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Trade liberalisation and labour demand within South African manufacturing firms

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Abstract

Using new detailed tariff data, wages disaggregated by skill level and firm level information, this paper ascertains the relationships between trade, technology and labour demand and investigates the effects of tariff changes on factor prices in South African manufacturing. We find evidence that trade liberalization and technological change have affected the skill structure of employment. Export orientation, raw materials imports, training, investment in computers and firm age are positively associated with the skill intensity of production. We also find that tariff liberalisation raised the return to capital relative to labour, but that the negative impact on labour is concentrated on semi-skilled workers. Tariff liberalisation mandated a rise in real returns to unskilled workers.

1. Introduction

The 1990s heralded a period of increased globalization of the South African economy. In 1992 trade sanctions imposed on South Africa were removed. In 1994 the government committed itself to an ambitious program of tariff liberalisation, as agreed in the Uruguay round of the GATT/WTO negotiations. The democratically elected government in 1994 also implemented a macro-economic policy (GEAR) that was expected to transform South Africa into a "competitive, outward orientated economy" (GEAR, 1996).

In response to these changes, output growth increased and trade rose as a share of production and consumption. Employment growth, however, remained poor. Data, provided by the South African Standardised Industrial Database (Quantec, 2004), indicates that over 700 000 semi- and unskilled workers lost formal employment in manufacturing, mining and services between 1990 and 1998.[1] The coinci-

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[1]Much controversy surrounds the reliability of South African statistical series (see Standing et al. (1996) for a critique). Statistics South Africa's *Survey of*

dence of ‘jobless’ (or rather ‘job-shedding’) growth, the rising skill and capital-intensity of production and the increased integration of South Africa into the international economy has stimulated much research on the impact of international trade on labour.

The results of this research are inconclusive. Bell and Cattaneo (1997), Nattrass (1998), Bhorat (1999) and Birdi *et al.* (2001) argue that trade liberalisation negatively affected employment. In contrast, Fedderke *et al.* (2003) and Edwards (2001) argue that skill-biased technological change accounts for most of the decline in employment of unskilled labour and that the impact of trade on labour is small. Fedderke *et al.* (2003:35) for example conclude that “*demand factors, and trade liberalization related factors in particular, did not prove to carry a negative impact on labor in South African manufacturing”.* Edwards (2003) uses manufacturing firm level data to identify whether trade liberalisation has induced ”*unskilled labour saving technical progress*” (or “*defensive innovation*” as Wood (1994) refers to it). He finds some evidence for it, but the impact is too small for trade liberalisation to account for the decline in employment experienced by these firms.

This study extends existing research on the impact of trade and technology on labour in South Africa in a number of ways. Firstly, we use firm level data to identify factors accounting for differences in the skill structure of employment within manufacturing firms. The specifications of the functions are similar to those of Edwards (2003), but our estimates include factor payments, which are derived from household survey data. Secondly, we use the firm level surveys to estimate changes in economy-wide factor returns arising from trade liberalisation between 1994 and 2003. The empirical methodology, namely the “mandated factor return” regression approach, is similar to that of Fedderke et al. (2003). However, unlike their study where they analyse the impact of product price changes on factor returns, we use

total employment and earnings (STEE) shows a decline in formal sector (excluding agriculture) employment during the late 1990s. In contrast, the October Household Surveys show a small rise in employment once agriculture and the informal sector are included. However, in all cases employment growth has been poor.

tariff data in our estimates and are thus able to directly link trade liberalisation to changes in factor demand. The paper also disaggregates the impact of tariff liberalisation on labour by skill.

We find some evidence that trade liberalization and technological change have affected the skill structure of employment. Export oriented firms, firms importing large shares of their raw materials and firms facing low tariff levels tend to be relatively skill intensive. Indicators of technological change such as training, investment in computers and firm age are also positively associated with the skill intensity of production. In our mandated wage equations, we find that tariff liberalization has raised the return to capital relative to labour. However, the negative impact on labour is concentrated on semi-skilled workers and unskilled workers are mandated a real increase in factor returns.

The structure of the paper is as follows. Section 2 presents a brief overview of the theoretical relationship between trade, technology and factors. The section also develops the specifications used in the econometric analysis. Section 3 presents the data used in the analysis and Section 4 discusses the results of the econometric analysis. Section 5 concludes the paper.

