Trade Liberalisation and Factor Returns in South Africa, 1988-2002

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Abstract

This paper estimates the impact of trade liberalisation on factor returns in South Africa between 1988 and 2002. A particular contribution of the paper is that tariff data are explicitly used in the analysis. In addition, the paper models trade-induced technological change. The paper finds that tariff liberalisation from 1988 to 2002 negatively affected wages of South African labour relative to the return to capital. However, the decline in demand for labour is concentrated amongst skilled labour. Tariff liberalisation mandated a decline in the wages of skilled labour relative to both capital and less-skilled labour. The paper also finds some evidence of trade-induced technological change. The results suggest that trade-induced technological change positively benefited skilled labour relative to capital and less-skilled labour and thus partly ameliorated the negative direct effect on skilled labour arising from a reduction in tariffs. The net effect for skilled labour, however, remains negative relative to less-skilled labour and capital. The results of the paper, therefore, suggest that factors other than trade liberalisation account for the decline in employment experienced during the 1990s.

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1. Introduction

The South African economy has undergone substantial structural reform during the 1990s. The election of a new government in 1994 initiated a range of new policy reforms that were designed to encourage economic growth as well as uplift the standard of living of the previously disenfranchised majority. These reforms were far reaching including the writing of a new constitution, a macroeconomic strategy, new labour legislation and an overhaul of all social and welfare policies. In addition, the government committed itself to an ambitious program of tariff liberalisation, as agreed in the Uruguay round of the GATT/WTO negotiations.

The successes of these policies in South Africa have been mixed. Output has grown, but slowly. Exports of manufactures have increased but not by enough to generate an export-led growth boom similar to those of East Asia and a few other dynamic emerging economies (Edwards and Golub, 2004). Moreover, South African net trade remains capital and skill-intensive, which is paradoxical given South Africa's abundance of labour (Bell and Cattaneo, 1997; Tskikata, 1999; Allenye and Subramanian, 2001). More importantly, formal employment of semi- and unskilled labour declined despite the modest improvement in output growth. Data, provided by the South African Standardised Industrial Database (2003), indicates that over 700 000 semi- and unskilled workers lost formal employment in manufacturing, mining and services between 1990 and 1998. [1]

The coincidence of 'jobless' (or rather 'job-shedding') growth, rising skill and capital-intensity of production and increased integration of South Africa into the international economy has led researchers and policy makers to question possible links between trade liberalisation, structural change and employment growth (Bell and Cattaneo, 1997; Nattrass, 1998; Bhorat, 1999; *Fedderke et al., 2003* ; Birdi *et al.*, 2001, Edwards, 2001a). Yet, there is still no consensus on the impact of trade liberalisation on employment and factor returns relative to other influences such as

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[1] Much controversy surrounds the reliability of South African statistical series. Statistics South Africa's *Survey of 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.

technological change and factor market rigidities. 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 (2001a) argue that technological change accounts for most of the decline in employment. Evidence of skill-biased technological change is also found by Bhorat and Hodge (1999) and Edwards (2002) who find that *within-sector* shifts (i.e. technology), as opposed to *between-sector* shifts are the primary cause of the rising skill intensity of production in South Africa. Although this technological change could be trade-induced, existing evidence of such a relationship is weak (Edwards, 2003).

The lack of consensus on the impact of trade liberalisation on labour in South Africa arises from a number of limitations in existing research. Firstly, South Africa, as a middle-income country, does not fit in well with the one-cone two-product two-country Heckscher-Ohlin-Samuelson (HOS) model generally used to analyse the impact of trade liberalisation between developed and developing countries. According to the Stolper-Samuelson (SS) theorem, trade liberalisation is predicted to raise wage inequality in developed economies, but reduce wage inequality in developing economies. However, middle-income countries like South Africa compete with both developed and developing countries leading to potentially ambiguous outcomes arising from trade liberalisation. This paper explores this relationship in more detail.

Secondly, in empirical applications a disjuncture between empirical methodologies and testable hypotheses drawn from the HOS model frequently arise. For example, the Stolper-Samuelson theorem relates product price changes to factor returns and not to changes in employment. Yet, only Fedderke *et al*. (2003) directly analyse the relationship between product prices and factor returns in South Africa using Leamer's (1996) Stolper-Samuelson-consistent 'mandated wage' regressions. They find that product price movements were biased against capital leading them to 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*" (Fedderke *et al*. 2003:35). No study as yet, has estimated mandated wage regressions for skilled and unskilled labour.

Most South African studies analyse changes in the structure of trade or the factor content of trade and then infer an impact on employment or wages (Bell and Cattaneo, 1997; Bhorat, 1999; Hayter *et al*., 1999, Edwards, 2001a). In these 'factor-content' studies, labour imbedded in imports reduce the demand for domestic labour while labour imbedded in exports increase the demand for domestic labour. However, the 'factor-content' approach lacks theoretical foundations and is not a strict application of the Stolper-Samuelson theorem as it uses trade flows, which are an endogenous outcome, to proxy price changes (Leamer, 2000). Such a relationship is only valid under restrictive assumptions regarding the nature of the production and consumption functions (Deardorff and Staiger, 1988; Deardorff, 2000).

The third reason for a lack of consensus in this debate is that none of the existing studies adequately link trade liberalisation using tariff or non-tariff data to changes in product prices or trade flows.[2] As a consequence, the relationship between trade liberalisation, production, trade flows and employment is mostly *inferred* from changing trends during the 1990s. Such inferences are invalid as the 1990s are characterised by, amongst others, structural breaks such as the election of a democratic government, the ending of sanctions, a new macroeconomic programme and new labour legislation. In addition, there is substantial disagreement over the extent to which South Africa has liberalised its trade (Holden, 1992; Bell, 1992, 1997; Belli *et al*., 1993; Fedderke and Vase, 2001; Van Seventer, 2001). Although nominal tariffs have fallen since 1994, Fedderke and Vase (2001) argue that effective protection rates have risen or are still high for many sectors.

Finally, the empirical research suggesting that technological change has reduced the demand for labour, particularly unskilled labour (Bhorat and Hodge, 1999; Edwards, 2001; Edwards, 2002 and Fedderke *et al*., 2003), does not cater for the possibility the technological change may be trade-induced. In order to compete against cheaper foreign imports firms may be forced to raise productivity through "*unskilled labour saving technical progress*" or "*defensive innovation*" as Wood (1994) refers to it. Trade also increases skill-biased technological transfers (through imitating foreign technology or through the transfer of goods) from developed countries (Pissarides, 1997).[3]

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[2] Edwards (2003) uses two firm level surveys to estimate the impact of tariff reductions on labour demand. No consistent relationship is found for various categories of labour.

[3] A further problem is that many of these studies are conducted using a partial equilibrium framework where skill-biased technological change reduces relative employment and wages of less-skilled labour. In a general equilibrium framework, skill-biased technological change does not necessarily raise wage inequality as the impact depends on the sector bias and not the factor-bias of technological change (Leamer, 1996; Haskel and

This study extends existing research on the impact of trade on labour in a number of ways. Firstly, it critically reviews the theoretical relationship between trade liberalisation and technological change within middle income economies such as South Africa (still to be completed). Secondly, it analyses the impact of trade liberalisation on factor returns in South Africa using a consistent set of scheduled tariffs at the sector level for the period 1988-2002. The paper is thus able to identify the impact of tariff liberalisation on factors from the various other changes that occurred during the 1990s in South Africa.

Thirdly, the paper applies and extends the "mandated factor return" methodology developed by Leamer (1998) and modified by Feenstra and Hanson (1999) to account for the endogeneity of prices and technology. The two-stage method developed by Feenstra and Hanson (1999) has been applied to the US, UK (Haskel and Slaughter, 2001) and recently to South Africa (Fedderke *et al*., 2003). This paper extends this empirical methodology by explicitly focussing on the impact of tariff liberalisation on factor returns, both directly and indirectly through induced technological change. The paper thus attempts to deal with Wood's (1994) criticism that technological change may be trade-induced.

The paper also extends the empirical research in South Africa by disaggregating the impact of tariff liberalisation on labour, into the impact on skilled and unskilled labour. The advantage of focussing on skills as opposed to just capital and labour is that some insight is provided into the dramatic decline in employment of less-skilled labour in South Africa during the 1990s. Further, South African regional trade flows conform more closely with its perceived relative endowments of skilled and less-skilled labour than its relative endowments of labour and capital. Allenye and Subramanian (2001), for example, find that South Africa is paradoxically 'revealed' to be capital abundant relative to both developed and developing countries, but, consistent with theory, is 'revealed' to be unskilled labour abundant relative to developed countries and skilled labour abundant relative to developing countries. Focussing on skills thus fits more closely with predictions derived from the HO model.

Slaughter, 1998).

A final contribution of this study is that the robustness of the relationship between trade liberalisation and factor returns is tested using a variety of data sources at different levels of aggregation (3- digit Standard Industrial Classification (SIC) data, 80 sector Supply-Use based data and firm level data).

The following section develops the theoretical relationship between trade, technological change and factor returns. In section 3 the empirical methodology is presented. The data and specification of the regression equations are discussed in Section 4. Section 5 presents the results, and section 6 concludes.

2. Theory

The standard model used for the analysis of trade and labour is the two-sector two-factor two-country Heckscher-Ohlin-Samuelson model. From this model theoretically consistent relationships are drawn between product movements and factor returns (Stolper-Samuelson theorem) and technological change and factor returns (Findlay and Grubert, 1959). For example, the model predicts that improvements in productivity or prices of a sector raise the relative wage of the factor used intensively in that sector.

