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Trade, Technology and Wage Inequality in South Africa

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Abstract

Significant declines in employment have coincided with trade liberalisation in South Africa stimulating many debates on possible causal relationships between the two. Existing research has, however, focussed on explaining employment trends rather than changes in the relative wage of less skilled to skilled labour. Further, the role of technology in influencing relative wages has been neglected. This paper draws upon standard international trade theory and analyses the relationship between trade, technology, factor supplies and the relative wage of less skilled workers in South Africa since 1970. The econometric results are in general weak. Nevertheless, a number of conclusions can be reached. Firstly, the rise in relative wage of less skilled workers since the early 1970s and into the 1990s is inconsistent with the view that trade liberalisation and skill biased technological change lie behind the dramatic decline in less skilled employment since the early 1980s. Secondly, there is weak evidence that tariff reductions and improvements in the real effective exchange rate have improved the relative wage of less skilled labour. Although the rise in relative wage of less skilled labour is consistent with these changes, the decline in employment of less skilled labour is not. These results suggest that the reason for the decline in employment of less skilled labour lie in other areas such as the labour market.

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Since the early 1980s South Africa has made much progress in liberalising the trade regime. Starting with the removal of quantitative restrictions, the process has shifted in focus to import liberalisation through tariff reductions. As South Africa has integrated itself into the world economy so concerns about the impact on employment, production and growth are being raised. This has stimulated much research on trade and employment in South Africa, although no consensus has been reached (Bell and Cattaneo, 1997, Bhorat, 1999, Fedderke, Shin and Vase, 1999, Edwards, 2001). Bell and Cattaneo (1997) conclude that "trade liberalisation in particular is likely to have significant adverse effects on manufacturing employment, including employment in relatively low-wage sectors and regions". In contrast Fedderke . (1999) and Edwards (2001) argue that trade positively affected labour income and employment, but that technological change more than reversed these gains.

There has, however, been limited research on the impact of trade and technology on income inequality in South Africa. Although Fedderke *et al.* (1999) analyse capital and labour earnings mandated by trade, lack of data prevents them from focussing on the impact on relative wages. According to the standard developed-developing country trade model trade liberalisation raises the relative wage of less skilled labour within developing countries as the country specialises in the production of less skill intensive products.[1] As result it has been argued that trade liberalisation is an important vehicle for raising wages, employment and living standards in developing countries. The outcome, however, may be ambiguous in middle-income countries such as South Africa. With trade liberalisation middle-income countries expose themselves to competition against low wage countries such as India and China, as well as to competition from high wage skill intensive developed countries (see Wood, 1997). Depending on the relative declines in protection of high skilled and less skilled products, a multitude of outcomes affecting relative wages are possible.

Technological change is another factor that can affect relative wages. There is strong international evidence to suggest that technology, especially Hicks neutral technological change, has had significant negative impacts upon the relative wages of less skilled labour in developed countries (Lawrence and Slaughter, 1993, Berman, Bound and Griliches, 1994, Baldwin and Cain, 1997, and Bhagwati and Dahejia, 1994). There is also some evidence to suggest that the relative wage of less skilled labour has fallen in developing and middle income countries (indicating greater income inequality) which contradicts the standard predictions of simple trade theory (see Hanson and Harrison, 1995, and Berman, Bound and Machin, 1997).

Other studies have suggested that institutional and supply side factors such as changes in relative endowments of skilled and less skilled labour, declining power of unions and the decline in real minimum wages are the dominant forces changing relative wages (Baldwin and Cain, 1994, Blanchflower and Slaughter, 1998). It is also argued that supply side rigidities within European countries have prevented the decline in relative wage of less skilled labour in the face of greater competition from developing regions and that this has resulted in greater unemployment of less skilled labour.

Despite the economic and political implications, the influence of trade and technology on relative wages in South Africa has not yet been fully explored. The objective of this paper is to explore this area in more depth. In particular, the paper aims to examine the impact of trade liberalisation, technological change and the relative supply of skilled labour on the relative wage of South African labour.

The paper is structured into 5 sections. After the introduction, section 2 develops the methodological framework for analysing the effect of trade, technology and relative supplies on

[1] *The effect of trade on relative wages works through the transmission of relative output price changes to industry labour demand and thus factor reward (Stolper-Samuelson effect).*

relative wages. Section 3 presents a brief overview of trade liberalisation, trade flows and changes in relative wages in South Africa since 1970. Key questions relating to the possible relationship between trade and relative wages are identified within this section. This section is followed by an econometric analysis to confirm if the trends in relative wages are theoretically consistent with trade, technology and labour supply trends within South Africa. Section 5 concludes the paper with a number of policy suggestions.

2. Methodology

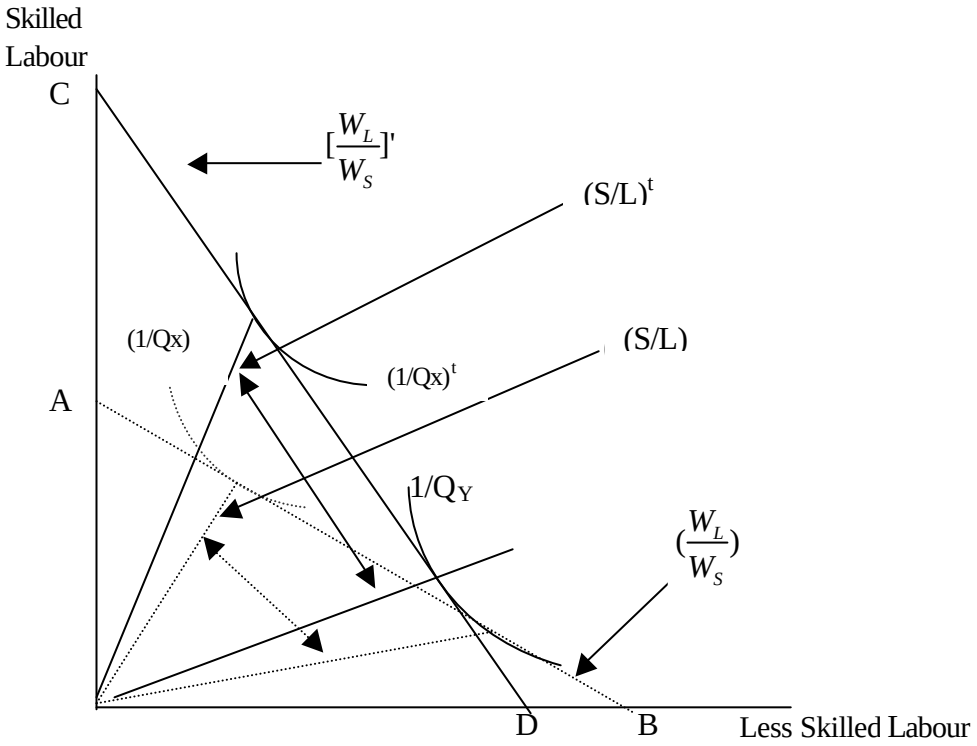
To explore the impact of trade and technology on the relative wage of skilled and less skilled workers in South Africa, we consider the standard Heckscher-Ohlin-Samuelson (HOS) model. The HOS model assumes a world of constant returns to scale and perfect competition. One of the basic assumptions of this theory is that in a two-good world with trade, Stolper-Samuelson theorem works. This theorem states that an increase in the relative price of a commodity raises the real return of the factor used relatively intensively in the production of that good and the real return of the other factor declines. Thus, in this manner, international trade redistributes income by a change in the terms of trade.

2.1 Trade Effect

To examine the impact of the Stolper-Samuelson effect on the South African economy, we consider a two goods-two factors-two country model. We assume that the countries are South Africa (SA here after) and Rest of the World (ROW here after); goods are skilled-labour-intensive and less skilled-labour-intensive (X and Y respectively); production of these goods requires two factors of production, skilled labour and less skilled labour (S, L respectively). To explore the Stolper-Samuelson effect, we first assume that Hicks neutral sectoral differences do not exist between the two countries; SA is a relatively low skill labour abundant country while ROW is relatively skilled labour abundant. SA is a small open economy, which implies its production and consumption policies do not influence world relative prices. Initially the country (i.e. SA) settles in equilibrium where wages of both factors of production have been determined through demand and supply forces. This equilibrium is illustrated below in Figure 1.

In Figure 1, we have illustrated that at the initial commodity prices, both unit value isoquants are tangent at an equilibrium less skilled-skilled wage ratio (as represented by line AB). Since good X is relatively skilled-labour-intensive, the skilled-less skilled labour ratio (S/L) is higher for good X. Now assume that SA follows trade liberalisation policies that reduce the price of good X (i.e. skilled-labour-intensive good) relative to good Y (i.e. less skilled-labour-intensive good). This would cause a decrease in the production of good X and an expansion in the production of good Y which is depicted in Figure 1 as an outward shift in the relevant good X unit value isoquant to $(1/Q)^t$. Since expanded production of good Y requires more less skilled labour and good X industry releases too much skilled labour relative to less skilled labour, wages would therefore change. The wage of less skilled labour rises and the wage of skilled labour falls. The new equilibrium ratio of the relative prices of the two factors of production is shown by line CD. The slope of line CD is greater than the slope of line AB, which implies that new less skilled-skilled wage ratio is greater than the previous relative wage. This higher ratio would induce firms to substitute less skilled workers with the skilled workers. As a result the skilled-less skilled labour ratio would increase in both sectors. In Figure 1, this substitution is represented by a movement of each industry's (S/L) to $(S/L)^t$.

Figure 1: Stolper-Samelson effect



We have presented the trade effect in a very simple model, which suggests that effect of trade liberalisation in SA should be examined within the context of an increase in the skilled-less skilled labour ratio and a decline in the relative price of the skilled-less skilled-labour-intensive goods[2].

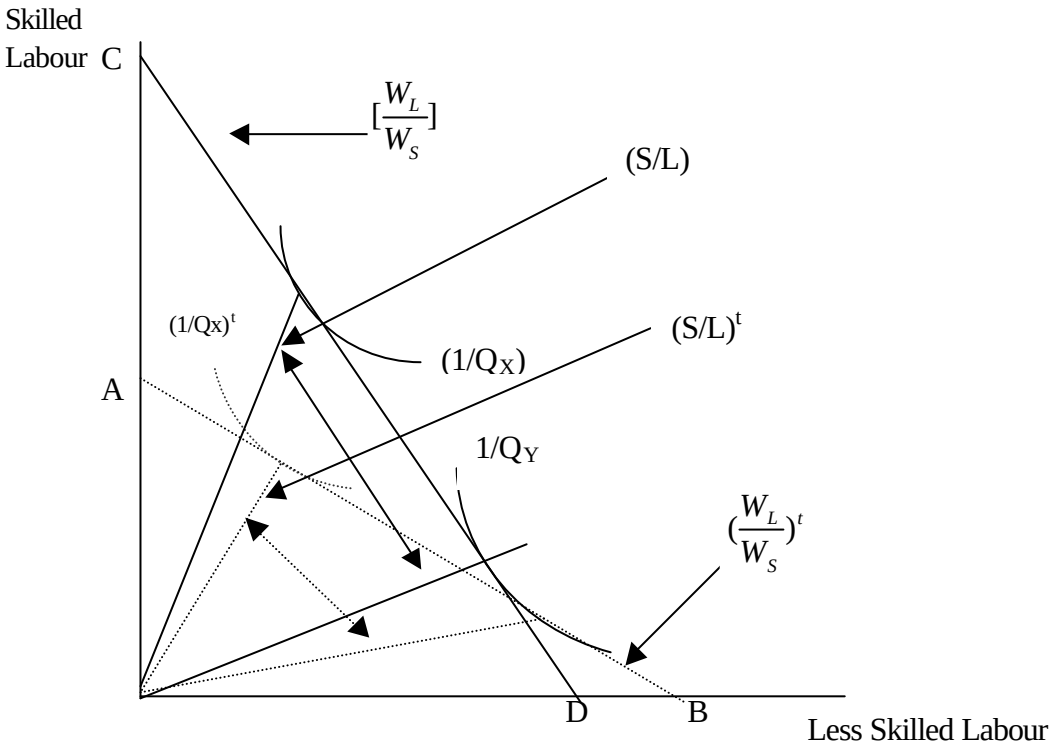
2.2 Technology effect

The standard Heckscher-Ohlin-Samuelson trade model assumes that technology is constant and identical across countries. Findlay and Grubert (1959) have shown that a Hicks neutral technological change (in either sector) could produce changes in the relative wage via a shift in the unit value isoquant. As explained in Figure 2, we first assume that in SA Hicks neutral technological change occurs more rapidly in favour of skilled-labour-intensive sector. Thus the unit value isoquant, $(1/Q_X)$ shifts downwards to $(1/Q_X)^t$, which causes a decline in the relative wage of less skilled-skilled workers, as represented by line AB, and consequently the skilled-less skilled labour ratio declines in both the sectors[3].

