base.[21] This data is used to estimate export demand functions for developed countries between 1980-98 using both the aggregated and disaggregated data set. The export functions were also estimated for developed and developing countries between 1970-98 using the aggregated data set, but total South African exports were used as the dependent variable in each case. Although the coefficients are elasticities with respect to changes in total exports and not regional exports, the signs will indicate whether labour costs are important determinants of exports in each case. The long run coefficients estimated using the DFE estimator and the aggregated data set are presented in Table 7.

The signs of the coefficients are as expected. The responsiveness of exports to changes in relative productivity, capacity utilisation and regional income appear similar for developed and developing countries. However, RULC vis-à-vis developed economies appear to have a more severe impact on exports in the long run (-1.88) than RULC vis-à-vis developing countries (-1.16). This is consistent with the weak cross section results for developing countries shown earlier. The long run coefficients for developed countries using bilateral export data over the period 1980-98 are also presented. The signs of the coefficients are again consistent with expectations. The long run coefficients for regional income and relative wages are similar to those estimated using total exports over the period 1970-98. The responsiveness of exports to changes in capacity utilisation, RULC and relative productivity is substantially less. In all these regressions exports appear to respond more significantly to changes in relative wages than relative productivity.

The rich disaggregated data set constructed enables a much more detailed analysis of the relationship between exports and labour costs at the country level. Table 8 presents the long run coefficients estimated using the DFE estimator for individual developed countries and the entire pooled data set. In the latter case fixed effects are assumed for each sector in each country. The dependent variable in each case is real bilateral exports from South Africa. Because the data are not aggregated, it is also possible to separate the exchange rate and relative wage effects in these regressions. Foreign income is proxied by total imports (in US$) by each country from the rest of the world.

The results overall are weak. In the regression with RULC the average long run coefficients when the data for all countries are pooled are of the correct sign. They are, however, substantially lower than the estimates found when using the aggregated panel. The weak results for the pooled regression reflects the wide dispersion in results for the country specific estimates. The coefficient on RULC is negative for all but Netherlands and the US. Further, those coefficients with the correct sign suggest a very inelastic

[21] Bilateral data classified according to the Harmonised System was available for all countries from 1988. The time period, however, was seen to be too short to yield reliable estimates. Further, substantial increases in exports over this period as South Africa re-entered into the world economy induced trends into the data. Level analysis in these circumstances is likely to be inappropriate. Export equations using HS regional exports with variables in log differences were estimated. The results were poor.

response in exports to changes in RULC. Low elasticities were also found for relative wages and relative productivity. A further feature is the rapid convergence to long run equilibrium shown in the error correction term.

Time series versions of the McDougall (1951) model (equation 5a) with the log total export ratio (X_{isa}/X_{ij}) as dependent variable were also run for all countries between 1980-98. This enabled the inclusion of developing countries for which trade data are available. RULC was significant in 8 of the 19 countries, of which 6 were of the correct sign (Chile, Hungary, India, Mexico, Poland, Singapore). Interestingly, no significant coefficients were found for developed countries. When relative productivity and relative wages were included, three countries had significant coefficients with the correct sign on relative productivity and nine had the correct sign on relative wages.

The poor results may reflect the shorter time period over which the functions are estimated. As discussed, the DFE produces biased estimates when *T* is low. Bilateral trade and RULC vis-à-vis individual countries are also volatile. Some of this volatility is smoothed out in the aggregation process enabling superior estimates of the coefficients.

Conclusion

This paper has sought to extend Golub's (2000) analysis of South African competitiveness in manufacturing in two main directions. First, to assess South African comparative advantage we have extended the analysis of relative unit labour costs, productivity and wages to the industry level. Second, we have focussed on the relationship between these variables and South Africa's export performance.

Our measure of international competitiveness, relative unit labor costs—the ratio of wages to labour productivity—shows a strong improvement over the 1970-1998 sample period for most sectors, with particularly large improvements in the late 1990s. This improvement is much larger vis-à-vis developed than developing countries, however. Level comparisons, although they must be treated with more caution, also suggest that South Africa was still not competitive in most sectors in the late 1990s against other developing countries, despite some gains.

Much of the improvement over time in international competitiveness reflects relative wage movements rather than relative productivity. That is, South African relative wages measured in a common currency declined relative to other countries more rapidly than productivity. The relative wage decline substantially reflects the large depreciation of the rand against other currencies. In the long run improvements in competitiveness through exchange rate depreciations are not sustainable.

We have also evaluated sector competitiveness rankings and their evolution over time. No clear pattern emerges as to the nature of South African comparative advantage. Those sectors with the highest levels and improvements of competitiveness include a variety of labor intensive, capital-intensive, and natural resource intensive goods.

Moreover, sectoral competitiveness rankings have changed substantially over time in an unpredictable fashion.

Both simple charts and econometric methods show that South African exports and respond strongly to relative unit labour costs. Export growth in the 1990s has been far superior to that of the Apartheid era, in large measure because of improved relative unit labour costs. The surge in exports in the 1990s is greater than can be explained by relative unit labour costs, however, reflecting the structural changes associated with the end of Apartheid and the new outward-oriented economic policies. We estimate that a 1 % decline in RULC in developing and developed countries results in a 1.2 % and 1.9 % increase in South African real exports in the long run, respectively. We also decompose the effects of relative unit labour costs into relative productivity and relative wages. In general we find that relative wages are more important determinants of trade than relative productivity. Our estimates suggest that a 1 % rise in wages reduces total exports by between 1.5 % and 3 % % in the long run.

Several policy conclusions can be inferred from these findings.

Firstly, sustainable growth of output, exports and employment, all depend on labour productivity growth, together with wage moderation. While this paper has not directly investigated the sources of South Africa's labour productivity growth, some of the requisite policy measures are well known.

One such area is education. Although the rewards may only be realised in the long run, improvements in education, particularly the quality thereof, can substantially raise the productivity of South Africa's labour force and through this export performance. The positive impacts on economic growth of improved educational quality have been shown by Fedderke (2001).

Increased investment in new technology and productive capacity is a further avenue through which to improve labour productivity. Increased investment in new technology can be encouraged through an accelerated program of tariff liberalisation. This lowers the cost of access to foreign technology as well as induces productivity gains through increased international competition. Work by Jonsson and Subramanian (2000) has shown a positive relationship between improved TFP growth and trade liberalisation. The necessity of liberalising trade has been given further impetus by the significant real depreciation of the currency during late 2001. This will have substantially raised the cost of imported machinery.

Second, over time, productivity growth enables real wage growth. It is important, however, to ensure that growth of labour costs does not outstrip productivity growth, and that unit labour costs remain international competitive. Given that South African relative unit labour costs, although much reduced, remain high compared to a number of newly industrialising countries with which South Africa competes, further reductions in relative unit labour costs would be beneficial.