The relationship between trade, technology and factor returns can be shown more explicitly using the Lerner diagrams in Figure 1. Two factors, skilled and less-skilled labour, are used to produce two products, skill-intensive machinery (M) and less-skill-intensive footwear (F), according to constant returns to scale technology. Factors are mobile between sectors, but not internationally. Preferences are identical and homothetic and both product and factor markets clear competitively.[4]

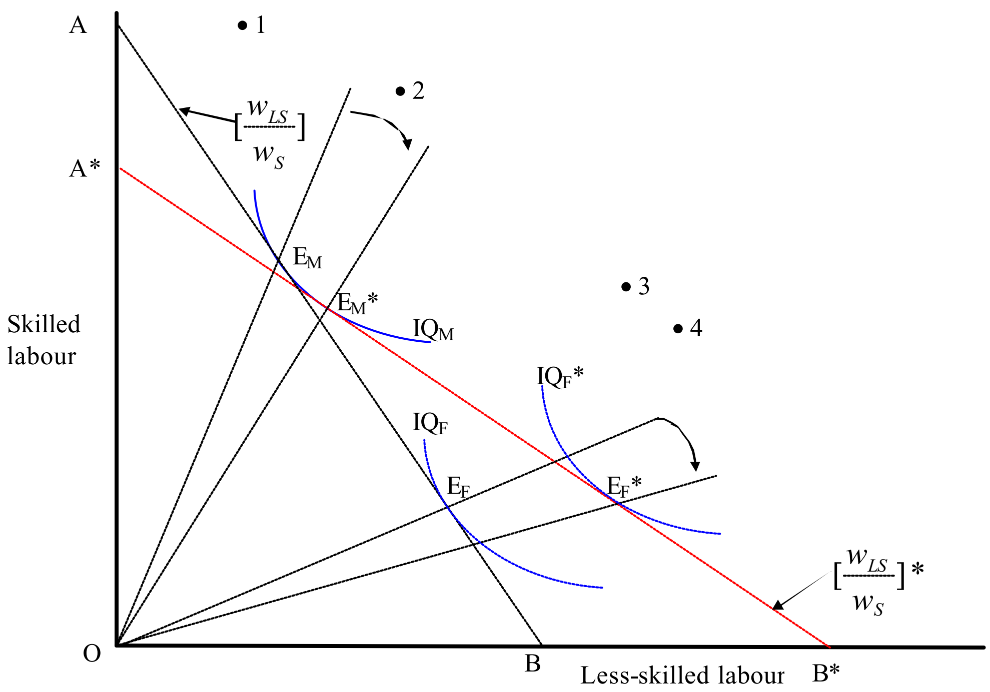
Unit-value isoquants for machinery (IQ_M) and footwear (IQ_F) represent the minimum set of capital and labour combinations that are required to produce a unit value of output. Equilibrium occurs when zero profits are earned in both sectors of the economy, i.e. when the *unit-isocost* line is tangent to both the unit-value isoquants.[5] The equilibrium wage of less-skilled labour relative to skilled labour (w_{LS}/w_S) is given by the absolute value of the slope of the unit-isocost line AB.

[4] Helpman and Krugman (1985) have studied the trade effect under imperfect competition.

[5] This precludes the possibility of full specialisation, as is the case in country 1.

Trade liberalisation that reduces the price of less-skill-intensive footwear, shifts the unit-value isoquant to IQ_F outwards to IQ_F^* as more footwear production is required in order to generate a unit value of output. At existing factor prices losses are made in the footwear sector causing production resources to shift out of footwear and into machinery production. The shift in production towards the relatively high-skill-intensive machinery sector raises the demand for skilled labour relative to less-skilled labour. In response, the wage of skilled labour rises, the wage of less-skilled labour falls and a new equilibrium factor price ratio $[w_{LS}/w_S]^*$ is established. Wage inequality has therefore risen. Production also becomes less skill-intensive as firms substitute skilled labour for less-skilled labour. Similarly, in a small open economy Hicks-neutral technological change has an equivalent impact on relative wages if technological regression occurs in the footwear sector, or if technological progress occurs in the machinery sector (Findlay and Grubert, 1959).[6]

Figure 1: Lerner diagram



[6] In a closed economy with Cobb-Douglas consumption functions, neutral technological change is passed fully onto domestic prices and factor returns are not affected (Feenstra and Hanson, 1999; Krugman, 2000). Factor biased technological change also affects relative factor payments. However, in a small open economy, it is the sector bias of the factor biased-technological change that drives the relative wage shifts (Leamer, 1996; Haskel and Slaughter, 1998). In a closed economy or large open economy, factor biased technological change affects relative prices and therefore relative factor returns (Feenstra and Hanson, 1999; Krugman, 2000).

This model, however, faces a number of shortcomings. Firstly, the model exaggerates the impact on factor incomes arising from changes in relative product prices. For example, the reduction in the price of footwear, from tariff liberalisation or international price trends, has no impact on relative wages in country 1 in Figure 1 as footwear is a non-competing product. Real wages in country 1 actually rise. Further, in response to lower product prices within less-skill-intensive sectors, firms may shift production towards more skill-intensive products, i.e. they move up the ladder of comparative advantage. "*By shifting outputs to more capital and/or skill-intensive products, countries can insulate themselves from competition from low (unskilled) wage products countries"* (Robbins, 1996: 38). This case is represented by country 2 in Figure 1 which begins to specialise in the production of machinery. Although relative wages rise (and are equal to slope of the isoquant through point 2), they rise by less in country 3. If the price of footwear declines a lot, real wages may actually increase. Once multiple products are introduced, the likelihood of such movements up the ladder of comparative advantage rises.

A second problem associated with the standard HOS model is that is fails to adequately account for the impact of trade liberalisation on middle-income countries such as South Africa. These economies compete against both developed and developing economies. The impact on relative factor payments depends on the relative reduction in tariffs or prices in response to the opening of the economy. This relates to Davis' (1996) argument that the impact of trade liberalisation on factor returns is dependent on factor abundance in a *local*, not *global*, sense. Middle-income economies may be less-skilled labour abundant in a global sense, but skill-abundant in a local sense. For example, liberalisation of trade between country 3 and countries 1 and 2 may be expected to raise the return of less-skilled labour in country 3, which is relatively abundant in less-skilled labour in a global sense. However, country 3 is skill-abundant in a local sense relative to country 4. Liberalisation between country 3 and 4 (and possibly multi-lateral liberalisation) will therefore raise wage inequality in country 3.[7]

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[7] This relationship becomes clearer in a multi-product model (see Edwards, 2003b). Wood (1997) develops a multi-product framework to explain how the entry of China and India into the world market may have raised wage inequality within Latin American economies during the 1980s.

Thirdly, the HOS model assumes technological change is exogenous to the model. This has been criticised by Wood (1995) who argues that firms raise productivity through "*unskilled labour saving technical progress*" in response to international competition. He therefore argues that the impact on wage inequality shown in Figure 1 under-estimates the full impact once trade-induced technological change is accounted for. 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*". Within a single sector model, a rise in the relative demand for skilled labour arising from defensive innovation will raise relative wages. However, the relationship is ambiguous in a general equilibrium framework. This can also be shown using Figure 1. Trade-induced technological progress within the footwear sector will shift the unit-isoquant inwards, offsetting the outward shift arising from trade liberalisation. Trade-induced technological change can thus moderate changes in factor payments arising from trade liberalisation. Similarly, the factor payment effect will be moderated if defensive innovation causes a shift up the ladder of comparative advantage.[8]

This theoretical analysis suggests that the impact of trade liberalisation on factor payments may be more muted than is commonly argued in the literature. Multiple products enable firms to move up the ladder of comparative advantage and insulate themselves from international competition. Trade-induced technological change offsets some of the decline in profitability and therefore the effect on relative wages. Further, the impact of trade liberalisation on factor payments in middle-income economies is shown to be ambiguous.

3. Empirical Methodology

Both tariff liberalisation and technological change in a small open economy affect relative factor payments by altering the relative profitability of production across sectors. With different factor intensities across sectors, the consequent changes in production affect relative factor demand and hence factor returns. Assuming perfect competition, equilibrium is re-established once zero profits are equal across all

[8] A similar criticism can be levelled against the argument by Pissarides (1997) that skill-biased technological transfers raise wage inequality within developing countries. If the technological transfers raise the competitiveness of the traditional less-skill intensive export sector, wage inequality may decline.

sectors, and there is no further incentive for resources to shift.[9] The zero-profit condition that drives the adjustment in relative factor returns is neatly summarized as

$$P = AW \qquad (1)$$

where P is an (N x 1) vector of N domestic value-added prices,[10] W is an (M x 1) vector of M domestic factor prices and A is an (N x M) matrix of input intensities whose A_{ij} element is the share of factor i per unit output j. Differentiating these zero-profit conditions produces[11]

$$\hat{P} = \theta \hat{W} - \hat{TFP} \qquad (2)$$

which can be rewritten as

$$\hat{P} + \hat{TFP} = \theta \hat{W}\,. \qquad (3)$$

$\hat{P}$, $\hat{W}$ 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 whose θ_{ij} element is the share of factor i in the average cost of producing one unit of product j. Equation (2) 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 shares, and technological change. Through the given production technology, factor price changes are therefore directly linked to change in product prices or technological change.

Given data on exogenously determined product price changes ($\hat{P}_{jt}^{Exog}$), TFP growth ($\hat{TFP}_{jt}^{Exog}$) and cost shares (θ) the zero-profit condition (3) can be estimated directly as

$$\hat{P}_{jt}^{Exog} = \sum \theta_{ijt}\beta_i + \varepsilon_{jt}\,. \qquad (4)$$

and

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[9] Helpman and Krugman (1985) have studied the trade effect under imperfect competition.

[10] 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.

[11] See Leamer (1996) for the detailed algebraic manipulations as well as the implications of including second order effects for discrete changes in the variables. See also Feenstra and Hanson (1999) for the derivation of this relationship using the dual measure of total factor productivity growth.

$$\hat{TFP}^{Exog}_{jt} = \sum \theta_{ijt}\delta_i + \upsilon_{jt}\,. \qquad (5)$$

Leamer (1996:23) refers to these as 'mandated wage' regressions, where the estimated δ_i's and β_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. A key feature of the zero profit relationship (3) is that relative factor returns are influenced by the sector bias of changes in product prices and technological change (Findlay and Grubert, 1959). 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.

A number of problems arise in the estimation of the zero profit conditions as set out in equation (3) and specified in equations (4) and (5). Firstly, the derivation of zero profit condition in growth terms in equation (2) does not account for variations in factor prices across industries. Differentiating the zero-profit conditions in equation (1) while allowing for sectoral variations in factor payments produces

$$\hat{P} = -\hat{TFP} + \theta\hat{W} + \theta(\hat{W}_i - \hat{W}) \qquad (6)$$

where $\hat{W}_i$ represents the industry specific factor price change and $\hat{W}$ the average change in factor prices for the economy as a whole. The bracketed value thus reflects the difference between the industry specific factor price change and the average change for all sectors, i.e. the "*change in wage differentials*" (Feenstra and Hanson, 1999: 911). Thus, to the extent that the change in wage differentials is correlated with the factor shares, the omission thereof will lead to biased estimates of the mandated wages.[12]

A second problem in estimating the impact of prices and technological change on factor returns is the identification of exogenous TFP growth and product price

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[12] Feenstra and Hanson (1999) thus combine the change in wage differentials term with TFP growth to obtain a measure of "effective" TFP growth This measure shows how the average factor price changes, weighted using the cost share in each industry, differ from the change in product price of that industry. Using the dual measure of TFP growth $EFTP \equiv \hat{TFP} - \theta(\hat{W}_i - \hat{W}) = (\theta\hat{W}_i - \hat{P}) - \theta(\hat{W}_i - \hat{W}) = (\theta\hat{W} - \hat{P})$.