[2] *Helpman and Krugman (1985) have studied the trade effect under imperfect competition assumption, Ethier (1974) has examined the trade impact through Stolper-Samuelson theorem within many factors and many goods framework.*

[3] *Relative technology improvements in the unskilled-labour-intensive sector would bring an impact on the relative wage similar to the Stolper-Samuelson effect.*

Figure 2: Findlay-Grubert effect



2.3 Relative Supplies Effect

Small changes in the relative factor supplies do not bring any change in the relative wage under diversified production. However, if a country were engaged in specialised production, then even small changes in the relative factor supplies would affect the relative wage[4]. The mechanism of the role of relative labour supplies is presented in Figure 3.

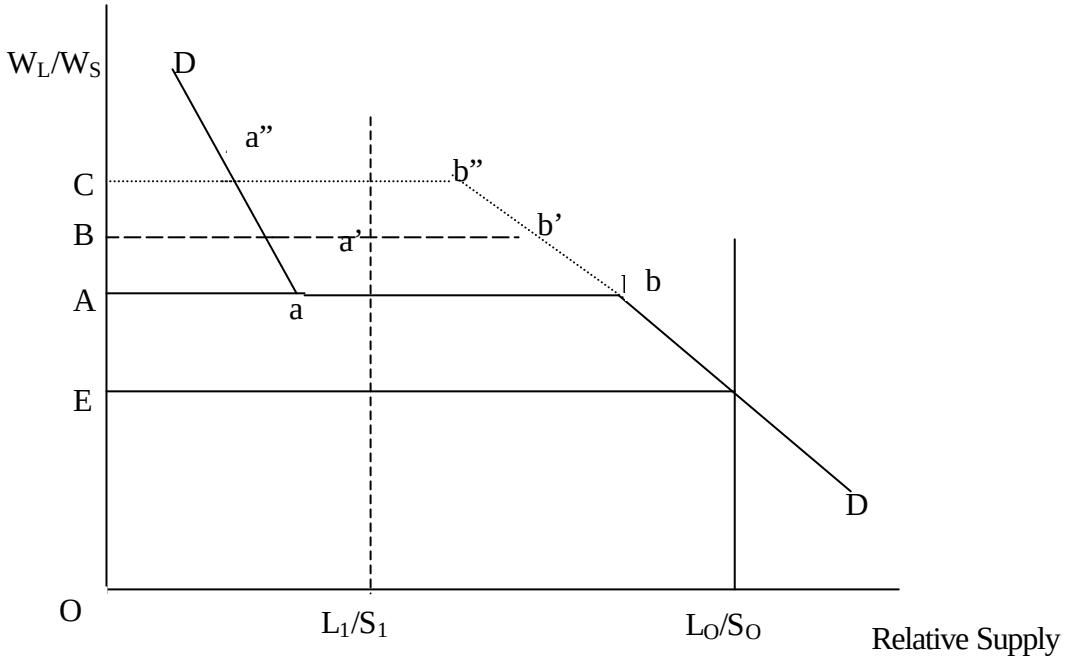
In Figure 3, relative factor supplies are measured along the horizontal axis and the relative wage along the vertical axis. Once the country is open to trade, then line *DabD* is the demand curve, with the height of the flat segment, *ab*, determined by the relative international price and South African trade barriers. The length of the segment represents the range of factor endowments in which a trading country would be producing both goods. Over this range, the relative supply does not affect the relative wages to change; only a change in relative price would affect the relative wage behaviour. For simplicity further assume that the technology does not change[5]. Consider for a moment that the relative supply in South Africa is at L_0/S_0 level and it changes over a narrow range around this point only. This will allow SA to completely specialise in the production of less skilled-labour-intensive good. Let there be trade liberalisation which shifts the demand curve to *Da`b`D* and let relative supply shifts in either direction (as indicated by the arrows) but remains on the *b`D* segment. In this case the relative wage will change only in response to the shift in the relative supply and trade liberalisation (or the technology) would have no effect.

[4] *Under specialised production, relative prices and relative technology have no effect on the relative wage.*
[5] *A skill biased technological improvement in sector one, for example, will shift the* DabD *curve downwards and hence a decrease in the relative wage.*

2.4 Trade, Technology and Relative Factor Supplies Effect

Suppose again that SA initially has very little relative endowment of skilled labour, represented by L_0/S_0 in Figure 3. Again let there be trade liberalisation and the demand curve, *DabD* shifts upward to *Da"b"D* also assume that due to expanded educational opportunities the relative supply of less skilled labour decreases to L_1/S_1. This shift in the relative supply is assumed to move the SA to the range of diversification. Further, assume that Hicks neutral technological improvement occurs in the favour of skilled-labour-intensive sector, which pushes the demand curve, *Da"b"D,* downward to *Da`b`D* and reduces the impact of the trade liberalisation and relative supplies on the relative wage. Thus in this case, changes in the relative wage can be explained in terms of changes in the relative supply, trade liberalisation as well as relative technology.

Figure 3: Trade, technology and relative supplies



Initially, the relative wage in the SA was at *OE*. This relative wage indicates that SA had a very little relative endowment of skilled labour. Once trade liberalisation occurs and relative supply of the skilled labour also increases, the relative wage is then *OC*. An increase in the relative wage from OE to OA is due to the changes in the relative supply, up to OC is due to trade liberalisation and a decrease in relative wage to OB is due to Hicks neutral technological improvement in the favour of skilled-labour-intensive sector.

2.5 Econometric Framework

In the above theoretical framework, we have shown how the relative price, relative technology and relative factor supplies affect the relative wage. These effects can be illustrated in a more systematic way to develop an econometric model for estimation.

Lets consider a general production function for industry *j* at time *t*.

$$Q_i^j = A_i^j F_i\ (S_i^j, L_i^j) \qquad \text{i = 1,2 j = SA, ROW} \qquad (1)$$

where $Q_i^j, S_i^j, L_i^j, A_i^j$ denotes output, skilled labour, less skilled labour and Hicks neutral technological index for good *i* and country *j* and SA and ROW stand for South Africa and Rest of the World respectively. Sector 1 is relatively skilled-labour-intensive. The profit maximisation

condition implies that the two factors are paid the values of their marginal products. Denoting W_L^j, W_S^j as wages of the less skilled and skilled labour and p_i^j the price of the good *i*, perfect mobility of the two factors across the sectors would imply that

$$W_S = \tilde{P}_1^j f_1'(y_1^j) = \tilde{P}_2^j f_2'(y_2^j) \qquad \text{j = S or ROW}$$

$$W_U = \tilde{P}_1^j [f_1(y_i^j) - y_1^j f_1'(y_1^j)] = \tilde{P}_2^j [f_2(y_2^j) - y_2^j f_2'(y_2^j)] \qquad \text{j = SA or ROW}$$

where $y_i^j (\equiv \frac{S_i^j}{L_i^j})$ and $\tilde{P}_i^j (\equiv A_i^j P_i^j)$ represent the skilled-less skilled labour ratio and the price of normalised units of output.

Now if each country produces both goods, then changes in the wage of less skilled workers relative to skilled workers can be explained in terms of changes in relative prices and relative technology as follows;

Defining $w(\equiv \frac{W_L}{W_S})$ as the relative wage of the low skilled labour, $p(\equiv \frac{P_1}{P_2})$ as the ratio of prices of the skilled and less skilled-labour-intensive goods, and $a(\equiv \frac{A_1}{A_2})$ as relative technology, we can derive the following relationships

$$w^j = g(p^j, a^j) \qquad \text{j = SA or ROW} \qquad (2)$$

where $\frac{\partial g}{\partial p^j} < 0$ and $\frac{\partial g}{\partial a^j} < 0$

In contrast to diversified production, if both countries specialise in one of the two goods, then relative wages in each country are a function only of the relative supplies of the skilled and less skilled workers. That is

$$w^j = f(\bar{s}^j) \qquad \text{j = SA, ROW} \qquad (3)$$

where $s^j (\equiv \frac{\bar{S}}{\bar{L}})$ is the ratio of the endowment of skilled labour $(\bar{S})$ and less skilled labour $(\bar{L})$ and $\frac{dw^j}{d\bar{s}^j} > 0$. However, if we consider large changes in the endowments of skilled labour then relative wages are function of all the three variables. This is shown below

$$w^j = q(p^j, a^j, \bar{s}^j) \qquad \text{j = SA or ROW} \qquad (4)$$

where $\frac{\partial q}{\partial p^j}, \frac{\partial q}{\partial a^j}$ are negative and $\frac{\partial q}{\partial \bar{s}^j}$ is positive.

Using a log linear approximation of (4), and letting subscript, *t*, represents the variable at time *t*, we can estimate the following equation for South Africa

$$\ln w_t = a_0 + b_1 \ln Trade_t + b_2 \ln Tech_t + b_3 \ln Supp_t + e_t \qquad (5)$$

where t*rade* is a proxy for *p*, *tech* is a proxy for *a*, and *Supp* is a proxy for *s* .

3. Historical Development

3.1 The progress of trade liberalisation in South Africa

The progress of trade liberalisation in South Africa has been characterised by much volatility. Underlying the volatility in the trade regime are a number of political and macroeconomic shocks during the 1980s that induced temporary protection measures (surcharges) to ease balance of payments constraints. As a result it has been difficult to gauge the extent of protection changes, particularly between the late 1980s and early 1990s.[6]

As indicated in Table 1, the first shift away from import substitution industrialisation began in 1972 with the relaxation of Quantitative Restrictions (QRs) and the introduction of an export incentive system in 1980.[7] Although increases in tariffs compensated for the relaxation of QRs, Bell (1997: 72) argues these were not fully compensatory resulting in a net decline in protection. During the 1980s the picture becomes more confusing. While the relaxation of QRs continued into the 1990s, import surcharges implemented in response to Balance of Payments pressures arising from the debt crisis in the mid 1980s raised protection. Furthermore, there was an increase in the number of applications for protection in the form of *ad valorem* and formula duties as businesses experienced the effects of the economic downturn (Bell, 1993: 9). Evidence suggests that by 1988 the economy had become more protected than in 1984. Using effective protection rates Holden (1992: 187) estimates a 30 % average weighted rate of effective protection in 1984 with a range of 7 % to 143 %. By 1988 the average had risen to 70 % while the range had widened with a low of 9.9 % and a high of 348 %.

During the following 6 years the implementation of the 'structural adjustment programmes' for motor vehicles, clothing and textiles, the introduction of GEIS and the reduction of import surcharges substantially reduced the level of protection. From 1994 the process of reducing QRs was largely complete and the focus of trade reform shifted to import liberalisation through tariff reductions. [8] In accordance with its GATT offer, South Africa made considerable progress in rationalising the tariff regime and reducing tariff levels.[9] Average nominal protection for the whole economy fell from 29 % in 1990 to 15.1 % in 1997, while the range declined from a maximum of 1389 % to 72 %. For manufacturing the unweighted average nominal protection fell from 30 % to 15.6 % over the same period (Table 2). The total number of tariff lines was reduced from 12600 (at the nine-digit level) in 1993 to 7814 (at eight-digit level) in 1997. The number of line bearing formula duties declined from 1900 to 28 eight-digit lines between 1993 and 1997 while the number of lines bearing specific tariffs fell from 500 to 227 lines over the same period (WTO, 1998: 38). While concessions in the cases of "sensitive" industries such as textiles and clothing, and motor vehicles were negotiated the government has subsequently reduced the long adjustment period and high maximum tariff levels initially agreed upon (Roberts, 1998).

