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A Firm Level Analysis of Trade, Technology and Employment in South Africa

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ABSTRACT

This paper uses two firm level surveys, the National Enterprise (NE) survey and the World Bank and Greater Johannesburg Metropolitan Council (GJMC) co-ordinated survey, to explore the implications of globalisation on employment in South Africa. We use the firm surveys to analyse the impact of trade liberalisation on the level and skill structure of employment. In the latter case we extend existing research in this area by focussing on the relationship between trade and choice of technology. We also analyse the impact of increased export orientation and foreign direct investment on employment. The results indicate substantial heterogeneity in the response of firms to trade liberalisation. On average large firms negatively affected by trade liberalisation reduced employment. No such relationship was found amongst small firms. Overall, however, the decline in employment due to trade liberalisation is likely to be small. Export competitiveness has improved through trade liberalisation, but this has not led to increased employment. Evidence of the impact of technological change on the skill structure of employment is also found. Increased use of computers, foreign investment and the importation of raw material inputs raise the skill intensity of production.

1. INTRODUCTION

Since 1990 South Africa has experienced a significant rise in the skill intensity of production, a change brought about largely through a reduction in less skilled employment. At the same time, the government has embarked upon a program of tariff liberalisation in accordance with its GATT offer. Frequently, a relationship between the two changes is inferred, with trade liberalisation being accused of driving employment declines.

Empirical analysis of the impact of trade liberalisation on employment and wages in South Africa has grown significantly (Bell and Cattaneo, 1997, Nattrass, 1998, Bhorat, 1999, Fedderke, Shin and Vase, 1999, Edwards, 2001a, Birdi, Dunne and Watson, 2001), yet still no consensus emerges. One reason is that the extent to which South Africa has liberalised its economy has been mixed.[1] Although nominal tariffs have fallen since 1994, effective protection rates have risen or are still high for many sectors (Fedderke and Vase, 2000). Further, the tariff structure has remained complex with a large number of tariff lines and continued use of specific and compound tariffs (Van Seventer, 2001).

A second reason for the lack of consensus on the impact of trade on labour in South Africa is that existing empirical research is characterised by different theoretical frameworks, empirical methodologies and data sources.

Bell and Cattaneo (1997), in one of the first studies dealing with trade and employment within South Africa, utilise a factor content approach to estimate the direct employment impact of South Africa's changing trade structure between 1972 and 1993.[2] They argue that although exports raised manufacturing employment between 1985 and 1993, reductions in the labour coefficient of exports relative to both manufacturing and imports reduced the rate of growth of employment generated by export expansion.[3] Had the labour intensity of exports (export/gross output labour coefficient ratio) not fallen from its 1985 level, average annual growth of export employment would have been 3.67 % between 1985 and 1993, rather than the actual estimate of 3.1 %.

On the import side the average weighted labour coefficient of imports rose relative to manufacturing between 1972 and 1985, suggesting import displacing effects in relatively labour intensive sectors. This trend levelled off between 1985 and 1993, but has been followed by rising import penetration and sectoral shifts in imports that have negatively affected the ultra-labour intensive sector the most. Using a technique based on changes in import penetration ratios Bell and Cattaneo (1997) calculate that rising import penetration between 1985 and 1993 reduced total employment by 10.4 % of its 1993 level. Using a similar approach Edwards (1999) extends the time period of

[1] See Holden (1992), Bell (1993, 1997) and Belli *et al*. (1993) for contrasting overviews of the trade liberalisation process up until the early 1990s.

[2] Factor content studies are not well grounded in theory (see Baldwin and Cain, 1993: 7 and Leamer, 1996b) and require restrictive assumptions regarding the preference and production functions (see Deardorff and Staiger, 1988).

[3] The rise in capital intensity of production has tended to reduce the weighted average labour coefficients of exports, imports as well as overall manufacturing between 1972 and 1993.

analysis and estimates that rising import penetration reduced employment in total manufacturing by 2 % between 1993-97 with particularly strong declines in ultra-labour intensive sectors (9%).

However, indirectly the Bell and Cattaneo (1997) analysis suggests that technology and not trade is the dominant factor influencing employment. While relative shifts in the sectoral composition of exports towards capital intensive sectors accounted for 36 % of the decline in average weighted labour coefficient of exports, the remaining 64 % has presumably arisen from declining labour coefficients within individual exporting sectors. These within sector shifts towards more capital or skill intensive production techniques are commonly ascribed to technological change (Berman, Bound and Griliches (1994) and Berman, Bound and Machin (1997). On the import side sectoral shifts in imports only accounted for 17.3 % of the decline in the average weighted labour coefficient with the remaining 82.7 % again presumably due to technological change.

Bhorat (1999) and Edwards (2001a) have pursued similar factor contents approaches using different techniques. Bhorat (1999) follows the Katz and Murphy (1992) approach and finds that trade has positively affected employment since 1970. However, since tariff liberalisation only skilled labour has benefited. Edwards (2001a, 2001b) utilises input-output tables to deconstruct sectoral growth between 1984 and 1997. He finds that overall trade has had a net positive influence on manufacturing output during the 1990s, but has also been characterised by strong shifts in the sectoral composition of net trade towards capital intensive sectors. Overall, employment losses due to import penetration have been matched by employment gains through export growth. Technological change, defined as a reduction in labour per unit output, account for most of the decline in employment since 1993. A particular feature of this technological change is its very severe skill bias.

The importance of technological change is consistent with the view of Bhorat and Hodge (1999) who find that within sector shifts in the occupational structure of employment explain most of the rising skill intensity of employment in manufacturing and services. This they attribute to the use of IT and micro-electronics in the production process, i.e. skill biased technological change (see also Hodge and Miller, 1999). Further evidence of the impact of technology on the production process is provided by Bowles (1995 quoted in Nattrass,1998) who deconstructs growth in the overall capital-intensity of manufacturing production into sectoral shifts and technological change (intra-sectoral shifts). His results shows that the latter effect dominates. Edwards (???) applies similar decomposition techniques developed by Berman, Bound and Griliches (1994) and Berman, Bound and Machin (1997) to the overall growth in the skill intensity of production within South Africa. He finds that within sector shifts (technology) accounted for 58 % and 90 % of the rise in skilled share of total employment and manufacturing employment between 1994-98, respectively. These results are consistent with the results of Berman *et al*. (1994) and Berman *et al*. (1997) and suggest that technology and not trade (between effects) lies behind the rising skill intensity of production.

Fedderke, Shin and Vase (1999) use an alternative approach to the factor content studies and focus on the impact of relative price changes on the factor market, as is

outlined within the Stolper-Samuelson theorem. They extend the empirical methodology of Leamer (1996a) and use dynamic heterogeneous panel data econometric techniques to estimate wage changes mandated by product price changes. Relationships between product price changes and the skill intensity of production that are consistent with the Stolper-Samuelson theorem are found. Further, they find that changes in product prices mandated payments to capital and labour that were opposite to the impact of technology. Based on the assumption that South Africa is a small developing country with prices set by international markets, they argue that these results are consistent with the view that trade liberalisation positively affected the returns to labour.

There are a number of problems with this analysis. Firstly, South Africa is a middle income country trading with more and less developed economies. Using the Heckscher-Ohlin-Vanek model, the IMF (2000) show that the factor content of net trade 'reveals' South Africa to be capital abundant relative to both developed and developing countries. When using skilled-less skilled factors South Africa is 'revealed' to be less skill abundant relative to developed economies, but skill abundant relative to less developed economies. The impact of trade liberalisation on the price of skill intensive relative to less skill intensive (or capital intensive relative to labour intensive) products depends on tariff and quota reductions vis-à-vis these different economies. Thus, although the estimations support the Stolper-Samuelson theorem, unless the direction of price changes is known the impact on capital and labour is uncertain.

Secondly, the Stolper-Samuelson mechanism affects labour through price changes irrespective of whether they are trade induced. In a small country with perfect competition, domestic price changes will follow international price changes unless domestic measures such as tariffs cause a divergence between the two. If markets are imperfect rents may accrue to capital or labour depending on their market power and prices will not necessarily follow international price movements. The results may, therefor, capture changes in market power since 1970s rather than the impact of international trade.

A major concern with all these studies is that they assume that the choice of technology is unrelated to foreign trade. 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) These effects can also be experienced on the export side as firms use new technology in order to increase their export competitiveness. Indeed evidence by Belli *et al.* (1993) and Fallon and Pereira de Silva (1994) suggest that export growth in South Africa is correlated with Total Factor Productivity growth. Hayter *et al.* (1999) further notes that changes in production techniques have affected export orientated sectors the most. Jonsson and Subramanian (2000) using time series and cross section regression analysis find that TFP growth is positively related to openness (share of exports plus imports in GDP) and is negatively related to tariff protection. Finally, Birdi *et al.* (2001) find that import penetration positively affected employment between 1972-93, but negatively between 1972-97. The difference they attribute to trade induced

improvements in the efficiency of labour arising from trade liberalisation between 1993-97. No clear skill bias is associated with the improvement in labour efficiency as the sign of the relevant coefficient is similar for both high and low skilled labour.[4]

Despite the apparent importance of technological change in influencing employment within South Africa, a number of questions remain. Firstly, much of the estimated within sector shifts towards more capital and skill intensive production techniques shown by Bowles (1995), Bhorat and Hodge (1999) and Edwards (???) may arise from the aggregation of firms into broad industrial sectors. Increased competition with low wage labour abundant economies may cause domestic firms to move up the value chain and produce higher quality products. These shifts which are due to trade will be interpreted as within sector shifts when firms are aggregated in accordance with broad industrial sector classification systems. Firm level analysis may give insight into the impact of trade liberalisation on the composition of products produced within individual firms.

Secondly, relative wages of less skilled labour have risen relative to skilled labour. Edwards and Abdi (2001) show that the relative wages of less skilled to skilled rose from 0.21 and 0.14 in 1970 to 0.40 and 0.34 in 1998 for the total economy and manufacturing, respectively. Within the total economy this growth was very strong during the 1970s, but has continued into the 1990s, a period of increased trade liberalisation. The rise in relative wage of less skilled combined with the significant decline in less skilled employment suggest that labour market factors dominate employment changes and that the impact of trade, if any, is relatively small. The significant within sector shifts towards more skill intensive production techniques discussed earlier may also reflect factor substitution responses to the rising relative wage of less skilled rather than technological change.

Thirdly, it is unclear to what extent technological change is being driven by global skill biased technological change (as argued by Berman *et al*. 1997), sector biased technological change (Findlay and Grubert, 1959), 'defensive innovation' (Wood, 1994, 1997) or trade induced technological transfers (Pissarides, 1997). It is likely that all these factors play a role, but the inability to separate the effects of each of these from each other as well as from other influences arising from the labour market or international trade flows inhibits quantitative assessment of the impact of each of them. This in turn limits suitable policy suggestions.

Insight into these various forces is also constrained by the availability of data. Existing research on trade, technology and employment in South Africa has predominantly utilised aggregated sector data. In aggregating much of the heterogeneity in firm responses is lost. Further, because the reduction in tariffs has not been uniform across sectors and across product lines within aggregated sectors, it has been difficult to create a coherent proxy for trade liberalisation at the sectoral level. The existence of non-tariff barriers prior to 1994 (particularly in agriculture) and the continued use of specific tariffs, formula duties and compound tariffs have further complicated the task. In the time series analyses an openness variable is commonly used to proxy trade liberalisation. This is problematic in the South African case as

[4] Because of data limitations they use race as a proxy for skill rather than occupational category or educational qualification.

much of the rapid rise in openness during the late 1980s has been driven by declining domestic output (Bell and Madula, 2001). Also the time period during which trade liberalisation has occurred is too short for the analysis of long run relationships using time series econometric techniques.

Because of the inability to adequately proxy trade liberalisation changes in employment trends during the 1990s are *inferred* to be related to trade liberalisation (as in Bhorat, 1999 and Edwards, 2001a). This is dangerous as the 1990s are characterised by structural breaks such as the election of a democratic government, the ending of sanctions, a new macroeconomic program and a new reconstruction and development program. It is not clear what the relative role of each of these are in influencing employment patterns.

Recently two firm level surveys, the National Enterprise (NE) survey and the World Bank and Greater Johannesburg Metropolitan Council (GJMC) co-ordinated survey, have become available. Although these have not explicitly been structured around analysing the impact of trade liberalisation, they contain a number of questions that permit the interrogation of new issues that are not possible when using aggregated time series data.

This paper draws upon these firm surveys to extend existing research on trade and employment in South Africa. The focus differs slightly from previous research in that the relationship between trade liberalisation and skill biased technological change is prioritised. The NE survey's focus on investment is particularly useful for this purpose. One objective of the paper is, thus, to evaluate the extent to which the residual (interpreted as skill biased technological change) in the input-output decomposition of Edwards (2001a) is due to trade liberalisation. In doing so Wood's (1994) critique of empirical research in the field of trade and labour that treats technological change as exogenous from trade related forces is dealt with. Other trade related relationships such as the impact of rising export orientation and foreign direct investment on employment are also dealt with.

The next section of the paper presents background information on sample size, foreign ownership, export orientation and changes in employment. This is followed by a more detailed analysis of the impact of trade liberalisation on firms' employment behaviour using cross-tabulations. To test the robustness of these relationships to the inclusion of other variables cross sector econometric techniques are used to estimate labour demand functions. A conclusion ends the paper.

2. BACKGROUND ANALYSIS OF THE SURVEY DATA

2.1 Sample information

The World Bank and Greater Johannesburg Metropolitan Council large manufacturing survey covers manufacturing firms with more than 50 full-time

employees within the Greater Johannesburg Metropolitan Area (GJMA).[5] The survey was administered in 1999 and covers the period 1997 and 1998. Although the survey is not national in its coverage, firms within the GJMA account for 40 % of South Africa's large manufacturing firms and approximately 42 % of formal manufacturing employment (Chandra *et al*. 2001a). In selecting the sample, firms were first stratified on the basis of 8 sectors (see Table 2) and three full employment size-classes (small: 50-99 employees, medium: 100-199 and large: 200-10000).[6] Within these multi-strata, simple random sampling was performed.