2. Theory

There are various avenues through which trade liberalisation affects labour demand. The standard model used for the analysis of trade and labour is the two-sector two-factor two-country Heckscher-Ohlin-Samuelson (HOS) model.[2] From this model theoretically consistent relationships are drawn between product price movements and factor returns (Stolper-Samuelson theorem) and between technological change and factor returns (Findlay and Grubert, 1959). According to the Stolper-Samuelson theorem, a decline in the output price of the unskilled labour intensive sector relative to the skill intensive sector lowers the relative wage of unskilled labour relative to skilled labour. This arises because the price shock induces a shift in resources out of

[2] See Slaughter (1998) for a review of many of the international studies.

the unskilled labour intensive sectors towards the skill intensive sectors, which in turn reduces the relative demand for unskilled labour. Thus, the model predicts that trade liberalisation raises wage inequality in developed economies as the relative price of skill-intensive products rises, but reduces wage inequality in developing economies as the relative price of unskilled labour intensive products rises.

The HOS model, however, faces a number of shortcomings. Firstly, the model predicts ambiguous impacts of trade liberalisation on middle-income countries such as South Africa, which compete against both developed and developing economies. The impact on relative factor payments therefore depends on the relative reduction in tariffs or prices in response to the opening of the economy. Davis (1996), for example, develops a framework that shows how liberalisation may raise wage inequality in middle-income economies, despite being globally abundant in unskilled labour. Identifying the impact of tariff liberalisation on middle-income economies is therefore an empirical matter.

The Stolper-Samuelson theorem also describes a long-run relationship between relative product price changes and relative factor returns. The short run dynamics as the economy shifts towards it long run equilibrium may have different welfare implications for factors. In the short run, factors are immobile or are sector specific. A reduction in price for a particular sector will therefore negatively affect the returns of all specific factors within that sector (see Neary, 1978). The long-run economy-wide effects may therefore differ from the short run sector or firm specific effects. Analysis using firm level data may therefore present useful insights into the adjustment process within firms as they respond to trade liberalisation.

Trade can also affect factors through its impact upon technological change. Wood (1994, 1995) criticises the standard HOS model in that it assumes technological change is exogenous. In response to greater import competition, firms may raise productivity through "unskilled labour saving technical progress", which he terms "defensive innovation". Pissarides (1997:20) also argues that trade-induced technological transfers "*cause more wage inequality in developing countries* *because the transfer technology is biased in favor of skilled labour".* Wood (1994) argues that the failure to account for "defensive innovation" explains why many international studies find a small impact of trade on employment and factor returns.

In this study we attempt to combine both the firm specific features that determine labour demand as well as capture the general equilibrium impacts of tariff liberalisation on factor demand, as is outlined in the Stolper-Samuelson theorem. The following section discusses the various methodologies utilised.

3. Empirical Methodology

To estimate the impact of trade liberalisation on labour demand and factor returns in South Africa, we draw on two methodologies. Firstly, we use the National Enterprise (NE) survey to estimate labour demand functions for manufacturing firms in South Africa. The objective is to identify how technology and trade affect the employment decision within firms. We therefore follow Hanson and Harrison (1995, 1999) and Edwards (2003) and estimate the function:

$$\ln\left(\frac{S}{U}\right)_i = a + \theta_1'\Phi_i + \theta_2'\Omega_i - \sigma\ln\left(\frac{w_s}{w_u}\right)_i + \gamma\ln y_i + \varepsilon_i \qquad (1)$$

where the skill:unskilled labour ratio is defined as a function of various technology or technical efficiency related variables (Φ), trade-related variables including measures of export and import orientation and tariffs (Ω), relative wages (w_s/w_u) and value added (y). Equation (1) is derived from a constant elasticity of substitution (CES) production function. It differs from the specification in Edwards (2003) by allowing for the possibility that the production technology is not homothetic, so that the level of output and technical progress can affect factor proportions (see Sato, 1977). Despite this, the CES function makes the restrictive assumption that the elasticity of substitution between all factor pairs is the same and necessarily positive $(\sigma > 0)$.[3]

A positive sign for γ means bigger firms are more skill intensive. Positive coefficients on Ω are consistent with trade-related skill-biased technological change. However, we can't infer any causal effects - trade-induced technological change - from the results as these estimates are in levels. Ideally, we would follow Berman *et al.* (1994) and Feenstra and Hanson (1999) and estimate equations for changes in factor shares as a function of wages, trade and technology variables. Nonetheless, we are able to gain insights into the relationships between trade related variables and the factor-intensity of the production structure.