Third, South African exports respond strongly to market forces and particularly relative unit labour costs, both overall and at the industry level. Sectoral rankings of competitiveness, however, are not readily identified with observable characteristics and change substantially over time. These findings suggest that there is no easy way to pick winners based on industry characteristics and that the government should not attempt to favour some sectors over others. Instead, as indicated above, a general environment which fosters productivity growth and wage moderation will entail rapid export growth. Market forces will then determine which industries are particularly successful in exporting.

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Appendix: Data sources and the construction of variables

The calculation of RULC, relative wages, relative productivity and relative TFP for the vast range of countries and sectors against which South Africa is compared is a data intensive process. This section briefly outlines the data sources and some of the changes made to the data in cases of missing values and clear inconsistencies.

Relative unit labour cost (RULC)

As discussed earlier unit labour cost for sector *i* in country *j* can be written as:

$$ULC_{ij} = w_{ij}.a_{ij}$$

where a_{ij} is the labour requirement per unit of real output in industry *i* in country *j*, (L_{ij}/Q_{ij}), and w_{ij} is the wage rate. The ULC_{ij} reflects the labour cost of producing a unit output of commodity *i* in country *j*.

The competitiveness of country *j* vis-à-vis country *k* can be written as a ratio of unit labour costs in a common currency. This is termed the relative unit labour costs and is calculated as

$$RULC_{ijk} = \frac{a_{ij} w_{ij}}{a_{ik} w_{ik} e_{jk}} \tag{21}$$

where e_{jk} is the bilateral exchange rate that converts foreign wages, w_{ik}, into domestic currency units.

While this approach provides a useful indication of movements in relative unit labour costs over time, is does not adequately reflect relative *levels* of unit labour costs at any particular point in time (Hooper and Larin, 1989).

To make comparisons between levels of unit labour costs it is necessary to convert a_{ij} into a common currency, i.e. convert real output in the unit labour requirements into comparable currencies. Traditionally PPP exchange rates are used, although the lack of PPP exchange rates for many countries necessitates the use of alternative proxies. Golub (2000), for example, utilises the mean real exchange rate as a proxy for the equilibrium exchange rate. From this it is then possible to estimate the PPP exchange rate taking differential inflation into consideration (see later). Incorporating these changes into equation (21), $RULC_{ikj}$ becomes

$$RULC_{ijk} = a_{ij}.\frac{PPP_{jk}}{a_{ik}}.\frac{w_{ij}}{w_{ik} e_{jk}} \tag{22}$$

where PPP_{jk} is the purchasing power parity between country *j* and *k*. In this format relative productivity is not affected by short term nominal changes in exchange rate, but relative wages are. When $RULC_{ijk}$ > (<) 1 the labour cost in producing a unit output (*j*) in country *i* exceeds (is less than) that of country *k*.[22]

[22] Other factors such as the cost of capital and the cost and reliability of services also influence the competitiveness of an industry.

The calculation of RULC required sector level data on wages and salaries, employment and value added. For the conversion of output and wages into comparable currencies data on nominal exchange rates and PPP exchange rates were also required. Depending on how value added data is deflated sector specific deflators or common manufacturing level deflators for each country are required.

Manufacturing data according to sector by country is generally available from two sources: the UNIDO Industrial Statistics database (INSTAT) and the OECD STAN data set. These data sets contain, amongst other variables, values for employment, real and nominal output, value added and wages and salaries. As the OECD STAN data set does not have data on many developing countries (other than Mexico and Korea) and data were at times not available during the 1970s it was decided to focus on the UNIDO data set. A comparison of RULC using the UNIDO and STAN data sets indicates that the UNIDO based values over–estimate RULC compared to the STAN based values by between 50 and 100 % (Table B.2).

These differences arise from different methods of obtaining the data. In particular, the STAN data set includes employer-paid fringe benefits which gives rise to lower estimates of RULC. For most countries these differences remained constant over time, although the USA and Japan show rising differences in RULC. To test the robustness of the econometric results, both the STAN and UNIDO based variables were used in the estimations. The sign and level of the coefficients were similar, suggesting that the fixed effects in the regressions capture much of the difference.

The UNIDO data for South Africa from 1994 appeared to have been estimated as for most sectors the share of wages and salaries in total value added was constant. As result value added, employment and wage data obtained from the Trade and Industrial Policy Strategies (TIPS) were used.

Relative wages were constructed by dividing the total wage bill by employment. The wage bill was first converted into a common currency using nominal exchange rates obtained from the World Development Indicators (WDI).

The relative productivity variable was constructed by dividing real value added by employment. This was then converted to a common currency using PPP exchange rates for 1987. Unfortunately, PPP exchange rates are not available for South Africa necessitating the construction thereof. PPP_t is represented as:

(23) $$PPP_t = \left(e_0^* \frac{P_0^\$}{P_0^d} \right) \frac{P_t^d}{P_t^\$}$$

where $\left(e_0^* \frac{P_0^\$}{P_0^d} \right)$ is the equilibrium real exchange rate and P_t^d and $P_t^\$$ are domestic and foreign prices at time *t*. Given the equilibrium real exchange rate it is possible to calculate PPP_t for all *t* using the correct domestic and foreign prices. However in SA case we do not have this information. Golub (2000) overcomes this problem by using the average real exchange rate $\sum_{t=1}^{n} \frac{1}{n} \left(e_t \frac{P_t^\$}{P_t^d} \right)$ as a proxy for the equilibrium real exchange rate. This is the process followed here. Manufacturing value added deflators calculated from nominal and real manufacturing value added obtained from the World Development Indicators (WDI) were used as the price indices. Ideally, one should utilise sector specific PPPs, but as these were not available a common PPP for manufacturing as a whole was assumed.[23] While this may distort level comparisons at the sector level, the trends in RULC will not be affected. In the econometric analysis level differences are captured by the inclusion of sector specific intercepts leaving the estimates of the slope coefficients unaffected.

Two approaches to deflating value added were pursued. In the first case sector value added was deflated to base year 1987 using a common value added deflator for each country derived from the WDI. In the second case, sector value added was deflated using sector specific deflators calculated from the nominal and real output values and indices in the UNIDO data set. This approach assumes that the output and value added deflators are the same. The sector specific deflators were highly variable at times, and various procedures were used to correct the data (see later). The correlation coefficient between the common value added deflator and the sector specific deflator exceeded 0.8 in most cases. The exception was Italy were the correlation coefficient was below 0.3 for almost all sectors.[24] RULC values calculated using the value added deflator were lower than those calculated using the sector specific deflator prior to 1980, but higher during the 1990s (Table B.3). The sector specific deflator based RULC depict a greater decline in RULC and thus improvement in competitiveness over the period. Nevertheless, the ranking of sectors according to RULC calculated using the different deflators are similar, particularly since the 1980s. The Spearman's correlation coefficient exceeded 0.78 for the 1980s and 1990s. The rank correlation coefficient was lower at 0.41 in the 1970s.