The NE survey covered manufacturing and service related firms over the entire nation and was administered in late 1999 and early 2000 and covers the period from early 1998. The sample was selected from a 'universe' of over 40 000 firms constructed from two separate databases purchased from commercial marketing agencies. Their lists in turn are derived from credit agencies, and include all firms which have used or applied for credit from financial institutions or suppliers during the three years prior to the purchase of the database (Gelb, 2001). Firms were stratified on the basis of 13 sectors,[7] two employment size classes (small: 0-50 employees and large: above 50 employees) and in the case of the small firms, also by location.[8] Within these multi-strata, simple random sampling was performed.

Tables 1 and 2 present the number of manufacturing firms and distribution of these firms across sectors for the NE survey and GJMA surveys, respectively. The NE survey consists of 941 firms, 39 % of which are large firms consisting of more than 50 employees. Each of the nine sectors accounts for roughly 11 % of the sample. Relative to the national data-base from which these firms were drawn, large firms are under sampled in the food & beverages and clothing sectors. Small firms within the Gauteng and Western Cape region are under sampled in most sectors.

The GJMA survey used in this analysis only covers large manufacturing firms and consists of 325 firms which is similar in number to the NE survey (367). Metal products, electrical products and iron & steel firms accounted for a large share of these firms, although only the iron & steel sector was over sampled relative to the national population. Relative to the national population and the NE survey textile firms were under sampled in the GJMA survey reflecting the high proportion of textile firms within the Western Cape and KwaZulu-Natal. The GJMA survey also undersampled firms from the food & beverages sector.

Compared to the national population, the survey over samples the iron and steel industry, but under samples the textile & garment sector and food & beverages sector.

[5] A small firm survey was also administered (Chandra *et al*. 2001b). However, the questionnaire is not fully compatible with that of the large manufacturing survey and has not been analysed as result.

[6] The master database was constructed from the total number of registered firms from the following databases: UIF, Matrix Marketing and BMR. See Annex 2 of the large firm survey report (Chandra *et al*. 2001a) for more details on the sampling and weighting procedures.

[7] In addition to the manufacturing sectors presented in Table 1, finance & business, IT services, tourism & catering and retail services were included.

[8] The cities and towns included (together with their peri-urban environment) were: Cape Town, Port Elizabeth, East London, Durban, Pietermaritzburg, Bloemfontein, Kimberley, Nelspruit, and all of Gauteng, together with parts of the North West Province adjacent to Gauteng, such as Brits, Odi and Rustenburg (Gelb, 2001).

Using appropriate weights, national and regional results can be estimated. For comparative purposes the GJMA survey is weighted up to the national level.

Table 1: NE survey sample by size, foreign ownership and export orientation

	No. of firms	Sectoral share (%)	Large firms (% all firms)	Small firms (% all firms)	Foreign firms (% all firms)	Large foreign (% large firms)	Small foreign (% small firms)	Exporter (% all firms)	Large exporter (% large firms)	Small exporter (% small firms)
Food & beverages	101	11	43	57	13	23	3	43	60	29
Wood, pulp & paper	119	13	34	66	5	15	0	45	73	30
Chemicals, rubber & plastics (1)	121	13	34	66	14	32	3	46	71	34
Auto assembly & components	93	10	42	58	24	56	0	39	67	19
Textiles & clothing	116	12	39	61	10	22	2	38	58	25
Fabricated metal	102	11	43	57	12	27	0	50	82	26
Furniture	86	9	41	59	5	11	0	48	80	25
Electrical, electronic & other machinery	110	12	40	60	20	34	6	56	84	38
Printing & publishing	93	10	39	61	6	17	0	31	47	21
Total	**941**	**100**	**39**	**61**	**12**	**27**	**2**	**44**	**69**	**28**

Note: (1) not Pharmaceuticals.
All firms with at least a 10 % foreign ownership are included in the category "Foreign firms". All firms who responded with 'yes' to the question: "Does the firm export part of its production?" are included in the category "Exporter". Not all of these firms exported in the last financial year.
Percentage shares may not sum to 100 % due to rounding up.

Table 2: GJMA large firm survey sample by size, foreign ownership and export orientation

	No. of firms	Sectoral share (%)	Foreign firms (% all firms)	Exporter (% all firms)
Food & beverages	26	8	23	65
Chemicals	48	15	42	75
Vehicles & auto parts	34	11	15	82
Textiles	14	4	36	57
Metal products	57	18	14	67
Furniture & paper	34	11	6	59
Electronics & electrical machinery	56	17	32	82
Iron & steel	56	17	34	68
Total	**325**	**100**	**26**	**71**

Note: Large firm is defined as a firm with over 50 employees.
Percentage shares may not sum to 100 % due to rounding up.

The distribution of large firms that are exporters and/or fully or partly foreign owned are very similar across surveys. Between 26-27 % of large firms are partly or fully foreign owned which far exceeds the share foreign ownership for small firms (2 %) in the NE survey. The value for small firms appears very low and is substantially lower than in the GJMA survey (ranges between 5-20% of small firms (see Table A13 in Chandra *et al.* (2001b)). This difference between large and small firms is also evident in the comparison of exporters vs. non-exporters where a greater proportion of large firms export (69-71 %) relative to small firms (28 %).

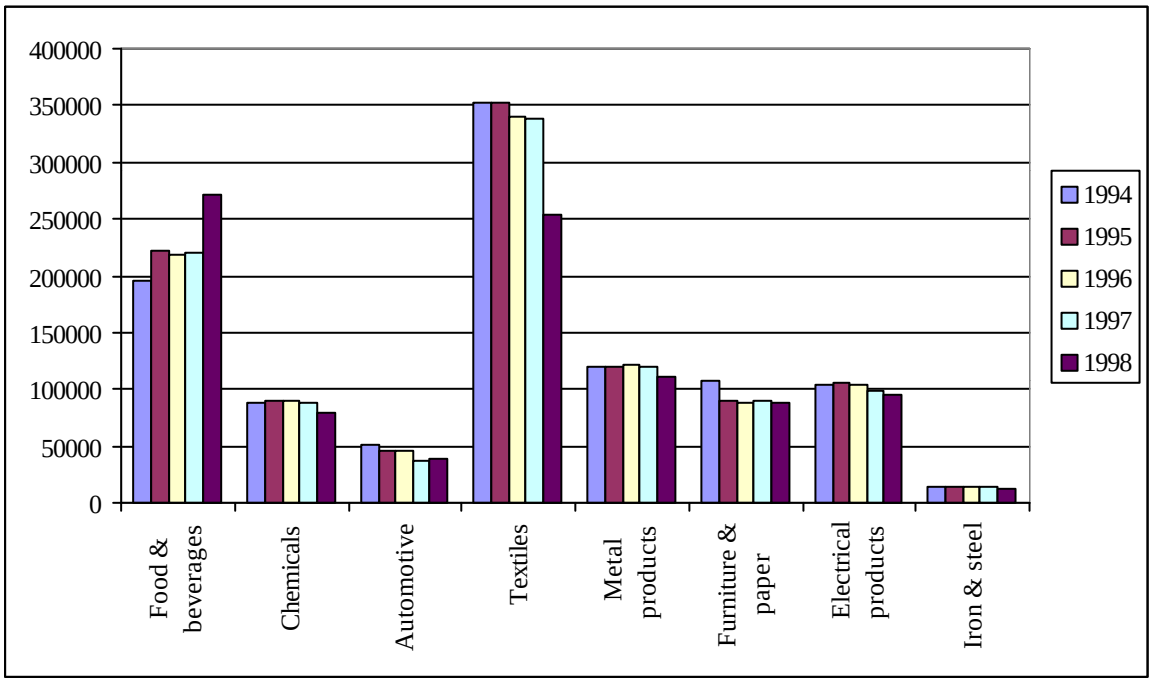
At the sector level there are few differences across surveys in the percentage of large firms exporting, but some differences arise in foreign ownership. Compared to the GJMA survey a relatively high percentage of large NE survey firms have some foreign ownership in the automotive and metal product sectors. In contrast foreign ownership is relatively low in the clothing & textile sector. Looking at exporters, a relatively high percentage of metal products firms, but a relatively low percentage of automotive firms export in the NE survey sample.

Overall the surveys appear compatible with few significant differences between them.

2.2 Employment

As outlined by Bhorat (2001) and Edwards (2001a) formal employment has fallen significantly since 1994. This decline has also been characterised by a skill bias with the bulk of the decline falling on lower skilled occupational categories. Employment changes within the survey are consistent with these trends. As shown in Figure 1 for the GJMA survey, total full-time employment for a consistent set of firms declined for all but the food & beverages sectors between 1994-98.[9] The median level of employment also declined from 138 in 1994 to 118 in 1998. The declines were notably strong in the textile and automotive sectors where employment declined by 28 % and 25 %, respectively, over the entire period. Poor employment growth was also widespread across sectors, particularly between 1997-98 with only 36 % of all firms increasing employment during this time period.

Figure 1: Total full-time employment according to sector since 1994, GJMA survey



Note: Only firms for which full-time employment data were available for all periods were included. These firms made up 59 % of the total sample. Many firms did not supply employment data for the earlier years. The downward trends since 1996 do not change if the sample of firms used to calculate total full-time employment is increased through excluding 1994 and 1995.

[9] Part-time employment is small accounting for 5.4 % of total employment in 1998 and 4.5 % in 1997 according to the GJMA survey.

Neither survey provides information on the level of employment according to occupational categories over a number of years. It is thus not possible to estimate the change in total employment according to skill category. However, the NE survey provides information on whether a firm increased, decreased or retained full-time employment for 5 occupational categories between the start of 1998 and the end of 1999, roughly a two year period. The share of firms within each sector that increased, decreased or did not change employment are presented in Figure 2 for each occupational category. Firms are also classified according to size, ownership and trade orientation traits. The bars below the zero line represent the percentage of firms that reduced employment of that particular occupational category. The bars above the zero are comprised of the percentage of firms that increased employment (middle component) and firms that did not change employment (top component). The absolute value of each column sums to 100%.

Some interesting results emerge. Looking at Figure 2 we find substantial heterogeneity in the employment decision of firms both between and within the size, ownership and trade orientation categories presented.[10] The vast majority of small, domestic and non-exporter firms did not change employment in any occupational category (upward of 70 % in most cases). In contrast, we find significant diversity amongst large firms, foreign firms and exporters with large shares of firms within these categories either increasing or decreasing employment.

Overall, the number of firms that decreased employment in the NE survey exceeded those that increased employment for all skill categories. Because the actual change in employment for each firm is not available it is difficult to determine whether this reflects a net decline in employment since the beginning of 1998. However, the median level of employment in firms that reduced employment was significantly higher than in firms that raised or did not change employment for all skill categories.[11] This together with the relatively high share of firms that reduced employment suggests a net decline in total employment since 1998. The decline employment is not even across skill categories with less skilled labour more negatively affected, particularly amongst large, foreign and export firms. For example, over 40 % of large and foreign firms reduced employment of semi-skilled and unskilled labour. The median level of employment in these firms was also significantly higher than in those firms that raised or did not change employment.[12] In each case the number of firms reducing unskilled employment exceeded the number reducing highly skilled or skilled technical employment. In contrast no skill bias is evident in the number of large, foreign and export firms that increased employment. Between 15 % and 27 % of these firms increased employment across all skill categories. The results suggest a relatively large net decline in employment of less skilled labour within large, foreign and export firms. No such relationship can be inferred from changes in employment amongst small, domestic and non-export firms.

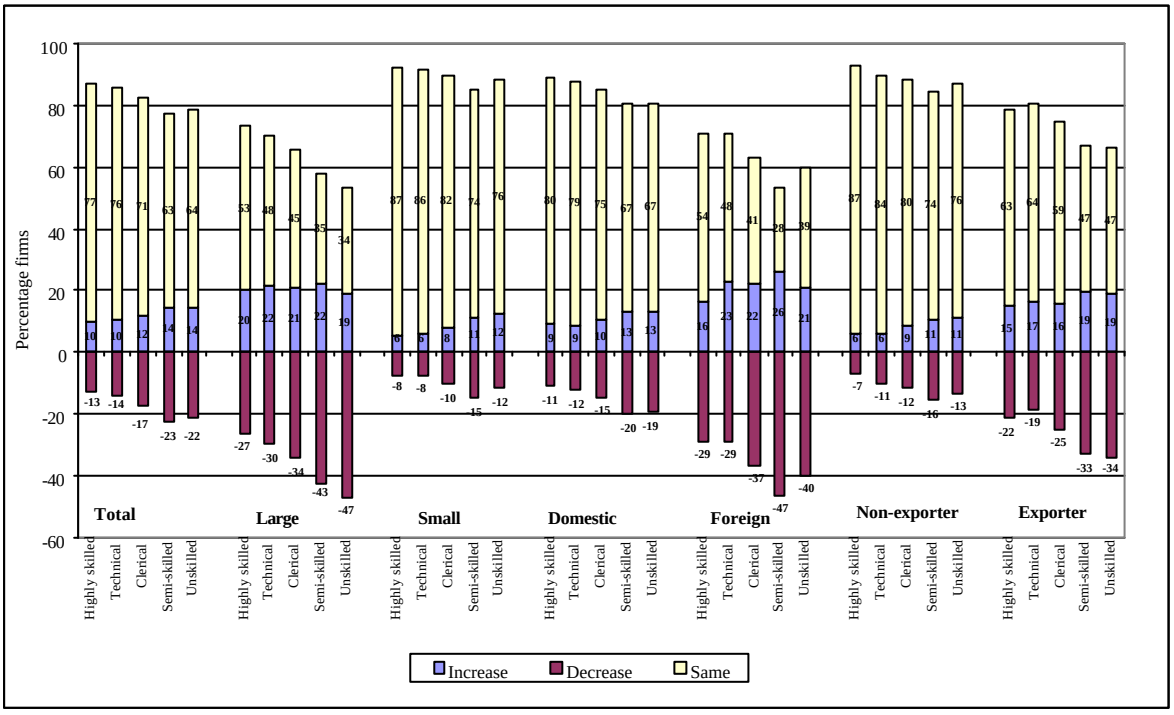
[10] The differences in responses are significantly different from zero.