Equation (1) is estimated separately for the ratios of managerial / professional, skilled/artisanal and semiskilled labour to unskilled labour. It is also estimated for the ratio of more-skilled labour (managers/professionals and skilled / artisanal workers) to less-skilled labour (semiskilled and unskilled workers). The estimation therefore extends initial work by Edwards (2003) by estimating a greater range of relative demand functions. More importantly, this study also constructs wage data from household surveys to be used in the analysis. Together with the output term, this mitigates the potential for omitted variable bias encountered in Edwards (2003).

The second approach to estimating the impact of trade liberalisation on factor demand deals with the general equilibrium impact of tariff changes on factor payments. The NE survey provides a single cross section of data. This lack of consistent employment data over a time for each firm precludes any analysis of how trade liberalisation has affected firm-level labour demand.[4] However, we are able

[3]This motivates the use of factor share equations based on a translog cost function. Behar (2004) estimates shares using NE data and finds some occupations could be complements. However, factor share equations estimated in levels produce results entirely consistent with the CES estimates, which present the results of key interest in a more appealing form. Furthermore, presenting the CES estimates allows ready comparison with Edwards (2003).

[4]Edwards (2003) estimates change in labour demand functions for each skill category. However, the employment changes are in a categorical format (increase,

to use the information provided in the survey to identify how trade liberalisation will have affected relative factor demand within a general equilibrium context. The approach is a direct application of the Stolper-Samuelson relationship: changes in relative product prices affect relative productivity across sectors and the subsequent shifts of resources affect relative factor demands and hence factor returns. The key equation is the zero profit condition:

$$P = AW \tag{2}$$

where P is a vector of N firm level domestic value-added prices,[5] W is a vector of M domestic factor prices and A is an (N x M) matrix of input intensities in which element A_{ij} is the share of factor i per unit of output j. Differentiating these zero-profit conditions produces:[6]

$$\hat{P} = \theta\hat{W} - \hat{TFP} \tag{3}$$

which can be rewritten as:

$$\hat{P} + \hat{TFP} = \theta\hat{W} \tag{4}$$

$\hat{P}, \hat{W}$ and $\hat{TFP}$ represent the percentage change in value-added prices, wages and total factor productivity, respectively.θ is an (N x M) initial cost-share matrix in which element θ_{ij} is the share of factor i in the average cost of producing one unit of product j. Equation (3) represents a system of equations in which product price changes in each industry are equal to economy-wide changes in factor prices (factors are perfectly mobile within the country), weighted by initial factor

decrease, no change) and only cover the period early 1988 to late 1999. The employment changes thus do not represent the impact of the more extensive tariff liberalisation that has taken place from 1994.

[5] Value-added price is calculated as $P^G - ZP^G$ where P^G is a vector of gross-output prices and Z is the (N x N) intermediate input requirement matrix.

[6] See Leamer (1996) for details or Feenstra (1999) for an alternative derivation of this relationship using the dual measure of total factor productivity growth.

shares, and technological change. Through the given production technology, factor price changes are therefore directly linked to changes in product prices or technological change.

Given data on cost shares (θ), exogenously determined product price changes $\left(\hat{P}_{jt}^{Exog}\right)$, and TFP-growth, the zero-profit condition (4) can be estimated directly as:

$$\hat{P}_{jt}^{Exog} = \Sigma\theta_{ijt}\beta_i + \varepsilon_{jt} \quad (5)$$

and

$$T\hat{F}P_{jt}^{Exog} = \Sigma\theta_{ijt}\delta_i + \nu_{jt} \quad (6)$$

Leamer (1996:23) refers to these as 'mandated wage' regressions, where the estimated $\delta_i^{'}s$ and $\beta_i^{'}s$ are changes in factor payments "*that are needed to keep the zero profits condition operative in the face of changes in technology and product prices*", respectively. The approach therefore estimates the economy wide factor payments that are consistent with changes in product prices and technology. These can then be compared with actual wage changes to identify the contribution of product price changes and technological change towards the overall change in factor prices.

A key feature of the zero profit relationship (4) is that relative factor returns are influenced by the sector bias of changes in product prices and technological change. Thus price increases or technological improvements in less skill-intensive sectors cause resources to shift towards these sectors, which in turn raise the relative demand for less-skilled labour. The wage of less-skilled labour relative to skilled labour rises as a result.