Haskel and Slaughter (2001) find that the fraction of actual industry wages accounted for by changes in industry-specific differentials is small (11%). They thus ignore the term measuring the change in wage differential when estimating their mandated factor return regressions.

movements from observed data. In large countries total factor productivity growth feeds into product price changes rendering the identification of exogenous price changes from observed price changes difficult. Theoretically, the identification problem falls away in small countries where prices are set exogenously resulting in a zero pass-through of TFP growth to product prices.[13] However, where products are differentiated and/or where domestic firms have pricing power as a result of import quota restrictions, TFP growth may still feed into lower domestic prices.

One option is to regress the sum of observed TFP growth and product price changes on factor shares to obtain the net price and technology effect on mandated wages. However, as Feenstra and Hanson (1999: 908) show, when TFP growth is calculated using the dual measure, the mandated wage regression *"becomes an identity and cannot offer any predictions of the implied changes in factor prices, other than those that which actually occurred."*[14]

Leamer (1996) deals with the identification 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 ($\hat{P}_{jt} + \lambda T\hat{F}P$) and technological change ($(1-\lambda)T\hat{F}P$) from observed data and hence the estimation factor returns mandated by 'globalisation' (equation (4)) and technology (equation (5)). Using this approach, he finds that product price movements raised wage inequality in the US during the 1990s.

Feenstra and Hanson (1999) and Haskel and Slaughter (2001) deal with the identification problem in a more systematic manner by treating prices and technological change as endogenous variables. Their approach involves two stages. In a small open country model observed price changes and TFP growth are first regressed on a set of causal factors Z_{pr} and Z_{tech} which are assumed to drive price

[13] If TFP growth reflects global technological change, then world product prices will adjust in response to changes in world output. The identification problem in a global setting thus remains.

[14] Equation (6) can easily be re-written as the dual measure of TFP growth $T\hat{F}P = \hat{P} - (\theta\hat{W} + \theta(\hat{W}_i - \hat{W}))$

changes and TFP over time.[15] The price and TFP regressions are respectively written as

$$\Delta \log P_{jt} = \sum_{pr \in S_{pr}} Z_{pr,jt} \delta_{pr} + \upsilon_{jt} \tag{7}$$

and

$$\Delta \log TFP_{jt} = \sum_{tech \in S_{tech}} Z_{tech,jt} \delta_{tech} + \upsilon_{jt} \tag{8}$$

where υ_{jt} is the random error. The estimated coefficients δ_{pr} and δ_{tech} capture the contribution of the structural variables Z_{pr} and Z_{tech} to changes in prices and TFP, respectively. In the second stage the contribution of each underlying variable is regressed on cost shares. The second-stage regressions for prices and TFP are written respectively as:

$$\hat{\delta}_{pr} Z_{pr,jt} = \sum_{i \in I} \theta_{ijt} \beta_{it,pr} + \varepsilon_{jt} \tag{9}$$

and

$$\hat{\delta}_{tech} Z_{tech,jt} = \sum_{i \in I} \theta_{ijt} \beta_{it,tech} + \varepsilon_{jt} \tag{10}$$

where $\beta_{it,pr}$ and $\beta_{it,tech}$ respectively yield the wage changes mandated by the sector bias of each explanatory factor included in $Z_{pr,jt}$ and Z_{tech} , which exercises its influence through ? logP_{jt} and ? logTFP_{jt}.

Within a closed or large country setting TFP growth feeds into domestic prices implying that equation (7), with TFP growth included as a regressor, and equation (8) form a system of equations that together determine TFP growth and product price changes. In estimating mandated factor returns for the US, Feenstra and Hanson (1999) therefore estimate a reduced form equation as their first-stage regression,

$$\Delta \log P_{jt} + \Delta \log TFP_{jt} = \sum Z_{jt} \delta + \upsilon_{jt} . \tag{11}$$

Using this two-stage approach, Feenstra and Hanson (1999) find that foreign outsourcing (share of imported intermediates in total cost) and computer expenditure

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[15] In a small country prices are set exogenously and the pass-through of TFP growth to product prices is zero.

are important causes of the increased wage inequality in US manufacturing during the 1980s. Haskel and Slaughter (2001) apply the two-stage approach to UK manufacturing over the period 1960-90 and find that the number of innovations in a sector, declining unionisation and import-price pressure from Newly Industrialised Countries mandated rising wage inequality at various stages during the 1970s and 1980s. Within developing countries, the only available study using the two-stage approach appears to be that of Fedderke *et al*. (2003) who apply the approach to South Africa. They find that openness, rising capacity utilisation and increased industry concentration raise the return to labour, but that research and development and a rising skill composition of the labour force reduce the return to labour. Overall, these results provide some support for the role of trade in raising wage inequality in developed economies, but reducing wage inequality (or raising the return to labour) in developing economies.

Two shortcomings in the above studies remain. Firstly, these studies use proxies for the impact of trade liberalisation on factor remuneration, rather than direct measures of protection such as tariffs and non tariff barriers. Haskel and Slaughter (2000) remedy this by focussing on the impact of tariff reductions and transport costs on product prices, but find no strong evidence that falling tariffs and transport costs mandated rising wage inequality in the UK. A more serious problem is that these studies fail to account for the endogeneity between trade and TFP growth, as is emphasised by Wood (1994, 1995), Pissarides (1997) and Robbins (1996).[16] International competition may induce productivity improvements through defensive innovation (Wood, 1994), technological transfer, both directly or imbedded within imported goods (Pissarides, 1997), and a reduction in x-inefficiency (Robbins, 1996). These productivity improvements will in turn affect outcomes such as openness and import penetration. Within South Africa, there is also growing evidence of a positive impact of openness and trade liberalisation on TFP growth (Belli *et al.*, 1993; Fallon and Pereira de Silva, 1994; Hayter *et al.*, 1999; Jonsson and Subramanian, 2000;

[16] Feenstra and Hanson (1999) allow for the endogeneity between price and TFP growth in their mandated wage regressions. Fedderke *et al.* (2003) correct for possibly endogeneity between TFP growth and research and development. Neither study, however, deals with the possibly endogeneity between TFP growth and trade. For example, in the reduced form estimation (equation (11) above) of Fedderke *et al.* (2003), which has openness as a regressor, TFP growth that is trade-induced will affect the level of imports and hence the openness variable. The endogeneity problem can be solved if tariff data are used as these changes are expected to be independent of TFP growth. Openness is an endogenous variable and is the outcome of various influences such as tariff liberalization, demand shifts and technological change.

Fedderke, 2001). The presence of trade-induced technological change suggests that openness (Fedderke *et al*. 2003) and outsourcing (Feenstra and Hanson, 1999) are not independent of TFP growth. The endogeneity of these variables may lead to biased coefficient estimates in their first stage regressions.

Given the availability of tariff data, one approach to dealing with the problem of trade-induced-technological change is to estimate the first-stage price and TFP equations as a simultaneous equation system. This can take the form of the following two-equation model

$$\Delta \log P_{jt} = \delta_1 \Delta \log TFP_{jt} + \delta_2 \Delta \log TAR_{jt} + \sum_{\text{pr} \in \text{S}_{\text{pr}}} Z_{pr,jt} \delta_{pr} + \upsilon_{jt} \qquad (12)$$

and

$$\Delta \log TFP_{jt} = \lambda_1 \Delta \log TAR_{jt} + \sum_{\text{tech} \in \text{S}_{\text{tech}}} Z_{tech,jt} \delta_{tech} + \mu_{jt} \qquad (13)$$

where TAR_{jt} represents tariff rates and $Z_{pr,jt}$ and Z_{tech} represent other structural variables influencing prices and technological change, respectively. Combining these two equations, the first-stage relationship can be simplified as

$$\Delta \log P_{jt} + \Delta \log TFP_{jt} = \alpha_1 \Delta \log TAR_{jt} + Z'\delta + \varepsilon_{jt} \qquad (14)$$

where $\alpha_1 = (1+\delta_1)\lambda_1+\delta_2$, $\varepsilon_{jt} = (1+\delta_1)\mu_{jt}+\upsilon_{jt}$ and Z is a matrix of all structural variables. δ is the coefficient vector and is equal to $(1+\delta_1)\delta_{tech}+\delta_{pr}$ where the structural variables are common across (12) and (13) (i.e. $Z_{tech} = Z_{pr}$), $(1+\delta_1)\delta_{tech}$ for structural variables only found in the TFP regression (13) and δ_{pr} for structural variables only found in the price regression (12). Because tariffs are exogenous, the estimation of the reduced form equation (14) does not suffer from the endogeneity problems that arise once openness or outsourcing (import penetration) are used to proxy the trade effect.

If the system of equations (12) and (13) is valid, tariff liberalisation affects factor payments in two ways. Firstly, tariff liberalisation directly affects product prices (*direct price effect*), which according to equation (12) equals $\delta_2 \Delta \log TAR_{jt}$. These product price changes affect factor payments through the Stolper-Samuelson linkages. Secondly, as shown in equation (13), tariff liberalisation impacts on TFP growth. The net impact of trade-induced technological change, however, depends on the pass-through of technological change to product prices. From equations (12) and (13), the net impact of trade-induced technological change equals $(1+\delta_1)\lambda_1\Delta\log TAR_{jt}$. If pass-through is complete (δ_1=-1), as in a closed economy, factor prices are unaffected by trade-induced technological change as the impact is fully absorbed by a reduction in prices. Where the pass-through is incomplete ($-1<\delta_1<0$), as is expected in small economies, trade induced technological change is only partially absorbed by price reductions and the remainder is absorbed by factor price changes as outlined by Findlay and Grubert (1959).

Two additional comments need to be made. Firstly, Krugman (2000) shows that in a general equilibrium framework non-neutral technological change can have an impact on relative prices in a closed or large open economy. Thus trade-induced technological change that is factor biased can still affect relative product prices, even in a closed or large open economy where pass-through is complete (δ_1=-1). In this case the coefficient δ_2 will represent both the direct price impact and the indirect impact through non-neutral trade-induced technological change.[17]

A second point is that the impact of trade-induced technological change in this model differs from that foreseen by Wood (1994). Trade-induced technological change offsets the negative impacts on factor returns arising from lower tariff protection within that sector. This is clearly shown in the coefficient for the tariff variable in the reduced form equation (14) ($\alpha_1 = (1+\delta_1)\lambda_1+\delta_2$) where component attributed the trade-induced technological change ($(1+\delta_1)\lambda_1$) is negative and the component attributed to the direct price effect (δ_2) is positive.[18] Trade-induced technological change thus ameliorates, rather than exacerbates, the impact of tariff liberalisation on factor returns.

The following section presents the data and the specification of the regression equations that are estimated.

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[17] The tariff variable can also be interacted with factor variables in order to estimate the complementary relationship between tariff changes and factor biases. See Feenstra and Hanson (1999) for further discussions on this matter.