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[6] *For a more detailed discussion on trade liberalisation see Holden (1992), Levy (1992) and Bell (1997).*

[7] *The "Reynders Commission of Inquiry" in 1972 into South Africa's export trade emphasised the need to diversify into non-gold exports through export promotion methods.*

[8] *QRs on agricultural products were still prevalent.*

[9] *Bell (1997: 76) notes that the tariff reduction proposed exceed those required by the commitments entered into by South Africa in the Uruguay round.*

Table 1: Chronology of trade liberalisation

1972-1976	• Export Development Assistance scheme introduced.
1979-80	• Substitution of tariffs for QRs resulting in net decline in protection (Bell, 1997). • Rise in gold price resulting in the appreciation of rand.
1980	• Reinforced system of export incentives.
1983-85	• Proportion of value of imports subject to QRs fell from 77% to 23% over period. • Relaxation of import permits by switching from a positive list to a negative list. • Real depreciation of rand .
1985-1992	• Proportion of tariff items subject to QRs fell from 28% in 1985 to less than 15% in 1992.
September 1985	• Introduction of 10% import surcharge on all imported goods not bound by GATT.
August 1988	• Differential surcharge rates applied to Luxury goods (60%), Capital goods (10%), Motor vehicles (20%) and Intermediate goods (10%). • Increased applications for ad valorem and formula duties by businesses (Bell, 1993)
1989	• "Structural adjustment programmes" involving a system of duty free imports for exports implemented for motor vehicles and textiles and clothing.
1990	• General Export Incentive Scheme (GEIS) introduced. Provided a tax-free financial export subsidy to exporters based on the value of exports, degree of processing and local content of the exported product.
1990-91	• Reduction of import surcharges to 40%, 5%, 15% and 5% for Luxury, Capital, Motor vehicles and Intermediate goods, respectively.
23/6/1994	• Import surcharges abolished for Capital and Intermediate goods.
1/10/1995	• Remaining import surcharges abolished.
1994	• SA's GATT offer during Uruguay Round: (1) Bound about 98% of all tariff lines at the HS eight-digit level as against 18% before the round (2) Reduction in the number of tariff rates to six: 0%, 5%, 10%, 15%, 20% and 30% (3) Rationalisation of the over 12000 tariff lines (4) Tariffication of QRs on agricultural products (5) Special provisions (extensions of the adjustment period and raised maximum tariff rates) for textile, clothing and motor vehicle industries granted. • Decision taken to phase out GEIS.
1995	• Payments under GEIS became taxable, range of eligible products reduced.
1996	• New Tariff Rationalisation Process (TRP) formulated. Tariff lines and peaks to be reduced, Formula and specific duties to be converted into ad valorem rates, Imports that have no "suitable substitutes" are to be duty free, ad valorem rates of 30% on final products, 20% on intermediate goods and 10% on primary goods are generally not to be exceed. • GEIS limited to manufacturing goods.
1997	• Termination of export subsidies provided under GEIS.

Sources: Bell (1997), Belli *et al.* (1993), Tsikata (1999) and WTO (1998).

3.2 Sectoral incidence of protection

The extent of change is more clearly reflected in the sectoral incidences of protection presented in Table 2. Estimation of protection is problematic given the existence of non-tariff barriers and the granting of exemptions. [10] Within agriculture tariff protection in 1992 is understated because of the existence of numerous quantitative restrictions.[11] With the tariffication of these QRs subsequent to 1994 in accordance with the GATT agreement, the 1997 values are more reflective of nominal tariff protection. The exclusion of specific and compound duties, as well as problems associated with calculating *ad valorem* equivalents of formula duties further induce biases into the estimates of protection (WTO, 1998: 41). Care must thus be taken when making direct comparison between the values of protection across different years.

[10] *Belli* et al. *(1993: 14) note that because of certain exemptions tariffs collected and official tariffs differ. 1990 protection levels based on collection are lower than those calculated on the basis of the statutory rate and also have lower coefficients of variation. However, the incidence of protection is roughly the same in both calculations.*

[11] *QRs in manufacturing fell mainly on the textiles subsector.*

Table 2: Nominal rates of protection

	1990[1]	1992	1997	1992-97[2] % change	1990-96[3] % change
		Simple Average			Weighted
Whole Economy	29		15.1		
Agriculture	16	7	5.6	-18%	
Mining and Quarrying	3	2.4	1.4	-29%	
Manufacturing	30		15.6		-4.1
Food	}	11.5	14.5	24%	-0.4
Beverages	} = 24	10.6	10.3	-3%	-33.6
Tobacco	}	27.8	35.6	27%	-2
Textiles	}	48.4	34.9	-27%	-63.9
Wearing apparel	}	50.2	59	17%	2.6
Leather & leather products	}	16	14.9	-6%	-51.6
Footwear	} = 62	34.5	24.9	-27%	-4.2
Wood & wood products	22	13	10	-21%	-17.9
Paper & paper products	}	10	7.5	-23%	-4.8
Printing, publishing & recorded media	} = 13	10.5	7.9	-23%	-9
Coke & refined petroleum products	}	15.65	5.55	-61%	-16.2
Basic chemicals	}	14.6	4.8	-63%	-16.6
Other chemicals & man-made fibres	}	16.7	6.3	-59%	-15.8
Rubber products	}	23.1	15.7	-31%	-3.5
Plastic products	} = 22	28.8	12.3	-55%	3.7
Glass & glass products	}	10.9	8.1	-24%	-8.4
Non-metallic minerals	} = 27	28.2	7.9	-70%	-3.7
Basic iron & steel	}	8.3	4.3	-43%	-12.7
Basic non-ferrous metals	} = 8	8.8	3	-59%	-28.5
Metal products excluding machinery	20	12.4	9	-25%	1.1
Machinery & equipment	n/a	7.6	3.7	-45%	-2.7
Electrical machinery	n/a	15.9	6.6	-55%	-18.7
Motor vehicles, parts & accessories	n/a	28.7	18.8	-33%	9.3
Other transport equipment	n/a	7.3	12.3	60%	9.3
Furniture	22	21.3	20.8	-2%	-1.8
Other industries	n/a	11.8	7.7	-32%	-4.1

Source: Belli *et al* (1993), WTO (1993, 1998) and Tsikata (1999).

Notes:

1. Data only available for aggregated sectors.
2. Calculated as (tariff 97-tariff92)/(1+tariff92).
3. From Tsikata (1999).

   In calculating the results for 1997 specific and compound duties in South Africa's tariffs have been ignored. *Ad valorem* duties even when referred to as minima or maxima in the tariff book are used for the calculations (WTO, 1998: 41). This may bias the estimates for 1997 downward as in cases where the minima is used for calculations a higher formula duty may have been applied instead. This is particularly the case where no maximum *ad valorem* rates are specified for formula duties. Bell (1997: 75) critiques the Belli *et al.* (1993) estimates which include estimates of the ad valorem equivalents of formula duties. He argues that in calculating *ad valorum* equivalents of formula duties Belli *et al.* (1993) utilised the highest formula duties. Their results may over emphasise protection. The decline in tariff protection suggested within the table may thus appear to be more dramatic than is the case.

Protection is uneven with manufacturing the most protected and mining the least protected. In comparing the 1990 and 1997 protection levels it is apparent that tariff reductions have been achieved within all the broad sub-sectors with nominal protection falling from 30 % to 15.6 % in manufacturing, from 16 % to 5.6 % in agriculture and from 3 % to 1.4 % in mining. Recent work by Van Seventer (2001) shows that by 2001 protection in manufacturing and agriculture had fallen to 6.7 % and 4 %, respectively. The range of tariff levels in each of these sub-sectors has also fallen considerably (not shown).

Within the manufacturing sub-sectors reductions in tariff levels have been uneven with chemical related products, plastic product, electrical machinery and other transport equipment

experiencing the largest percentage declines in protection. Nominal tariff levels remain strongest in clothing (59 %), tobacco (35.6 %) and textiles (34.9 %) and weakest in basic non-ferrous metals (3 %), non-electrical machinery (3.7 %) and chemicals (4.8 %).

Although average unweighted (and weighted - see final column in Table 2) tariffs have fallen, wide variations within the sub-categories make the estimation of average protection difficult. Much of the decline in manufacturing protection has also arisen from strong tariff reductions in intermediate and capital goods. This in turn raises effective protection rates. Various estimates of effective rates of protection in the 1990s yield different results. Tsikata (1999) finds that overall effective rates of protection in manufacturing fell from 30.2 % to 22.2 % between 1990-96, but was characterised by a rising dispersion at the 4 digit SIC level. Fedderke and Vase (2000) find that sectors for which effective protection *increased* between 1988-98 accounted for nearly 50 per cent of total GDP. This is probably an overestimate as it includes agriculture where tariffication of non-tariff barriers (such as quotas) took place. Nevertheless their results do not suggest that South Africa has undergone severe trade liberalisation, particularly in labour intensive sectors such as textiles, wearing apparel and leather. This uncertainty surrounding the extent to which protection has been reduced makes an analysis of the relationship between employment, wages and trade liberalisation extremely difficult.

Of key interest to this paper is the effect that tariff reductions have had on the prices of skill intensive products relative to less skill intensive products. As discussed in the methodology section, these changes have direct implications for changes in relative wages via the Stolper-Samuelson effect. Table 3 presents three different estimates of the ratio of protection in skill intensive industries relative to less skill intensive industries. In each case the ratio declined between 1992-97 reflecting relatively greater tariff reductions in skill intensive industries than in less skill intensive industries.[12] From the theoretical analysis this should imply that trade liberalisation since 1992 has reduced the price of skilled intensive products relative to less skill intensive products and is expected to have boosted the relative wage of less skilled labour.[13]

Table 3: Weighted relative skilled to less skilled tariff protection

	1992	1997
by skill intensity[1]	0.73	0.51
by wage[2]	1.23	0.87
by share employment[3]	0.84	0.72

Notes: Calculations based on tariff data in Table 2.

1. Manufacturing sectors intensive in use of skilled and less skilled labour are defined as those industries above or below the mean skill intensity of production (skilled labour as share of total labour) calculated as an average between 1994-98. In calculating aggregate protection of the skill intensive and less skill intensive sectors each industry's tariff is weighted by its sales as a share of total manufacturing sales in 1990.
2. Skill intensive sectors are those sectors in which the average wage exceeds the mean manufacturing wage between 1994-98. Less skill intensive sectors are those sectors in which the average wage is less than the mean manufacturing wage between 1994-98. The weighting procedure is as above.
3. Protection in skill intensive industries is calculated by weighing each industry's tariff rate by its share of total skilled labour in manufacturing in 1990. Protection in less skill intensive industries is calculated by weighing each industry's tariff rate by its share of total less skilled labour in manufacturing in 1990. This approach is used by Lawrence and Slaughter (1993).