In estimating equation (3), it is necessary to identify exogenous changes in prices and total factor productivity growth from observed data. In large countries, total factor productivity growth feeds into product price changes, which makes the identification of exogenous price changes from observed price changes difficult.[7] Within a small country, however, the identification problem falls away because prices are set exogenously resulting in a zero pass-through of TFP growth to product prices.

To estimate exogenous price changes arising from trade liberalisation in South Africa, we impose this small country assumption. We also make the simplifying assumption that domestic firms price up to the import parity price. The tariff-induced change in output price can then be calculated as $\hat{P_j} = \frac{(t_{j,fin} - t_{j,ini})}{1 + t_{j,ini}}$ where $t_{j,fin}$ and $t_{j,ini}$ represent the final and initial tariff rates for product j, respectively. While this approach captures the direct impact of tariff liberalisation on factor returns, it does not capture the possible indirect effects of trade liberalisation on productivity growth.

4. Data

4.1. Firm survey and factor prices

The core dataset is from the National Enterprise Manufacturing Survey (NE survey). The NE survey is national in coverage and consists of 941 manufacturing firms, 39 % of which are large firms consisting of more than 50 employees. The survey was administered in late 1999 and early 2000 and covers the period from early 1998. For a thorough description of the data sets see Bhorat & Lundall (2002).

In the NE survey, the four occupation groups considered are managerial/professional, skilled/artisan (technicians, welders), semi-skilled

[7] See Feenstra and Hanson (1999) and Haskel and Slaughter (2001) who use a two-step approach to dealing with the identification of exogenously induced changes in prices and technology. Leamer (1996) deals with endogeneity problem by assuming that all sectors have the same rate of technological pass through to value-added prices, namely $\hat{P} = -\lambda T\hat{F}P$

where λ is the pass-through rate. This enables the identification of exogenous price changes $\left(\hat{P}_{jt} + \lambda T\hat{F}P\right)$ and technological change $\left((1-\lambda) T\hat{F}P\right)$ from observed data.

(machinery operators) and unskilled (labourers, security guards). One drawback of the NE survey is that it does not have wage data. Edwards (2003) controls for wages and other industry specific factors by including industry dummies in labour demand equations. However, if wages vary within sectors, this may lead to omitted variable bias.

Behar (2004) constructs wages and costs of capital for the NE survey using data from the 1997 October Household Survey in an approach similar to that of Teal (2000). Using information on individuals' location, the industry they work in and whether or not they are unionised, Behar (2004) calculates average wages for each occupation and matches them to firms with the same characteristics. An adjustment for potential firm size effects on wages is motivated and implemented. Behar also constructs costs of capital based on firm-level attributes and the industry-level depreciation rates used by Fedderke *et al.* (2001). The data are then used to construct the relative wage variables and the factor share variables used to estimate the labour demand equation (1) in various forms and the mandated factor return equation (5).

Table 1 presents a list of the variables used in the factor demand and mandated wage regressions

4.2. Tariff liberalisation

The impact of trade liberalisation on labour will depend on the extent to which the economy has liberalised its trade. This issue is particularly relevant in South Africa as there is substantial disagreement on the extent to which protection has fallen since the 1980s (Holden, 1992; Bell, 1997; Belli *et a*l., 1993; Fedderke and Vaze, 2001).[8]

Table 2 presents sector level information on protection and the change in protection between 1994 and 2003. These estimates are derived from the South African tariff schedules, which are specified at the 8-digit Harmonised System level. These rates include *ad valorem*

[8]For a detailed discussion on trade liberalisation see Holden (1992), Bell (1997) and Jenkins et al. (1997).

equivalents of formula, specific and mixed duties, which are set equal to the collection rates if the latter exceeded the ad valorem component of the scheduled rates. Lack of consistent import price data and quantity units prohibited the calculation of *ad valorem* equivalents according to the standard approach (tariff value / f.o.b import value). The use of collection rates leads to an under-estimate of protection levels as highly protected products may not be imported and exemptions on duty are frequently granted (e.g. imported intermediate inputs are often duty free when the final product is to be exported). We also adjust these rates for surcharges using data obtained from Quantech (2004).