[11] The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for differences in medians. For each skill level the difference in medians was significantly different from zero at the 1% significance level.

[12] The median level of unskilled and semi-skilled employment in firms that reduced employment over the two years from 1998 was 60 and 90, respectively. The respective median levels of employment for firms that raised or did not change employment was 30 and 40.

Looking within large firms some evidence of the substitution of less skilled for skilled labour is found. Skill neutral effects (such as changes in output) dominate individual firm's employment decisions with high shares of firms increasing or decreasing employment in all skill categories simultaneously. For example 71 % of firms that decreased employment of professional & managerial labour also decreased employment of unskilled labour. Some substitution towards skilled labour also occurred. Of the large firms that increased employment of professional & managerial labour, 49 % also increased employment of unskilled labour, while 33 % and 18 % reduced or did not change employment of unskilled labour, respectively. Of all firms that that increased or did not change employment of professional & managerial labour, 38 % decreased employment of unskilled labour. These firms account for approximately 26 % of all large firms. Unfortunately, because of the lack of firm level employment data according to skill over time we are unable to ascertain whether the skill intensity of production rose in firms that reduced both highly skilled and less skilled labour. Nevertheless, aggregate level data and the substitution towards skilled labour shown provides some, albeit weak, evidence for the existence of skill biased technological change at least amongst large firms.

Figure 2: Changes in full-time employment between the beginning of 1998 and the end of 1999 according to occupation



Note: Highly skilled consist of professional and managerial, clerical includes sales and semi-skilled consist of semi-skilled production workers (machine operators etc).
The Pearson chi-square test was used to test for independence in response between large and small, foreign and domestic and exporter and non-exporter. According to this statistic the employment decision within each sub-category of the small-large, domestic-foreign, exporter-non-exporter classifications are significantly different from each other.

2.3 Trade and foreign ownership

This section briefly outlines the particular features of export oriented and foreign owned firms in the two surveys. As shown in Tables 1 and 2 approximately 70 % of large firms export compared to 28 % of small firms. The share of small firms declines further (to 18 %) if only firms that exported in the last financial year are included. Within the GJMA small firm survey approximately 16.5 % of small firms (6 – 49 employees) exported (Chandra *et al*. 2001b). This suggests that many small firm exporters do not have long-term linkages with export markets and export on a piecemeal basis. The share of large firms exporting is high across all sectors with food & beverages, clothing & textile and printing & publishing found at the lower end. Yet, the share output exported is low for most sectors with only vehicles & auto components and iron & steel firms exporting more than 20 % of their output (Tables 4 and 5). Very low levels of export orientation are evident in firms within the textiles & clothing, machinery & equipment, food & beverages and printing & publishing sectors. The average in all sectors is also biased upwards by the existence of a few firms with very high levels of export orientation. This is evident in the lower median share of output exported by exporters in all sectors shown in Table 5 (10 % in 1998).

Table 4: Mean share output exported for exporters only (%), NE survey

	Share output exported		
	all firms	**Large firms**	**small firms**
Food & beverages	15.0	12.4	25.8
Wood, pulp & paper	19.6	22.0	14.8
Chemicals, rubber & plastics	10.4	13.1	6.5
Auto assembly & components	25.0	31.5	6.1
Textiles & clothing	13.8	13.7	13.9
Fabricated metal	17.7	22.1	11.5
Furniture	18.9	20.0	16.4
Electrical, electronic & other machinery	14.2	15.0	13.3
Printing & publishing	10.5	3.5	15.0
Total	**15.3**	**16.7**	**12.8**
- Domestic	12.7	14.3	10.7
- Foreign	23.6	21.4	41.5

Note: Estimates based on nationally weighted data. A large number of observations are lost as many firms did not supply information on sales. The share output exported includes those firms who stated that they are exporters, but did not export during the last financial year.
There were only 6 small foreign owned export firms preventing a comparison of mean export orientation with domestic owned firms.

Table 5 also shows the percentage of raw material inputs (excluding utilities) imported. Chemical products are highly import intensive with an average of 48.8 % of raw material imported in 1998. The median is close to the mean suggesting that this high result is not due to outlying data points. Mean shares of imported raw material inputs in excess of 30 % were also found for textiles, vehicles & auto parts, electronics & electrical machinery and furniture & paper, although the median in all these cases was less than 15 %. Foreign firms are significantly more import intensive, with 39.3 % of raw material imported as opposed to 21.2 % for domestic firms. This difference is even more stark when using the median import shares of 30 % for foreign and 10 % for domestic.[13] We can thus expect sizeable differences across sectors in the impact of and response to trade liberalisation.

[13] A two tail test was used to test whether the means were significantly different from each other. The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for differences in medians.

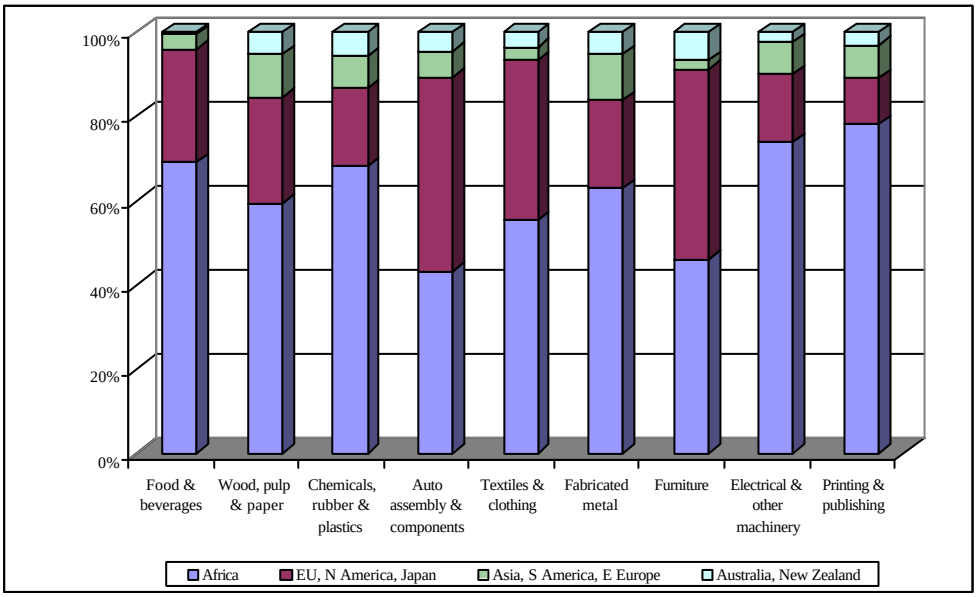
Table 5: Share output exported and raw material inputs imported by sector (%), GJMA survey

	Exports				Imports	
	1997		1998		1998	
	Mean	Median	Mean	Median	Mean	Median
Food & beverages	13.1	3.0	14.3	7.0	17.7	10.0
Chemicals	10.4	5.0	12.0	6.0	48.8	40.0
Vehicles & auto parts	24.1	15.0	27.3	18.0	35.5	10.0
Textiles	7.6	5.0	9.1	5.0	45.3	10.0
Metal products	16.4	10.0	18.3	10.0	22.4	2.0
Furniture & paper	7.3	5.0	8.0	7.0	31.4	7.0
Electronics & electrical machinery	15.3	10.0	19.4	14.0	32.7	15.0
Iron & steel	20.7	10.0	22.6	13.0	22.9	5.0
Total	**12.7**	**5.0**	**14.7**	**10.0**	**26.3**	**10.0**
- Domestic	13.4	5.0	15.2	10.0	21.2	10.0
- Foreign	11.9	7.0	13.0	7.0	39.3	30.0

Note: Export values include only exporters. The median share of output exported amongst exporters was also lower than the mean when using the NE survey.
Import values refer to the percentage raw material inputs (excluding utilities) imported.

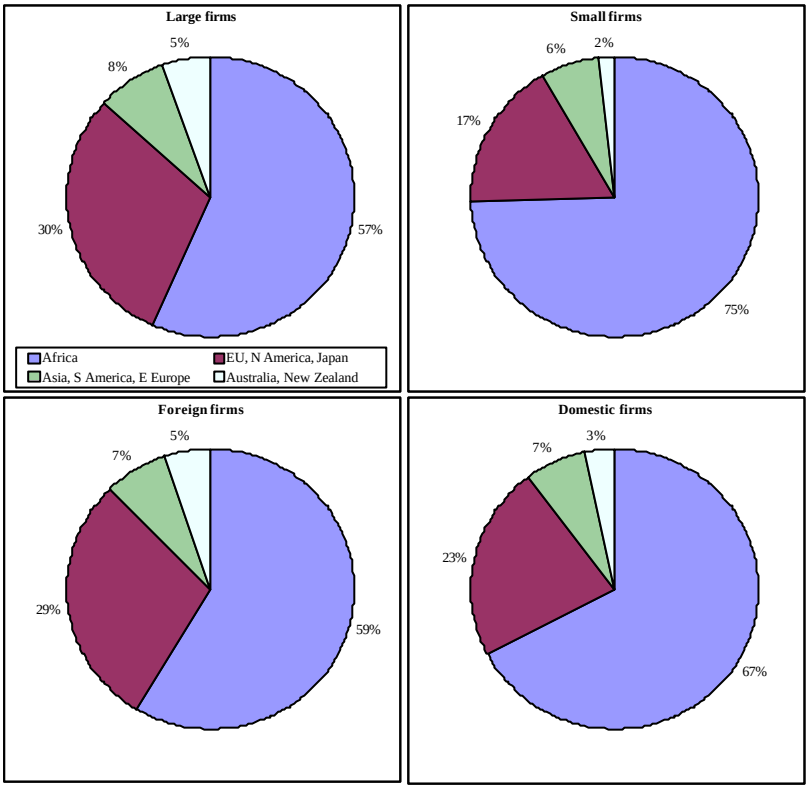
As shown in Figure 2 Africa dominates as an export destination and on average accounts for 65 % of each firm's exports. The average share of output exported to Africa is high for all sectors, but is very high (exceeds 65 %) for printing & publishing, electrical & other machinery, food & beverages and chemicals, rubber & plastics. The second most important destination is the EU, North America and Japan which on average account for 24 % of exporters exports. The auto assembly & components and furniture sectors are strongly orientated towards this region with an average of 46 % of exports destined for these countries. Looking at the destination of exports according to firm size and foreign ownership in Figure 3 we see that the bias towards Africa is relatively strong for small firms (75 %) with large firms selling relatively high shares of their exports (30 %) to EU, North America and Japan. Domestic owned firms appear to be more orientated towards African markets, but the shares are not significantly different from each other.

Figure 2: Mean share of exports to different regions according to sector (%), NE survey



Notes: Calculated as the average of the firm's share of exports to each region. This does not necessarily reflect the regional distribution of total exports.

Figure 3: Mean share of exports according to region (%), NE survey



Some mixed results emerge with respect to the export orientation of foreign firms. The NE survey (Table 4) indicates that export orientated foreign firms export a greater percentage of their output (23.6 %) than domestic firms (12.7 %). However, within the GJMA survey (Table 5) the level of export orientation is lower for both foreign (13 %) and domestic (15.2 %) firms, the difference of which is not significantly different from zero. To explore the relationship between export orientation and foreign ownership further, we make use of pair-wise correlation coefficients between the share output exported and the share foreign ownership for each sector. The correlation coefficients for the NE survey are presented in Table 6. The correlation coefficient was positive for all 9 sectors and significant in 6 (at the 10 % level) when using all firms in the sample. Therefore there is strong evidence that foreign firms are more export orientated than domestic firms are. The relationship is particularly high for the automotive, textiles and machinery and equipment sectors. A positive correlation coefficient between share foreign ownership and share sales exported was found using the total sample within the GJMA survey, but this was only significant at the 10 % level. Of the individual sectors within the GJMA survey only the fabricated metal products had a significant (at 5 % level) positive correlation coefficient. An analysis of the pair-wise correlation coefficients for large and small firms separately suggests that much of the relationship found using all firms in the NE survey sample may arise from very strong relationships within small firms which are not included in the GJMA survey. The sample size of the foreign owned small firms suggests that this relationship may not be robust.

Table 6: Pair-wise correlation coefficients between exports/sales and percentage foreign ownership, NE survey

	All firms		Large firms		Small firms	
Food & beverages	0.209	**	0.117		0.409	***
Wood, pulp & paper	0.119		0.027		-	
Chemicals, rubber & plastics	0.385	***	0.234		0.881	***
Auto assembly & components	0.510	***	0.345	**	-	
Textiles & clothing	0.493	***	0.508	***	0.224	*
Fabricated metal	0.190	*	0.027		-	
Furniture	0.014		-0.076		-	
Electrical & other machinery	0.409	***	0.246		0.574	***
Printing & publishing	0.007		0.051		-	
Total	**0.311**	*******	**0.224**	*******	**0.340**	*******

Note: *, ** and *** signify significance at the 10%, 5% and 1% level, respectively

Although export orientation has grown constantly since the mid 1980s (Bell and Madula, 2001, Edwards, 2001a), a trend also evident in the GJMA survey (Table 5), the overall level of export orientation is low compared to other African and East Asian countries. Within Cameroon, Ghana, Kenya and Cote d'Ivore similar shares of firms export, but these exporters export between 28 % and 60 % of their output (Rankin, 2001). Export firms in Indonesia, South Korea, Malaysia, Philippines and Thailand export between 36 % and 64 % of their output (Chandra *et al*. 2001a). Some of this failure is due to past isolation and import substitution policies. Some is also due to the failure of small enterprises to enter into the export market. The survey data indicates that a greater share of large firms export and that these firms have more stable linkages with export markets than small firms. A further reason is the lack of foreign direct investment in South Africa. Foreign owned firms are more export orientated than domestic firms are, particularly amongst small enterprises.