[12] *Care must again be taken when interpreting these results. In aggregating sectors some of the diversity within each sector is lost. For example, the clothing sector is characterised by both high skill products such as designer clothing as well low skill products such as basic shirts.*

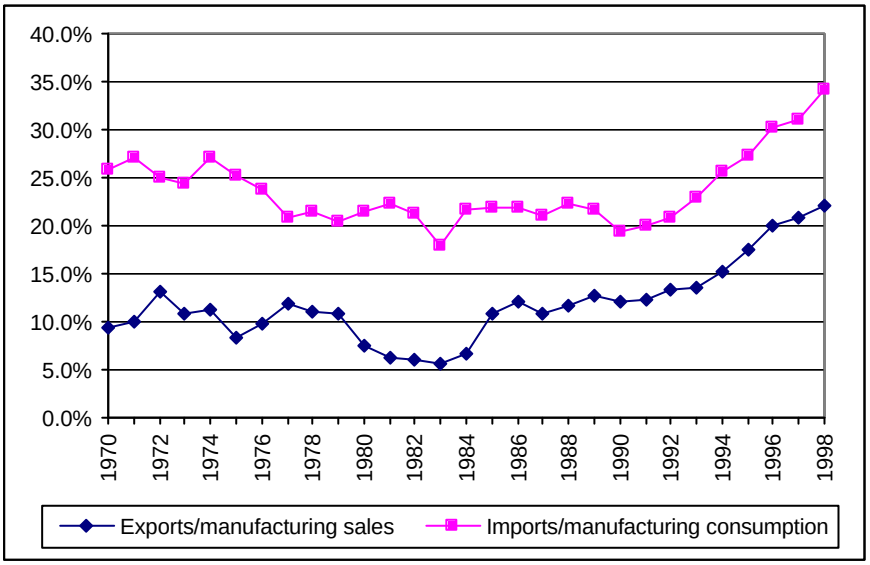
[13] *Whether the relative price of skill intensive products rose or fell overall, depends on movements in international prices. If the relative world price of skill intensive products rose faster than the reduction in relative protection, then the relative price of skill intensive products will have risen.*

3.4 Trade flows

In the past South Africa industrialised through a process of import substitution, encouraged by protection. However the fall in the gold price in 1981, the debt crisis from September 1985, the gradual liberalisation of trade policies and the use of export promotion schemes shifted South Africa into a more open trade regime.[14] A key feature of this change has been a reduction in the importance of mining in total exports, and the entrance of the manufacturing sector into the global economy.

Prior to the mid 1980s the mining sector and notably gold dominated total exports with shares of 56% and 40 % of total exports in 1984, respectively. By 1997 these shares had fallen to 34.2 % and 15 %, respectively. In contrast, manufacturing exports grew rapidly driven by a substantial real devaluation of the rand in the mid 1980s, and the export of domestic surplus (the 'vent-for-surplus' argument of Fallon and Pereira de Silva, 1994) as a domestic recession took hold. The effect was a rise in manufacturing share of total exports from 17.4 % in 1984 to 43.8 % in 1998. The growing importance of manufacturing exports to the South African economy is also reflected in the rise in share of manufacturing gross output exported from 6.6 % in 1984 to 22 % in 1998 (Figure 4).

Figure 4: Manufacturing exports and imports as shares of sales and consumption respectively



Notes: Own calculations using Wefa data.

Imports are heavily concentrated on capital and intermediate goods (over 75 % of total imports) and reflect the high import dependency of the capital-intensive basic metals and chemicals sub-sectors. As a share of total manufacturing consumption imports exceeded 25 % during the early 1970s, but declined as output and investment growth slowed and protection rose during the mid 1980s. With the re-emergence of South Africa into the international community and slight recoveries in investment and output growth in the 1990s, import growth has risen dramatically. Manufacturing imports as a share of total manufacturing consumption rose from 19.4 % in 1990 to 34.1 % in 1998 (Figure 4).

[14] *Belli* et al. *(1993) argue that although these changes have increased the export orientation of the South African trade regime, an anti-export bias remained in the early 1990s. Tsikata (1999) drawing from IDC (1997) notes that this anti-export bias persisted into 1996.*

As is evident in Figure 4 manufacturing trade has had an increasingly influential impact on production and employment decisions in the South African economy. The manufacturing sector's importance in the domestic economy, the rapid growth in manufacturing trade and the reduction in tariff protection suggest that this is a useful sector to analyse the impact of trade on relative wages. However, the importance of mining as a source of employment for less skilled suggests that change in this sector will also be crucial to an understanding of changes in relative wages in South Africa.

While manufacturing trade has increased, it is unclear from the aggregate analysis whether this has been driven by trade with developed or developing countries. As mentioned earlier, the impact of trade liberalisation on wages and employment in middle-income countries such as South Africa is ambiguous. To gauge whether South Africa has behaved as a developed or developing country under trade liberalisation, Table 4 presents the regional breakdown of South African imports and exports excluding gold. For exposition purposes the regions have been divided into rich countries[15], rest of SADC (RSADC) and rest of world (ROW).

As shown in the Table, South African trade is dominated by rich countries. Looking first at exports, we note that trade with rich countries accounted for over 60 % of total trade for most years. This share has declined since 1988, driven largely by a rise in share of trade to RSADC and other developing countries. Trade with RSADC rose sharply during the early 1990s reaching a peak of 14.2 % in 1996. This shift appears to have been a once off adjustment in response to the ending of sanctions as the share has declined subsequently.

Table 4: South African regional trade flows of manufactures, %

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Exports										
Rich	62.10	57.15	52.26	50.67	49.11	48.72	51.78	48.74	48.30	55.12
SADC	14.48	16.12	18.39	17.37	18.88	19.79	18.88	20.02	18.80	17.53
ROW	23.42	26.73	29.36	31.95	32.01	31.49	29.35	31.24	32.90	27.35
Total value (US$ bill)	7.13	7.62	8.23	9.45	9.14	10.40	13.37	13.77	14.61	13.74
Growth	16.22	6.83	8.03	14.74	-3.21	13.80	28.47	2.99	6.12	-5.92
World trade (US$ bill)	2644.9	3019.2	3121.8	3407.5	3488.1	3894.3	4641.0	4878.5	5051.7	4970.9
SA share world trade	0.27	0.25	0.26	0.28	0.26	0.27	0.29	0.28	0.29	0.28
Imports										
Rich	85.02	84.84	82.48	79.81	79.54	79.57	79.46	77.69	76.76	77.17
SADC	0.29	0.26	0.27	0.38	0.46	0.45	0.40	0.38	0.55	0.63
China &India	0.79	0.96	1.25	1.67	2.20	2.40	2.81	3.43	4.23	4.50
ROW	13.90	13.94	16.00	18.14	17.81	17.58	17.33	18.50	18.46	17.70
Total value (US$ Bill)	13.53	13.43	14.11	15.38	15.43	19.00	23.85	23.69	23.79	23.83
Growth	0.57	-0.75	5.08	9.01	0.27	23.15	25.55	-0.67	0.40	0.16
SA share world trade	0.51	0.44	0.45	0.45	0.44	0.49	0.51	0.49	0.47	0.48

Source: South African data is obtained from TIPS and is based on the Customs and Excise Harmonised System classification. World data is UNComTrade data as published by Statistics Canada's World Trade Analyser.

The dominance of trade with rich countries is even more prominent on the import side with the share of total South African imports from rich countries exceeding 70 % for all years since 1988. Although the share of imports sourced from RSADC has risen, it is still extremely small (below 1.5 %).

The broad aggregate analysis presented in Figure 4 and Table 4 hides much of the changes that may have occurred at the sectoral level.[16] Nevertheless, it appears that trade liberalisation since

[15] *Rich countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.*

[16] *See Edwards and Schoer (2001) for a regional and commodity breakdown of South African trade flows.*

the late 1980s is associated with (a) significant increases in the share of manufacturing trade in production and consumption, and (b) a slight decline in the dominance of trade with rich countries. That trade is still dominated by rich countries suggests that South Africa most likely behaves as a developing country *vis-à-vis* the rest of the world. A variety of variables are later used in an attempt to capture any possible divergent effects on relative wages arising from trade liberalisation with both developed and developing countries.

3.5 Relative wage changes

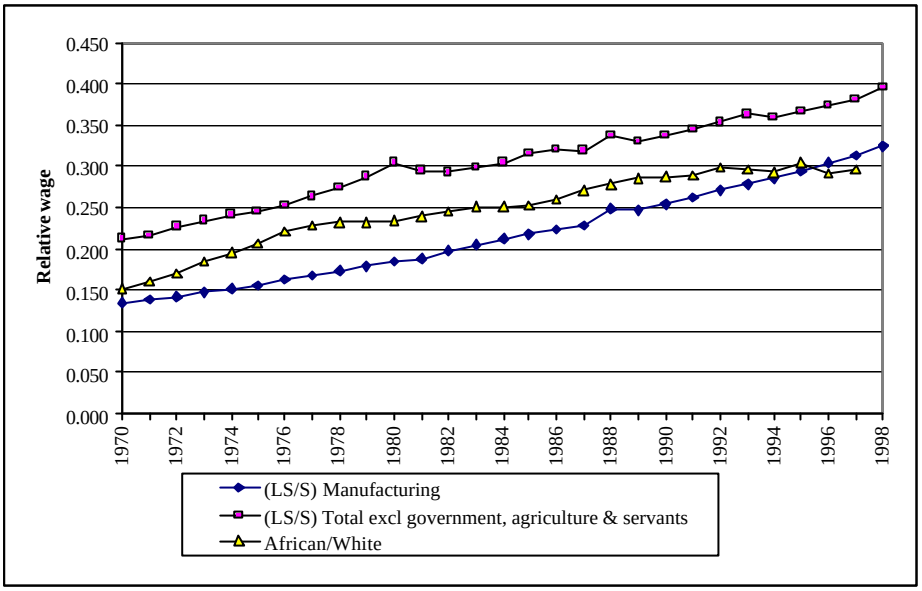
Figure 5 shows the relative wages of less skilled labour to skilled labour (LS/S) for the total economy excluding, government, agriculture and domestic servants and for manufacturing alone. Because this data has been interpolated from Population Census data and October Household Survey (OHS) data, care must be taken when interpreting short run trends. This is particularly the case with the manufacturing sector. As is shown in Figure 5 relative wages of less skilled have risen from 0.21 and 0.14 in 1970 to 0.40 and 0.34 in 1998 for the total economy and manufacturing, respectively. Within the total economy this growth was very strong during the 1970s, but has continued into the 1990s.

The rise in relative wage of less skilled labour comes as a surprise. International evidence that the relative wage of less skilled labour has fallen in developing countries is growing (see Hanson and Harrison (1995) on Mexico, Wood (1997) for an overview and theoretical analysis, and Berman Bound and Machin (1997) for a range of developed countries), although whether this has been driven by trade or technology is still debated. Within South Africa the shift towards more skill intensive production techniques (Bhorat and Hodge, 1999) and the relatively high investment in information technology at the firm level (Hodge and Miller, 1996) suggest that skill biased technological change is also present and that the relative wage of less skilled labour should also have fallen.

Given these concerns alternative data was sought to confirm these trends. Frequently African and white wages within manufacturing have been used as proxies for skilled and less skilled wages, respectively (Fallon, 1992 and Fallon and Pereira de Silva, 1994). Despite the shortcomings of this data as a proxy, particularly considering the rapid educational advancement of Africans since the early 1980s, the trend of relative manufacturing wage of Africans to whites is presented here as an imperfect 'check' on the occupational wage data. The data are broadly consistent in that they display an upward trend. However, since 1992 significant deviations in trend emerge with the relative wage of Africans stagnating.

The convergence in wages between Africans and whites has been attributed to (a) reduced labour market discrimination, (b) an improvement in the skills of blacks relative to those of whites, and (c) the growth of African trade unionism (Fallon, 1992: 18). Some of these influences will also have raised the relative wage of less skilled labour. Most wage discrimination studies find that wage discrimination has fallen significantly since the 1970s. As the level of wage discrimination decreases with occupational level, the wage impact of the decline in discrimination will have affected the less skilled relatively more and thus will have contributed towards the rise in the relative wage of less skilled labour. The rise in registered African membership in unions from 1.2 % of total employment to over 30 % between 1980-90, is also estimated to have placed upward pressure on African wages (Fallon, 1992). To the extent that union membership is concentrated amongst less skilled labour, this will also have placed upward pressure on the relative wage of less skilled labour. Finally, improved educational attainment by African workers since the 1970s will also have raised the relative wage of African labour. However, the impact of this change on the relative wage of less skilled labour cannot be inferred from its impact on the relative wage of Africans.