[18] If capital is sector specific, then firms may boost labour productivity, but not overall productivity, by raising the capital-labour ratio through labour shedding. TFP growth may therefore decline leading to the effect described by Wood (1994).

4. Data and specification

4.1 Data

The analysis is conducted using data at two levels of industry aggregation. The primary analysis, in which prices and technological change are treated endogenously, is conducted using 3-digit Standard Industrial Classification (SIC) data covering 28 sectors in agriculture, mining and manufacturing over the period 1988-2002. The data are obtained from the Trade and Industrial Policy Strategies' South African Standardised Industrial Database (SASID, 2003).[19] To test the robustness of the results, simple mandated factor return regressions similar to equation (4) are estimated using manufacturing firm level data for 1998 and data (80 sectors) obtained from the 1993 and 2000 Supply-Use tables provided by Statistics South Africa (1999, 2003). The firm level data are obtained from the World Bank and the Greater Johannesburg Metropolitan Council survey which consists of 325 large (50 or more employees) firms sampled from the Greater Johannesburg Metropolitan Area (Chandra *et al.*, 2001).

Disaggregated tariff data are obtained from various sources. Scheduled tariff rates at the 8-digit Harmonised System (HS) level for the years 1988, 1990, 1991, 1993, 1998, 1999, 2000, 2001 and 2002 are obtained from the Trade Analysis and Information System database (TRAINS), the Economic Research Division of the Industrial Development Corporation (IDC) and the Trade and Industry Policy Strategies (TIPS). Scheduled tariff rates for missing years are obtained from the South African government gazettes. Collection rates, calculated by dividing duties collected by the import value, are also used to test the sensitivity of the results to the measure of protection.[20] This data are obtained from TIPS. A concordance file obtained from TIPS is used to calculate the simple average tariff rates according to the SIC 3-digit and Supply-Use classifications.

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[19] This data can be obtained online from www.tips.org.za. Mining and agriculture are classified at the SIC 2-digit level.

[20] The simple average tariffs tend to bias estimated protection upwards as most information is available for highly protected products. Import weighted averages could be used, but these are biased downwards as consumers substitute highly protected products for less-protected products. Collection rates are also biased downwards as highly protected products may not be imported and exemptions on duty are frequently granted (e.g. imported intermediate goods are often duty free when the final product is to be exported).

Table 1 presents the average tariffs for the total economy, agriculture, mining and manufacturing over two year intervals for the period 1988-2002. In calculating the average tariff ad valorem tariffs and the ad valorem component of mixed and formula duties are used. Specific tariffs are not included. According to the scheduled tariff rates, average protection in the economy rose from 12.41% in 1988 to 13.32% in 1994 before declining to 6.63% in 2002. However, these values under-estimate protection levels during the late 1980s and early 1990s. The values exclude surcharges imposed between 1985 and 1995 in response to the debt crisis in the late 1980s. Further, protection from quantitative restrictions on imports and formula duties are not captured. Formula duties were frequently used within clothing and textile sectors and were used to ensure that the tariff inclusive import price did not fall below a set minimum. The IDC estimates that the average tariff for manufacturing in 1990 inclusive of ad valorem equivalents was equal to 29.3%. The average surcharge during this period was 11.85%.[21]

The lack of price data prevents a coherent estimation of ad valorem equivalents for all periods. However, three additional sets of tariff rates are constructed to test the robustness of the analysis. The average scheduled tariff rates are adjusted to include surcharges using data obtained from GATT (1993) and the Reserve Bank. The inclusion of surcharges raises protection during the early 1990s leading to a much larger decline in protection during the late 1990s. Collection duties are also used to estimate average protection in each sector. As shown in Table 1, the average collection rates are much lower than the scheduled rates, and also show a lower decline in protection.

Table 1: Average Tariff Rates (%), 1988-2002

	1988	1990	1992	1994	1996	1998	2000	2002
Scheduled tariff rates								
Total	12.41	12.38	13.32	12.62	10.30	7.84	7.17	6.63
Manufacturing	13.54	13.54	14.66	13.92	11.35	8.64	7.91	7.30
Agriculture	5.56	5.27	4.97	5.18	5.96	5.68	5.67	5.37
Mining	3.93	3.65	3.23	2.75	1.92	1.26	0.95	0.98
Scheduled tariff rates including surcharges								
Total	16.77	18.28	16.65	14.73	10.30	7.84	7.17	6.63
Manufacturing	18.35	20.06	18.35	16.25	11.35	8.64	7.91	7.30

[21] Quantitative restrictions were still applied in agriculture (74 percent of tariff lines) and five manufacturing sectors (food, beverages, rubber, tobacco and clothing) (Jonsson and Subramanian, 2001).

Agriculture	11.17	12.87	9.27	7.90	5.96	5.68	5.67	5.37
Mining	4.00	3.75	3.28	2.79	1.92	1.26	0.95	0.98
Collection rates								
Total	4.07	3.72	4.12	3.79	3.37	2.68	3.24	
Manufacturing	4.58	4.18	4.65	4.28	3.81	3.01	3.53	
Agriculture	1.57	1.61	0.33	0.76	0.58	1.18	6.32	
Mining	0.09	0.12	0.29	0.02	0.01	0.03	0.00	
Collection rates including surcharges								
Total	8.43	9.62	7.46	5.90	3.37	2.68	3.24	
Manufacturing	9.39	10.70	8.33	6.62	3.81	3.01	3.53	
Agriculture	7.18	9.21	4.63	3.48	0.58	1.18	6.32	
Mining	0.17	0.21	0.35	0.06	0.01	0.03	0.00	

Notes: Scheduled tariff rates include the ad valorem component of formula duties and mixed duties. Specific tariffs are not included. The ad valorem equivalents of formula duties may be substantially higher than the ad valorem component. Average tariffs are the weighted average of the 28 3-digit SIC categories using imports as weights.

Most of the remaining data used in the analysis is obtained from the South African Standardised Industrial Database (SASID, 2003). Information relating to the variable names and the methods used to construct the variables is presented in Table 2.

Table 2: Variable Names, Descriptions and Calculation Methods

	Variable description	Calculation method
Factor shares		
SIC 3-digit data		
L-share (θ_L)	Average labour cost share, 1988-2002	(wage bill)/(wage bill + GOS + intermediate costs) measured in current prices
K- share (θ_K)	Average capital cost share, 1988- 2002	(GOS)/(wage bill + GOS + intermediate costs) measured in current prices
S-share (θ_S)	Skilled labour cost share, 1997	Calculated using relative wage data obtained from a 1997 Accounting Matrix and data on the employment of skilled and less-skilled labour and the total wage bill obtained from TIPS.[22]
LS-share (θ_{LS})	Less-skilled cost share, 1997	
Supply-Use data		
L-share (θ_L)	Average labour cost share, 1993 and 2000	(wage bill)/(wage bill + GOS + intermediate costs) measured in current prices
K- share (θ_K)	Average capital cost share, 1993 and 2000	(GOS)/(wage bill + GOS + intermediate costs) measured in current prices
Firm level		
L-share (θ_L)	Labour cost share	(wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)
K- share (θ_K)	Capital cost share	(0.1*replacement capital)/(wage bill + 0.1*replacement capital + material costs + utility costs)
M-share (θ_M)	Intermediate cost share	$1 - \delta_L - \delta_K$; i.e. derived as a residual

[22] We know that $W_S L_S + W_{LS} L_{LS}$ = Wage bill where W is wage, L is labour and the subscripts S and LS refer to skilled and less-skilled labour, respectively. Assuming a constant relative wages (W_S/W_{LS} = constant) and total costs (C) for each sector, the labour shares in total cost can easily be calculated through substitution.

LS-share (θ_{LS})	Less-skilled cost share	(production worker wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)
S-share (θ_S)	Skilled labour cost share	(non-production worker wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)
Other variables		
$\hat{TFP}_j$	TFP growth	$\hat{TFP}_j = \Delta \log(Y_j) - \alpha_j \Delta \log(L_j) - (1-\alpha_j)\Delta \log(K_j)$ where Y_j is the sectoral value added, L_j the sectoral labour employed, K_j the sectoral stock of capital and α_j is the share labour remuneration in value added.
$\hat{P}_j$	Change in value added prices	ΔlogP
$\hat{P}_m$	Change in import price	$\Delta \log P_M$
KL	Capital-labour ratio	Capital in constant 1995 prices (R million)/labour
PPI^*	Foreign producer price index	Weighted average PPI constructed using total trade (exports + imports) as weights.
P^*_X	Export unit values of industrial countries (IFS)	

Notes: GOS refers to Gross Operating Surplus.

Labour and capital shares in total costs for the SIC 3-digit and Supply-Use data are calculated as the wage bill and gross operating surplus divided by total cost, respectively. There is no reliable disaggregation of the wage bill into payments to skilled and unskilled labour over time. The skilled and unskilled labour shares in total cost are therefore obtained from a 1997 Social Accounting Matrix.[23] These are adjusted to ensure that the sum of cost shares according to skill is equal to share of labour remuneration in total costs, as calculated using the SASID (2003) data and used in the SIC 3-digit analysis.

Calculating factor cost shares using the firm survey is more complex as there are no data on the returns to capital.[24] Following Leamer (1996), the return to capital is estimated as 10 % of the replacement value of the capital stock. This is slightly lower than the real interest rate during the late 1990s. The 10 % imposed on all sectors implicitly assumes that depreciation rates do not vary across sectors (Leamer, 1996). Total expenditure for each firm is calculated as the estimated return to capital plus expenditures on material inputs, utilities and wages (including allowances and

[23] 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.

[24] Data on net profits, machinery & equipment rentals and land rentals were available, but were missing for most firms.

benefits). Other indirect input costs relating to transport, rental, telecommunications, financial fees and licences fees are omitted, as many firms did not provide this data. Wages for production workers are also available, although the occupational breakdown of this group is not specified. How close an indicator production workers are of less-skilled labour is thus indeterminate. The share production workers, non-production workers, capital and other material costs in total expenditure are calculated using this data. Missing data resulted in only 57 % of the firms being included in the firm analysis.

TFP growth rates are calculated as the residual between growth in value added and factor share-weighted growth rates of capital and labour. As is well documented, TFP growth rates calculated in this manner are subject to a number of methodological limitations (Domar 1961). Nevertheless, we continue with this method as it is the standard approach used in similar analyses. Table 3 presents some of the key sector level data used in this analysis.

4.2 Specification

The primary objective of the econometric analysis is to estimate the change in factor payments mandated by tariff reductions. The empirical methodology closely follows the two-stage approach developed by Feenstra and Hanson (1999). Two sets of estimations are performed.