It was decided to utilise the sector specific deflators, despite their greater variability, as it was felt that price trends at the sector level deviated substantially from the aggregate for manufacturing as a whole. Further, the estimated sign of RULC and relative productivity in the econometric analysis using both deflators were qualitatively similar. The results were, therefore, robust to changes in the deflator used.

Trade data

International trade data were required for the export functions and as weights for the purpose of aggregating all countries into an aggregated panel data set. Trade data were obtained from a number of sources. Customs and Excise bilateral trade data classified according to the 8 digit Harmonised System was downloaded from the TIPS Online data site. This was converted into the ISIC classification system consistent with the UNIDO data set using a concordance file obtainable from the same site. Unfortunately, this data are only available from 1988 precluding its use in any econometric analysis to estimate

[23] As Golub and Hsieh (2000) show the use of different PPPs give rise to different results. The signs however were not reversed.
[24] Other exceptions were Japan: Electrical machinery (-0.03) and Professional goods (-0.66), Netherlands: Rubber products (-0.86), and UK: Miscellaneous petroleum products (-0.01).

the long run relationship between exports and RULC. It is also only available for the Southern Africa Customs Union (SACU) and not South Africa alone.

Total country exports and bilateral trade data between South Africa (essentially SACU) and each country were then obtained from Canada World Trade Analyzer. This data are available from 1980-98. The Canadian World Trade Analyzer data are classified according to SITC and were converted to the UNIDO ISIC classification using a concordance file constructed from one available on the Jon Haveman site (http://www.eiit.org/) (as used by Edwards and Schoer, 2001). Unfortunately the bilateral trade data were only complete for the developed countries. A further problem is that South Africa did not report any data between 1974-91 (Tsikata, 1999). The data for this period are then obtained from partner countries.

Total South African imports and exports according to sector between 1970-98 were obtained from TIPS and were used in the aggregate panel data set. The countries within the sample account for 55 % of total SA exports and 55 % of total SA imports. Although the countries sampled do not account for the entire trade, much of the missing trade can be located within Europe where it is expected that RULC will move concurrently with those of other developed countries.

In cases where real South African exports were used as the dependent variable, the nominal data were converted into real values using output deflators. Export and import price indices are not currently available for South Africa over the entire period and for all sectors.

Tariff data at the sectoral level for entire the period 1970-98 are not available. Aggregate tariff rates were calculated from customs revenue and imports for the entire period. Fedderke and Vase (2001) have calculated effective rates of protection according to sector using customs revenue for the period 1988-98. The values used in this study have been taken directly from their paper.

Other variables

Other variables such as real investment in machinery and equipment, real capital stock of machinery and equipment, real and nominal output, employment and capacity utilisation have been used in the study. This data were obtained from TIPS.

Issues relating to the updating of data

Different classification systems across countries and changes in these classification systems over time make the construction of a consistent data set difficult. While the UNIDO and STAN data sets attempt to compile a consistent data set, there are still numerous problems evident within the data.

Firstly, the classification of industrial sectors changed over the years. This resulted in large once off changes in the level of output or value added measured between years. This was problematic if the real index and employment had not been similarly adjusted.

In most cases employment, value added and output (real and nominal) were adjusted to be consistent with the reclassification of industrial sectors. At times the value added variable had not been adjusted correctly. Changes in gross output were then used to adjust the *level* of value added for that sector. The remainder of the series was adjusted using value added growth rates derived from the original data.

Secondly, real output indices used for the construction of sector level deflators were frequently only available for aggregated sub-sectors. Nominal output was similarly aggregated in order to calculate a common deflator for all the sectors within the aggregated group.

Thirdly, with the reclassification of industrial sectors the output, value added and employment of certain sectors was aggregated (e.g. iron & steel (371) with non-ferrous metal (372)). The aggregated sectors were disaggregated using the average share in the 3 to 5 years prior to the reclassification of sectors. Where possible alternative data sources were used (STAN data for OECD countries). Employment levels were adjusted using relative average wages prior to the reclassification.

Fourthly, data were sometimes missing for a number of sectors and countries for a number of years. In cases where these covered periods of up to 3 years average annual growth rates were used to adjust the data when no alternative sources were available. If these periods exceeded 3 years then the country was either dropped or alternative data were used to update the data. For example, the missing value added and output data for France from 1993 was estimated using the STAN data set. Wages and salaries prior to 1977 were estimated in a similar manner.

In order to further check the data for outliers and level changes the following assessment procedure was used:
Sector level deflators for each country were analysed for sudden shifts or outliers. When nominal output and the real index clearly diverged as the result of once off shifts, the initial level of the real index was adjusted and the original growth rates were used to adjust the trend in the real index. Compound growth rates were used to replace outlying deflators.
Figures of RULC for each country were then analysed for outliers and sudden shifts in levels. The raw data was re-analysed in problematic cases. This process was useful in identifying errors in the value added data.

Tables

Table 3
Labour cost competitiveness and the structure of South African real exports, cross section results

	1970-98 Coef.	1970-79 Coef.	1980-89 Coef.	1990-94 Coef.	1995-98 Coef.
RULC	-4.66 **	-5.74 ***	-3.71 *	0.20	0.47
	2.00	1.13	2.18	1.24	0.87
Constant	20.87 ***	21.85 ***	20.36 ***	19.90 ***	20.54 ***
	0.72	0.66	0.80	0.33	0.27
R2	0.20	0.54	0.12	0.00	0.01
obs	24				
F(1,22)	5.42 **	25.72 ***	2.89 *	0.03	0.30
	Coef.	**Coef.**	**Coef.**	**Coef.**	**Coef.**
Rel Prod	11.53 ***	5.59 ***	9.88 ***	-0.12	-0.44
	2.77	1.21	3.49	1.92	1.00
Rel Wage	-10.44 ***	-5.00 ***	-10.49 **	1.44	2.67 **
	3.91	1.76	5.07	2.45	1.44
Constant	14.81	17.16 **	22.81 *	13.91 *	10.56 **
	9.49	6.84	11.89	7.72	4.67
R2	0.51	0.51	0.30	0.03	0.19
obs	24				
F(2,21)	10.74 ***	10.76 ***	4.55 **	0.31	2.45

Note: Dependent variable is log real exports. All variables are in logarithmic form.
***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.

Table 4

Labour cost competitiveness and the structure of trade according to country, log total exports ratio (Xisa/Xij) as dependent variable.

	1980-89			**1990-98**		
	(1)	**(2)**		**(3)**	**(4)**	
	RULC	**Rel Prod**	**Rel Wage**	**RULC**	**Rel Prod**	**Rel Wage**
Developed countries(1)						
France	-3.24***	3.32***	-4.43***			
Hong Kong	-2.51*	2.68*				
Italy	-4.79***	4.74***	-5.69***			
Japan			-3.73**			
Netherlands	-3.57***	2.45***	-3.00***			
Spain						
UK	-3.17***	3.16***	-4.77***			
USA	-2.32**	1.88**	-3.80***		1.08*	
Developing countries (1)						
Chile						
Hungary				-1.28*	1.48*	
India	-1.71*	2.08**				
Poland						*1.38***
Singapore			-2.33**			-1.96*
Turkey	-1.21**	1.50***				
Zimbabwe			*1.86**			

Notes: Dependent variable is log (Xisa/Xifor). Export data obtained from the Canadian World Trade Analyzer.