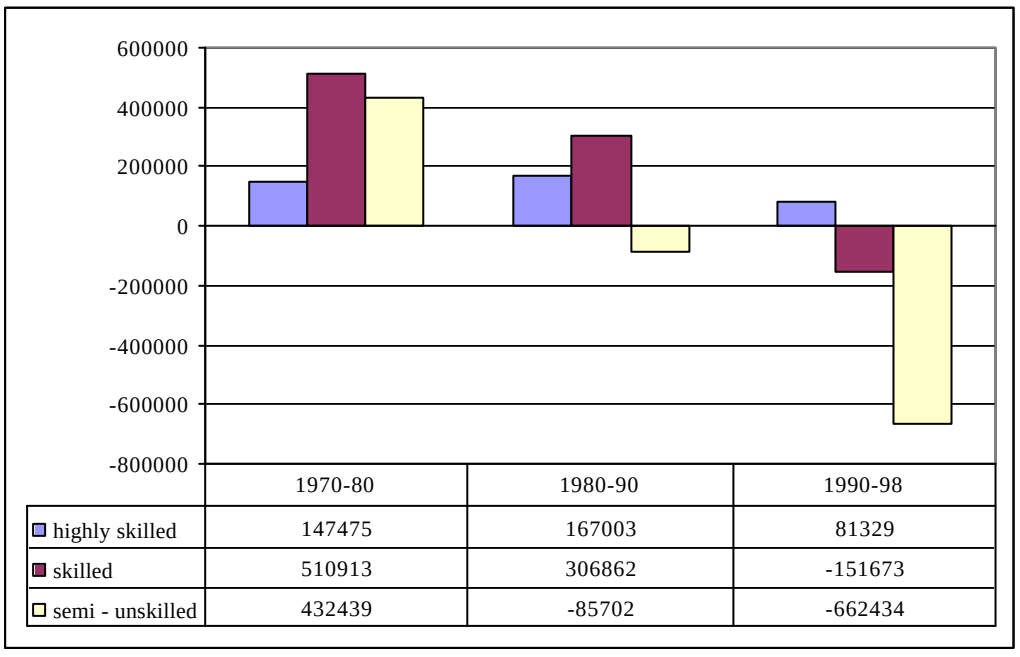
Figure 5: Relative skilled to less skilled wages since 1970



Notes: Skilled labour consists of (a) Professional, semi-professional and technical occupations, (b) Managerial, executive and administrative occupations and (c) certain transport occupations e.g. pilot, navigator. Less skilled includes all the remainder. The wage data was produced by Quantech Research for the World Bank. African and white wages were obtained from Statistics South Africa.

Further 'checks' using average wages and stochastic dominance methods were performed using October Household Surveys (OHS) and SALDRU data (see Appendix). These are broadly consistent with the upward trend displayed in Figure 5, although some ambiguity still exists in the second half of the 1990s.

Figure 6: Employment changes according to skill, total economy excluding agriculture, government and domestic servants.



	1970-80	1980-90	1990-98
highly skilled	147475	167003	81329
skilled	510913	306862	-151673
semi - unskilled	432439	-85702	-662434

Notes: Data sourced from Wefa.

A second feature of the South African labour market is the significant decline in employment of less skilled labour relative to skilled labour (Bhorat, 2000, 2001 and Edwards, 2001). The change

in employment structure since 1970 is clearly reflected in Figure 6 which displays the worsening employment position of less skilled labour, particularly during the 1990s. Continued rises in relative wage in the face of declining employment is one of the key relationships that require explanation in order to fully understand the employment dynamic in South Africa. It has been argued that non-market forces such as real wage growth, labour legislation and union bargaining account for much of this relationship (Fallon, 1992). The role of market driven forces arising from trade or technology is less clear.

4. Empirical analysis

As discussed in the previous section, the relative wage of less skilled labour has risen since 1970. This has occurred in the context of an opening of the trade regime and increased manufacturing trade, particularly since the mid 1980s. The co-existence of these trends is consistent with expectations regarding the impact of trade liberalisation on relative factor returns within developing countries. However, as discussed in the methodology section a number of other factors such as technology and relative factor supply can also account for the trend in relative wage. In this section we aim to estimate the extent to which each of these factors (international trade, technology and relative supply labour) account for the rise in relative wages of less skilled since 1970.

A descriptive analysis of the data from 1970 using figures is first presented. This serves as an initial consistency check to see whether the trends in relative wages are theoretically consistent with trade, technology and labour supply trends within South Africa. This is followed by an econometric analysis of the relationship.

4.1 Data

For the purpose of analysis data on relative wages, international prices, technology and relative factor supplies are required.

Wage data on highly skilled, semi-skilled and unskilled data have been calculated by Quantech Research. High skilled labour consists of professional, semi-professional & technical occupations, managerial, executive & administrative occupations and certain transport occupations (pilot, navigator). Unskilled labour consists of elementary labour while semi-skilled labour includes the rest. The wage data for these skill categories are constructed for 11 industrial sectors from Population Census data and the 1997 October Household Survey. The aggregate remuneration per skill derived from these sources was adjusted to ensure consistency with total labour remuneration obtained from a variety of Statistics South Africa sources. Because data were missing and had to be interpolated for various years the data are subject to criticism, particularly when used for short-term comparisons. This is more of a problem for the disaggregated industrial sectors than for the aggregate economy as a whole.

As reflected in equation 5 all variables, other than relative wage, have been defined as skilled relative to less skilled. In the case of wages the construction of the less skilled/skilled wage variable was simple as wage data was available for highly skilled, semi-skilled and unskilled labour. Relative wage has been calculated as the employment weighted average semi-skilled and unskilled wage divided by high skilled wage.

Calculating the relative price variable was more difficult. A variety of data sources and approaches to calculating the relative price index have been used in the international literature. Ideally import and export price indices should be used be used to measure the impact of international trade on domestic prices (as in Lawrence and Slaughter, 1993). However, as this

data is only available in South Africa from 1988 (Jansen and Joubert, 1998), it is of limited value. Alternatively, as is done in this paper, the producer price index (PPI) or domestic price deflators (Sachs and Shatz, 1994 and Baldwin and Cain, 1997) can be used. PPI data were obtained from Statistics South Africa (various years).

This still leaves the problem of calculating the price of skilled products relative to less skilled products. Lawrence and Slaughter (1993) calculate the price of skill intensive (less skill intensive) products by weighing each industry's price by its share of total skilled (less skilled) labour in manufacturing using a particular base year. Baldwin and Cain (1997) define industries as either skill intensive or less skill intensive according to whether their direct plus indirect labour coefficient is respectively greater than or less than the median for manufacturing as a whole. Output values are then used as weights to calculate the skilled and less skilled price indices. A variety of approaches have been used in this paper. In an approach similar approach to Baldwin and Cain (1997) skill intensive (less skill intensive) industries are classified as those industries in which the average skilled/less skilled employment ratio is greater (less) than the average for manufacturing as a whole calculated between 1994-98 (referred to later as *skill defined*). Output values in 1990 are then used as weights to calculate the relevant price indices. A further price index was created where skill intensive sectors were defined as those industries in which the average wage was greater than the average for manufacturing as a whole (referred to later as *wage defined*).

The above series does not adequately capture the possible impact of changes in the price mining resources on the relative wage of South African labour. Because mining production is relatively low skill intensive and is a significant export sector, its inclusion in the analysis is imperative. The US$ gold price has been used as an indicator of the relative price of less skill intensive products. An increase in the gold price raises the relative price of less skilled products which is expected to increase the relative wage of less skilled workers.

Finally, the real effective exchange rate (REER) provided by the Reserve Bank is used as a proxy for competitiveness. The real effective exchange rate (REER) captures the relative price of South African products to the price of foreign products (based on CPI). A rise thus reflects a reduction in the competitiveness of SA producers vis-à-vis its competitors, which will cause a flow of productive resources from nontradable sectors to tradable sectors. If we assume that the relatively less skill intensive primary sector and manufacturing sector are the tradable sectors, this will raise the relative demand for less skilled labour and similarly raise the relative wage.

Further, as developed countries dominate South African trade, changes in the REER will largely reflect changes in the price of developed country products relative to South African products. We would thus expect a decline in the REER to raise the competitiveness of South African exports and import-competing firms. However, because many high skill products are not exported by South Africa we may expect to see the relatively less skill intensive product prices rise as export demand for these products rises. This is particularly the case with low skill intensive natural resources which are dollar denominated. Thus, a depreciation of the real exchange rate may raise the relative price of less skill intensive products relative to skill intensive products and positively affect the relative wage of less skilled.

A variety of relative technology indices are calculated using TFP growth and average productivity measures such as GDP/L and sales/L as indicators of technological change. We also used machinery & equipment imports as a share of total capital machinery & equipment capital stock. These variables were calculated in a similar manner to those of the relative price variables using production price indices.

Matriculants as a share of population aged between 15 and 19 were used as a proxy for relative factor supplies. A rise in the variable reflects a rise in the skill endowment of South Africa and should be positively related to the relative wage of less skilled. Data for the construction of this variable were drawn from Statistics South Africa yearbooks, various publications from the education departments and from various South African Institute of Race Relations (SAIRR) *"Race Relations Surveys*".

4.2 Graphical overview

We first review the data to explore the long run trends of the trade, technology and labour supply variables in conjunction with relative wages in South Africa. Assuming South Africa behaves as a developing country we would expect the following relationships to be associated with the rise in the relative wage of less skilled labour:

- A decline in the price of skill intensive goods relative to less skill intensive goods as South Africa exposed itself to international trade. In accordance with the Stolper-Samuelson theorem this would result in a rise in the relative wage of less skilled labour.

- A decline in the relative productivity of the skill intensive sector. This can arise from both stronger relative growth in productivity within less skilled sectors, or relatively greater declines in productivity of the skill intensive sector. We would thus expect to see a negative relationship between relative wage of less skilled labour and the relative productivity of skill intensive sectors.

- A rise in the relative skill endowment of labour. As the relative supply of skilled labour increases, so the relative wage of less skilled labour rises. This would show up in the form of a positive relationship between relative wage of less skilled and relative labour supply.

4.2.1 Level analysis

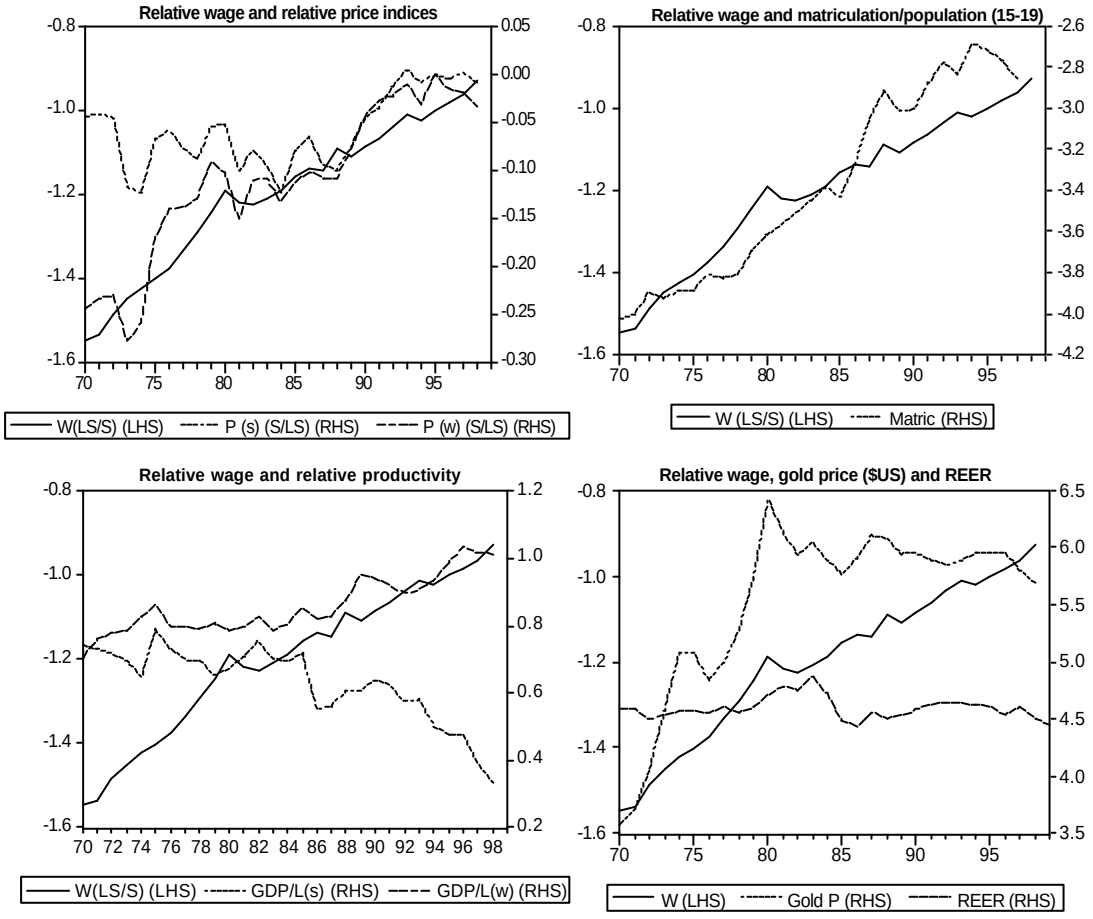
Figure 7 presents time plots of some of the key explanatory variables. Alternative indices to those shown were also constructed and will be referred to where differences are evident.