2.4 Other key characteristics of foreign and export firms

Table 7 draws upon the NE survey and compares foreign and export firms with domestic and non-export firms according to a number of firm characteristics. Because large and small firms differ in many respects these comparisons were made for small and large firms separately. In the process of comparing these firms both the means and the medians of the relevant firm characteristics were calculated. As is clear from Table 7 the means and the medians do not coincide indicating a non-normal distribution of the variables. The discussion that follows will draw reference to the median results. Differences between the means and medians within the large or small categories were tested for significance. The results are also shown in the table.

Table 7: Key characteristics of foreign and export firms, NE survey

	Large		Small			Large		Small	
	Domestic	**Foreign**	**Domestic**	**Foreign (1)**		**Non-exporter**	**Exporter**	**Non-exporter**	**Exporter**
Average									
Investment/assets 98 (%)	11.4	12.9	53.0	215.6		10.1	12.5	52.2	75.3
Investment/assets 97 (%)	10.1	12.3	22.1	30.9		9.4	11.2	14.0	42.2
High skilled/unskilled	**0.79**	**1.71****	0.86	1.41		**0.65**	**1.18****	0.82	1.01
Skilled/low skilled	0.40	0.83	0.90	1.10		0.50	0.53	0.89	0.94
Output (R millions)	352.6	410.1	6.7	8.5		**129.4**	**474.1*****	**4.9**	**11.3***
K/L ratio (R millions)	0.32	0.30	0.17	0.34		**0.14**	**0.39*****	0.12	0.31

Q/L (R millions)	**0.35**	**0.48***	0.38	0.48		**0.20**	**0.45*****	0.26	0.69
Employment	744.0	737.1	19.4	18.9		**335.5**	**917.5*****	**18.3**	**21.9****
Medians									
Investment/assets 98 (%)	5.0	6.8	7.1	48.6		5.7	6.0	7.4	7.5
Investment/assets 97 (%)	**5.0**	**7.3****	2.8	1.9		5.0	5.6	2.7	4.9
High skilled/unskilled	**0.21**	**0.49*****	0.50	0.88		0.20	0.30	0.50	0.57
Skilled/low skilled	**0.15**	**0.25*****	0.42	0.73		**0.11**	**0.23*****	0.42	0.40
Output (R millions)	**32.9**	**70.0*****	**3.20**	**5.85****		**25.0**	**57.0*****	**3.00**	**4.00*****
K/L ratio (R millions)	**0.10**	**0.23*****	0.06	0.04		**0.07**	**0.16*****	0.07	0.06
Q/L (R millions)	**0.23**	**0.32*****	**0.16**	**0.50****		**0.12**	**0.32*****	**0.15**	**0.22*****
Employment	**130**	**185*****	16	15		**118**	**167****	**15**	**19*****

Notes: (1) There were at most 16 observations for small foreign firms. Care must be taken when comparing the results for small foreign firms with large foreign firms.
The differences in results between domestic and foreign and non-exporters and exporters were tested for large and small firms separately. A two tail test was used to test whether the means were significantly different from each other. The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for differences in medians.
*, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.
Output per labour and K/L are calculated using full time employees. High skilled consists of professionals and managerial labour. Skilled consists of professional, managerial and skilled technical labour. Less skilled consists of unskilled and semi-skilled production workers.

Foreign and export firms differ from domestic and non-export firms, respectively, in many aspects. This is noticeably evident amongst large firms. Large, foreign and export firms are more skill intensive, produce more output, are more capital intensive and employ more labour which is also more productive (as shown in the Q/L ratio). The difference amongst small firms is less obvious. Small foreign and export firms have higher output and labour productivity, but are not more skill intensive when compared to domestic and non-export firms, respectively. No difference in investment rate is evident.

The results are consistent with the view that technological transfers through foreign ownership and export competition increase the skill intensity of production. The relationship may also reflect the structure of South African comparative advantage given increased competition from low wage less skill abundant developing economies. Globalisation trends such as increased exports and greater foreign direct investment are likely to benefit more capital intensive and skill intensive firms within sectors. This view is consistent with existing analysis of trade flows which reveal a capital and skill intensive export structure (Tsikata, 1999, Edwards, 2001b, Lewis, 2001) and relatively high growth of skill intensive exports since 1993 (Edwards, 2001a).

2.5 Discussion

The background analysis of the survey data highlights a number of relationships and trends that are of interest to the trade and labour debate. The surveys indicate that there is substantial heterogeneity in the employment decision across firms. The bulk of small, domestic owned and non-export firms did not change employment between 1988 and the end of 1999. In contrast, a high percentage of large, export and foreign owned firms reduced employment, particularly of semi-skilled and unskilled labour. An understanding of the employment processes within these firms is thus central to further insight into the employment problem in South Africa. The varied nature of the

employment response across firms suggests that firm specific effects such as the reduction in protection of specific product categories may have an influence on employment.

The relatively large decline in employment of less skilled labour may reflect the effect of skill biased technological change. Evidence that a substantial share of firms raised their skill intensity of production through increasing the employment of skilled labour while decreasing the employment of less skilled labour is further support for this hypothesis. Not clear, however, is the extent to which trade related factors such export orientation, foreign ownership and trade liberalisation lie behind the rising skill intensity of production. The relatively large decline in employment of less skilled labour amongst export orientated and foreign owned firms suggests that a relationship does exist, at least for export orientation and foreign ownership. More sophisticated empirical techniques are required to test the robustness of this relationship.

The background analysis of the data also indicates that foreign and export firms are on average more skill intensive, more capital intensive, more productive and larger than domestic owned and non-export firms. These relationships are stronger amongst large firms. The growth in exports and foreign direct investment during the 1990s may have benefited skilled labour relative to less skilled labour.

3. A PRELIMINARY ANALYSIS OF TRADE LIBERALIZATION ON EMPLOYMENT AND TECHNOLOGICAL CHANGE

The analysis so far has not focussed on the extent to which trade liberalisation may have driven some of the relationships and trends identified above. Of particular interest is the extent to which trade liberalisation influences technological change. In this section we explore this relationship in more detail.

The GJMA and NE survey were not specifically structured around an analysis of the impact of trade liberalisation on firms' behaviour. Nevertheless, certain questions were included that enable the classification of firms according to the severity (significantly, moderately, and little/not affected) of the impact of trade liberalisation on a firm's operation. These questions were:

NE survey

(a) What has been the impact of the cut in import tariffs since 1994 on the following aspects of *your* operation? (Q 54a and Q81)

- Lower production price in South Africa[14]
- Loss of SA market share to foreign competitors
- Made your exports more competitive

(b) What is the impact of the following on *your* operations? (Q55 and Q83)

- SA regulations affecting export shipments
- Foreign tariffs raising the price of your exports
- Foreign licenses or other barriers limiting access to export markets

[14] This is slightly ambiguous. It is not clear whether the lower product price is due to import prices of substitutes or lower prices of inputs in the production of the firm's product. The impact on each firm will differ in each case.

GJMA survey
(a) Have lower import duty/tax cuts since 1994 affected your business? (q4.9a)
(b) If yes have the duty/tax cuts lowered the product sales price through stiffer international competition? (q4.9b)

In each of the NE and GJMA surveys firms were requested to select one of the following categories in response to the above questions: significantly affected, moderately affected, and little/not affected.

3.1 Theoretical considerations

In standard trade theory the impact of trade liberalisation on an economy is analysed using a general equilibrium framework. The most common theoretical model used for this purpose is the Heckscher-Ohlin model from which the Stolper-Samuelson theorem can be derived. 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. In response to the relative price shock output of skill intensive sectors rise while output of the unskilled labour intensive falls. Further, all firms respond to the change in relative wages and substitute skilled labour for less skilled labour which reduces the skill intensity of production within each industry.

Because this paper draws upon firm level surveys some of these general equilibrium effects are unlikely to be captured. Nevertheless, a number a number of testable hypotheses regarding the impact of trade liberalisation on employment and technology choice can be derived. Firstly, output falls in import competing firms experiencing a reduction in protection. Through derived demand this translates into a decline in employment across all occupational categories, although the extent of the decline for each skill category is dependent on changes in relative wages as outlined in the Stolper-Samuelson theorem. We would thus expect to see relatively large employment declines in sectors that are negatively affected by trade liberalisation. In contrast, export competing sectors gain from trade liberalisation as input costs decline and relative output prices shift in their favour. We would thus expect to see employment increases in export orientated firms or firms for which imports constitute a large share of domestic raw material requirements.

The impact of technology on employment within firms depends on the nature of this technology. If a particular firm or sector experiences Hicks neutral technological change, then in a general equilibrium framework output and employment across all skill categories in this sector will increase relative to other sectors. If factor intensities differ across sectors relative factor payments will change (see Findlay and Grubert (1959)) Thus if Hicks neutral technological change occurs in skill intensive sectors, the relative wage of skilled labour will rise. These effects are general equilibrium in nature. At the firm level the marginal impact of Hicks neutral technological change may be a reduction in employment in the short run as less factors are required to produce a given output. However, as in the general equilibrium case, Hicks neutral technological change has a uniform impact on all factors of production within the firm. Only if factor payments change will relative factor demands change.

In contrast, trade induced technological change does not necessarily have a uniform impact on factor usage. According to Wood (1994) firms facing increased import competition invest in skill intensive technology or restructure production such that it becomes more skill intensive in order to remain competitive, a process he calls 'defensive innovation'. This process negatively affects employment and wages of less skilled labour. We would thus expect to see relatively high investment in skill intensive production technology coinciding with a rising skill intensity of production within firms experiencing a reduction in tariffs on their products. Alternatively, firms may re-organise the production process without changing the stock of technological capital. This can take the form of a reduction in *x*-inefficiency whereby slack labour is reduced or through the re-setting of machinery to produce output using more skill or capital intensive techniques. Aguirregabiria and Alonso-Borrego (2001) argue that this may have a larger impact on the occupational structure of employment than new investment. We would thus expect to find relatively high shares of firms restructuring production in the face of increased import competition.

Pissarides (1997) discusses a further form of trade induced technology transfers. Trade increases technological transfers from developed to developing countries through the imitation of foreign technology and the transfer of technology imbedded within imported goods. These technological transfers "*cause more wage inequality in developing countries because the transfer technology is biased in favor of skilled labour*" (Pissarides, 1997: 20). According to this view we would find a positive correlation between the share of imports in raw materials used and the skill intensity of production.

A final form of technological change is pervasive skill biased technological change as discussed by Berman, Bound and Griliches (1994), Berman, Bound and Machin (1997) and Machin and Van Reenen (1998). [15] The effect of skill biased technological change is revealed in greater usage of computers in the production process which raises the demand for skilled labour relative to less skilled labour in all sectors. We would expect to see rising skill intensity across all sectors, but these changes will be particularly strong in sectors or firms where large investments have been made in skill intensive machinery. Because this form of technological change is unrelated to trade liberalisation, we would expect to find no relationship between skill intensive investment and trade liberalisation. Where a relationship exists this is likely due to 'defensive innovation' or the importation of raw materials that complement skilled labour rather than skill biased technological change.

In the following section simple cross tabulations are used to explore the impact of trade liberalisation on market share, employment, export performance and technological change. Preliminary conclusions regarding the severity of the impact of trade liberalisation on employment are then tested formally using econometric techniques.

[15] The skill biased technological change has to be pervasive across countries. In a general equilibrium model localised skill biased technological change will not necessarily raise the returns to skilled labour (Berman, Bound and Machin, 1997). See Haskel and Slaughter (1998) on the sector bias of skill biased technological change in a general equilibrium context.

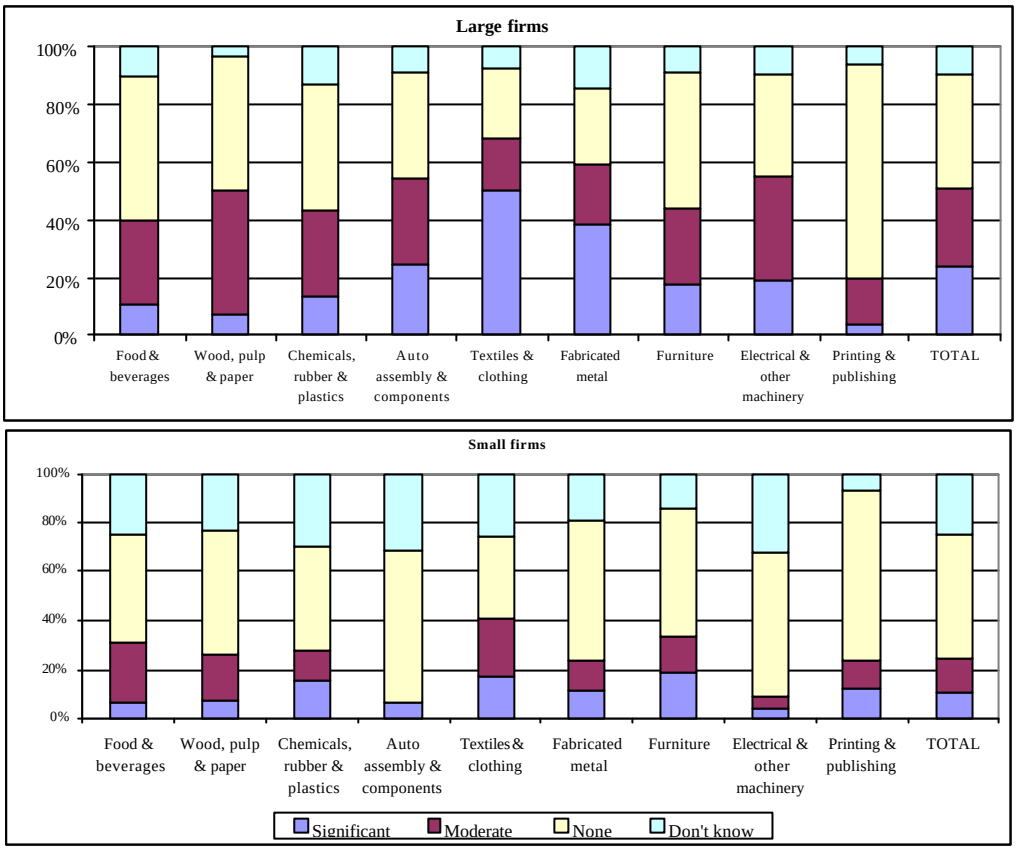
3.2 Impact of trade liberalisation on market share and product price

Figure 4 and Figure 5 present the distribution of NE survey firms according to the impact of trade liberalisation on market share and product price. Because the impact of trade liberalisation on market share varied across sectors for large firms, the sectoral responses are presented. The sectoral results for small firms are presented as well, even though there is no significant variation across sectors. The impact of trade liberalisation on product prices using the NE survey are presented for small and large firms in Figure 5. The results did not differ across sectors and only the total distribution for each size category is presented. Where different the results using the GJMA survey are discussed.