In the first set of estimations, we follow Haskel and Slaughter (2000) and impose the small country Heckscher-Ohlin (HO) assumption in which technological change is exogenous and product prices are determined by world prices plus a tariff wedge. The data are pooled and the following regression is estimated

$$\Delta \log P_{jt} = \mu + \delta_1 \Delta TAR_{jt} + \alpha_j + \varepsilon_{jt} \qquad (15)$$

where TAR is the logarithm of tariffs, μ is a constant α_j is a sector specific factor that is either fixed (fixed effects) or iid over sectors (random effects) and ε_{jt} is an iid error term. Variables, such as world prices, that affect product prices, but have been excluded are captured by the factor α_j.

Table 3: Average values of key variables, 1988-2002

	K/L	S/LS	TFP growth	Factor shares			Tariff levels			Average annual change in tariffs		
				K share	Skilled share	Less-skilled share	Scheduled	Incl. surcharge	Collection + surcharge	Scheduled	Incl. surcharge	Collection + surcharge
	Rmill		%				%	%	%	%	%	%
Agriculture, forestry & fishing [1]	0.01	0.01	2.0	0.44	0.02	0.17	5.5	8.1	4.4	-0.2	-5.2	-5.6
Coal mining [21]	0.06	0.05	-1.8	0.28	0.03	0.19	0.0	0.0	0.1	0.0	0.0	0.0
Gold & uranium mining [23]	0.03	0.02	1.7	0.00	0.00	0.00	6.0	6.0	0.6	-21.4	-21.5	-3.0
Other mining [22/24/25/29]	0.11	0.04	-0.5	0.30	0.03	0.19	2.4	2.4	0.1	-9.9	-10.1	-33.7
Food [301-304]	0.02	0.07	1.5	0.10	0.02	0.10	15.0	17.9	8.1	-0.8	-3.3	-2.0
Beverages [305]	0.08	0.13	-0.9	0.22	0.04	0.09	16.1	24.0	9.8	-0.3	-5.1	-16.6
Tobacco [306]	0.05	0.13	-0.4	0.37	0.02	0.05	46.4	58.8	24.0	-4.1	-6.7	-0.2
Textiles [311-312]	0.01	0.05	0.7	0.08	0.03	0.19	29.1	31.1	15.4	0.2	-1.1	-1.0
Wearing apparel [313-315]	0.00	0.04	-0.1	0.07	0.03	0.24	46.6	51.8	26.2	1.5	-0.9	-1.9
Leather products [316]	0.01	0.04	2.5	0.07	0.01	0.12	14.9	17.9	12.7	-2.1	-4.6	-0.1
Footwear [317]	0.00	0.03	0.5	0.09	0.02	0.24	28.1	32.2	27.6	-1.0	-3.1	2.8
Wood products [321-322]	0.01	0.03	1.6	0.13	0.02	0.20	10.9	12.3	4.4	-2.0	-3.6	-5.9
Paper products [323]	0.07	0.08	-0.1	0.13	0.03	0.12	8.1	8.6	5.8	-2.7	-3.4	4.2
Printing & publishing[324-326]	0.02	0.20	-3.2	0.12	0.10	0.17	7.8	9.7	3.5	-5.7	-8.1	-11.4
Coke & refined petroleum [331-333]	0.50	0.23	-1.8	0.27	0.03	0.04	5.9	5.9	0.2	-3.7	-3.7	4.1
Basic chemicals [334]	0.17	0.15	3.5	0.15	0.05	0.11	5.6	5.8	2.2	-11.9	-12.2	-5.5
Other chemicals [335-336]	0.04	0.19	3.8	0.11	0.06	0.10	9.1	11.6	5.5	-7.3	-9.8	-11.2
Rubber products [337]	0.03	0.10	0.6	0.12	0.05	0.18	15.5	17.0	16.3	-3.6	-4.8	-2.4
Plastic products [338]	0.01	0.10	-0.2	0.10	0.05	0.18	15.0	17.6	14.3	-4.7	-6.5	-5.6
Glass & glass products [341]	0.05	0.07	3.0	0.13	0.04	0.18	9.6	12.8	11.3	-3.4	-6.6	-6.1
Non-metallic minerals [342]	0.06	0.07	3.7	0.18	0.04	0.18	8.7	10.2	9.5	-5.2	-6.9	-6.1
Basic iron & steel [351]	0.16	0.12	6.1	0.10	0.05	0.15	6.6	6.9	3.7	-4.7	-5.1	-0.8
Non-ferrous metals [352]	0.23	0.12	4.8	0.21	0.03	0.09	5.9	6.2	1.1	-9.8	-10.3	-1.6
Metal products [353-355]	0.02	0.08	0.4	0.11	0.04	0.19	11.2	13.6	10.4	-3.8	-6.1	-7.3
Machinery [356-359]	0.01	0.14	1.1	0.09	0.07	0.17	6.0	7.8	3.5	-5.1	-8.1	-14.4
Electrical machinery [361-366]	0.01	0.19	1.6	0.13	0.07	0.14	11.4	14.7	10.0	-4.5	-7.3	-8.1
Communication equipment [371-373]	0.01	0.19	0.2	0.08	0.05	0.12	9.1	12.4	7.0	-10.7	-13.6	-13.8
Professional & scientific equipment [374-376]	0.01	0.19	-4.5	0.14	0.07	0.17	3.4	6.7	4.3	-20.4	-26.2	-21.0
Motor vehicles [381-383]	0.03	0.17	2.2	0.08	0.04	0.09	22.3	24.9	6.3	-3.5	-4.9	-6.5
Other transport equipment [384-387]	0.03	0.17	0.0	0.09	0.10	0.22	4.8	6.7	2.7	-16.4	-19.1	-29.4
Furniture [391]	0.00	0.05	-0.3	0.08	0.03	0.19	20.4	24.8	17.9	-1.5	-4.1	-9.4
Other manufacturing [392-393]	0.02	0.09	-0.5	0.41	0.02	0.09	11.2	14.8	11.8	-6.6	-9.6	-12.0

To allow for a fuller specification, this equation is modified to include various other exogenous determinants of prices. The modified regression is

$$\Delta \log P_{jt} = \mu + \delta_1 \Delta TAR_{jt} + \delta_2 \Delta TFP_{jt} + \delta_3 (\Delta TAR_{jt} \times KL_{jt}) + \delta_4 \Delta PPI^{*}{}_{t} + \alpha_j + \varepsilon_{jt} \tag{16}$$

where ΔTFP is total factor productivity growth, KL is the capital-labour ratio and PPI^* is an index of foreign producer prices (in logarithms). This specification modifies the assumption of a common pass-through of tariffs to domestic prices (δ_1) by interacting tariff changes with capital-labour ratios (KL). As argued by Haskel and Slaughter (2000), less competitive industries with higher capital-labour ratios may show less pass-through from tariff reductions to domestic prices. TFP growth proxies world technological change and ΔPPI^* represents changes in world prices.

In the second set of estimations, we explicitly account for the possible endogeneity of technological change and product prices and estimate functions as outlined in equations (12), (13) and (14). The TFP growth function is specified as

$$\Delta TFP_{jt} = \nu + \lambda_1 \Delta TAR_{jt} + \lambda_2 \Delta CAP_{jt} + \lambda_3 FDI_t + \lambda_4 FACT_{jt} + \lambda_5 \Delta P^{*}_{X,t} + \gamma_i + \varepsilon^{*}_{jt} \tag{17}$$

where ΔCAP is the log growth in machinery & equipment capital, FDI is total foreign direct investment as a share of gross domestic product, $FACT$ is a factor ratio of either skilled labour to less-skilled labour or capital to labour and $P^*{}_X$ is an index of export unit values for industrial countries obtained from the International Financial Statistics (IFS). The growth in capital stock is expected to capture spill-over effects over and the coefficient should capture the positive effect over and above that implied by the share of capital in income (Romer, 1986, Fedderke, 2001). Indicators of human capital, such as university enrolment, the matriculation rate and the proportion of school students studying maths, used by Fedderke (2001) in his analysis of TFP growth in South, are excluded as the data are not available for the full period. Foreign direct investment as a share of GDP is sourced from the Reserve Bank Quarterly Bulletin (Reserve Bank, 2004) and is expected to capture the transfer of technology through foreign ownership. The skills ratio or capital labour ratio is included to proxy differing abilities of firms to adopt new technology. Foreign export unit values are included as a further indicator of the impact of international competition on technological change. Rising foreign export prices may also negatively affect technological change as it raises the cost of technology imbedded in imported intermediate goods. Other variables such as innovations, union density, change in computerisation, concentration, R&D, property rights and patents used in studies such as Haskel and Slaughter (1998) and Fedderke (2001) are excluded because of lack of data. However, some of these effects that are constant over time will be captured by the sector specific factor α_j included in the pooled regressions.

To account for the endogeneity of TFP growth and price changes, we estimate the system of equations (16) and (17) using Baltagi's (1981) error-component two-stage least-squares (EC2SLS) method.

These specifications account for the first-stage regressions. In the second stage the average tariff induced-changes in product prices for each sector between 1988 and 2002 are regressed on the average factor shares using OLS. The regressions are weighted using average value added between 1988 and 2002.