25 sectors are included.

When real bilateral exports were used as the dependent variable no significant results were found for the UK and Italy. Only relative productivity was significant for the US between 1980-89. All remaining coefficients were of similar size and sign.

***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.

Table 5
Average long run export coefficients using DFE and MG estimators, log real exports as dependent variable

	Dynamic fixed effects estimator				**Mean group estimator**		
	X Demand	**X demand with Rel Prod and Rel Wage**	**Reduced form**	**Reduced form with Rel Prod and Rel Wage**	**Reduced form ARDL (1,1,1,1)**	**Reduced form PAM**	**Reduced form with Rel Prod and Rel Wage ARDL (1,1,1,1,1)**
RULC	-2.32		-2.19		-1.64	-1.71	
					0.54	*0.43*	
Rel Productivity		1.90		1.90			1.31
							0.44
Rel Wage		-3.04		-2.80			-1.52
							0.63
Capacity			-7.18	-4.94	-4.41	-3.63	-5.46
					2.45	*1.53*	*2.71*
World income	2.36	1.67	2.14	1.65	2.02	2.37	2.06
					0.61	*0.51*	*0.90*
ecm	-0.13	-0.15	-0.13	-0.15	-0.34	-0.34	-0.40
	0.02	*0.02*	*0.02*	*0.02*	*0.04*	*0.03*	*0.05*

Notes: Log real exports as dependent variable. The standard error is in italics below the coefficient.

Table 6
Average long run export coefficients for broadly defined manufacturing sectors using DFE estimator, log real exports as dependent variable

	Natural resource	**Labour**	**Chemical**	**Machinery & metal products**
	Coef.	**Coef.**	**Coef.**	**Coef.**
With RULC				
RULC	-1.29	-2.68	-2.55	-1.52
Capacity	-8.10	-8.50	-6.55	-0.92
World income	1.60	2.46	3.30	1.95
ecm	-0.13	-0.13	-0.10	-0.23
With relative productivity and relative wages				
Rel Prod	2.17	2.18	1.30	1.33
Rel Wage	-2.20	-3.24	-3.04	-2.47
Capacity	-7.04	-7.70	-3.75	-0.05
World income	1.24	2.36	2.80	0.90
ecm	-0.14	-0.14	-0.12	-0.29
obs	196	196	112	168

Table 7

Long run coefficients estimated using the DFE for developed and developing countries, log total exports as dependent variable

	Developing countries	**Developed countries**	
Dependent variable	**1970-98 Total exports**	**1970-98 Total exports**	**1980-98 SITC exports to developed countries**
With RULC			
RULC	-1.16	-1.88	-1.05
Capacity	-6.86	-6.85	-2.60
Region income	1.23	1.12	1.05
ecm	-0.14	-0.14	-0.28
With relative productivity and relative wages			
Rel Prod	1.19	1.10	0.69
Rel Wage	-1.53	-1.46	-1.56
Capacity	-5.24	-6.35	-1.61
Region income	0.94	0.64	0.41
ecm	-0.16	-0.14	-0.32
obs	627	627	450

Notes: The dependent variable for developed and developing country regressions over the 1970-98 period is total South African exports. The developed country regression over 1980-98 uses SITC data taken from the Canadian World Trade Analyzer. This data are converted to from US dollars to real rands using sector specific output deflators and nominal exchange rates.

Table 8

Long run coefficients estimated using the DFE for developed countries over period 1980-97, log real bilateral exports as dependent variable

	Total	**Canada**	**France**	**Hong Kong**	**Italy**	**Japan**	**Netherlands**	**Spain**	**UK**	**USA**
With RULC										
RULC	-0.06	-0.32	-0.89	-0.07	-0.61	-0.97	0.44	-0.16	-0.11	0.07
Capacity	-1.35	2.47	-4.53	-3.60	-1.55	2.05	-4.72	6.50	-2.10	-0.46
World imports	1.00	0.94	1.25	0.75	0.53	0.65	1.61	0.94	1.23	0.99
ecm	-0.43	-0.54	-0.40	-0.52	-0.48	-0.38	-0.47	-0.41	-0.34	-0.39
With relative productivity, relative wages and bilateral exchange rate										
Rel Prod	-0.04	1.31	0.70	0.09	0.37	1.16	-0.51	0.22	-0.01	-0.50
Rel Wage	-0.12	-2.12	-1.44	-0.12	-0.62	-2.28	0.84	-0.52	0.48	0.12
Exchange rate	0.49	1.56	0.35	-0.40	2.14	1.76	-1.13	0.91	-0.25	0.75
Capacity	-0.44	3.29	-4.02	-4.12	-1.37	2.62	-3.65	6.42	-1.86	0.08
World imports	0.74	1.44	2.35	0.98	-0.61	1.02	2.25	0.61	1.26	0.36
ecm	-0.43	-0.56	-0.40	-0.50	-0.49	-0.38	-0.45	-0.42	-0.32	-0.37

Notes: Bilateral export data taken from the Canadian World Trade Analyzer. Converted from SITC to SIC using a concordance file adapted from J. Haveman.

Exports converted to Rands using the R/US$ exchange rate and then converted into real values by deflating with sectoral output deflators.

Appendix Tables

Table A1

Short run export coefficients using DFE, log real exports as dependent variable

	X Demand (1) Coef.		X demand with Rel Prod and Rel Wage (2) Coef.		Reduced form (3) Coef.		Reduced form with Rel Prod and Rel Wage (4) Coef.	
Exports(-1)	0.87	***	0.85	***	0.87	***	0.85	***
	0.02		*0.02*		*0.02*		*0.02*	
RULC	-0.65	***			-0.64	***		
	0.10				*0.10*			
RULC(-1)	0.36	***			0.36	***		
	0.12				*0.12*			
Rel Prod			0.59	***			0.60	***
			0.13				*0.13*	
Rel Prod(-1)			-0.31	**			-0.32	**
			0.13				*0.13*	
Rel Wage			-0.74	***			-0.71	***
			0.10				*0.10*	
Rel Wage(-1)			0.29	**			0.31	***
			0.12				*0.12*	
Capacity			0.00	***	-0.82	***	-0.64	**
			0.00		*0.31*		*0.32*	
Capacity(-1)			0.00	***	-0.11		-0.07	
			0.00		*0.32*		*0.32*	
Sanctions	-0.02		-0.04		-0.03		-0.04	
	0.03		*0.03*		*0.03*		*0.03*	
World income	0.88	***	0.81	***	0.80	***	0.77	***
	0.18		*0.18*		*0.18*		*0.18*	
World income(-1)	-0.57	***	-0.56	***	-0.52	***	-0.53	***
	0.18		*0.19*		*0.18*		*0.19*	
Constant	-5.09	***	-2.56	*	-0.32		0.56	
	1.24		1.50		*1.89*		1.95	
F-test	1027.6		791		786		639	
obs	672		672		672		672	
Sectors	24		24		24		24	

Notes: All variables other than the sanction dummy are in logs.
Values in italics below coefficients are the standard errors
***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.