The negative impact of trade liberalisation is measured through its impact on a firm's product price or loss of market share to foreign competition. The impact on market share differs significantly for large and small firms with the former more severely affected than the latter. This is clearly shown in the total columns in Figure 4 where 51 % of large firms were either significantly or moderately affected compared to 24 % of small firms. Relatively low impacts on market share for small firms were also found within the GJMA small firm survey where 30 % of small firms found that dumping of imports by domestic and foreign firms significantly or moderately affected their business operations (Chandra *et al*. 2001b). For large firms the impact of trade liberalisation on product prices was less severe than the loss of market share with 43 % of firms experiencing significant or moderate declines in product prices due to trade liberalisation (Figure 5). In contrast the impact of price declines for small firms was more widespread than the loss of market share with 35 % of small firms significantly or moderately affected. 16 % of small firms were unaware of the impact of trade liberalisation on product prices suggesting that this value could be substantially higher.

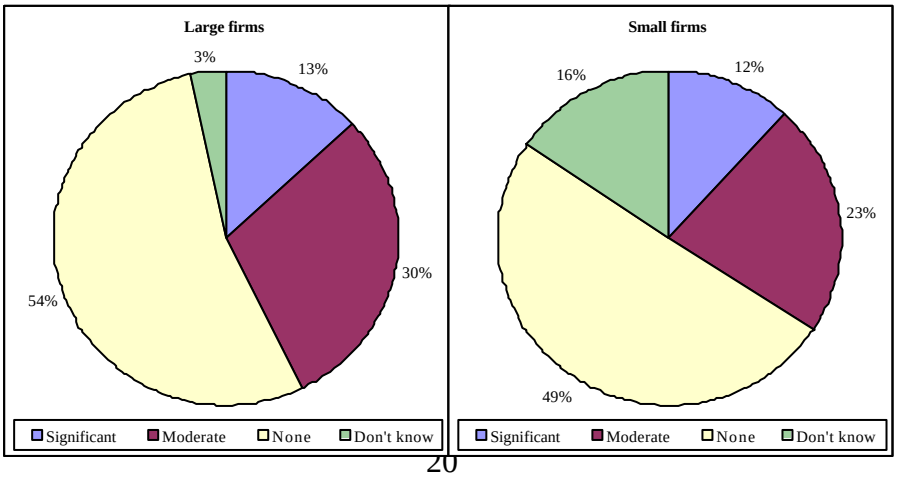
The share of GJMA survey firms affected by trade liberalisation was substantially lower than in the NE survey. The GJMA survey asks whether lower import duty/taxes since 1994 have affected their business and product prices. Only 36 % of firms experienced significant or moderate negative impacts of trade liberalisation on their business which is lower than the share firms experiencing declining market share due to trade liberalisation in the NE survey. It is possible that some of the NE survey responses to the impact of trade liberalisation on market share are really due to greater domestic competition rather than import competition. In the case of the impact of trade liberalisation on product prices, the share of firms *significantly* affected are similar across both surveys (13 % and 15 % for the NE and GJMA surveys, respectively), but the NE survey results show a substantially greater share of firms *moderately* affected (30 %) compared to the GJMA survey (12 %). The differences suggest that regional location (the GJMA only covers Gauteng while the NE survey is national in its coverage) or differences in the implementation of the surveys may give rise to different results.

Figure 4: Loss in market share from increased foreign competition since 1994 (% firms in each sector), NE survey



The impact of trade liberalisation on market share was not even across sectors. As shown in Figure 4, a very high percentage of clothing & textile (50 %) and metal product (38 %) firms experienced significant declines in market share. In contrast, only 16 % of firms within these two sectors experienced significant negative effects of trade liberalisation on product prices. The impact of trade liberalisation is being felt through rising import penetration (brought about through legal as well as illegal imports) rather than through price competition. This effect is not uniform across size differences as a much lower percentage of small textile (17 %) and metal products (11 %) firms were significantly affected by loss of market share. The difference between large and small firms is also evident in the other sectors. These differences reflect substantial inter- and intra-sector heterogeneity in the impact of trade liberalisation on market share. There is substantially less heterogeneity in the impact of trade liberalisation on product prices.

Figure 5: Decline in product price due to trade liberalisation, NE survey



The substantial heterogeneity in the impact of trade liberalisation on firms both between and within sectors highlights the difficulty in analysing the impact of trade liberalisation on employment using broadly defined industrial categories. Overall trade liberalisation has negatively affected a high percentage of large firms, but predominantly through loss of market share rather than price decreases. In the case of small firms, the majority of firms were not affected by trade liberalisation at all or, if so, were largely affected by product prices.

3.3 The impact of trade liberalisation on employment

There are no questions within the surveys that ask firms for the direct and indirect (via new technology) impact of trade liberalisation on employment. Cross tabulations are, therefore, used to analyse whether employment declines were relatively high in firms that were significantly or moderately affected by trade liberalisation. Although these tables only identify correlation and not causation, they can be used to check whether the data are consistent with the view that trade liberalisation had a '*significant*' negative effect on employment.

The NE survey is used to analyse the skill bias of employment changes due to trade liberalisation. Unfortunately, occupational employment changes in the NE survey are only given for the beginning of 1998 to the end 1999. We cannot therefor ascertain the extent to which trade liberalisation contributed towards the decline in employment since 1994, as much of the impact will have already taken place prior to 1998. Because the GJMA survey has total employment data from 1994, it is possible to analyse whether a relationship between employment changes and tariff liberalisation exists over the period 1994-98. It is not possible, however, to analyse the impact on the occupational structure of employment using this survey. In both surveys the measured impact of trade liberalisation on employment in import competing firms will be biased downwards if a large number of firms have closed due to trade liberalisation as these firms are not captured in the survey.

Figure 6: Employment changes according to the impact of tariff liberalisation on the loss of SA market share to foreign competition, NE survey (% firms)

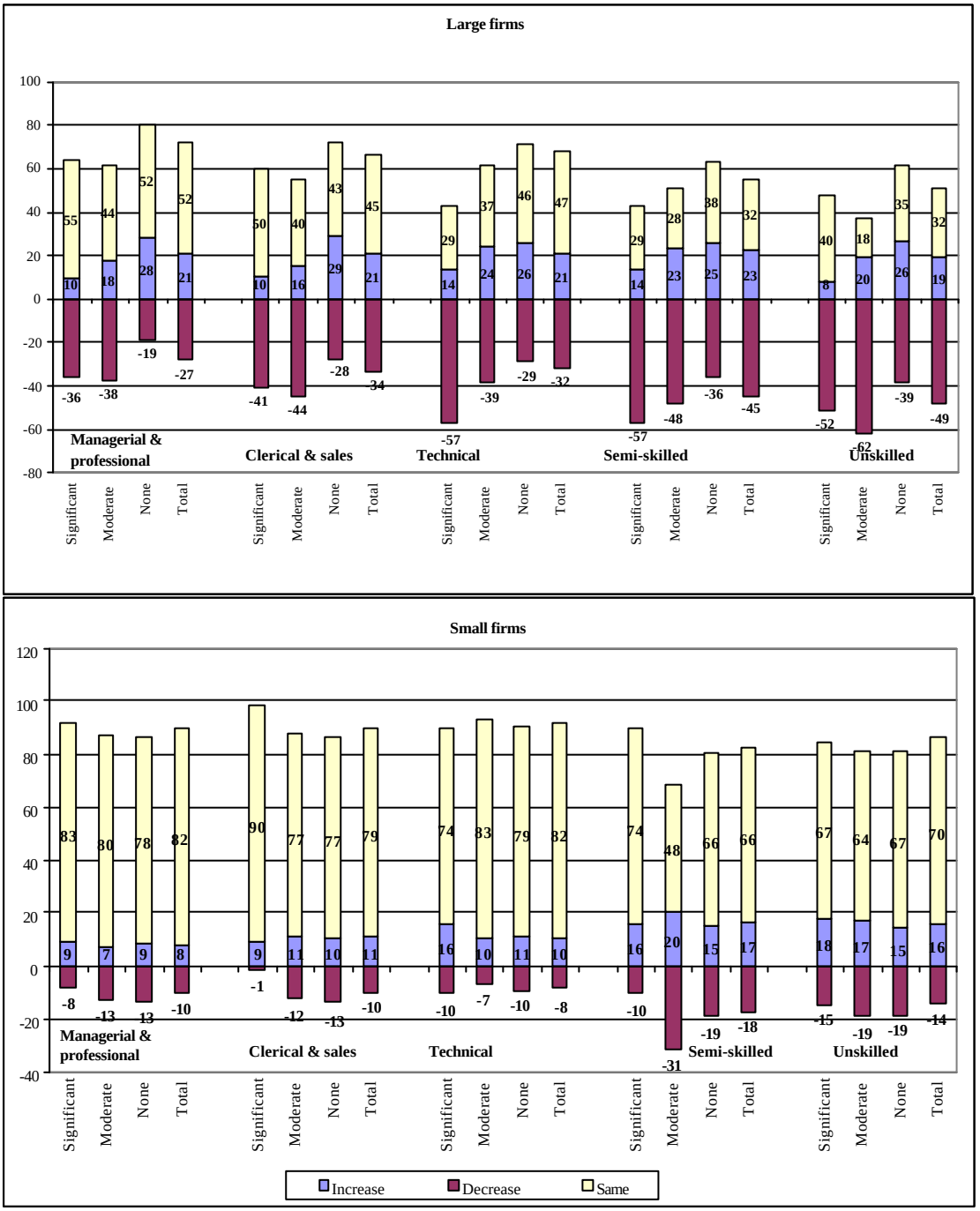


Figure 6 presents the NE survey share of firms that increased, decreased or did not change employment according to the severity of the impact of trade liberalisation on the loss of market share to foreign competition. The lower, middle and upper segments of each column reflect the percentage of firms that reduced employment, raised employment and did not change employment, respectively. The sum of the absolute values of each segment within each column sum to 100 %. The figure can be used to analyse whether firms that experienced negative effects from tariff liberalisation have reduce employment relatively more than firms that have not been

negatively affected. Separate diagrams for large and small firms have been constructed.

Evidence in support of the view that trade liberalisation negatively affected employment can be shown by either

- a high share of firms that were significantly or moderately affected by trade liberalisation reducing employment across all skill categories relative to firms that were not affected, and/or
- a low share of firms that were significantly or moderately affected by trade liberalisation increasing employment across all skill categories relative to firms that were not affected.

There is no evidence of either of these relationships in the figure for small firms.[16] For all skill categories the share of firms that reduced employment was equal to or higher amongst those firms not affected by trade liberalisation than those significantly affected by trade liberalisation. The opposite is the case with employment increases. Together these contradict expected employment impacts arising from trade liberalisation.

A consistent relationship is evident amongst large firms where according to the Pearson chi-square statistic the distribution of employment changes differs significantly across trade liberalisation categories.[17] In all skill categories the share of firms decreasing employment was higher amongst firms significantly affected by trade liberalisation than firms not affected. The opposite is true in the case of employment increases where the share of firms increasing employment progressively rises as the effect of trade liberalisation diminishes. This trend holds for all skill categories and is entirely consistent with our expectation regarding the impact of trade liberalisation on employment in import competing firms at the firm level. Interestingly, for many occupational categories the highest share of firms decreasing employment occurred amongst firms moderately affected by trade liberalisation suggesting that other factors are also at play.

Table 8 presents the average and median change in full time employment over the period 1994-98 using the GJMA survey. These changes are separated according to the impact of tariff liberalisation on the firm. A negative relationship exists between the change in full time employment and the impact of trade liberalisation on the firm, although it is weak. As shown in Table 8 the median firm not affected by lower import duties/taxes since 1994 raised employment by 7.7 %. In contrast the median firm that was affected reduced employment by 8.9 %. The difference is significant at the 10 % significance level. A similar result is found when comparing firms according to the impact of trade liberalisation on product prices, although only the means are weakly significantly different from each other. The statistical power of the relationship is weak suggesting little or no relationship between tariff liberalisation and employment changes between 1994-98. This is also suggested by the pair-wise correlation coefficients between the percentage reduction in product price and the percentage decline in employment which is insignificantly different from zero.

[16] This can also be shown using the Pearson chi-square test for each employment category.

[17] For semi-skilled labour the relationship is only significant for large and small firms combined.

Table 8: Mean and median % change in employment between 1994-98 according to impact of trade liberalisation, GJMA survey

	Mean	Median
Have lower import duties/taxes since 1994 affected your business?		
No	35.6%	7.7%
Yes	-2.9%	-8.9%
Significance		*
Have duty/tax cuts lowered product prices through stiffer competition?		
No	25.1%	7.7%
Yes	-7.1%	-13.9%
Significance	*	

A two tail test was used to test whether the means were significantly different from each other. The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for differences in medians.
*, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

No consistent relationship between trade liberalisation and employment is found across firm characteristics using either survey, although where a relationship existed it was negative. This is particularly evident amongst large firms. The evidence lends some support, albeit weak, to the view that trade liberalisation reduces employment within firms that experience a reduction in protection on the products they sell. There are, however, a number of caveats to this conclusion. Firstly, Figure 6 indicates that trade liberalisation is not the dominant influence affecting employment changes. In all but two cases, the share of firms reducing employment exceeded the share increasing employment, irrespective of the impact of trade liberalisation on market share.