According to the data, average tariffs in manufacturing declined from 14.5% to 9.3% between 1994 and 2003. If surcharges are included, average protection in manufacturing in 1994 was 19.5%. The decline in protection during the 1990s is therefore more severe once surcharges are included. Looking at the sector level tariff rates for 1994, very high protection rates (more than 30%, inclusive of surcharges) are found in tobacco, textiles, wearing apparel, footwear and furniture. Low rates (less than 10%) are found in coke & refined petroleum, basic chemicals and basic metals.

Table 2 also presents the average annual change in tariffs between 1988 and 2002 for each sector. Large declines in scheduled tariff rates inclusive of surcharges (more than 13% per annum) are found in textiles, wearing apparel, footwear, communication equipment and other manufacturing. Despite the large declines, tariffs in many of these sectors (wearing apparel, textiles and footwear) remain high. Sectors experiencing small declines in protection (less than 5% per annum) include tobacco, wood products, paper products, coke & petroleum and basic iron and steel.

5. Results

We first present the results of the labour demand functions and proceed to the estimates of the mandated wage regressions.

5.1. Labour demand

Table 3 presents the results of estimates of equation (1) for all firms and for the restricted sample of large firms.

Data availability only enables us to estimate the relative labour demand equations in levels and not changes. It is thus difficult to identify the direction of the causal relationship between the explanatory variables and the skill intensity of production suggested by the estimated coefficients. Nevertheless we find relationships between trade, technology and relative factor demand that are consistent with theoretical expectations.

Looking first at the trade related variables, we find that firms that import a larger proportion of their raw materials are consistently more skill intensive. For example, column 7 suggests that, *ceteris paribus*, a firm that sources ten percentage points more of its raw materials abroad will have a workforce that is 3.36% more skill intensive. Similar results are found in Edwards (2003), but this relationship is now shown to be robust to the inclusion of small firms. The relationship between skill intensity and imported raw materials is consistent with Pissarides (1997), who argues that imports may complement skilled labour.

The data also produces constant evidence that firms experiencing higher tariffs are less skill-intensive, especially in skilled & artisanal labour, where a ten percentage point higher tariff rate is associated with 21.84% lower demand relative to unskilled labour. Less-skill intensive firms are also the most concerned about losing market share because of tariffs changes. This is consistent with the view that tariff liberalisation induces "defensive innovation" and thereby raises the skill structure of employment within firms. However, the relationship most likely reflects relatively high tariffs imposed on low skilled and labour intensive sectors such as clothing, footwear and textiles. These tariffs reflect South Africa's comparative advantage, which lies in natural resource intensive products and not labour-intensive goods (Nordas, 1996; Edwards and Golub, 2004) and the effect of rent-seeking, particularly within the clothing and textile sectors (GATT, 1993: 170).

Firms expecting to be more export competitive because of lower tariffs also tend to be less skill-intensive, but this result appears to be driven by the smaller firms as the variable is insignificant for the large firm sample. For large firms, the export dummy is moderately significant and positive, suggesting *greater* skill-intensity for export orientation. Similar results are found by Edwards (2003) and Rankin *et al.* (2004) who also find that large firms are more export oriented. The size and skill relationship may reflect the importance of economies of scale and productivity in accessing the export market.

The results also show a positive association between skill-intensity of production and the various indicators of technology. Firms that train more tend to have more skilled workforces, suggesting that training complements rather than substitutes skills. This is also true for investment in computers, where for example a ten percentage point rise in the proportion of computer investment corresponds to a 17.46 percentage rise in the proportion of skilled & artisanal workers in large firms. While the effect is far larger than for training, the importance of computers is consistent across skill types for large firms only. New firms are also more skill-intensive, reflecting the use of newer technology that complements skilled labour.

For large firms, the significant positive coefficients on Value Added present consistent evidence that bigger firms are more intensive in skills of various types. However, the contradiction between columns 7 and 8 suggests the relationship between output and skill intensity may be non-linear and that this relationship only materialises beyond some level of output.