5. Results and analysis

5.1 Preliminary data analysis

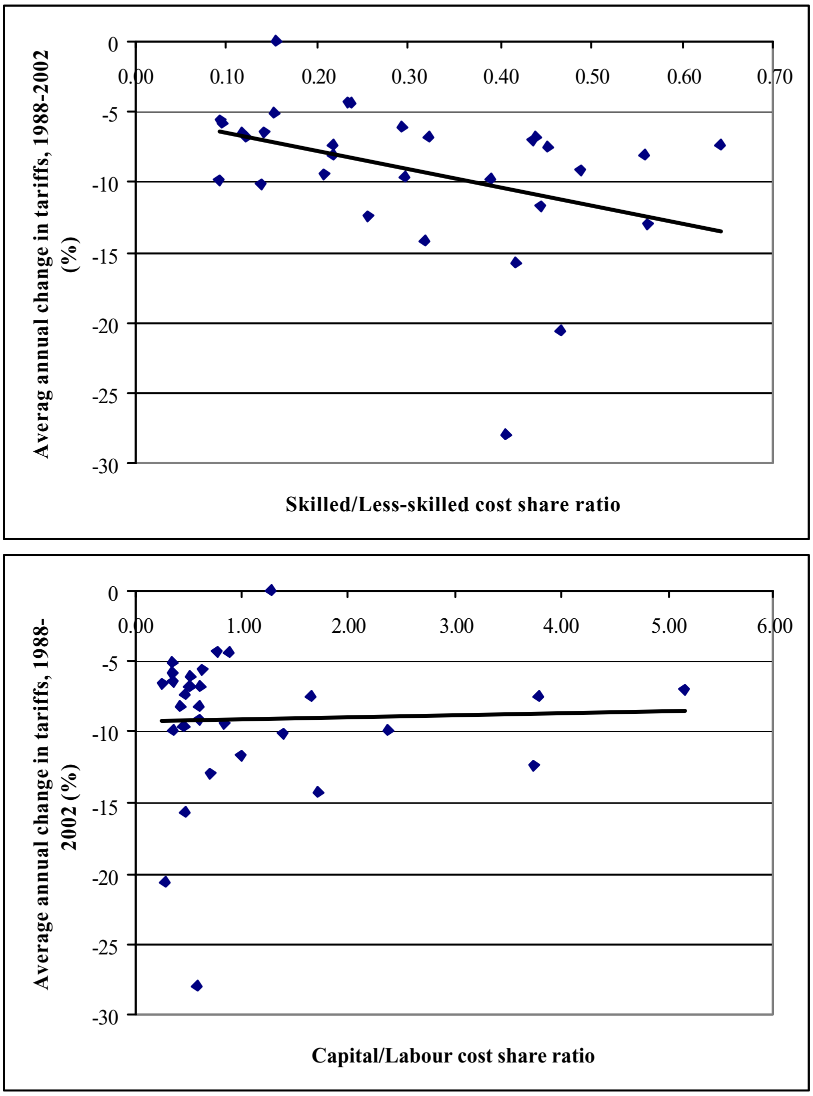
Table 3 presents the average values of a number of key variables for the period 1988-2002. Average TFP growth between 1988 and 2002 is positive in most sectors with high values experienced in basic iron & steel (6.1%), non-ferrous metals (4.8%), basic chemicals (3.8%), non-metallic minerals (3.7%) and chemicals (3.5%). Low TFP growth is experienced within professional and scientific equipment (-4.5%) and printing & publishing (-3.2%). There is a slight bias in TFP growth towards labour-intensive sectors. Average TFP growth for skill-intensive sectors between 1988 and 2002 equals 0.6% per year compared to 0.74% for less-skill intensive sectors.[25] According to the general equilibrium framework of Findlay and Grubert (1959), the concentration of technological change in less-skill-intensive sectors will have raised less-skilled wages, lowered skilled wages and hence reduced wage inequality.

[25] The weighted-average values are constructed using average factor shares between 1988 and 2002 as weights (i.e. the factor share columns in Table 3). Sectors are therefore treated equivalently, irrespective of size in terms of output or employment. Similar sector biases, but not levels, are obtained when using factor values (employment according to skill and capital stock) as weights. The averages exclude the gold sector, which accounts for a large share of total employment, but no imports.

Looking at tariff rates, very high protection rates (more than 30%, inclusive of surcharges) are found in tobacco, textiles, footwear and clothing. Low rates (less than 10%) are found in some mining sectors, coke & refined petroleum, basic chemicals, basic metals and other transport equipment. Average tariffs are marginally lower in skill-intensive sectors (13.97%) than in less-skill-intensive sectors (15.98%). Tariff levels are also lower in capital-intensive sectors (8.6%) than labour-intensive sectors (15.55%).

The final columns of Table 3 present the average annual change in tariffs between 1988 and 2002 for each sector. Large declines in scheduled tariff rates (more than 15% per annum) are found in professional & scientific equipment, gold & uranium mining and other transport equipment. Sectors experiencing low declines in protection (less than 5% per annum) include footwear, food, textiles, clothing, furniture, wood products, paper products and coke and refined petroleum. On average tariffs inclusive of surcharges have fallen relatively strongly in skill-intensive sectors (-6.69% per annum between 1988 and 2002), compared to less-skill-intensive sectors (-7.01% per annum). Using the capital-labour division, tariff declines are concentrated in labour-intensive sectors (-7.37%) compared to capital-intensive sectors (-6.31%). These sector biases are also shown in Figure 2, where a much stronger relationship is evident when using the factor intensities according to skill. According to the Stolper-Samuelson theorem, the sector biases of tariff reductions will have placed downward pressure on the return to labour relative to capital, with relatively large declines experienced amongst skilled labour. In the following section these relationships are explored using more robust econometric techniques.

Figure 2: Sector bias of tariff reductions, 1988-2002



5.2 *Regression analysis*

We follow two approaches in estimating the mandated factor returns arising from trade liberalisation. In the first approach, we impose the assumption that technological change is exogenous. We therefore estimate the tariff pass-through equations (15) and (16) and then estimate the second stage mandated factor return equation (see equation (9)) where tariff induced changes in product prices are regressed on factor proportions. In the second approach, we allow for the endogeneity of technological change. The price and TFP equations (16 and 17, respectively) are estimated simultaneously.

5.2.1 Exogenous technological change

Table 4 presents the results of the price regressions specified in equations (15) and (16) using the scheduled tariff rates and the collection rates excluding and including surcharges.

Table 4: Pass-through of tariffs to domestic prices, Exogenous technological change

	Scheduled rates		*Scheduled rates + surcharges*		*Collection rates*		*Collection rates + surcharges*	
	Eq (15)	***Eq (16)***	***Eq (15)***	***Eq (16)***	***Eq (15)***	***Eq (16)***	***Eq (15)***	***Eq (16)***
	(1)	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***	***(7)***	***(8)***
	coeff	**coeff**	**coeff**	**coeff**	**coeff**	**coeff**	**coeff**	**coeff**
Δ Tariff	0.086 ***	0.079 ***	0.087 ***	0.088 ***	-0.005	0.003	0.003	0.010
	0.028	*0.030*	*0.026*	*0.027*	*0.011*	*0.012*	*0.013*	*0.013*
TFP growth		-0.384 ***		-0.390 ***		-0.419 ***		-0.420 ***
		0.049		*0.049*		*0.043*		*0.043*
Δ Tariff*K/L		-0.271		-0.307		-0.143 *		-0.191 **
		0.238		*0.231*		*0.086*		*0.089*
Δ PPI*		1.092 ***		1.064 ***		2.343 ***		2.324 ***
		0.301		*0.300*		*0.296*		*0.298*
Obs	434	434	434	434	403	403	403	403
Wald	9.67 ***	90.52 ***	11.63 ***	94.74 ***	0.21	164.74 ***	0.06	166.53 ***

Notes: The standard errors are presented in italics below the estimated coefficient. *, **, and *** represent significance at the 10%, 5% and 1% level, respectively. Estimations were performed using a random effects model.

The estimated pass-through of tariffs to domestic prices is significant in all regressions using scheduled tariff rates, but in no regression using collection rates. According to the results in columns 1 to 4, a 10% decline in tariff rates reduces products prices by between 0.79% and 0.88%. The pass-through appears to be robust to the inclusion of additional variables to proxy world demand and supply. As shown by the ΔTariff*K/L interaction term, the pass-through of tariffs to prices appears to be lower in capital intensive sectors, but this relationship is only significant when using collection rates. The lower pass-through rate may reflect higher barriers to entry or greater product differentiation within these sectors.

TFP growth is also found to have a significant negative impact on product prices. A 10% increase in TFP growth reduces product price inflation by between 3.8% and 4.2%. In a small country model producing homogenous goods, technological change is expected to have zero transfer to product prices as prices are set in international markets. However, the negative relationship is consistent with the impact of global technological change on international prices, or the existence of product differentiation. The significance of the coefficient may also reflect biases associated with the endogeneity of TFP growth. This possibility will be explored later. Finally, rising world prices positively affect domestic prices.

Using only the significant tariff related coefficients, tariff-induced changes in product prices are calculated. The tariff-induced price changes are then regressed on factor shares to estimate mandated factor returns consistent with these price changes. The coefficients represent the average change in factor earning mandated by trade liberalisation between 1988 and 2002.

Table 5: Mandated factor returns from tariff liberalisation, Exogenous technological change

	Scheduled rates		*Scheduled rates + surcharges*		*Collection rates*		*Collection rates + surcharges*	
	Coef.	**Coef.**	**Coef.**	**Coef.**	**Coef.**	**Coef.**	**Coef.**	**Coef.**
Labour (L) and capital (K)								
K-share (β_K)	0.001	0.001	-0.005	-0.005	-0.001	0.001	0.000	0.002
	0.004	*0.004*	*0.004*	*0.004*	*0.001*	*0.001*	*0.000*	*0.002*
L-share (β_L)	-0.018 ***	-0.017 ***	-0.023 ***	-0.023 ***	0.001	0.000	-0.001 ***	-0.001
	0.005	*0.005*	*0.005*	*0.005*	*0.001*	*0.002*	*0.000*	*0.002*
β_L - β_K	-0.019 **	-0.018 **	-0.019 **	-0.019 **	0.002	-0.001	-0.001	-0.003
Mean P change	-0.004	-0.003	-0.006	-0.006	0.000	0.000	0.000	0.000
Obs	31	31	31	31	31	31	31	31
F-stat	14.08 ***	14.08 ***	40.78 ***	40.78 ***	1.43	1.82	14.23 ***	0.55
Adj R2	0.458	0.458	0.720	0.720	0.027	0.050	0.461	-0.030
Less-skill (LS), Skilled (S) and capital (K)								
K-share (β_K)	-0.004	-0.004	-0.011 ***	-0.011 ***	-0.001	0.001	0.000	0.002
	0.004	*0.003*	*0.003*	*0.003*	*0.001*	*0.002*	*0.000*	*0.002*
S-share (β_S)	-0.103 ***	-0.094 ***	-0.118 ***	-0.118 ***	0.001	-0.002	-0.004	0.000
	0.026	*0.024*	*0.023*	*0.023*	*0.005*	*0.011*	*0.003*	*0.014*
LS-share (β_{LS})	0.009	0.008	0.007	0.007	0.001	0.001	0.000	-0.002
	0.009	*0.009*	*0.008*	*0.008*	*0.002*	*0.004*	*0.001*	*0.005*
β_S - β_K	-0.099 ***	-0.090 ***	-0.107 ***	-0.108 ***	0.002	-0.004	-0.003	-0.002
β_{LS} - β_K	0.013	0.012	0.018	0.018	0.002	0.000	0.000	-0.004
β_S - β_{LS}	0.112 ***	0.103 ***	0.125 ***	0.126 ***	0.000	0.004	0.003	-0.002
Mean P change	-0.004	-0.003	-0.006	-0.006	0.000	0.000	0.000	0.000
Obs	31	31	31	31	31	31	31	31
F-stat	16.2 ***	16.2 ***	48.35 ***	48.35 ***	0.92	1.2	9.74 ***	0.36
Adj R2	0.595	0.595	0.821	0.821	-0.008	0.019	0.458	-0.066

Note: Only significant tariff-related coefficients in Table 4 are used to calculate the tariff-induced price changes that are used as the dependent variables in the mandated factor return regressions. Average sectoral value added is used as weights in regressions. *, **, and *** represent significance at the 10%, 5% and 1% level, respectively.