Secondly, Figure 6 presents the distribution of firms according to employment change *within* particular tariff liberalisation classifications (significant, moderate and none). They do not give an indication of the total number of firms that both reduced employment and were negatively affected by trade liberalisation. In the NE survey these firms account for between 18 % and 29 % (latter for unskilled labour) of all large firms for which consistent data are available. If we include small firms the range declines to between 9 % and 15 %. Using the GJMA survey, firms significantly or moderately affected by tariff reductions account for 22 % of the decline in total employment excluding the food & beverages sectors between 1994-98. If the food & beverages sector is included then these sectors actually positively affected employment. The vast majority of firms made employment decisions that were unrelated to trade liberalisation. Other macro-economic shocks such as the interest rate hike, poor economic growth etc. dominate employment decisions. Trade liberalisation may have exacerbated the decline, but is not the dominant cause of the decline. A further implication of these numbers is that the impact of trade liberalisation on employment via technology choice will not be very large.

Thirdly, this analysis is only a consistency check on whether the data conforms with our expectations regarding employment changes in firms experiencing increased international competition. Without further information we cannot identify a causal relationship. This is particularly important as a lower percentage of firms experienced negative impacts on prices arising from trade liberalisation. From the theoretical perspective (Stolper-Samuelson) it is the price change that is the primary linkage through which factor earnings (and in the case of labour market rigidities) are affected.

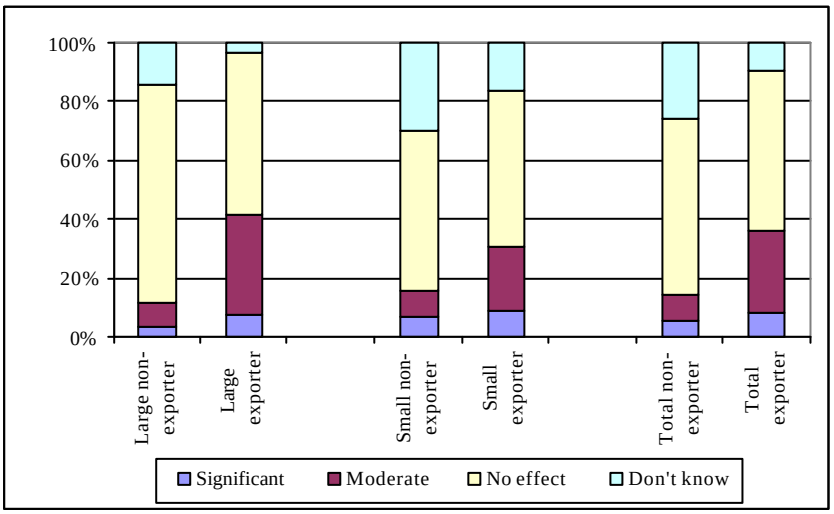
Finally, political economy objectives or interpretation problems may have affected the way in which firms responded to the survey. Casale and Holden (2000) show that firms have been successful in raising tariffs on the basis of expected employment declines. Many firms that are struggling due to factors unrelated to trade may condemn trade liberalisation as the cause of their woes as a means to lobby for protection. The vast differences between the GJMA and the NE surveys on the impact of trade liberalisation also indicate biases arising from different approaches to administering of the surveys. The small firm NE survey and the GJMA surveys were conducted by visits to firms while the large firm NE survey was conducted via fax or post.

3.4 Impact of trade liberalisation on export performance

By lowering the price of imported and domestic import competing products, trade liberalisation reduces the cost of production and the anti-export bias associated with protection. This results in a movement of productive resources away from import competing sectors towards export oriented sectors. Thus according to the theory, employment losses occurring within import competing firms are negated by employment gains within the export sectors.

Figure 7 presents the distribution of NE survey firms according to the impact of trade liberalisation on export competitiveness. Firms have been categorised into exporters and non-exporters as well as according to size categories. Some inconsistencies in the data are evident as a few non-exporters claim their export performance has been positively affected by trade liberalisation. These firms may be referring to the impact of lower input prices on their production costs.

Figure 7: The impact of trade liberalisation on export competitiveness, NE survey (% firms)



Note: The difference in share structure between exporters and non-exporters is significant.

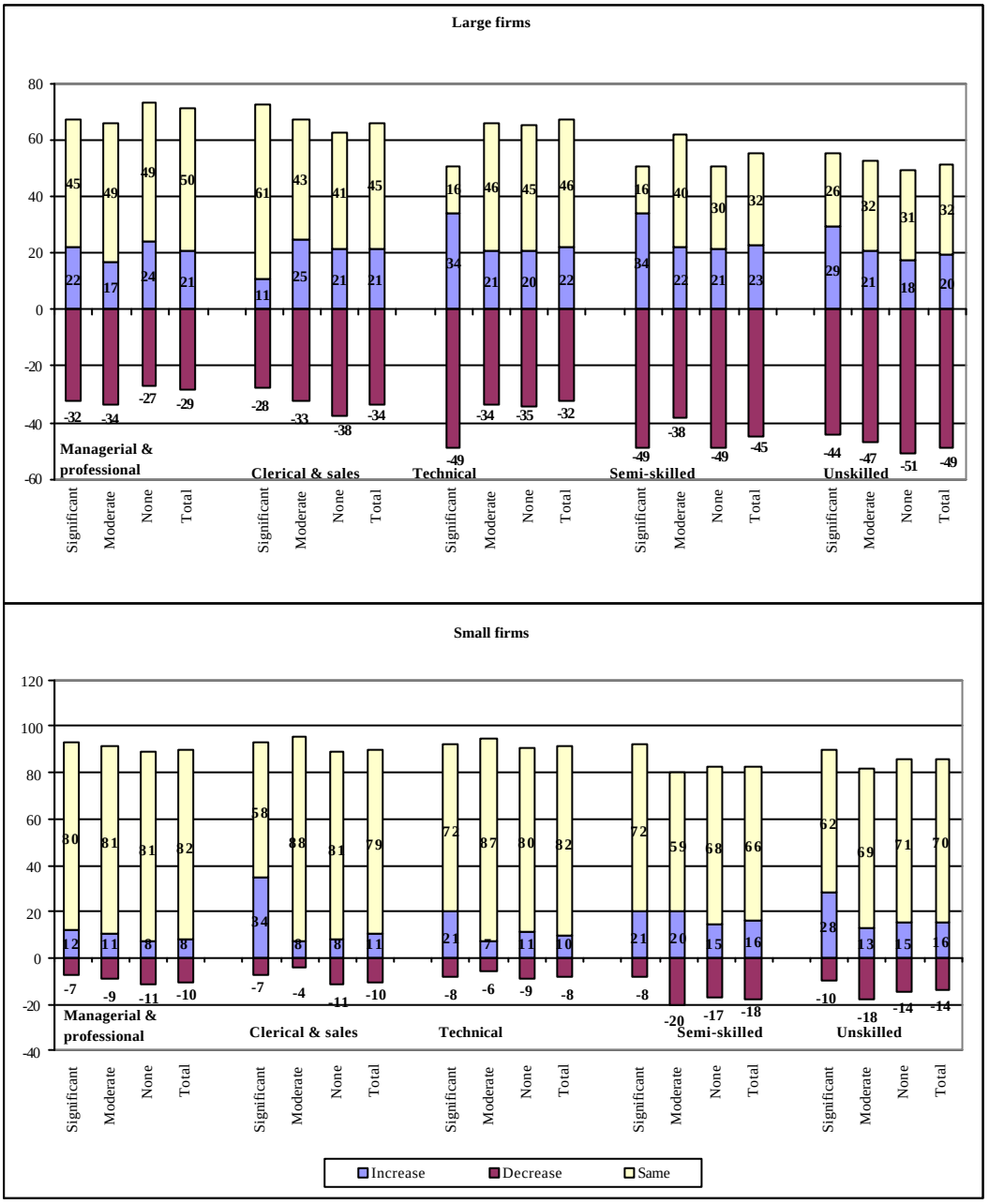
The reduction in tariffs positively affected export performance, particularly amongst large exporters where over 40 % of firms felt that their export competitiveness

improved. If we include small exporters this percentage declines to 36 %. Overall, trade liberalisation positively affected export competitiveness in 28 % of all firms.[18] This is relatively low when compared to the approximately 35 % of firms that were negatively affected by trade liberalisation. Despite this 44 % of firms argue that import tariffs are too high in terms of the cost of imported materials. This value is similar for exporters and non-exporters and large and small firms.

If firms respond to the increase in competitiveness by raising exports, we would expect a positive impact on employment over the medium term. In the short term an increase in export may not raise employment, particularly if excess capacity exists. This was evident during the 1980s where declining domestic demand raised exports as firms searched for international markets in order to rid themselves of surplus production (Tsikata, 1999). Further, if the improvement in competitiveness is seen as temporary, firms may raise output through increasing the number of shifts or hours worked using their existing labour force rather than increasing employment. Some insight into the employment impact of increased competitiveness is shown in Figure 8 which presents the share of firms that increased, decreased or did not change employment according to the impact of trade liberalisation on the export competitiveness of NE survey firms. As in the earlier figures, employment changes only cover the period 1998 to end of 1999 so much of the employment impact of increased competitiveness may already have taken place.

[18] 18.8 % of all firms in the GJMA survey experienced significant or moderate reductions in raw material prices as result of tariff liberalisation.

Figure 8: Employment changes according to impact of tariff liberalisation on export competitiveness, NE survey (% firms)



A positive relationship between improved competitiveness and employment would be revealed in progressively rising (falling) shares of firms increasing (decreasing) employment as competitiveness improved. No such relationship is evident amongst managerial & professional, clerical & sales and skilled technical labour within large firms. The trends in employment increases and decreases are consistent with expectations within the unskilled labour category, but according to the Pearson Chi-square test this relationship is not significant. This relationship was also analysed using the GJMA survey which enabled the calculation of employment changes between 1994-98, although at the expense of the sample size.[19] No significant

[19] The sample size fell to 185.

relationship between the mean change in employment and the impact of tariff liberalisation on raw material prices was found. Thus even over the longer run, the relationship between improved competitiveness (export and domestic) and employment appears weak amongst large firms.

The relationship between changes in employment and improved competitiveness are better amongst small firms. For all occupational categories the share of firms that increased employment was higher amongst firms for which competitiveness improved significantly than amongst firms where competitiveness was not affected. The opposite relationship was evident when analysing the share of firms that reduced employment. These results suggest that at least amongst small firms improved competitiveness led to greater employment growth. Overall, however, the relationship is poor.

There are number of reasons for the relatively low percentage of firms positively benefiting from trade liberalisation and the poor employment generation amongst these firms. As shown earlier South African firms are characterised by low levels of export orientation implying that improvements in cost competitiveness will not translate into substantial increases in exports, at least in the short run. Imported products are also only one intermediate input and account for low percentages of raw material inputs (Table 5). A reduction in import prices would not give rise to significant improvements in export performance, particularly as many import competing firm did not find that trade liberalisation significantly reduced their product price. Other factors such as trade barriers, market access restrictions, transport facilities and the real exchange rate may be more important determinants of export performance. Further, lower domestic prices as result of trade liberalisation may not be perceived as being due to trade liberalisation in which case firms would understate the impact of trade liberalisation on export competitiveness. The significant real depreciation of the currency since 1994 will also have negated much of the positive impact of trade liberalisation on imported input costs. Finally, on average only 75 % of capacity was utilised over the survey period suggesting that export growth is likely to be achieved through increased capacity utilisation rather than an increase in production capacity over the short term.

3.5 Trade liberalisation and technology choice

In this section we briefly analyse the relationship between employment changes and technology. In particular, we are interested in determining whether trade liberalisation has encouraged the adoption of skill biased or labour saving technology. This is analysed by cross-tabulating the most important reason for the firm's last significant fixed capital expenditure on the severity of the impact of trade liberalisation. This gives insight into whether a relatively high percentage of firms that have experienced significant or moderately negative impacts from trade liberalisation have invested in labour saving technology compared to other firms. Such a relationship is consistent with the effect of 'defensive innovation'. The analysis of the impact of technological transfers (Pissarides, 1997), pervasive skill biased technological change and a reduction in x-efficiency on employment is dealt with in the econometric analysis that follows this section.

Table 9 presents the cross tabulations according to a number of firm characteristics (ownership, size and trade orientation) and the severity of the impact of trade liberalisation on market share and product price. The values are the share of total firms within that row category, i.e. each row sums to 100 %.

Table 9: Most important reason for investment according to impact of tariff liberalisation and firm characteristics (% firms), NE survey

Impact of trade liberalisation	Most important reason for investment								
	Expected sales growth	Reduce wage cost by cutting workforce	Reduce labour conflict by cutting workforce	Raise efficiency through new technology	Improve product quality through new technology	Replace old machinery	Increase export competitiveness	Diversify products	Other
Most important reason for investment according to impact of tariff cuts on product prices									
All firms (1)									
Significant	24.5	2.8	1.8	24.2	16.2	9.3	6.2	7.6	7.4
Moderate	26.5	6.6	2.0	25.3	15.5	9.9	4.1	4.1	6.1
None	27.4	5.2	1.5	25.0	7.6	11.2	6.2	9.6	6.5
Total	27.6	5.3	1.6	23.7	10.3	11.6	5.1	8.4	6.4
Obs	536								
Most important reason for investment according to loss of market share to foreign competitors									
All firms (1)									
Significant	15.7	7.6	4.1	29.8	13.2	8.5	7.1	8.0	5.9
Moderate	29.6	3.8	0.8	29.5	11.8	10.9	2.1	3.8	7.7
None	29.6	5.2	1.0	19.7	9.2	12.2	6.5	10.9	5.8
Total	27.2	5.4	1.6	23.5	10.5	11.5	5.3	8.7	6.5
Obs	543								
Most important reason for investment according to firm characteristics									
Domestic	27.6	5.4	1.4	20.3	10.4	12.5	4.9	**11.9**	5.8
Foreign	26.5	4.6	1.6	**27.4**	9.1	11.2	3.4	4.1	12.0
Small	27.6	6.1	0.9	17.1	9.2	13.1	4.8	**13.8**	7.4
Large	27.1	3.5	2.4	**29.6**	12.7	10.7	4.5	4.9	4.7
Non-exporter	26.2	5.7	1.2	17.7	10.3	14.3	3.8	**14.0**	6.8
Exporter	29.2	4.7	1.7	**25.6**	10.3	9.7	5.9	6.8	6.1

Note: (1) No significant relationship between reasons for investment and the impact of trade liberalisation were found amongst large and small firms. The results for all firms are given as result.
Many observations are missing as not all firms answered all the relevant questions.
The reasons for investment are significantly different between small and large and between exporter and non-exporters.