These figures suggest that trade has had an ambiguous affect on relative wages of South African labour. While the skill defined and wage defined relative price indices move together during the 1990s, their trends diverge sharply in the period prior to this. The skill defined relative price index rises strongly during the 1970s and 1980s, while the wage define relative price index gradually declines. The latter index is consistent with the rise in relative wage of less skilled, although the strong growth in relative wages during the 1970s suggests other factors have played a more significant role. The trend during the 1990s for both indices is inconsistent with the view that relative prices have raised the relative wage of less skilled as a negative relationship was expected. Alternative relative price indices display similar trends till 1990. However, when using import prices calculated in Jansen and Joubert (1998) a declining relative price is shown during the 1990s. Using import price data, the wage defined relative price index fell from 1.11 in 1991 to 0.66 in 1998 (similar trends were evident when using the other weighted indices). This result is also consistent with the data on relative tariffs which fell from 1.23 to 0.87 for the wage defined index between 1992-97 (Table3). These latter results provide some support for a positive impact of trade liberalisation on the relative wage of less skilled during the 1990s. However, given that the trends in relative prices are not robust to changes in the price indices, little weight can be placed on these interpretations.

The REER and the US$ price of gold are further proxies for relative price changes. As discussed earlier we would expect a positive relationship between the gold price and relative wage and a negative relationship between REER and relative wage. During the 1970s the rapid rise in gold

price appears to have boosted the relative wage of less skilled and is consistent with expectations arising from the Stolper-Samuelson theorem (gold production is relative less skill intensive). Non-market forces such as the fear of over-dependence on migrant mineworkers from abroad during the 1970s also led to the granting of substantial wage increases in order to attract domestic labour during the first half of the 1970s (Fallon, 1992: 16). Subsequent to the early 1980s, however, the decline in the gold price is inconsistent with the continued rise in relative wage of less skilled. Looking at the REER, no strong relationship is evident, although the significant real depreciation of the rand during the early 1980s and again during the 1990s may have boosted the relative wage of less skilled.[17]

Figure 7: Time plot of key variables in log levels



Notes regarding variable names: P(s) and P(w) stand for skill defined and wage defined relative price indices. GDP/L (s) and GDP/L (w) stand for skill defined and wage defined average labour productivity indices.

The model in section 2 suggests that the relative wage of less skilled labour is negatively related to the relative technology of skill intensive sectors. This implies that an increase (decrease) in the relative technology of the skill (less skill) intensive sector should decrease (increase) the relative wage of the less skilled worker. Looking at the relative wage and relative productivity (skilled/less skilled) diagram in Figure 7, we see two divergent trends in relative productivity indices. Skill defined DP/L falls while the wage defined equivalent rises. When using total factor productivity to construct the indices, we see a decline in the relative productivity of skill intensive sectors for all weighted indices. The downward trending relative productivity indices are consistent with the rise

[17] *Alternative measures of REER calculated by Golub (2000) using CPI show a downward trend during the 1970s as well as a more significant downward trend from the 1980s. This trend is consistent with the rise in relative wage of less skilled labour.*

in relative wage of less skilled labour. However, given that the two series in Figure 7 diverge, it is unclear how sector biased technological change has affected relative wages.

To date research in South Africa (Bhorat, 1999, Fedderke *et al*., 1999 and Edwards, 2001) has mainly focused on exploring the impact of trade and technology from the demand side perspective. Supply side effects, arising from changes in the relative endowment of labour, have not yet been explored. As explained in the methodology section of the paper, large changes in relative supplies of endowments of labour do affect the relative wage within a diversified structure of trade. This is particularly the case where the economy is initially engaged in specialised production of a particular commodity and then moves to a diversified trade. In these cases a rise in the relative endowment of skilled labour will reduce the relative wage of skilled labour and improve wage equality.

Using the number of successful matriculants as a share of the total population aged between 15-19 as a proxy for relative skill endowment, Figure 6 shows an accelerated rise in the endowment of skilled labour between 1970-94. This trend is consistent with the decline in relative wage of skilled labour during this period.

None of these variables is entirely adequate in explaining the upward trend in relative wage of less skilled labour. Drawing from Fallon (1992) it appears that much of the trend is explained by non-market forces such as a decline in wage discrimination, particularly amongst less skilled, and a rise in union membership amongst African workers. Nevertheless, it is possible that trade, technology and supply factors have a greater influence in explaining changes in the relative wage of less skilled labour. This analysis follows.

4.2.2 Growth rates

The graphical preview of the data in levels suggest that the variables are nonstationary. The variables were then tested for nonstationarity using the Dicky-Fuller and Augmented Dicky-Fuller (ADF) tests. In all cases the variables were found to be integrated of order 1 (i.e. nonstationary) raising the possibility of a long run stable relationship between some of these variables, i.e. the variables are cointegrated, is raised.[18] A useful procedure for testing for cointegration with multiple variables is the Johansen technique. However, because of the sample size it was decided not to pursue this option and the regressions were estimated using log growth rates.[19] The growth rate time plots of some of the relevant variables are shown in Figure 8.

The time plots in Figure 8 show no clear relationship between growth in relative wage and growth in relative price of skilled products. However, an expected positive relationship between the growth rate in the gold price and relative wages is evident during the 1970s and early 1980s. An expected negative relationship between the growth rate of the REER and relative prices is also evident from the early 1980s. This is particularly strong up to 1990 where many of the turning points coincide. The relationship between the growth rate of relative wages and the growth rates of the other variable is unclear and many of these figures have been excluded. In the following section the relationship between relative wages and some of the key variables are explored using econometric techniques.

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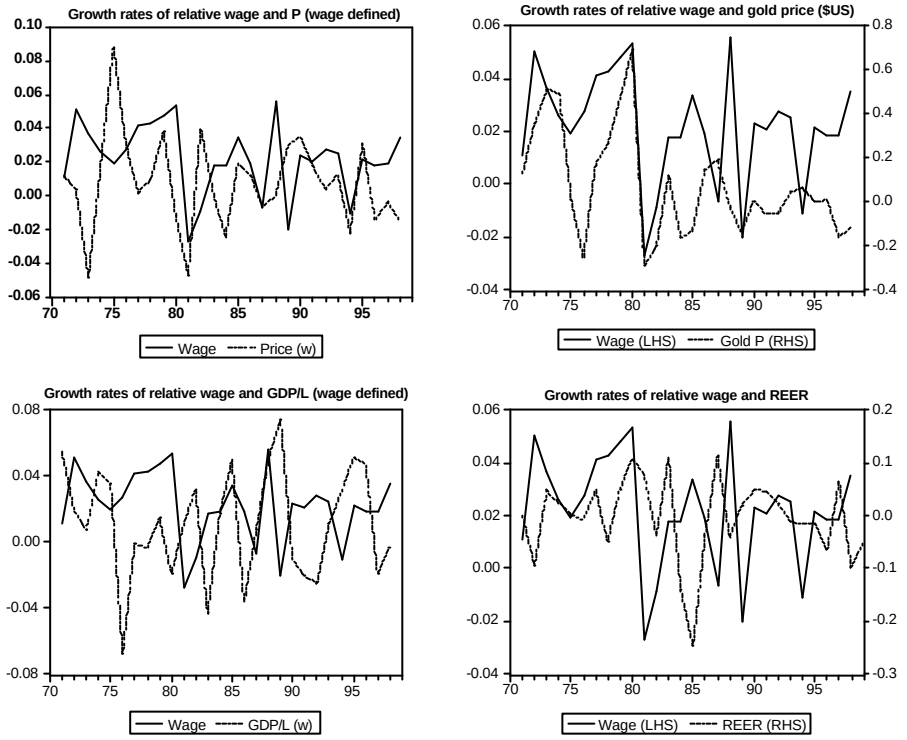
[18] *The relative wage index appears to be trend stationary, although the ADF test says it has a unit root. The poor power of the ADF test in small sample sizes such as this, make it extremely difficult to distinguish between trend stationary and difference stationary processes.*

[19] *We tested for cointegration using a number of specifications of the function. One cointegrating vector was found when using the gold price ($US), relative wages, matriculants as a share of the population, and either openness or imports of machinery & equipment as a share of total capital machinery & equipment capital stock. A 2nd order VECM model was then estimated. The results suggest a long run positive relationship between relative wage, the gold price and the relative supply of skilled labour. These are consistent with the theory.*

Figure 8: Time plot of key variables in log growth rates



4.3 Econometric results

Using log growth rates the following equation was estimated: $\Delta \ln w_t = a_0 + b_1 \Delta \ln Trade_t + b_2 \Delta \ln Tech_t + b_3 \Delta \ln Supp_t + e_t$

Because the variables are in log growth rates, the coefficients represent a type of short-run elasticity. The estimation was repeated using the various proxies used to measure the three 'generic' variables included in the equation. Some of the results using wage defined variables where applicable are presented in Table 5.

Three sets of regressions are presented. The first estimation regresses relative wage growth of less skilled on growth in relative prices, two technology variables (relative GDP/L growth and relative TFP growth), relative labour supply growth and growth in openness. No variables were significant with the low Fstatistic indicating that the independent variables as a whole failed to significantly explain changes in the relative wage. The relative price and technology indices in regression (1) were calculated using the 'wage defined' approach; i.e. skill intensive sectors were defined as those industries in which the average wage was greater than the average for manufacturing as a whole. Poor results were also obtained when skill intensive sectors were defined relative to the average skill intensity of production. These have not been shown as result.

These results use variables that fail to consider the impact of changes in the price of mining related activity, and in particular gold, on relative wages. The mining sector is a large employer of less skilled labour and changes the price of mining output can have substantial effects on the wage of less skilled labour. In regression (2) the gold price and REER variables were included. The results suggest that the gold price, REER and sector biased technological change explain some of the changes in relative wage of less skilled labour. The Fstatistic is significantly different from zero and an adjusted R^2 of 0.485 was attained.

Table 5: Regression results, dependent variable is growth of relative wage of less skilled labour, 1970-98

Variable	Coefficient (1)	Coefficient (2)	Coefficient (3)
Constant	0.025	0.020	0.021
	(3.43)[a]	(3.98)[a]	(8.31)[a]
Relative price growth (S/LS)[c]	0.124	0.166	
	(0.717)	(1.37)	
Gold price growth (US$)		0.061	0.069
		(4.23)[a]	(6.70)[a]
REER growth		-0.150	-0.175
		(-3.22)	(-5.09)[a]
Relative GDP/L growth (S/LS)	-0.207	-0.309	-0.259
	(-1.31)	(-2.68)[b]	(-3.36)[a]
Relative TFP growth (S/LS)	0.178	0.143	
	(1.03)	(1.17)	
Matric/population growth	-0.019	-0.032	
	(-0.27)	(-0.65)	
Openness growth (X+M/GDP)	-0.043	-0.023	
	(-1.32)	(-0.98)	
Growth in days lost due to strikes			-0.016
			(-3.96)[a]
R-squared	0.157	0.635	0.731
Adjusted R-squared	-0.064	0.485	0.682
F-statistic	0.710	4.232	14.967
Prob(F-statistic)	0.623	0.007	0.000
Durbin-Watson stat	1.861	2.085	2.001
# observations	25	25	27

Notes: t-statistics in parentheses.

a. The coefficient is significant at the 1% level.

b. The coefficient is significant at the 5 % level.

c. S and LS stand for skilled and less skilled, respectively.