Table 5 presents the estimated mandated factor returns for each of the first-round results in Table 4. These mandated factor return regressions are first estimated using capital and labour cost shares and then using capital, skilled labour and less-skilled labour cost shares. The coefficients represent the average change in factor earning mandated by trade liberalisation between 1988 and 2002.

The mandated factor return results using capital and labour cost shares generally show that trade liberalisation reduced the demand for labour relative to capital. Tariff reductions mandated a 1.7% average annual decline in wages for labour between 1988 and 2002 when using the scheduled rates and a 2.3% decline once surcharges are included. Although trade liberalisation mandated no significant change in the return to capital, the difference in mandated returns to capital and labour is significantly different from zero.

Looking at mandated returns according to skill, we find that tariff reductions mandated a significant negative return to skilled labour in all regressions using scheduled tariff rates. The negative impact ranges from -9.4% per annum when using the unadjusted scheduled tariff rates to -11.8% per annum once surcharges are included. The impact on less-skilled labour is insignificantly different from zero. The mandated return to capital is negative, but only once surcharges are included. However, in all regressions, the average annual mandated return to skilled labour is significantly less than the return to capital (9 to 10.8 percentage points) and the return to less-skilled labour (10.3 to 12.6 percentage points). The mandated return to capital is insignificantly different from the return to less-skilled labour.

These results therefore differ slightly from those found by Fedderke *et al.* (2003) who find that openness mandated rising returns to labour relative to capital. This study finds that trade liberalisation mandated declining returns to labour relative to capital. This result is consistent with factor content studies that ‘reveal’ South Africa to be relatively capital abundant relative to its trading partners (Allenye and Subramanian, 2001).

However, the decline in returns to labour fell heavily on skilled labour, which reflects the relatively large decline in protection within skill-intensive sectors (see Figure 2). This result is consistent with Fedderke *et al.* (2003) who find that product price movements between 1970 and 1997 favoured skill-intensive sectors. The results are also consistent with factor content studies that 'reveal' South Africa to be skill abundant relative to high and middle-income economies who account for the bulk of South Africa's trade (Allenye and Subramanian, 2001). Tariff liberalisation, has therefore reduced wage inequality; a result that is consistent with Stolper-Samuelson predictions of trade liberalisation in a developing country.

5.2.2 Endogenous prices and technological change

A limitation of the previous estimation is that it does not take into account the possible endogeneity of TFP growth. As argued by Wood (1994), trade liberalisation induces technological change as firms respond to increased international competition. In this section, we allow for the endogeneity of technological change. First, the price and TFP functions represented by equations (16) and (17), respectively, are estimated using Baltagi's (1981) error-component two-stage least-squares (EC2SLS) method. Only the scheduled tariff rate data are used in this analysis, as the collection duties continued to give insignificant results. From the results of these regressions, we are able to estimate mandated factor returns arising directly from product price changes and indirectly via trade-induced technological change.

Table 6 presents the estimated coefficients of the first round price and TFP growth regressions using the scheduled tariff rates (columns 1 and 2) and the adjusted tariff rates (columns 3 and 4).

Looking first at the price regressions, we note that the coefficient on the change in tariff variable (ΔTariff) is significant and positive and is of a similar size to the tariff coefficient estimated in the previous regressions. The impact of foreign prices on domestic prices also remains positive and significant. TFP growth remains negative and significant, but the pass-through to domestic prices increases. This is inconsistent with the small country assumption in which prices are set in international markets and may reflect the presence of product differentiation or domestic market power.

The TFP growth regression includes a number of explanatory variables. Tariff increases have a negative impact on TFP growth, but only through the interaction term (ΔTariff*K/L). TFP growth in capital-intensive sectors is therefore relatively strongly affected by changes in tariff rates. One explanation is the generally high proportion of imported intermediate goods used the production of capital intensive products. Rising tariffs therefore inhibit the importation of technology imbedded in imported intermediate goods.

Table 6: First round regressions allowing for endogenous technological change, simultaneous equation approach

	Scheduled rates		*Scheduled rates + surcharges*	
	Price equation	***TFP equation***	***Price equation***	***TFP equation***
	(1)	***(2)***	***(3)***	***(4)***
	Coef.	Coef.	Coef.	Coef.
TFP growth	-0.527 **		-0.590 ***	
	0.252		0.199	
Δ Tariff	0.080 **	0.005	0.094 ***	0.015
	0.033	0.030	0.029	0.028
Δ Tariff*K/L	-0.350	-0.576 **	-0.462	-0.626 **
	0.287	0.258	0.291	0.252
K/L	-0.001	0.015	-0.006	0.011
	0.061	0.035	0.039	0.035
ΔK/K		-0.083 **		-0.082 **
		0.035		0.035
FDI/GDP		0.442 *		0.449 *
		0.233		0.233
ΔPexport		-0.195 ***		-0.197 ***
		0.075		0.075
ΔPPI^{*}	1.027 ***		0.969 ***	
	0.315		0.318	
constant	0.089 ***	0.003	0.093 ***	0.003
	0.015	0.005	0.008	0.005
Obs	434	434	434	434
Wald	35.63 ***	29.81 ***	39.1 ***	30.3 ***

Changes in the capital stock of machinery & equipment have a negative impact on TFP growth, a result that is also found by Fedderke (2001). The negative sign suggests the lack of positive spill-over effects within the sector arising from investment in machinery & equipment. Foreign direct investment as a share of GDP is positively related to TFP growth. Foreign direct investment leads to a transfer to technical know-how to firms, which in turn boosts productivity.

The above results show two avenues through which tariff liberalisation affects factor payments. Firstly, tariffs directly affect product prices and therefore the relative profitability of industries across sectors. Secondly, tariffs directly affect technological change, which also affects the relative profitability of industries across sectors. Table 7 presents the mandated factor returns from tariff-induced changes in prices and TFP growth.

Table 7: Mandated factor returns from tariff liberalisation, simultaneous equation estimation

	Scheduled rates			*Scheduled rates + surcharges*		
	Price equation	***TFP equation***	***Net effect***	***Price equation***	***TFP equation***	***Net effect***
	Coef.	**Coef.**	**Coef.**	**Coef.**	**Coef.**	**Coef.**
Labour (L) and capital (K)						
K-share (β_K)	0.001	0.002	0.002	-0.005	0.002	-0.003
	0.004	*0.002*	*0.003*	*0.004*	*0.002*	*0.004*
L-share (β_L)	-0.017 ***	0.003	-0.014 ***	-0.025 ***	0.003	-0.022 ***
	0.005	*0.003*	*0.004*	*0.005*	*0.003*	*0.005*
β_L - β_K	-0.018 **	0.001	-0.017 **	-0.020 **	0.001	-0.019 **
Mean P change						
Obs	31	31	31	31	31	31
F-stat	14.08 ***	3.03 *	12.47 ***	40.78 ***	3.88 **	36.27 ***
Adj R2	0.458	0.116	0.425	0.720	0.157	0.695
Less-skill (LS), Skilled (S) and capital (K)						
K-share (β_K)	-0.004	0.003	-0.001	-0.011 ***	0.004	-0.008 **
	0.003	*0.002*	*0.003*	*0.004*	*0.002*	*0.003*
S-share (β_S)	-0.096 ***	0.030 *	-0.065 ***	-0.127 ***	0.032 **	-0.095 ***
	0.024	*0.017*	*0.020*	*0.025*	*0.016*	*0.025*
LS-share (β_{LS})	0.008	-0.006	0.002	0.008	-0.007	0.001
	0.009	*0.006*	*0.007*	*0.009*	*0.006*	*0.009*
β_S - β_K	-0.092 ***	0.027	-0.065 ***	-0.116 ***	0.029 *	-0.087 ***
β_{LS} - β_K	0.012	-0.009	0.003	0.019	-0.010	0.009
β_S - β_{LS}	-0.104 ***	0.036	-0.068 **	-0.135 ***	0.039 *	-0.096 ***
Mean P change						
Obs	31	31	31	31	31	31
F-stat	16.2 ***	3.06 **	12.17 ***	48.35 ***	4.03 **	33.96 ***
Adj R2	0.595	0.167	0.520	0.821	0.227	0.761

Note: All regressions are weighted by the average sectoral value added.

Mandated factor returns arising from tariff-induced changes in product prices are very similar to those estimated under the assumption of exogenous technological change. Through its impact on product prices, tariff liberalisation mandated a decline in the return to labour relative to capital (-1.8 to -2 percentage points per annum). However, the mandated decline in the return to labour again fell heavily on skilled labour who experienced a decline in wages relative to both capital (-9.2 to -11.6 percentage points per annum) and less-skilled labour (-10.4 to -13.5 percentage points per annum). On average, tariff reductions mandated 9.6% to 12.7% annual decline in the wage of skilled labour from 1988-2002. Most of this decline, however, would have taken place during the intensive period of liberalisation between 1994 and 1998. Mandated returns to labour as a single category, however, do not differ significantly from those of capital.

The results for trade induced technological change (TFP equation) are generally poor with no significant difference in the mandated returns to capital and labour. However, there is some evidence to suggest that trade induced technological change mandated a positive return to skilled labour. Trade induced technological change mandated a 3% annual growth in return to skilled labour. This is significantly larger than the return to capital and less-skilled labour, but on when using the scheduled tariffs inclusive of surcharges.

These results suggest that trade-induced technological change offset some of the negative impact of trade liberalisation on the return to skilled labour. However, the net effect on skilled labour remained negative leading to a decline in return relative to both capital and less-skilled labour.

5.3 Robustness of results

The robustness of the results is assessed in three ways. Firstly, the first-stage regressions allowing for endogenous technological change are re-estimated with import price data replacing the tariff data. Import prices are obtained from TIPS and cover the period 1970-2002. The longer-time period allows for a more robust estimation of the pass-through of import prices, and hence tariffs, to domestic prices and TFP growth. The coefficients estimated in the first stage are then used to impute change in value added prices arising from tariff liberalisation (including surcharges) from 1988-2002.

Two alternative data sources are also used to test the sensitivity of the mandated wage regressions to data source and level of industrial disaggregation. Firstly, manufacturing firm level data consisting of 325 large (50 or more employees) firms sampled from the Greater Johannesburg Metropolitan Area in 1998 is used (Chandra *et al.*, 2001). Secondly, data on 80 industrial sectors (agriculture, mining and manufacturing) are obtained from the 1993 and 2000 Supply-Use tables provided by Statistics South Africa (1999, 2003). The two-stage procedure is not possible using these data sources as the necessary price data are not available. We thus 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 as $t_{j,fin}$ and $t_{j,ini}$ represent the final and initial tariff rates for product j, respectively. For the firm level data, we compute the average annual change in output prices due to tariff liberalisation from 1993-97, 1997-2000 and 1993-2000.[26] For the Supply-Use data we calculate the change in value added price $\hat{P}_{VA,j} = \hat{P}_j - \sum_{i=1}^{N} a_{ij}\hat{P}_j$ between 1993 and 2002 using the average intermediate input coefficients a_{ij} for 1993 and 2000. Only scheduled tariff rates excluding surcharges are used to calculate price changes for the firm and Supply-Use data.