Table A.2

Sector specific estimation and diagnostic results based on ARDL(1,1,1,1) specification.

		ECM	RULC	Capacity	Sanctions	Income	se	SC	FF	NO	HE	R2
Food	coeff	-0.19	-4.36	-25.48	0.07	-2.73	0.12	0.57	4.88		2.65	0.85
	Prob	[.146]	[.050]	[.216]	[.846]	[.167]		[.459]	[.040]		[.115]	
Beverages	coeff	-0.20	0.82	-22.16	0.08	0.91	0.22	3.10	0.14		7.62	0.96
	Prob	[.088]	[.749]	[.082]	[.926]	[.836]		[.095]	[.708]		[.010]	
Textiles	coeff	-0.09	-4.37	6.78	-1.77	8.43	0.11	0.38	2.19		0.14	0.95
	Prob	[.415]	[.164]	[.455]	[.477]	[.453]		[.544]	[.157]		[.710]	
Apparel	coeff	-0.24	-3.17	-4.44	-0.32	4.93	0.24	0.09	0.28		0.14	0.95
	Prob	[.238]	[.001]	[.672]	[.602]	[.309]		[.773]	[.604]		[.713]	
Leather	coeff	-0.45	-2.11	14.81	-0.92	-0.51	0.18	9.97	1.40		0.08	0.96
	Prob	[.001]	[.003]	[.005]	[.013]	[.747]		[.005]	[.252]		[.785]	
Footwear	coeff	-0.34	0.06	-28.26	-0.20	0.30	0.40	1.00	0.13		1.56	0.75
	Prob	[.070]	[.980]	[.113]	[.789]	[.948]		[.331]	[.720]		[.222]	
Wood products	coeff	-0.43	-3.41	-6.48	0.11	-0.15	0.30	1.47	5.64		2.50	0.84
	Prob	[.020]	[.003]	[.091]	[.771]	[.946]		[.241]	[.029]		[.126]	
Furniture	coeff	-0.29	-7.26	-0.26	-1.24	0.88	0.44	0.01	0.18		9.92	0.96
	Prob	[.025]	[.005]	[.979]	[.139]	[.909]		[.919]	[.679]		[.004]	
Paper products	coeff	-0.50	-1.57	-0.73	-0.06	1.62	0.14	1.05	2.01		0.36	0.95
	Prob	[.025]	[.070]	[.826]	[.732]	[.017]		[.318]	[.174]		[.555]	
Printing	coeff	-0.52	-0.69	-15.91	-0.61	2.05	0.33	0.00	0.16		0.02	0.79
	Prob	[.011]	[.638]	[.099]	[.111]	[.124]		[.989]	[.694]		[.885]	
Industrial chemicals	coeff	-0.23	-1.15	-6.50	-0.53	2.16	0.13	0.02	1.91		3.23	0.97
	Prob	[.108]	[.344]	[.251]	[.198]	[.014]		[.904]	[.184]		[.084]	
Other chemicals	coeff	-0.20	-6.07	3.17	-1.12	2.59	0.21	6.71	0.43		0.15	0.91
	Prob	[.143]	[.211]	[.810]	[.192]	[.020]		[.018]	[.523]		[.700]	
Rubber	coeff	-0.12	2.91	-14.59	0.48	8.84	0.21	0.02	1.09		1.92	0.96
	Prob	[.498]	[.585]	[.648]	[.735]	[.091]		[.883]	[.310]		[.178]	
Plastic	coeff	-0.12	0.32	-11.09	0.22	4.19	0.16	0.28	0.03		1.28	0.98
	Prob	[.060]	[.931]	[.390]	[.768]	[.213]		[.606]	[.857]		[.268]	
Glass products	coeff	-0.35	-0.81	-3.23	0.18	3.59	0.21	0.12	0.41		3.01	0.85
	Prob	[.165]	[.550]	[.453]	[.649]	[.113]		[.728]	[.532]		[.095]	
Other non-metallic minerals	coeff	-0.49	3.13	-2.29	-0.76	6.15	0.32	2.99	0.10		0.12	0.63
	Prob	[.007]	[.109]	[.508]	[.046]	[.029]		[.101]	[.750]		[.727]	
Iron and Steel	coeff	0.02	32.22	18.86	4.76	16.90	0.14	2.02	0.79		1.10	0.94
	Prob	[.778]	[.778]	[.833]	[.771]	[.729]		[.172]	[.387]		[.304]	
Non-ferrous metal	coeff	-0.10	-0.15	20.50	-1.65	-3.69	0.26	0.42	0.95		4.92	0.82
	Prob	[.543]	[.955]	[.651]	[.668]	[.724]		[.523]	[.343]		[.036]	
Fabricated metal products	coeff	-0.25	-1.20	-1.37	0.35	5.40	0.18	1.09	0.65		0.06	0.95
	Prob	[.047]	[.327]	[.789]	[.410]	[.018]		[.310]	[.430]		[.809]	
Non electrical machinery	coeff	-0.44	-2.49	-2.89	-0.27	1.35	0.28	6.04	0.11		1.85	0.84
	Prob	[.022]	[.113]	[.491]	[.491]	[.006]		[.024]	[.741]		[.185]	
Electrical machinery	coeff	-0.14	3.15	-6.13	0.85	2.06	0.23	2.33	2.77		4.18	0.94
	Prob	[.286]	[.524]	[.610]	[.533]	[.062]		[.144]	[.113]		[.051]	
Transport	coeff	-0.69	-1.23	-1.75	-0.48	4.44	0.34	3.26	3.66		7.46	0.78
	Prob	[.001]	[.384]	[.430]	[.128]	[.003]		[.088]	[.072]		[.011]	
Professional & scientific	coeff	-0.90	-1.80	1.37	-0.30	0.73	0.17	0.26	0.00		2.95	0.95
	Prob	[.000]	[.000]	[.372]	[.033]	[.003]		[.616]	[.969]		[.098]	
Other manufacturing	coeff	-0.24	-1.62	-4.77	-0.31	-0.28	0.11	9.88	1.66		1.58	0.97
	Prob	[.069]	[.006]	[.216]	[.191]	[.845]		[.006]	[.213]		[.220]	

Note: SC refers to the Lagrange multiplier test of residual serial correlation, FF refers to Ramsey's RESET test for functional form using the square of the fitted values and HE refers to Ramsey's RESET test based on the regression of squared residuals on squared fitted values.

Table A.3

Sector specific estimation and diagnostic results based on ARDL(1,1,1,1,1) specification.