The rapid rise in gold price during the 1970 raised demand for labour in the mines. As Hofmeyr (2001) notes real wages for African workers rose substantially during this period while white wages stagnated. Although crude, race has been interpreted as a proxy for skill. Within mines the real wage of African workers trebled between 1971-1977 (Hofmeyr, 2001). The increased demand for African workers on the mines also forced agricultural wages upwards and can be expected to have placed upward pressure on African wages in manufacturing. These trends are consistent with the rapid rise in relative wage shown in Figure 5. As the gold price collapsed in early 1980s, so too did the relative wage of less skilled labour (see Figure 10 below). Movements in the gold price are less satisfactory in explaining the continued rise in relative wage of less skilled subsequent to the early 1980s.

It appears that changes in the REER played an increasing role in explaining movements in the relative wage subsequent to the 1980s. The negative coefficient to growth in REER suggests that declines in the REER subsequent to the gold price collapse in the early 1980s helped alleviate some of the pressures on rand denominated wages. The decline in REER, particularly after the mid 1980s helped improve the competitiveness of South African manufacturing exports. A one percent decline in REER (1 % improvement in competitiveness) is estimated to raise manufacturing exports by between 0.63 % and 1.4 % (Tsikata, 1999, and Golub, 2000). As shown in Figure 4 manufacturing exports as a share of manufacturing sales rose strongly from the mid 1980s. The negative coefficient of REER is also consistent with the view that trade liberalisation in the 1990s has positively affected the relative wage of less skilled as the REER fell during this period.

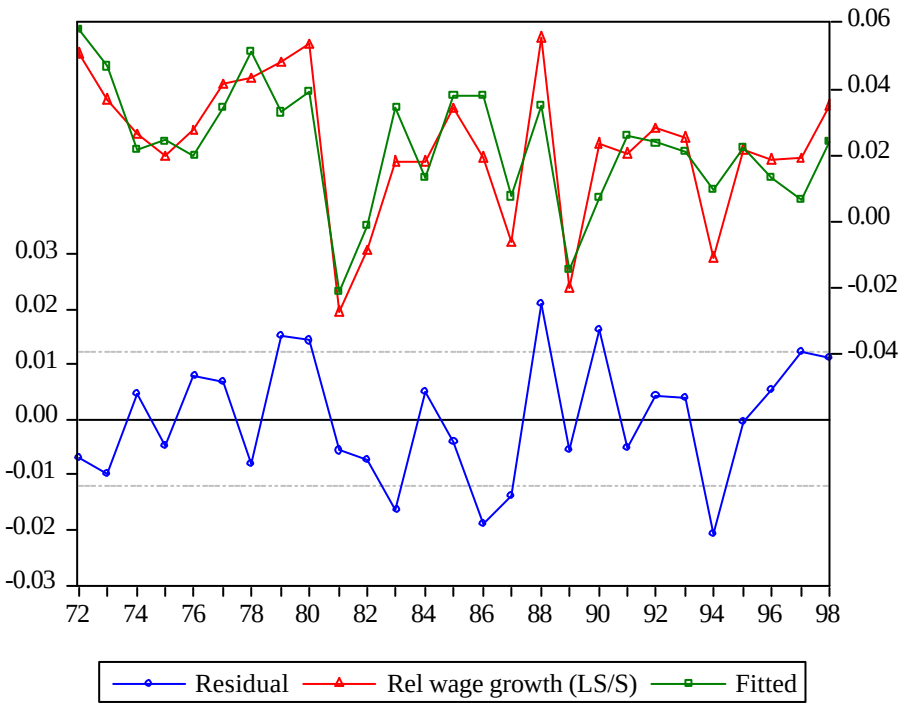
The results also suggest that relative productivity improvements in the less skill intensive sectors has also boosted relative wages of less skilled labour. Absorption of new technology in the

economy has helped raise productivity within less skilled sectors. This may have actually been labour displacing, but productivity enhancing. This result would be consistent with the results of Edwards (2001) where it was found that labour shedding occurred most strongly amongst low skilled labour. This result, however, was not robust to changes in the relative productivity index used. The results where not significant when using TFP, machinery & equipment imports as share total investment or openness as indicators of technology or when using alternative employment or skill defined indices. Little confidence can, thus, be placed on this result.

The proxy for relative labour endowments is not significant in any regression. This is possibly due to the proxy used which does not adequately capture changes in the quality of education. The significant rise in matriculants from the early 1980s is due to the expansion of education to Africans. However, due to discriminatory policies this education was of a poorer quality to that offered to whites. A better result may arise if the quality of education were included into the proxy directly.

These results provide some evidence in support of the rise in relative wage of less skilled labour, even throughout the 1990s. However, they appear at odds with the dramatic shedding of less skilled labour that has occurred throughout the economy in recent years (Bhorat, 2001, and Edwards, 2001). A possible cause of this is technological change which appears to have raised the relative productivity of less skilled labour. As domestic output stagnated since the 1980s, these productivity gains may have led to the shedding of less skilled employment. It is also possible that non-market forces such as changes in the labour legislation and/or changes in union activity have raised the wage of less skilled above what the market can support. As result unemployment has arisen. This view has been put forward by Nattrass and Seekings (2000) who argue that the extension of agreements made in bargaining councils to non-participants has negatively affected low wage low productivity industries. In an attempt to include these impacts upon relative wage a number of non-market variables relating to labour unrest were included into the regression analysis. Regression (3) presents the results when including the number of labour involved in strike action. The data on strike action were obtained from the Reserve Bank and are only available from 1973. The regression results are also shown in Figure 9 which presents the estimated results (fitted) as well as the residual.

Figure 9: Actual, fitted and residual of the regression in regression (3)



The inclusion of the strike action variable significantly improves the results as is shown by the rise in adjusted R^2 to 0.73. The coefficient is significant, but is unexpectedly negative. This result suggests that increased strike action is associated with declines in the relative wage of less skilled labour. It was expected that increased strike action would raise the relative wage of less skilled. The results do not change even when using lagged strike action values. Two possible explanations follow from this result. Firstly, strike activities, particularly amongst less skilled, may arise as a *result* of declining relative wages. A negative coinciding relationship is thus evident. Alternatively, increased numbers of strikes lead to the substitution of capital for less skilled which reduces the relative wage of less skilled. One would, however, expect a lagged relationship to emerge in this case as capital and labour are not immediately substitutable. Further analysis is required on this matter.

Many other regressions were estimated. Different proxies for trade, technology and labour supply were used. For example tariff revenue as a share of import value was used as a proxy for trade liberalisation. Developed and developing country trade (exports + imports) as a share of GDP was also used in order to analyse whether middle income countries such as South Africa are differently affected by trade with countries on either side of the development spectrum. Neither of these additional trade proxies yielded significant results. The log growth of African wages relative to white wages was also used as a dependent variable. The results for most variables were again poor, although a significant (at 5 % level) negative coefficient for growth in tariff revenue was estimated.[20] This result was robust to changes in the other variables. The negative coefficient is consistent with the view that trade liberalisation has positively affected the wages of less skilled since the 1980s as the growth in tariff revenue as share of import value has declined over this period.

5. Conclusion and notes

This paper explored the impact of trade, technology and factor supplies on the relative wage of less skilled labour in South Africa. Since 1970 the relative wage of less skilled labour has risen, a trend that has continued into the 1990s. This result was unexpected given the South African literature on the adoption of new skill intensive technologies across industries. At the same time employment of less skilled labour has declined raising questions about whether these trends reflect demand side forces or labour market effects. This paper draws upon international trade theory, and in particular the Stolper-Samuelson theorem, to analyse whether trade, technology and/or factor supplies can explain these trends.

The results are in general not very strong. No clear relationship over the entire period between the levels of trade, technology and relative wages are evident. It appears that the bulk of the upward shift in relative wage can be attributed to non-market factors such as the decline in racial wage discrimination and the emergence of unions. The effect of labour market regulations since 1994 is not clear, although it is argued that these may have had significant effects on employment (Nattrass and Seekings, 2000 and Hofmeyr, 2001) and through this relative wages. Nevertheless, the regression results permit some tentative conclusions with respect to the importance of trade, technology and factor supplies on relative wages.

Trade liberalisation has not negatively affected less skilled labour and thus cannot be responsible for the continued decline in employment amongst the less skilled. Tariff reductions

20 *A positive coefficient, significant at the 10 % level, was found for growth in machinery imports as share of machinery & equipment capital stock. This would suggest that the rise in machinery imports for investment purposes during the 1990s has led to a substitution of capital for less skilled labour and thus a decline in the relative wage of less skilled labour. Given the level of significance and the poor results when using other proxies for technology, little confidence is placed on this result.*

have been biased against relatively skill intensive sectors which will have placed upward pressure on the relative wage of less skilled. Although changes in relative price indices for manufacturing, tariff protection or openness do not explain movements in the relative wage of less skilled labour, the decline in tariff protection since the 1980s appears to have boosted the relative wage of African labour. If the relative wage of African to white labour can be used as a proxy for the relative wage of less skilled labour, the results suggest that trade liberalisation has positively affected the less skilled. This result is consistent with the results of Edwards (2001) and Fedderke *et al*. (2000).

Further evidence that changing international competitiveness has positively affected less skilled labour during the 1990s is supplied by the significant negative coefficient on the REER. The growth in REER has declined since the early 1990s which according to the econometric results will have positively affected the relative wage of less skilled labour.

Gold price movements have had a significant impact upon the relative wage of skilled labour. The rapid rise in gold price during the 1970s and the subsequent increase in demand for less skilled labour raised the relative wage of less skilled labour sharply. Movements in the gold price are less satisfactory in explaining the continued rise in relative wage of less skilled subsequent to the early 1980s. With the decline in gold price we would expect relative wage of less skilled to decline. However, as the mining sector declined in importance during the 1980s, the influence of this variable on relative wages is expected to diminish.

The upward pressure on relative wages arising from trade as suggested by these results, are inconsistent with the view that trade liberalisation has resulted in the decline in employment of less skilled labour shown in Figure 6. The cause of this must lie elsewhere. Two possible explanations can be given. Firstly, it is possible that sector biased technological change has positively raised the productivity of less skill intensive sectors and thus the relative wage of less skilled labour. However, because output growth has been constrained, the improved productivity gains have resulted in the shedding of labour within these sectors. The econometric results of regressions (1) and (2) provide tentative support for the role of sector biased technological change in raising the relative wage of less skilled labour. However, these results are not robust to changes in the technology proxy and further research is required prior to any conclusion being made.

A second explanation for the rise in relative wages in the face of declining employment is that labour market factors are raising the wage of less skilled labour above the equilibrium wage. There is a growing debate (Nattrass and Seekings, 2000 and Hofmeyr, 2001) on whether the new labour legislation, particularly the role of bargaining councils, have raised the wages of the low skilled low productivity industries. Firms respond to the upward pressure on wages by reducing employment. The results of this analysis are consistent with this view.

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Appendix A: Relative wage shifts

This section uses various sources of data and alternative techniques to 'check' the upward trend in relative wage of less skilled labour suggested by the time series wage data. Wage data according to occupational category is obtainable from the Population Censuses, the October Household Surveys (OHS) and other sources such as the Statistics on Living Standards and Development (SALDRU) survey. Two approaches were pursued to verify the trends evident in the time series wage data. In the first approach simple averages are compared, while in the second stochastic dominance tests are used to compare the distribution of wages across income bands.