Looking at disaggregated occupations in columns 1-6, all the relative wage coefficients are significant. For example, a 1% rise in the relative managerial & professional/unskilled wage would lead to an approximately equal fall in relative demand for managerial & professional labour. As one would expect, semi-skilled labour appears to be a closer substitute for unskilled labour than the higher skilled occupations are. However, but for column 5, the estimates are similar enough for the elasticity restrictions assumed by the CES technology mentioned in section 2 not to be of concern in this application. Columns 7 and 8 suggest that more- and less-skilled labour are not as easily substitutable - the insignificant coefficient for large firms suggesting they may not be at all - which is to be expected as the inputs measured are more aggregated.[9][10]

In a 2-factor estimate, the absolute value of the conditional labour demand elasticity for factor i is $\mid \eta_i \mid = (1 - s_i)\,\sigma$ (Cahuc and Zylberberg, 2004), where s_i is that factor's cost share. Using the sample average factor share, the estimates in Table 3 yield the demand elasticities given in Table 4. Equation 1 is not the ideal platform for finding these elasticities, but the results nonetheless suggest the data adequately control for the effects of wages on labour demand.

Almost all estimates fall comfortably within the [0.15, 0.75] interval found in the majority of international studies (Hamermesh, 1993). Estimates are consistent with those reported by Nattrass (2004), albeit slightly less elastic, and are close to those found by Behar (2004).

Having used Table 3 to provide a picture of some of the relationships between technology, trade, given wages and relative skill demand, we now look at some indicators of the expected effects of tariff changes on relative wages.

5.2. Mandated wage changes

This section discusses the mandated wage regression results, which are presented in Table 5. The estimated coefficients reflect the percentage change in factor returns that are consistent with product price changes induced by trade liberalisation between 1994 and 2003. These changes in factor returns do not necessarily reflect actual changes experienced as numerous other changes to the factor and product markets

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[9] The relative wage is produced by restricting the coefficients on managerial/professional and skilled/artisan wages to be equal and those on semiskilled and unskilled to be equal.

[10] Together with the higher values in columns 5 and 6, the results also suggest the production technology would be usefully represented by a two-level CES function.

between 1994 and 2003 will also have affected factor returns. The coefficients, however, provide some insight into the general equilibrium contribution of trade liberalisation to changes in factor returns.

As shown in Table 5, tariff liberalisation between 1994 and 2003 mandated a decline in returns to all factors. However, tariff liberalisation also reduced product prices by approximately 9% during this period, implying that real factor returns have not necessarily fallen. Tariff liberalisation has negatively affected demand for semi-skilled workers the most, resulting in a mandated decline in wages of 15.2% in the complete sample and 18.7% in the large firm sample. Skilled and artisanal workers also experienced a relatively large decline in mandated wages of between 10.6% and 14.1%. The mandated decline in wages for skilled, artisanal and semi-skilled workers exceeds the decline in product prices arising from tariff liberalisation, pointing to a decline in real wages.

Unskilled labour appears to be the least affected. Tariff liberalisation mandated a decline in wages of 6.9% in the full sample and 5.1% in the large firm sample. This decline is significantly smaller than the mandated decline for semi-skilled labour, but because of relatively high standard errors is not significantly different from that for other labour categories.

Looking at the return to capital relative to aggregated labour, we find that tariff liberalisation has raised the demand for capital relative to labour. Tariff liberalisation mandated a 10.8% to 13.4% decline in the return to labour compared to a 4.8% to 6.9% decline in the return to capital. When compared to product price changes, this implies a real decline in the return to labour and a real rise in the return to capital. The difference in returns is also significant and suggests that tariff liberalisation mandated a rise in return to capital relative to labour of between 3.9 and 8.6 percentage points. However, the results for disaggregated labour show that the decline in the relative return to labour is largely driven by the decline in the return to semi-skilled labour. These results differ substantially from those of Fedderke et al. (2003) who find that product price movements benefited labour as opposed to capital.

Although tariff liberalisation mandated a decline in the return to aggregate labour, real wage rigidities may have translated these wage effects into employment effects. Lack of wage moderation in the face of increased international competition may have encouraged firms to shed labour, contributing to the job-shedding growth observed in the 1990s.

6. Conclusion

This study uses firm level data to investigate the impact of trade liberalization and technological change on the demand for factors in South Africa. Two approaches are followed. Firstly, relative labour demand functions are estimated. Using the variation in employment responses across firms, we are able to identify how the skill intensity of production is related to a range technology and trade related variables. The second approach uses the mandated wage framework developed by Leamer (1996). In this approach, the production characteristics of the firm are used to estimate changes in factor prices that are consistent with changes in tariffs between 1994 and 2003. The methodology draws upon the general equilibrium relationship outlined in the Stolper-Samuelson theorem.