		ECM	Rel Prod	Rel W	Capacity	Sancti ns	Y	se	SC	FF	HE	R2
Food	coeff	-0.14	0.21	-4.70	-41.26	-0.19	-5.40	0.12	0.98	**3.70**	**4.62**	0.83
	Prob	[.376]	[.975]	[.210]	[.451]	[.786]	[.456]		[.338]	[.072]	[.041]	
Beverages	coeff	**-0.24**	1.53	3.34	**-22.37**	0.36	3.49	0.19	**4.77**	0.15	**9.80**	0.97
	Prob	[.036]	[.444]	[.276]	[.026]	[.656]	[.352]		[.044]	[.704]	[.004]	
Textiles	coeff	-0.05	4.38	-6.28	6.44	-3.32	11.30	0.12	0.14	1.97	0.72	0.95
	Prob	[.650]	[.546]	[.481]	[.695]	[.666]	[.665]		[.714]	[.180]	[.404]	
Apparel	coeff	**-0.43**	**5.31**	**-2.64**	**-9.58**	**-0.55**	**9.45**	0.23	0.39	0.39	0.04	0.96
	Prob	[.032]	[.000]	[.000]	[.089]	[.071]	[.021]		[.543]	[.540]	[.843]	
Leather	coeff	**-0.44**	1.63	**-1.78**	13.17	**-0.65**	-1.58	0.20	**7.67**	0.45	0.21	0.95
	Prob	[.014]	[.250]	[.025]	[.100]	[.080]	[.460]		[.014]	[.513]	[.652]	
Footwear	coeff	**-0.33**	-0.06	1.17	-29.95	0.37	-0.63	0.41	1.21	0.06	1.86	0.74
	Prob	[.080]	[.982]	[.667]	[.120]	[.723]	[.895]		[.288]	[.813]	[.185]	
Wood products	coeff	**-0.39**	2.60	**-5.04**	-5.68	0.12	-2.24	0.32	1.49	**3.67**	**3.13**	0.82
	Prob	[.035]	[.403]	[.027]	[.291]	[.775]	[.669]		[.240]	[.073]	[.089]	
Furniture	coeff	**-0.27**	4.01	**-7.94**	4.76	-0.58	0.33	0.44	0.63	0.48	**4.74**	0.96
	Prob	[.070]	[.315]	[.013]	[.679]	[.516]	[.970]		[.440]	[.498]	[.039]	
Paper products	coeff	**-0.49**	0.40	-1.17	2.39	-0.13	**1.92**	0.14	0.25	2.90	0.97	0.94
	Prob	[.032]	[.673]	[.163]	[.599]	[.563]	[.007]		[.623]	[.108]	[.333]	
Printing	coeff	**-0.58**	1.07	0.70	**-18.38**	**-0.66**	**2.46**	0.33	0.10	0.29	0.53	0.79
	Prob	[.009]	[.456]	[.682]	[.051]	[.061]	[.069]		[.757]	[.598]	[.472]	
Industrial	coeff	**-0.29**	-0.24	-0.90	-2.91	-0.67	**2.31**	0.13	0.40	0.06	0.54	0.97
chemicals	Prob	[.056]	[.840]	[.302]	[.528]	[.068]	[.004]		[.537]	[.816]	[.469]	
Other chemicals	coeff	**-0.50**	1.15	**-2.84**	0.85	**-0.75**	**1.57**	0.18	1.99	0.00	2.49	0.92
	Prob	[.005]	[.428]	[.052]	[.849]	[.012]	[.000]		[.178]	[.994]	[.126]	
Rubber	coeff	-0.04	-27.30	25.93	-84.29	3.95	22.74	0.20	0.13	1.12	1.11	0.96
	Prob	[.810]	[.819]	[.817]	[.827]	[.831]	[.754]		[.719]	[.306]	[.302]	
Plastic	coeff	-0.11	-0.62	0.59	-11.31	0.30	4.40	0.17	0.30	0.24	0.81	0.98
	Prob	[.129]	[.895]	[.915]	[.509]	[.759]	[.268]		[.591]	[.634]	[.376]	
Glass products	coeff	-0.34	0.81	-0.70	-3.72	0.16	4.39	0.21	0.04	0.03	2.79	0.85
	Prob	[.171]	[.600]	[.704]	[.489]	[.709]	[.096]		[.850]	[.861]	[.107]	
Other non-	coeff	**-0.49**	-1.67	**4.98**	-6.94	-0.38	**8.88**	0.32	**4.14**	0.54	0.01	0.64
metallic minerals	Prob	[.005]	[.443]	[.045]	[.142]	[.437]	[.016]		[.059]	[.474]	[.918]	
Iron and Steel	coeff	0.03	-13.08	16.72	14.40	3.56	2.64	0.15	1.68	0.30	0.04	0.94
	Prob	[.755]	[.745]	[.773]	[.790]	[.783]	[.856]		[.213]	[.592]	[.836]	
Non-ferrous	coeff	-0.19	3.30	-1.86	4.04	0.11	-5.64	0.23	**6.42**	1.02	**6.18**	0.86
metal	Prob	[.371]	[.152]	[.427]	[.736]	[.913]	[.471]		[.022]	[.328]	[.020]	
Fabricated metal	coeff	-0.22	0.11	-2.65	2.22	0.34	3.64	0.18	**3.31**	1.07	0.01	0.95
products	Prob	[.137]	[.957]	[.356]	[.766]	[.495]	[.394]		[.088]	[.316]	[.932]	
Non electrical	coeff	**-0.70**	**3.91**	**-2.75**	1.88	0.43	**1.35**	0.26	**5.50**	0.20	1.32	0.86
machinery	Prob	[.004]	[.002]	[.005]	[.568]	[.301]	[.017]		[.032]	[.657]	[.262]	
Electrical	coeff	**-0.60**	**-3.52**	1.13	1.02	0.27	-0.44	0.22	2.21	1.85	1.45	0.94
machinery	Prob	[.037]	[.033]	[.463]	[.671]	[.386]	[.393]		[.157]	[.192]	[.240]	
Transport	coeff	**-0.71**	1.51	-1.43	-1.93	-0.43	4.32	0.36	2.80	2.96	**6.48**	0.76
	Prob	[.001]	[.467]	[.302]	[.636]	[.215]	[.033]		[.114]	[.104]	[.017]	
Professional &	coeff	**-1.02**	**1.71**	**-1.32**	1.11	**-0.22**	**1.15**	0.15	0.24	1.92	**5.15**	0.97
scientific	Prob	[.000]	[.000]	[.000]	[.341]	[.033]	[.000]		[.632]	[.185]	[.032]	
Other	coeff	**-0.33**	**1.27**	**-1.29**	-3.86	-0.26	0.27	0.13	**16.71**	1.32	1.10	0.96
manufacturing	Prob	[.061]	[.005]	[.068]	[.263]	[.242]	[.848]		[.001]	[.267]	[.303]	