Table 8 and Table 9 present the first round and second round results when using import prices instead of tariff data for the first round regression. As found in the earlier analysis there is a positive pass-through of import prices to value added prices, but a negative impact on TFP growth. The impact in both cases appears to be stronger in more capital intensive sectors.

The pass-through coefficients in the first-stage regression are used to estimate the price impact arising from trade liberalisation between 1988 and 2002. The mandated factor return regressions using the tariff-induced change prices and TFP are presented in Table 9. The results are also consistent with earlier estimates. Trade liberalisation mandated a decline in the return to labour relative to capital, but the decline falls most heavily on skilled labour. The results suggest that tariff liberalisation mandated a 2.2% annual decline in the return to skilled labour and a

[26] The firm level results are drawn from Edwards (2003b) and use slightly different tariff data to that used in the rest of the study.

0.3% annual increase in the return to less-skilled labour between 1988 and 2002. Trade-induced technological change in turn mandated a rising return to skilled labour (1.1% per annum) and a declining return to less-skilled labour (-0.2% per annum). The net effect, however, remains negative for skilled labour (-1.1% per annum) and insignificantly different from zero for less-skilled labour.

Table 8: First round regressions allowing for endogenous technological change, simultaneous equation approach using import prices, 1970-02

	Price equation Coef.		TFP equation Coef.	
TFP growth	-0.309	***		
	0.108			
Δ Pm	0.156	***	-0.082	***
	0.027		*0.026*	
Δ Pm*K/L	0.394	**	-0.747	***
	0.192		*0.199*	
K/L	-0.110	**	0.206	***
	0.047		*0.049*	
ΔK/K			-0.150	***
			0.023	
FDI/GDP			0.423	**
			0.212	
ΔOpenness	-0.010			
	0.016			
constant	0.095	***	0.018	***
	0.005		*0.005*	
Obs	992		992	
Wald	129.74	***	87.66	***

Notes: *, **, and *** represent significance at the 10%, 5% and 1% level, respectively.

Table 9: Mandated factor returns from tariff liberalisation, simultaneous equation estimation using import prices, 1988-02

	Price Equation Coef.		TFP equation Coef.		Net effect Coef.	
Labour (L) and Capital (K)						
K-share (δ_K)	-0.001		0.0004		0.000	
	0.001		*0.0003*		*0.000*	
L-share (δ_L)	-0.003	***	0.0015	***	-0.002	***
	0.001		*0.0005*		*0.001*	
δ_L - δ_K	-0.003	*	0.001		-0.002	*
Mean P change						
Number of obs	31		31		31	
F-stat	27.02	***	21.26	***	24.11	***
Adj R-squar	0.63					
Less-skill(LS), Skilled (S) and Capital (K)						
K-share (δ_K)	-0.002	***	0.001	***	-0.001	**

	0.001		*0.000*		*0.000*	
S-share (δ_S)	-0.022	***	0.011	***	-0.011	***
	0.004		*0.002*		*0.002*	
LS-share (δ_{LS})	0.003	*	-0.002	**	0.001	
	0.001		*0.001*		*0.001*	
δ_S - δ_K	-0.020	***	0.010	***	-0.010	***
δ_{LS} - δ_K	0.004	**	-0.003	***	0.002	
δ_S - δ_{LS}	-0.025	***	0.013	***	-0.012	***
Mean P change						
Number of obs	31		31		31	
F-stat	41.74	***	34.78	***	28.07	***
Adj R2	0.798		0.766		0.724	

Notes: *, **, and *** represent significance at the 10%, 5% and 1% level, respectively.

The mandated factor returns using the firm level and Supply-Use data are presented in Table 10.

Table 10: Mandated factor returns using firm level and Supply-Use data

	Firm level data			Supply-Use data
	1993-97 Coef.	1997-2000 Coef.	1993-2000 Coef.	1993-2002 Coef.
Less-skill (LS), Skilled (S) and capital (K)				
S-share (δ_S)	-0.021 ***	-0.018 **	-0.020 ***	…
	0.005	*0.007*	*0.005*	
LS-share (δ_{LS})	-0.008 **	-0.012 **	-0.010 ***	…
	0.004	*0.005*	*0.003*	
K-share (δ_K)	-0.014 **	0.017 *	-0.001	…
	0.007	*0.010*	*0.006*	
M-share (δ_M)	-0.013 ***	-0.001	-0.008 ***	…
	0.001	*0.002*	*0.001*	
				…
δ_S - δ_K	-0.007	-0.035 ***	-0.019 **	
δ_{LS} - δ_K	0.006	-0.029 **	-0.009	…
δ_S - δ_{LS}	-0.013 *	-0.006	-0.010	
Mean P change	-0.013	-0.004	-0.009	…
Adj R2	0.688	0.092	0.569	
Number of obs	187	187	187	…
F-stat	104.16 ***	5.74 ***	62.70 ***	
Labour (L) and capital (K)				
L-share (δ_L)	-0.011 ***	-0.014 ***	-0.012 ***	-0.030 ***
	0.004	*0.006*	*0.003*	*0.005*
K-share (δ_K)	-0.017 ***	0.015	-0.003	0.008 **
	0.007	*0.010*	*0.007*	*0.004*
δ_L - δ_K	0.006	-0.029 **	-0.009	-0.038 ***
Mean P change	-0.013	-0.004	-0.009	-0.001
Adj R2	0.663	0.070	0.531	0.42
Number of obs	186	186	186	93
F-stat	135.02 ***	5.69 ***	82.84 ***	29.35 ***

Notes: The dependent variable in the firm level database is the annualised change in product price between 1993 and 2000. The share of intermediate goods in total costs is included in the mandated factor return regressions using the firm survey. The dependent variable in the Supply-Use database is the annualised change in value added obtained by subtracting intermediate input price changes from output price changes arising from trade liberalisation. The Supply-Use results include agriculture, mining (excluding gold) and manufacturing. The Supply-Use equation is weighted by value added in 1993.

Standard errors are in italics below the coefficients. *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

According to the firm survey results, tariff liberalisation between 1993 and 1997 mandated a 2.1 %, 0.8 % and 1.4 % annual decline in the return to skilled labour, less-skilled labour and capital, respectively. The average annual decline in prices due to tariff liberalisation was 1.3 %, implying a real increase in incomes for less-skilled labour, but real declines for skilled labour and capital.

In contrast, tariff liberalisation between 1997 and 2000 had a significant negative impact on the returns to skilled and less-skilled labour relative to capital. Using the firm survey, tariff liberalisation mandated a 1.8 % and 1.2 % annual decline in wages for skilled and less-skilled labour, respectively, but mandated a 1.7 % annual *increase* in return to capital between 1997 and 2000. On average, prices declined by 0.4 % per annum, implying real declines in income to labour (-1.4 % and -0.8 % per annum for skilled and less-skilled labour, respectively) and strong real increases to capital (2.1 % per annum). As in the previous period, tariff liberalisation mandated a relatively large decline in wages for skilled labour compared to less-skilled labour, although the difference is not significant. These results are thus consistent with those found using the SIC 3-digit data, although the mandated decline in skilled wages are found to be lower.

Consistent results are also found when estimating the mandated returns to capital and labour. According to the Supply-Use results, tariff liberalisation mandated a 3% (2.9% real) average annual decline in returns to labour between 1993 and 2002. The firm level data also shows a mandated decline in wages for all periods, with relatively strong impacts between 1997 and 2000.

These results using alternative data sources thus support the conclusion derived from the 3-digit SIC data that trade liberalisation reduced the demand for labour relative to capital, but that the decline in labour demand is concentrated amongst skilled labour.

6. Conclusion

This paper used various different data sources and empirical methodologies to analyse the impact of trade liberalisation and product price movements on factor returns since the late 1980s. A particular contribution of the paper is that tariff data are explicitly used in estimating the impact of trade liberalisation on factor returns. In addition, the paper models trade-induced technological change.

A number of conclusions regarding the relationship between trade liberalisation and employment can be drawn from the results. The results show that tariff liberalisation from 1988 to 2002 negatively affected wages of South African labour relative to the return to capital. However, the decline in demand for labour is concentrated amongst skilled labour. Tariff liberalisation mandated a decline in the wages of skilled labour relative to both capital and less-skilled labour. Trade liberalisation during the 1990s did **not** mandate rising wage inequality.

The paper also finds some evidence of trade-induced technological change. Firms respond to international competition by improving productivity. This may be achieved through the importation of foreign technology imbedded in imported products, the reduction in x-inefficiency or 'defensive innovation'. The results suggest that trade-induced technological change positively benefited skilled labour relative to capital and less-skilled labour. It thus partly ameliorated the negative direct effect on skilled labour arising from a reduction in product prices arising from lower protection. The net effect for skilled labour, however, remains negative.

The results are consistent with factor content analyses of the structure of South African trade, which reveals South Africa to be abundant in capital relative to the world average, and less-skilled labour abundant relative to high and middle-income economies who are South Africa's dominant trading partners (Allenye and Subramanian, 2001). The results of this study are thus consistent with theoretical expectations given South Africa's relative factor abundance.

The results, however, are unable to explain the dramatic decline in employment of less-skilled labour, and the consequent rise in skill intensity of production, during the 1990s. There are various alternative explanations of the decline in demand for less-skilled labour. Firstly, real wage increases are a possible cause of the employment problem in South Africa. Trade liberalisation mandated constant wages for unskilled labour and declining wages for labour as a whole during the 1990s. Yet real wages rose by 2-3% per annum during the 1990s. Secondly, changes in product price and technological change induced by tariff liberalisation may be small relative to other impacts such as exogenous skill-biased technological change and/or international price trends. Edwards (2003b) finds that import prices shifted against less-skilled labour during the 1990s. Wood (1997) also shows that the price of developing country exports fell relative to developed country exports from 1975-1995. International price trends, may therefore account for the decline in demand for less-skilled labour.

These conclusions are necessarily preliminary. The study needs to be extended using tariff data inclusive of ad valorem equivalents. Protection levels used in this paper appear to under-estimate true levels of protection in the economy during the late 1980s and early 1990s. Protection through non-tariff barriers ideally also needs to be included. A further limitation of the current study is the assumption of a common pass-through of tariffs to domestic prices across all sectors. Although interaction terms were included to capture differential pass-through rates, these were largely insignificant. Alternative estimates of pass-through rates at the sector level need to found.

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