We find some evidence that trade liberalization and technological change have affected the skill structure of employment. Export oriented firms, firms importing large shares of their raw materials and firms facing low tariff levels tend to be relatively skill intensive. Indicators of technological change such as training, investment in computers and age are also positively associated with the skill intensity of production. In our mandated wage equations, we find that tariff liberalization has raised the return to capital relative to labour, but that the negative impact on labour is concentrated on semi-skilled workers. Unskilled workers are mandated a real increase in factor returns.

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Table 1: Variable names and descriptions

Variable name	Description
Factor Demand	
Labour Quantities	
Skilled Labour	Log[full time + 0.5*(part time)] of managerial/professional, skilled/artisanal or semiskilled labour
Unskilled Labour	Log[full time + 0.5*(part time)] of unskilled labour
More skilled	Log[full time + 0.5*(part time)] of managerial/professional, and skilled/artisanal labour
Less skilled	Log[full time + 0.5*(part time)] of semi-skilled and unskilled labour
Trade-related variables	
Exporter	Dummy variable for firms that export
Tariff 2000 (1994)	Tariff rates for 2000 (1994)
Tariff: market share	Dummy for firms expecting recent tariff changes to reduce their South African market share
Tariff: export competitiveness	Dummy for firms expecting recent tariff changes to enhance their export competitiveness
Technology-related variables	
% M in raw materials	Proportion of raw materials that are imported
Training share of I	Share of total investment spent on training the workforce during the last financial year
Computer share of I	Share of total investment spent on computers during last financial year
Machinery share of I	Share of total investment spent on machinery and equipment during last financial year
Log Age	Log of age of firm in 1999
Wage ratio	Log of ratio of skilled to unskilled or more skilled to less skilled annual 1998 wages
Value Added	Log[T*(1-r)], where T is turnover in R millions and r is the percentage of total costs consisting of raw materials costs (See Behar (2004))
Mandated Wages	
Factor shares	$\frac{w_i x_i}{\sum_j w_j x_j}$, where *w* is the wage or cost of capital, *x* is the labour quantity or capacity-adjusted value of fixed capital stock, and the denominator is total factor cost
$\hat{P}_j^{Exog}$	Change in tariff from 1994 to 2003, calculated as $(tariff_{2003}-tariff_{1994})/(1+tariff_{1994})$. Tariff rates at the 4-digit Standard Industrial Classification level are allocated to firms on the basis of their major product produced.
Cost capital	$(r-\pi)+\delta+t+\varphi$, where *r* is the prime lending rate, *π* is inflation, *δ* is the depreciation, *t* is the average effective corporate tax rate and *φ* is a risk adjustment for small and/or new firms.

Table 2: Measures of protection and change in protection for manufacturing

	Tariffs excluding surcharges		Tariffs including surcharges		Change excl surcharges	Change incl surcharges
	1994	2003	1994	2003	1994-03	1994-03
Food	11.9	11.8	18.8	11.8	-0.1	-5.9
Beverages	6.5	14.3	29.3	14.3	7.3	-11.6
Tobacco	29.2	36.0	41.7	36.0	5.3	-4.0
Textiles	38.1	22.6	41.3	22.6	-11.3	-13.2
Wearing apparel	62.5	35.0	75.1	35.0	-16.9	-22.9
Leather products	16.7	11.6	25.9	11.6	-4.4	-11.4
Footwear	36.8	22.7	48.0	22.7	-10.3	-17.1
Wood products	11.0	9.1	14.5	9.1	-1.7	-4.7
Paper products	9.8	6.2	11.3	6.2	-3.2	-4.6
Printing & publishing	9.5	4.8	16.1	4.8	-4.3	-9.8
Coke & petroleum	5.1	3.3	5.1	3.3	-1.7	-1.8
Basic chemicals	8.0	1.7	8.1	1.7	-5.9	-5.9
Other chemicals	11.6	4.5	16.2	4.5	-6.4	-10.1
Rubber products	16.5	11.4	18.6	11.4	-4.4	-6.0
Plastic products	17.5	9.8	19.8	9.8	-6.6	-8.4
Glass products	10.1	7.7	17.2	7.7	-2.2	-8.1
Non-metallic minerals	11.3	5.6	15.0	5.6	-5.1	-8.2
Basic iron & steel	8.2	4.3	8.8	4.3	-3.6	-4.1
Non-ferrous metals	10.4	2.2	10.8	2.2	-7.4	-7.7
Metal products	13.6	8.1	18.3	8.1	-4.8	-8.6
Machinery & equipment	7.4	3.7	10.4	3.7	-3.5	-6.1
Electrical machinery	13.5	7.7	18.3	7.7	-5.1	-8.9
Communication equipment	14.6	3.1	24.2	3.1	-10.1	-17.0
Professional & scientific	5.7	0.3	12.2	0.3	-5.1	-10.6
Motor vehicles	24.1	15.7	25.9	15.7	-6.8	-8.1
Other transport	7.0	0.9	12.3	0.9	-5.7	-10.2
Furniture	21.5	17.7	32.1	17.7	-3.1	-10.9
Other manufacturing	15.1	6.0	26.5	6.0	-7.9	-16.2
Weighted average	14.5	9.3	19.5	9.3	-5.6	-8.8