Table A4
Short run export coefficients for broadly defined manufacturing sectors using DFE estimator, log real exports as dependent variable

	Natural resource		**Labour**		**Chemical**		**Machinery and metal products**	
	Coef.		**Coef.**		**Coef.**		**Coef.**	
Exports(-1)	0.87	***	0.87	***	0.90	***	0.77	***
	0.04		*0.03*		*0.04*		*0.05*	
RULC	-0.79	***	-0.63	***	-0.55	***	-0.50	***
	0.20		*0.21*		*0.21*		*0.20*	
RULC(-1)	0.62	***	0.28		0.29		0.15	
	0.22		*0.24*		*0.21*		*0.24*	
Capacity	-1.13	**	-0.54		-0.55		-0.35	
	0.51		*0.74*		*0.64*		*0.63*	
Capacity(-1)	0.04		-0.56		-0.12		0.14	
	0.52		*0.76*		*0.65*		*0.63*	
Sanctions	-0.02		-0.05		-0.03		-0.01	
	0.05		*0.06*		*0.04*		*0.05*	
World income	0.76	**	0.84	*	1.11	***	0.71	***
	0.34		*0.48*		*0.28*		*0.33*	
World income(-1)	-0.55	*	-0.52		-0.77	***	-0.26	
	0.33		*0.50*		*0.28*		*0.35*	
Constant	2.04		-0.37		-3.62		-6.19	
	4.96		*4.74*		*3.81*		*3.73*	
F_test	129		248		346		162	
Relative productivity, relative wage and exchange rate								
	Coef		**Coef**		**Coef**		**Coef**	
Exports(-1)	0.86	***	0.86	***	0.88	***	0.71	***
	0.04		*0.03*		*0.04*		*0.06*	
Rel Prod	0.99	***	0.41		0.38		0.56	***
	0.26		*0.28*		*0.25*		*0.23*	
Rel Prod(-1)	-0.69	***	-0.11		-0.22		-0.18	
	0.28		*0.30*		*0.24*		*0.24*	
Rel Wage	-1.03	***	-0.64	***	-0.67	***	-0.63	***
	0.21		*0.21*		*0.22*		*0.21*	
Rel Wage(-1)	0.74	***	0.19		0.30		-0.10	
	0.25		*0.26*		*0.22*		*0.25*	
Capacity	-0.92	*	-0.39		-0.33		-0.22	
	0.53		*0.77*		*0.65*		*0.63*	
Capacity(-1)	-0.03		-0.67		-0.12		0.20	
	0.56		*0.78*		*0.65*		*0.62*	
Sanctions	-0.01		-0.06		-0.05		-0.04	
	0.06		*0.06*		*0.04*		*0.05*	
World income	0.95	***	0.82	*	1.01	***	0.48	
	0.35		*0.48*		*0.29*		*0.35*	
World income(-1)	-0.78	**	-0.49		-0.67	**	-0.21	
	0.35		*0.50*		*0.29*		*0.35*	
Constant	2.65		0.06		-3.28		0.61	
	4.74		*4.79*		*3.83*		*4.62*	
F_test	108		198		283		134	
obs	196		196		112		168	
Sectors	7		7		4		6	

Notes: (-1) implies a lag of one period.
Standard error are in italics below the coefficients
***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.

Table A5

Short run coefficients estimated using the DFE for developed and developing countries, log total exports as dependent variable

	Developing countries	Developed countries	
	1970-98 Total exports	**1970-98 Total exports**	**1980-98 SITC exports to developed countries**
	Coef.	**Coef.**	**Coef.**
Exports(-1)	0.86 ***	0.86 ***	0.72 ***
	0.02	*0.02*	*0.04*
RULC	-0.33 ***	-0.55 ***	-1.29 ***
	0.07	*0.10*	*0.18*
RULC(-1)	0.17 **	0.28 **	1.00 ***
	0.07	*0.12*	*0.19*
Capacity	-0.86 ***	-0.69 **	-0.03
	0.32	*0.32*	*0.54*
Capacity(-1)	-0.13	-0.30	-0.70
	0.32	*0.32*	*0.53*
Sanctions	-0.02	-0.04	-0.07 *
	0.03	*0.03*	*0.04*
World income	0.35 ***	0.28 ***	0.32 *
	0.11	*0.11*	*0.19*
World income(-1)	-0.17	-0.12	-0.03
	0.11	*0.11*	*0.19*
Constant	3.34 **	3.63 ***	-0.24
	1.46	*1.45*	*2.72*
F_test	760	773	129
Relative productivity, relative wage and exchange rate			
	Coef.	**Coef.**	**Coef.**
Exports(-1)	0.84 ***	0.86 ***	0.68 ***
	0.02	*0.02*	*0.04*
Rel Prod	0.24 ***	0.43 ***	0.39 *
	0.08	*0.12*	*0.21*
Rel Prod(-1)	-0.05	-0.27 **	-0.17
	0.08	*0.13*	*0.21*
Rel Wage	-0.41 ***	-0.50 ***	-0.94 ***
	0.08	*0.09*	*0.15*
Rel Wage(-1)	0.17 **	0.29 ***	0.43 ***
	0.09	*0.10*	*0.16*
Capacity	-0.65 **	-0.72 **	-0.09
	0.32	*0.33*	*0.56*
Capacity(-1)	-0.20	-0.20	-0.43
	0.32	*0.32*	*0.53*
Sanctions	-0.01	-0.01	-0.05
	0.03	*0.03*	*0.04*
World income	0.28 **	0.21 **	0.18
	0.11	*0.11*	*0.19*
World income(-1)	-0.13	-0.12	-0.05
	0.11	*0.11*	*0.19*
Constant	3.71 **	5.02 ***	4.10
	1.56	*1.55*	*2.89*
F_test	619	616	103
obs	672	672	450
Sectors	24	24	25

Notes: Standard error are in italics below the coefficients

***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.

Table B.1
Industrial sectors

Sector	ISIC	Broad sector
Manufacturing	300	
Food products	311	NR
Beverages	313	NR
Textiles	321	L
Wearing apparel, except footwear	322	L
Leather products	323	L
Footwear, except rubber or plastic	324	L
Wood products, except furniture	331	L
Furniture, except metal	332	L
Paper and products	341	NR
Printing and publishing	342	MM
Industrial chemicals	351	CH
Other chemicals	352	CH
Rubber products	355	CH
Plastic products	356	CH
Pottery, china, earthenware	361	NR
Glass and products	362	NR
Other non-metallic mineral products	369	NR
Iron and steel	371	NR
Non-ferrous metals	372	NR
Fabricated metal products	381	MM
Machinery, except electrical	382	MM
Machinery, electric	383	MM
Transport equipment	384	MM
Professional & scientific equipment	385	MM
Other manufactured products	390	

Note: Tobacco (314), Petroleum refineries (353) and Miscellaneous petroleum and coal products (354) have been excluded.
NR, L, CH and MM stand for natural resource intensive, labour intensive, chemical intensive and machinery & metal products. Other manufactured products sector has been excluded in the broad sub-sector analysis.