Comparison of average wages

While the OHS survey asks respondents for the rand value of their daily, monthly or yearly income, the response rate is generally extremely poor. This is particularly evident amongst whites, of which only 18 % provided this information in 1999. Rather than providing the actual value of their income, the data is alternatively given in the form of income bands. The low response rate and the racial bias of responses preclude a comparison of average wages according to skill category for the economy as a whole. However, a meaningful comparison of African wages is possible as the response rate exceeded 50 % for all occupational categories for all years. Drawing upon various sources, the relative monthly wage of skilled Africans is presented in Table A1.

Table A1: Comparisons of relative monthly wage (real) of less skilled labour using various sources, Africans only

	1993-Saldru	1995-OHS	1997-OHS	1999-OHS
Total economy				
Less skilled	R 1151.57	R 1204.23	R 1215.34	R 1808.56
Skilled	R 3085.95	R 3178.77	R 2501.96	R 3560.16
Less skilled/skilled	37.3%	37.9%	48.6%	50.8%
Total economy excluding government and agriculture				
Less skilled	R 1271.80	R 1375.94	R 1286.44	R 1800.75
Skilled	R 3179.57	R 3199.77	R 2145.16	R 3986.61
Less skilled/skilled	40.0%	43.0%	60.0%	45.2%
Manufacturing				
Less skilled	R 1504.61	R 1512.57	R 1407.59	R 1759.15
Skilled	R 3835.24	R 4368.28	R 2068.23	R 6628.62
Less skilled/skilled	39.2%	34.6%	68.1%	26.5%
Mining				
Less skilled	R 1504.61	R 1471.03		R 1512.00
Skilled	R 3835.24	R 2469.56		R 1906.34
Less skilled/skilled	39.2%	59.6%		79.3%

Notes: Wage data calculated using the OHS excludes self-employed. All data excludes domestic servants.

Government includes teachers, but excludes medical services.

Skilled includes ISCO 1988 categories 1, 2 and 3 (legislators, senior officials & managers, professionals and technicians and associate professionals) and less skilled includes the remainder.

Real values are obtained by deflating nominal wages by the CPI index.

The occupational categories in the SALDRU may differ slightly from those of the OHS.

The data in Table A1 displays constant trends across all years apart from 1997 which appears to be an outlier. This may be due to sampling errors and 1997 is excluded from the following discussion. The average real wage of skilled Africans in the economy rose from R3085.95 in 1993 to R3560.16 in 1999. The real wage of less skilled, however, rose faster from R1151.57 to R1808.56 over the same period. As result the wage of less skilled labour relative to skilled labour rose from 37.3 % to 50.8 %. The same trends are evident when the government and the agricultural sector are excluded, although the rate of increase in the relative wage is lower. These

trends are consistent with the time series wage data presented earlier. Further evidence is provided by Whiteford and van Seventer (2000) who note that highly skilled wages fell more rapidly than less-skilled wages between 1991-96. Their data shows that the relative wage of skilled to less skilled labour fell from 3.21 in 1991 to 3.04 in 1996.[21]

However, the trend in manufacturing wage contrasts the trend in the time series data. As opposed to rising, the relative wage of less skilled labour fell from 39.2 % to 26.5 % between 1993-99. This appears to be driven by large increases in the wage of skilled labour, particularly since 1995. These trends may reflect the rising scarcity of skilled labour in the economy as well as greater demand for skilled labour as computers and skill intensive technology are utilised in the production process.

The driving force behind the rise in the economy wide relative wage is the mining sector where the relative wage rose from 39.2 % to 79.3 % between 1993-99. This change in relative wage has arisen from a decline in the real wage of skilled labour and not a rise in the real wage of less skilled labour.

Stochastic dominance tests

Unfortunately most data on wages is only available in the form of income bands which precludes extensive comparisons of average wages. However, by using stochastic dominance tests it is possible to compare wages across time periods. Stochastic dominance tests are frequently used in financial economics to compare the returns to a variety of risky outcomes. They are also used in poverty analysis to analyse changes in the incidence of poverty.

If we assume workers have nondecreasing utility functions and that wages within each occupational category are characterised by some probability distribution then the expected wage in period *A* is said to first-order stochastically dominate the expected wage in period *B* if the cumulative probability distribution of wage *A* (W_A) lies to the right of wage *B* (W_B) for all wage levels.[22] If these conditions are satisfied then the expected wage in period *A* is guaranteed to exceed the expected wage in period *B*. If we further assume workers have nondecreasing utility function that are also strictly concave[23], then *second-order stochastic dominance* tests can also be used to compare wage distributions across years. For the expected W_A to dominate the expected W_B the accumulated area under the cumulative probability distribution of W_B must be greater than the accumulated area for W_A, below any given wage (see Mas-Colel, Whinston and Greene, 1995).

Figures A1 and A2 present cumulative distributions of real wages for the total economy (excluding agriculture, government and domestic servants) and manufacturing across income bands for a variety of years between 1980-99. The 1980 data is derived from the 1980s Census while the remaining data are sourced from the October Household Surveys. A clear example of first order dominance is the comparison of skilled wages in 1995 with 1997. The cumulative probability distribution of 1995 lies to the right of 1997 for all income bands reflecting a higher expected wage of skilled in 1995 than in 1997. An example of second order dominance is the

[21] *1991 and 1996 census data was used to estimate the changes in wages of skilled and unskilled labour. These authors must have estimated the mean wages on the basis of the income bands that were used in the censuses to classify wages. Stochastic dominance tests are preferable. Their data also indicates that real wages fell for both skill categories. The Wefa data, in contrast, shows a rise in the real wage of less skilled.*

[22] *A much weaker requirement for first-order stochastic dominance is required. For wage in period A (W_A) to stochastically dominate wage in period B (W_B), the cumulative distribution of W_A must* ***not*** *lie to the left of the cumulative distribution of W_B for all wage levels and it must lie to the right for at least one wage level.*

[23] *Marginal utility diminishes as wage increases, but never falls below zero. The workers under this assumption are risk-averse.*

comparison of less skilled wages in 1980 with 1999. Although the cumulative probability distributions intersect, the area under the 1999 distribution is greater than the area under the 1980 distribution for all wage levels suggesting that the wage of less skilled labour has fallen. These areas were calculated taking into account the different income band widths. Table A2 presents a summary of the results.

The results show a high degree of similarity when looking at the total economy (excluding agriculture, government and domestic servants) and manufacturing. The results suggest that that wage of skilled labour fell from 1980 to the mid 1990s. Looking at Figure A2 it the decline in skilled wage in manufacturing is particularly sharp. The decline in skilled may have slowed during the late 1990s as when analysing skilled wages for the total economy (not shown) expected skilled wage in 1999 second-order stochastically dominates expected wage in 1997.

Table A2: Comparison of expected wages using stochastic dominance criterion

Total excluding agriculture, government & domestic servants		**Manufacturing**	
$S_{80} > S_{97}$	First-order dominance	$S_{80} > S_{97}$	First-order dominance
$S_{80} > S_{99}$, $LS_{80} > LS_{99}$	Second-order dominance	$S_{80} > S_{99}$	Second-order dominance
$S_{95} > S_{97}$	First-order dominance	$S_{95} > S_{97}$	First-order dominance
$S_{95} > S_{99}$	Second-order dominance	$S_{95} > S_{99}$	First-order dominance
$LS_{97} > LS_{99}$	Second-order dominance		

Notes: S and LS stands for skilled and less skilled, respectively.

The results for less skilled wages are not as clear. A comparison between 1980 and 1999 for the total economy excluding agriculture, government and domestic servants suggests that real wages of less skilled labour have declined. However, much of this appears to have occurred during the late 1990s with real wages of less skilled falling between 1997-99. This is shown by the leftward movement of the 1999 cumulative probability distribution of less skilled wages in comparison to the early 1990s. For the total economy, real wages of less skilled actually rose between 1980-95.

The results do not present an unambiguous picture of the changing patterns of relative wages. To unambiguously show that relative wages of less skilled have fallen (risen) one needs to show that real wages of skilled have risen (fallen) while real wages of less skilled have fallen (risen). This is not possible in any case. However, the significant decline in wage of skilled labour from 1980 to the mid 1990s in comparison to the ambiguous effect on less skilled wages over this period provides some evidence that the relative wage of less skilled rose in manufacturing during this period. The same holds for the economy as a whole.

Overall, the results are broadly supportive of the time series data which show a rise in the relative wage of less skilled between 1980 and the mid 1980s. This trend may have changed during the late 1990s with wages of skilled labour rising faster than less skilled wages.

Figure A1: Cumulative distributions of monthly income for high skilled and less skilled labour, Total excluding government, domestic servants and agriculture

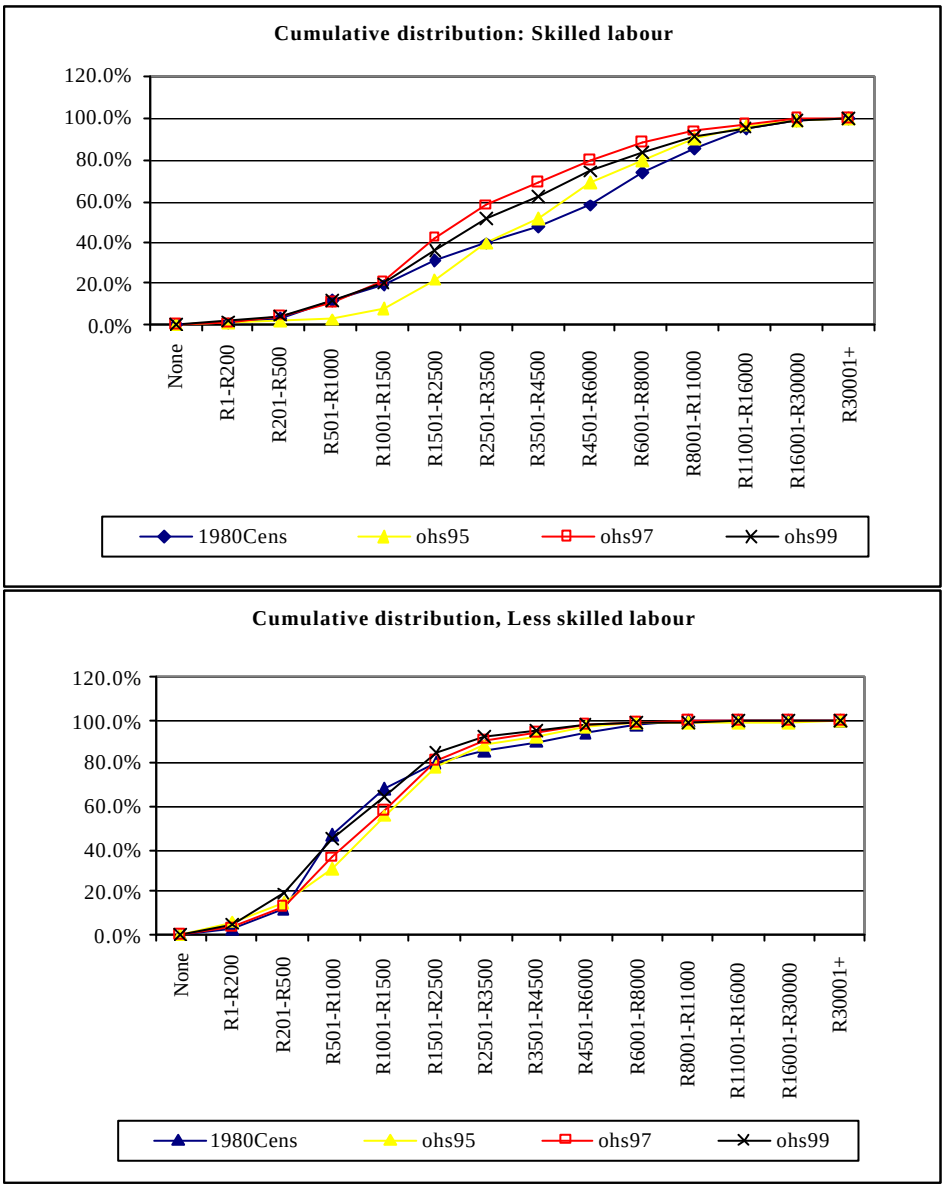

Figure A2: Cumulative distributions of monthly income for high skilled and less skilled labour, Manufacturing