Note: Change in tariff is measured as ($tariff_{t1}$-$tariff_{t0}$)/(1+$tariff_{t0}$). The weighted average tariff rate uses real output between 1994 and 2002 as weights.

Table 3: Relative labour demand equations

	Man&Prof/Unskilled		Skil&Art/Unskilled		Semi/Unskilled		More skilled/Less skilled	
	All	Large	All	Large	All	Large	All	Large
	1	2	3	4	5	6	7	8
Exporter		0.482*		0.443*				
Tariff 2000	-1.489*	-1.068	-2.184***	-1.835**	-1.267	-1.510*	-2.588***	-3.230***
% M in raw materials	0.718**	1.631***	0.858***	1.574***	0.857***	1.407***	0.336**	0.829***
Tariff: market share		-0.401*			-0.356*			
Tariff: export competitiveness	-0.506***		-0.524***		-0.439**			
Training share of I	0.013**		0.0140**		0.016***	0.020***		
Computer share of I		1.479***		1.746***		1.671***	0.382**	1.285***
Machinery share of I							-0.388***	
Log Age	-0.200**	-0.273**	-0.188*	-0.294**	-0.176*		-0.080*	
Relative Wage	-1.058***	-0.998***	-0.874***	-0.843***	-1.243***	-1.741***	-0.270***	-0.089
Log Value Added	0.036	0.152**	0.024	0.123*	0.081	0.185**	-0.059**	0.079*
Constant	0.846**	-0.404	0.357	-0.843*	0.188	-1.463***	-0.133	-1.566***
Number of obs	292	211	292	232	292	201	470	233
F statistic	8.8***	7.9***	8.03***	7.99***	8.73***	13.79***	12.96***	14.46***
R-squared	0.16	0.29	0.14	0.24	0.15	0.24	0.16	0.24

*Notes: I) *, **, *** denote significant at 10%, 5% and 1%, respectively. II) Apart from Tariff 2000, Relative Wage, and Value Added, insignificant variables are omitted. III) Industry and location dummies omitted because of potentially high correlation with wage and tariff data.*

Table 4: Labour demand elasticities

	Man & Prof / Unskilled		Skilled &Artisan / Unskilled		Semi / Unskilled	
	All	**Large**	**All**	**Large**	**All**	**Large**
Skilled	0.62	0.58	0.57	0.57	0.52	1.04
Unskilled	0.44	0.41	0.30	0.28	0.73	0.70

Table 5: Mandated factor returns from tariff liberalisation, 1994-2003

	All firms	**Large firms**
Capital and labour according to skill		
Managerial & Professional	-0.089***	-0.050
Skilled & Artisanal	-0.106***	-0.141
Semi-skilled	-0.152***	-0.187***
Unskilled	-0.067***	-0.075**
Capital	-0.069***	-0.051***
Differences		
Man & Prof – unskilled	-0.022	0.026
Skilled & Artisan – unskilled	-0.039	-0.066
Semi-skilled – unskilled	-0.085***	-0.112***
Man & Prof – capital	-0.020	0.002
Skilled & Artisan – capital	-0.037	-0.09
Semi-skilled – capital	-0.083***	-0.136***
Unskilled – capital	0.002	-0.024
Capital & labour		
Labour	-0.108***	-0.134***
Capital	-0.069***	-0.048***
Differences		
Labour – capital	-0.039***	-0.086***
% change in product price	-0.089	-0.087

*Notes: *, **, *** denote significant at 10%, 5% and 1%, respectively.*