Looking at the total rows expected sales growth and raising efficiency through new technology dominated firms' decisions to invest and were the primary reason for investment in approximately 50 % of all firms. Improvement of product quality and replacement of old machinery were also important with 10-11% of all firms citing this as the primary reasons for investment. The distribution of investment reasons does not change significantly when analysed according to firm characteristics relating to foreign ownership, size and export orientation. Some minor differences are evident with a relatively low share of small, domestic and non-exporting firms investing in order to raise efficiency through product quality. These firms have rather invested to diversify products.

Very few firms (less than 6 %) invested in order to reduce wage costs or labour conflict by cutting the workforce. The share of firms was low even amongst labour intensive sectors. Further, the share of firms who invested in order to cut the workforce was not significantly different between firms negatively affected by trade liberalisation and those not affected by trade liberalisation. In fact, there were no significant relationships between the severity of the impact of trade liberalisation and the distribution of firms according to their reasons for investment. The same result was obtained when firms were classified according to size. The poor results suggest that trade liberalisation has not encouraged investment in new technology in order to reduce employment. The relatively weak relationship is not due to the omission of firms that did not invest as a consequence of trade liberalisation. A high percentage (87 %) of the NE survey firms invested during the financial year prior to the administering of the survey. Further, no relationship between the mean investment rate and the severity of the impact of trade liberalisation was found. Those firms negatively affected by trade liberalisation were not less likely to invest or did not invest less than firms not affected by trade liberalisation.

Further analysis on the relationship between technology choice and trade is required prior to a conclusion being reached. While the major reason for investment may not be to reduce the labour force, the impact of efficiency improving investment may have the effect of reducing labour, particularly unskilled labour if this technology is skill biased. There may be an indirect relationship between a firms decision to invest for efficiency purposes, the severity of the impact of trade liberalisation and the decision whether to increase or decrease employment.

Cross tabulations of these variables cannot indicate causality, but they can show whether the data are consistent with the above relationship. To identify whether a relationship exists the reasons for a firm's investment are separately analysed according to the firm's employment decision and the impact of trade liberalisation on the firm. Table 10 presents these cross tabulations for unskilled labour. The row values sum to 100 %.

Table 10: Reason for investment according to change in unskilled employment and tariff impact (% firms), NE survey

	Reason for investment							
	Expected sales growth	**Reduce labour costs**	**Technology to raise efficiency & quality**	**Replace old machinery**	**Increase export competitiveness**	**Diversify products**	**Other**	**Total**
Employment fall & negative tariff effect	12.9	10.3	**51.5**	7.0	2.4	7.1	9.0	100
Obs								87
Employment rise & negative tariff effect	**36.7**	14.5	25.6	9.4	3.8	5.4	4.6	100
Obs								33
Employment fall & no tariff effect	16.5	12.3	30.5	15.4	3.2	11.4	10.8	100
Obs								60
Employment rise & no tariff effect	**47.7**	4.2	24.0	4.6	8.0	8.7	3.0	100
Obs								56
Total	24.6	10.1	36.2	9.2	4.0	8.4	7.6	100

Pearson								0.0121
Obs								236

Note: Many observations are lost as only firms for which there are data for employment changes, reason for investment and impact of tariffs liberalisation on market share are included. Negative tariff effect includes firms whose market share was significantly or moderately affected by trade liberalisation.

The results are consistent with the view that trade liberalisation has encouraged investment in unskilled labour saving technology. 51.5 % of firms that reduced unskilled labour and experienced significant or moderate negative impacts on market share from trade liberalisation invested in new technology in order to raise efficiency and product quality. This share is greater than for all other categories including firms that reduced employment and were not affected by trade liberalisation. The difference between these two categories appears to be related to the effect of tariff liberalisation. In other words firms that both reduced unskilled employment and were negatively affected by trade liberalisation were more likely to invest in new technology compared to those that were not negatively affected. Firms that raised employment invested largely in expectation of increased sales growth irrespective of whether they were negatively affected by trade liberalisation or not.

Interestingly, when we look at professional & managerial labour, we find that amongst firms that increased employment, those negatively affected by tariffs were more likely to invest in new technology to raise efficiency than those not affected by tariff liberalisation. Expected sales (41 % of firms) dominated reasons for firms experiencing no effects from tariff liberalisation and increasing employment. This is consistent with 'defensive innovation' where firms negatively affected by trade liberalisation invest in new technology that is skill biased.

While, there appears to be relationship between the severity of the impact of trade liberalisation, a decline in employment of less skilled and investment in order to raise efficiency and product quality, the overall impact on employment is likely to be small. Firms that reduced employment of unskilled labour, were negatively affected by trade liberalisation and invested in new technology in order to raise efficiency and product quality account for only 19% of all firms for which data were available. It is possible that firms re-organised production rather than investing in new technology (as argued by Aguirregabiria and Alonso-Borrego (2001)) and that the overall impact of trade liberalisation on employment via its impact on technological change is much larger. However, when looking at the reasons for a decline in employment, no relationship between severity of tariff liberalisation and changes in skilled and unskilled employment due to the re-organisation of production within firms is found.[20]

3.6 Discussion

[20] The following reasons for a decline in employment were provided: capital expenditure raising full capacity production level, change in production level due to market outlook (no change in full capacity production level), changes in labour laws and regulations, outsourcing or subcontracting, new machinery requiring fewer employees at any given production level, change in organisation of production within plant (no change in full capacity production level), higher wages or salaries, higher non-wage employee costs (benefits, hiring costs, etc) and reason is different from all of the above.

There is substantial inter- and intra-sector heterogeneity in the impact of trade liberalisation on firms. A high percentage (over 50 %) of large firms experienced significant or moderate declines in market share as result of greater import penetration. The clothing & textile, auto assembly & components and fabricated metal product sectors are the most significantly affected. The market share of small firms is largely unaffected by trade liberalisation (24 % were significantly or moderately affected). This may reflect the production of specialised output. The impact of trade liberalisation on product prices is weaker for large firms but greater for small firms. 35 % of small firms experienced significant or moderate reductions in product prices as result of trade liberalisation.

A negative relationship between the impact of trade liberalisation on employment for all occupational categories between 1998 and the end of 1999 is found for large firms using the NE survey. A similar relationship is found over the period 1994-98 using the GJMA survey, but only when the food & beverages sector is excluded. No relationship between trade liberalisation and employment is found for small firms. The impact of trade liberalisation on total employment is thus likely to be small. Using the GJMA survey it is shown that firms significantly or moderately affected by trade liberalisation only account for 22 % of the decline in total employment in large firms if the food & beverages sector is excluded. This is an upward limit as some of the decline in employment in these firms, as is the case with the majority of firms, will be unrelated to trade liberalisation. The decline in employment may largely be due to technological change, poor output growth and/or labour market factors.

The decline in employment in firms negatively affected by trade liberalisation is consistent with theoretical predictions that the economy restructures away from import competing sectors towards export orientated sectors. However, no relationship between the improvements in export competitiveness due to trade liberalisation and employment is found. The lower imported input costs as result of trade liberalisation may have been negated by the substantial real depreciation of currency since 1994. Further, exports firms may respond to increased cost competitiveness by reducing excess capacity or increasing the number of shifts or hours worked rather than increasing employment levels.

Although the direct impact of trade liberalisation on employment may be small, the impact via choice of technology may be substantially larger. This affect is also capped by the total share of the decline in employment accounted for by firms negatively affected by trade liberalisation (22 % in the GJMA survey). However, the impact of trade liberalisation may have substantial effects on the occupational composition of employment. No relationship between the reasons for a firm's last significant investment and the impact of trade liberalisation is found. In particular, firms negatively affected by trade liberalisation did not invest in order to reduce employment which is one indicator of 'defensive innovation'. Most firms invested in new technology in order to raise efficiency and product quality. However, of the firms that reduced employment of unskilled labour those negatively affected by trade liberalisation were more likely to invest in order to raise efficiency and product quality. In addition, of the firms that raised employment of professional & managerial labour those negatively affected by tariff liberalisation were more likely to invest in new technology to raise efficiency than those not affected. These trends suggest that

trade liberalisation may have increased the skill intensity of production, at least amongst import competing firms. The overall impact is likely to be small.

While these cross-tabulations are useful to derive preliminary relationships between trade liberalisation, technology and employment, the relationships are not necessarily robust to the inclusion of other variables. Some of the relationships found may be due to the impact of other variables that are correlated with the trade liberalisation variables. To explore the relationship between trade liberalisation, technology and employment in more detail econometric techniques are used in the following section to estimate labour demand functions. These techniques will also enable a more nuanced analysis of the relationship between trade induced technological change and employment. For example, we will be able to explore the relationship between the importation of inputs and the skill intensity of production.

4. ESTIMATING LABOUR DEMAND FUNCTIONS

Cross tabulations fail to account for the impact of various other variables on the relationship being analysed. For example, the negative relationship found between trade liberalisation and employment for large firms is not conditional upon the impact of other variables such as poor output growth that may also explain employment declines. Once the impact of poor output growth is captured, the relationship between trade liberalisation and employment may no longer exist.

In this section we use cross section econometric techniques to capture the partial impact of trade liberalisation and other variables including technology on the demand for labour. The section first presents a critical analysis of existing approaches used in the estimation of labour demand functions used in the trade and labour literature. It then develops an alternative specification dealing with some of the problems raised. A particular aspect of this labour demand function is that it incorporates features that capture the impact of skill biased technological change on employment.

4.1 Deriving labour demand functions

Various approaches have been used to derive labour demand functions (see Hammermesh, 1993). A common approach within the trade, technology and employment literature is to estimate factor cost share equations derived from a restricted variable translog cost function (Berman *et al.*, 1994, Machin and Van Reenen, 1998, Harrison and Hanson, 1999, Teal, 2000, Görg and Strobl, 2001)[21]. In these the share of skilled wages in the total wage bill (or value added) is regressed on factor payments, income and technology variables. In some cases (Harrison and Hanson, 1999, Aguirregabiria and Alonso-Borrego, 2001) relative wages or relative employment are used as the dependent variable.

[21] Hanson and Harrison (1995) implicitly estimate a type of factor share equation for Mexico. In their latter work (1999) they derive the functional form of their equation directly, but as in the earlier article, use relative wages and relative employment as the dependent variable rather than the share skilled wages in the total wage bill. This is done to solve for endogeneity problems in the factor share equation.

Alternatively labour demand functions are derived from the Cobb-Douglas production function (Currie and Harrison, 1997, Milner and Wright, 1998, Greenaway *et al.* 1999, Birdi *et al*., 2001). Following Milner and Wright (1998) production is modelled using a simple Cobb-Douglas function

1) $$Q = A^{g} U^{a} S^{b}$$

where Q is output, A is an index of Hicks-neutral technological progress, U is unskilled labour and S is skilled labour. For a finite profit maximising solution diminishing returns to scale ($\alpha+\beta<1$) or in the case of constant returns to scale ($\alpha+\beta=1$) one fixed factor are assumed. The assumption that markets are competitive and that wages and prices are exogenous is also made. The first order profit maximising condition states that the firm will employ factors till the point where the marginal revenue product equals the factor payment. This yields the following equations for less skilled and skilled labour respectively:

2) $$\begin{aligned} w_u = p.MP_u &= \alpha P A^{g} U^{a-1} S^{b} \\ &= \alpha P Q U^{-1} \end{aligned}$$

3) $$\begin{aligned} w_s = p.MP_s &= \beta P A^{g} U^{a} S^{b-1} \\ &= \beta P Q S^{-1} \end{aligned}$$

where w, P and MP_i are wage, product price and marginal product and the subscripts u and s refer to less skilled and skilled, respectively. Solving the system of equations to eliminate skilled labour from firm output yields the following equation:

4) $$Q = A^{g} U^{a} \left[\frac{\beta U}{\alpha} \frac{w_u}{w_s} \right]^{b}$$

The firm's derived demand for less skilled labour can be obtained by taking logs and rearranging such that less skilled labour is on the left hand side of the equation:

5) $$\ln U = \delta_0 + \delta_1 \ln A + \delta_2 \ln\left(\frac{w_u}{w_s}\right) + \delta_3 \ln Q,$$

where

6) $$\delta_0 = -\frac{(b \ln b + b \ln a)}{a+b}, \quad \delta_1 = -\frac{g}{a+b}, \quad \delta_2 = -\frac{b}{a+b}, \quad \delta_3 = \frac{1}{a+b}.$$

The demand for skilled labour can be defined in a similar manner:

7) $$\ln S = \delta_0^{*} + \delta_1^{*} \ln A + \delta_2^{*} \ln\left(\frac{w_s}{w_u}\right) + \delta_3^{*} \ln Q,$$

where

8) $$\delta_0^{*} = -\frac{(a \ln a + a \ln b)}{a+b}, \quad \delta_1^{*} = \delta_1 = -\frac{g}{a+b}, \quad \delta_2^{*} = -\frac{a}{a+b}, \quad \delta_3^{*} = \delta_3 = \frac{1}{a+b}.$$

Demand for less skilled labour is a negatively related to relative wages (w_u/w_s) and is positively related to output. The coefficient on technology δ_1 is negative indicating that technological progress given output reduces the demand for less skilled labour. Similarly, the demand for skilled labour is negatively related to the relative wages (w_s/w_u) and technology and is positively related to output.