Table B.2
Comparison of differences in RULC between STAN and UNIDO databases
($RULC_{UNIDO}$ /$RULC_{STAN}$)

		1970-74	1975-79	1980-84	1985-89	1990-94	1995-98
Canada	Weighted	1.41	1.46	1.50	1.46	1.53	1.40
	Unweighted	1.47	1.48	1.60	1.48	1.57	1.57
Italy	Weighted				1.23	0.87	0.85
	Unweighted				1.27	0.89	0.89
Japan	Weighted	1.30	1.36	1.43	1.46	1.63	2.09
	Unweighted				1.39	1.57	2.28
UK	Weighted	1.47	1.57	1.67	1.71	1.62	1.32
	Unweighted			1.74	1.77	1.63	1.36
USA	Weighted	1.59	1.70	1.79	1.84	1.93	1.98
	Unweighted	1.63	1.76	1.82	1.89	1.97	2.02

Note: Comparison based on common Value added deflator used to deflate sectoral value added.

Unweighted is the simple average across sectors. Weighted values are calculated using total value added, employment and wages and salary for manufacturing. For Japan and the UK the STAN values for total manufacturing were available, but were not available for sectors.
Data are only available for developed countries.

Table B.3
RULC using common value added deflator divided by RULC using sector specific deflator, unweighted average for manufacturing.

	1970-74	1975-79	1980-84	1985-89	1990-94	1995-98
Canada	0.88	0.84	0.98	1.01	1.19	1.15
France	0.8	0.79	0.96	1.02	1.24	1.25
Italy	0.61	0.67	0.84	0.98	1.3	1.45
Japan	0.71	0.77	0.97	1.02	1.28	1.45
Netherlands	0.81	0.83	1.01	0.98	1.11	1.1
Spain	0.87	0.83	1	1.03	1.39	1.76
UK	1.12	1.03	1.01	1	1.16	1.14
USA	1.07	0.88	0.95	0.98	1.15	1.19
Kenya	0.41	0.53	0.65	0.98	1.26	1.39
Zimbabwe	0.72	0.67	0.74	0.95	0.99	1.12
Hong Kong	na	0.93	1.08	0.97	1.04	1.1
India	0.64	0.59	0.83	0.99	1.36	1.4
South Korea	0.8	0.74	0.84	0.98	1.28	1.4
Singapore	0.64	0.7	0.87	1.01	1.21	1.36
Chile	0.49	0.59	0.57	1.01	1.24	1.34
Hungary	0.96	0.96	0.99	0.96	0.96	0.94
Mexico	0.69	0.7	0.64	1.04	1.09	1.05
Poland	1.12	0.89	1.15	1	1.11	0.59
Turkey	0.9	0.83	0.83	0.97	1.52	1.84

Note: based on simple average. Excludes Tobacco (314), Petroleum refineries (353) and Misc. petroleum products (354).
Kenya excludes 372 and also 371 from 1995.

Figure 1: Relative unit labour costs since 1970

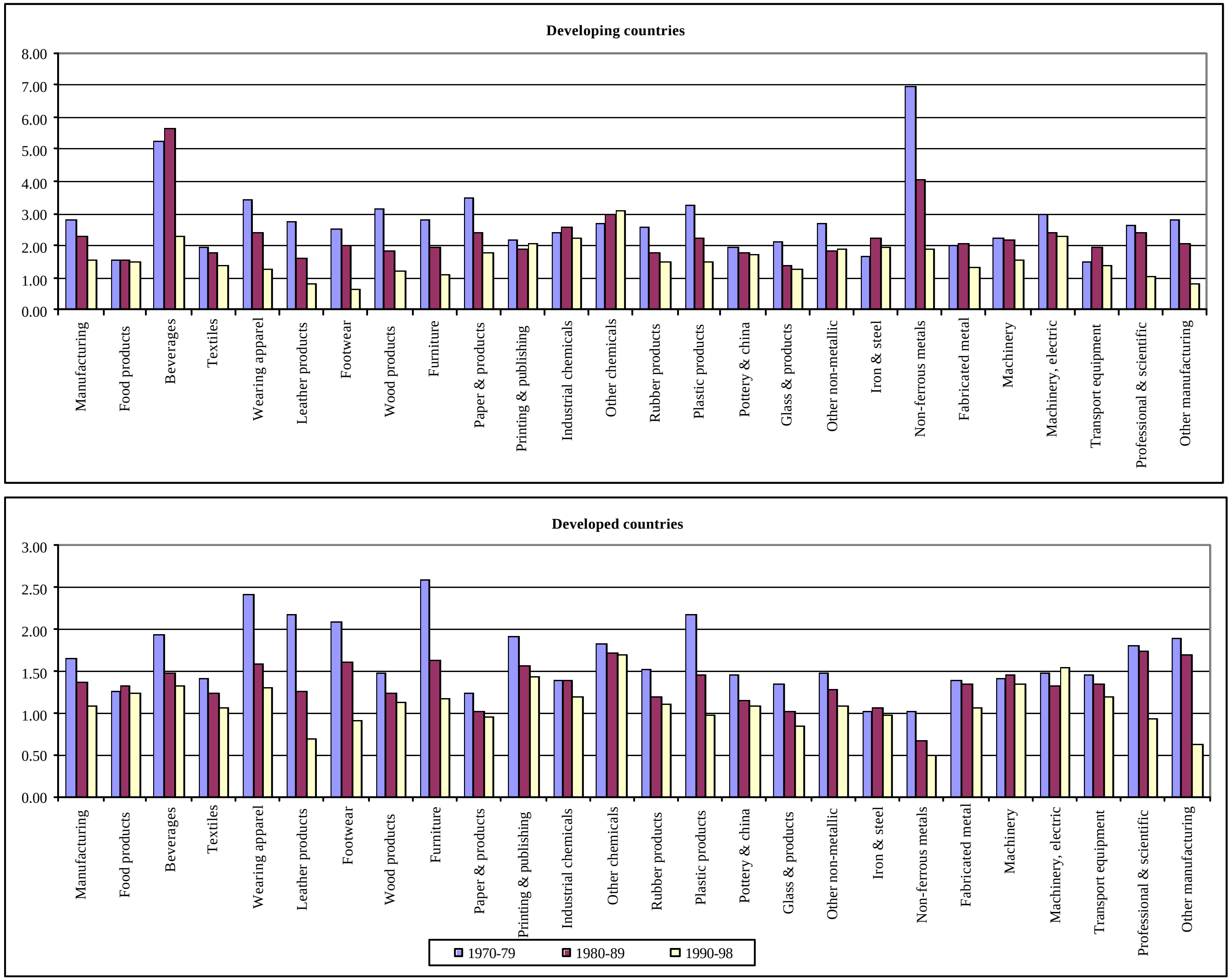

Figure 2: RULC and export performance