There are a number of problems associated with the estimation of the factor demand equations 5 and 7. As discussed by Thomas (??) equations 1, 2 and 3 make up a three

equation simultaneous system in the endogenous *Q*, *S* and *U* with all prices being exogenous. The estimation by OLS of equations 5 and 7 will lead to simultaneous equation bias as the endogenous variable *Q* on the right hand side of each equation is not independent of the error term. The equations need to be estimated using a simultaneous equation estimation method. Identification problems will also exist if prices do not vary across firms or sectors. If product prices are constant the output function (equation 1) is not identified, although the profit maximisation equations 2 and 3 will still be identified (Thomas, ???: 311).

Another problem is the assumption of perfect competition and the implication that product and factor prices are exogenous to the firm. In their review of the literature on trade and labour Harrison and Hanson (1999) note that firms in Mexico and Morocco responded to trade liberalisation by reducing profit margins (Mexico and Morocco) and cutting wages (Mexico). In both countries protection gave rise to rents which were captured by capital in Morocco, but were shared in Mexico due to the existence of strong unions. This introduces further endogeneity problems into the system of equation defined above. Currie and Harrison (1997) approach this problem by assuming imperfectly competitive Cournot firms using Cobb-Douglas production technology. They also introduce a wage equation to allow for market power in the labour market.

Further criticisms relate to the functional form of the production function and related factor demand equations. The first criticism is that the elasticity of substitution in a Cobb-Douglas production function is equal to unity. A 1 % increase in relative wages (w_u/w_s) always leads to a 1 % increase in the skill intensity of production (S/U) irrespective of the Cobb-Douglas production function assumed. A second problem, and of direct relevance to the question we are addressing here, is that technology is exogenous and has a uniform impact on skilled and less skilled employment within the sector. This is clearly shown by the equivalence of the coefficients ($\delta_1 = \delta_1^*$) on A. The exogeneity of technology is inconsistent with the view that increased international competition induces productivity growth or other forms of technological change. Further, the uniform impact of technology on factors is criticised by Wood (1994) who argues that trade liberalisation leads to 'defensive innovation' which affects the skill composition of production.

Greenaway *et al.* (1999) overcome the exogeneity of the technological change by modelling the technical efficiency parameter (A) as function of import penetration and export orientation. In their labour demand functions technology is modelled as:

9) $$A = e^{\lambda_1 T} M^{\lambda_1} X^{\lambda_2}, \quad \lambda_0, \lambda_1, \lambda_2 > 0,$$

where T is a time trend, M is import penetration and X is export orientation. Increased international competition both for import competing and export orientated firms forces gives rise to efficiency gains (interpreted as a reduction in *x*-inefficiency by Greenaway *et al.* (1999)) which has a negative impact on factor demand given a unit of output.[22] This approach has also been used by Birdi *et al.* (2001) to analyse the

[22] Note that this is a partial equilibrium analysis of the impact of technological progress on factor demand. In a general equilibrium context (see Findlay and Grubert, 1959) sector biased technological change affects relative wages and thus employment within the firm. These general equilibrium effects are not captured in this analysis.

impact of trade on the skill intensity of production in South Africa. However, the model is inadequate for this purpose as technological change still has a uniform impact on factor demand. The impact of increased import penetration and export orientation affects *A* which has similar impacts on employment of skilled and less skilled labour within firms.

An alternative approach and one that is followed in this paper is to use a constant elasticity of substitution (CES) production function. This has been used by Haskel and Slaughter (1998) although their focus was on the sector bias of skill biased technological change in a two-factor, two-sector, two-country model. The CES production function is represented as:

10) $$Q = A[\alpha_1 U^{-p} + \alpha_2 S^{-p}]^{-1/p}, \quad p \geq -1$$

where *A* again reflects an efficiency parameter and α_1 and α_2 are the distribution parameters. Assuming profit maximisation under perfect competition the factor employment equations for less skilled and skilled labour are given, respectively, by

11) $$\frac{\alpha_1}{A^p}\left(\frac{Q}{U}\right)^{1+p} = \frac{w_u}{P}$$

12) $$\frac{\alpha_2}{A^p}\left(\frac{Q}{S}\right)^{1+p} = \frac{w_s}{P}$$

Together equations 10 to 12 solve for the endogenous variables *Q*, *S* and *U*. Using equations 11 and 12 relative labour demand can be expressed as:

13) $$\frac{S}{U} = \left(\frac{\alpha_2}{\alpha_1}\right)^{s}\left(\frac{w_s}{w_u}\right)^{-s}$$

where $\sigma = 1/(1+p)$ is the elasticity of substitution. Relative labour demand (*S/U*) is positively affected by a rise in (α_2/α_1) and a decline in (w_s/w_u).

The difference from the Cobb-Douglas approach can easily be shown. Like the Cobb-Douglas approach *A* has a uniform impact on skilled and less skilled labour and does not change relative labour demand. Changes in the skill intensity of production, however, can arise through changes in the ratio of the share parameters (α_2/α_1). Following Haskel and Slaughter (1998) we interpret a rise in (α_2/α_1) as evidence of skill biased technological change. Thus skill biased technological change can arise in a number of ways: an increase in α_2, *ceteris paribus*; an increase in α_2 that exceeds and increase in α_1; an increase in α_2 and a fall in α_1; a fall in α_2 that is smaller than the fall in α_1; and a fall in α_1, *ceteris paribus*.

By modelling (α_2/α_1) as a function of import penetration and export orientation we are able to treat technological change as a function of trade related variables. For example we can model skill biased technological change as:[23]

[23] An alternative specification is $\left(\frac{a_2}{a_1}\right) = l_0 \Phi^{l_1} M^{l_2} X^{l_3}$. The difference is that when logged the variables Φ, *M*, and *X* in equation 14 will not be in log form whereas they will be in the alternative specification. There appears to be no consistency in the literature on the inclusion of technology variables in log form or not. Greenaway *et al*. (1999) and Birdi *et al*. (2001) log all technology related

14) $$\frac{a_2}{a_1} = e^{l_0} e^{l_1 \Phi} e^{l_2 M} e^{l_3 X}, \quad l_2, l_3 > 0$$

where M is import penetration, X is export orientation and Φ reflects the effect of all other variables affecting technical efficiency. This has an advantage over Greenaway *et al*. (1999) in that the skill bias of trade induced technological change is modelled explicitly. A rise in export orientation can lead to a rise in the relative demand for skilled labour through the transfer of foreign technology via access to blueprints for production, through meeting foreign quality requirements and through a reduction in *x*-inefficiency which falls relatively heavily on less skilled labour. A rise in import penetration or import competition can also raise the skill intensity of production in import competing firms through 'defensive innovation'. A further benefit of this approach is that other technology related variables can also be included. For example, trade induced skill biased technological change brought about by the importation of inputs that complement skilled labour (as discussed by Pissarides, 1997) can captured by the inclusion of variables such as the import share of raw material purchases and the share imported machinery & equipment in total investment. Pervasive skill biased technological change can be captured by the inclusion of variables relating to the usage of computers.

Substituting equation 14 into equation 13 and taking the logarithm we can estimate the following relative labour demand function:[24]

15) $$\ln\left(\frac{S}{U}\right)_i = q_{0i} + q_1 \Phi_i + q_2 M_i + q_3 X_i - s\left(\frac{w_s}{w_u}\right)_i + e_i$$

where $q_0 = l_0$, $q_1 = s\, l_1$, $q_2 = s\, l_2 > 0$, $q_3 = s\, l_3 > 0$ and the subscript i refers to the individual firm.

4.2 Data, variables and econometric methodology

We estimate the labour demand function specified in equation 15 using both the NE and GJMA surveys. For comparative purposes the Cobb-Douglas labour demand functions (5 and 7) with A adjusted using equation 9 are estimated alongside the CES based relative labour demand function (equation 15). The labour demand functions are estimated in levels as well as changes in labour demand.

Both the NE and GJMA surveys supplied detailed employment information for a number of occupational categories for the year over which the survey was administered. This information was used to construct the dependent variables in the labour demand and relative labour demand functions estimated in levels. Ideally one should standardise for work hours as there may be substantial heterogeneity among firms in hours worked (Hammermesh, 1993: 68). If this is the case the correlation between wages and hours worked will not be picked up in the estimated relative wage

variables. Hanson and Harrison (1995), Harrison and Hanson (1999) and Görg and Strobl (2000) do not log the technology variables.

[24] By solving for S in equation 13 and substituting into the production function it is possible to define U in terms of relative wages, (a_2/a_1) and output. However, because this function cannot be log linearised the marginal productivity equations (11 and 12) or the relative labour demand equation (13) are estimated.

coefficients.[25] In the level estimations professional and managerial occupation categories are classified as highly skilled; professional, managerial and skilled technical occupation categories are classified as skilled; and semi-skilled production workers and unskilled labour are classified as low skilled. The labour demand functions for the year of the survey were first estimated using OLS. Because of wide variations between the mean and median, the functions were also estimated using iteratively re-weighted least squares (IRLS) to correct for outliers. IRLS by downweighting outliers is robust against outliers of both the dependent and independent variables (Hamilton, 1998).

There were a number of problems associated with the estimation of the labour demand functions in differences. The GJMA survey has recall data on total employment from 1994 enabling an analysis of the change in *total* employment over a 4 year period using the Cobb-Douglas based labour demand function. It was also possible to estimate functions for the change in total labour demand over shorter periods. Because of missing observations during the early years this frequently increased the sample size. The estimation of the CES based labour demand functions for the change in relative demand for skilled labour was, however, not possible as no data on occupational employment levels over time was available from the GJMA survey.

Information on the change in occupational employment prior to 1999 was available from the NE survey, but only in the form of a binary variable. Firms were requested to indicate whether full-time employment increased, decreased or stayed the same between the beginning of 1998 and the end of 1999 for all five occupational categories. This enabled an analysis of occupational employment changes over roughly a 2 year period. Because of the binary dependent variable (employment increase = 1 and employment decrease = 0) a maximum likelihood probit model was used to estimate changes in employment for each occupational category using the Cobb-Douglas based labour demand functions.

Table 11 presents a list of independent variable used in the econometric analysis.

Table 11: List of variable names and descriptions

Variable name	Description
Technology related variables	
Foreign	Dummy variable for firm with more than 10 % foreign ownership
Log I/Assets	Log investment in last financial year/value capital stock
Share M&E in I	Share of machinery & equipment in total investment during last financial year (NE)
Imported M&E as share M&E investment	New imported machinery & equipment as share of total investment in machinery & equipment during 1998 (GJMA)
Share computers in I	Share of computers in total investment during last financial year
% M in raw materials	Percentage of total raw material costs comprised of imported raw materials
Share training in I	Training expenditure during previous and current financial year divided by total investment during last financial year (NE)

[25] It is possible to adjust employment numbers using capacity utilisation. However, this assumes that the 'effective' use of labour is constant across occupational categories within firms. Although inter-firm differences will still be picked up if labour is adjusted for capacity utilisation, the loss in sample size was too severe to pursue this option.

% workforce trained	Number of workers trained as share of total workforce in 1998
Trade related variables	
Exporter	Dummy variable for firm that exports
Mkt share-significant Mkt share –moderate Mkt share-None Mkt share-unknown	Dummy variables for firms experiencing significant, moderate, no and unknown impact of trade liberalisation since 1994 on market share (NE)
Tariff effect-significant Tariff effect-moderate Tariff effect-None	Dummy variables for firms experiencing significant, moderate, no and unknown impact of trade liberalisation since 1994 on business (GJMA)
Price-significant Price-moderate Price-none Price-unknown	Dummy variables for firms experiencing significant, moderate, no and unknown impact of trade liberalisation since 1994 on product price (GJMA and NE)
Export-significant Export-moderate Export-none Export-unknown	Dummy variables for firms experiencing significant, moderate, no and unknown impact of trade liberalisation since 1994 on export competitiveness (NE)
Material P-significant Material P-moderate Material P-none Material P-unknown	Dummy variables for firms experiencing significant, moderate, no and unknown impact of trade liberalisation since 1994 on raw material prices (GJMA)
Other variables	
Log relative w	Log of average skilled wage/average less skilled wage. Average wages calculated using employment numbers as weights.
Expected sales up Expected sales down Expected sales same	Dummy variable for expected sales to rise, decline and not change relative to the last financial year (NE)
Log sales	Log of total turnover (R million) in most recently completed financial year (NE) and in 1998 (GJMA)
Age	Age of the firm in 1999 (NE) & in 1998 (GJMA)
employ ≤ 50	Firms with 50 employees or less
50 < employ ≤100	Firms with between 51 and 100 employees
100<employ≤200	Firms with between 101 and 200 employees
200 <employ	Firms with greater than 200 employees
Wood	Wood and wood products
Chemical	Chemical products
Auto	Automotive
Textile	Clothing & textiles
Metal	Metal products
Furn	Furniture
Furniture & paper	Furniture & paper
Machine/electrical products	Machinery & equipment
Print	Printing and publishing

Hourly wage data was only available from the GJMA survey. The wage data provided is the average hourly wage rate for entry level workers and excludes overtime and non-wage costs. Any bias in these other wage costs across occupational categories will lead to biases in the estimated wage coefficient. A number of data points were also missing and these were replaced with the average sector wage. This approach was also followed in Görg and Strobl (2001). Average high skilled and less skilled wages were then constructed for each firm using occupational employment as weights. Relative wages are expected to have a negative impact on the relative demand for skilled labour. The lack of wage data in the NE survey prohibits an analysis of the impact of relative wages on labour demand. The sector dummies

included in the regression will capture sector specific average wages. However, if wages vary at the firm level, the omission thereof will induce omitted variable bias in the estimates. Because there is no recall data on wages within the GJMA survey the first difference equations will also be mis-specified resulting in omitted variable bias.

A variety of technology related variables were used to capture the impact of trade induced technological change as well as pervasive skill biased technological change. As in Hanson and Harrison (1995) and Harrison and Hanson (1999) machinery & equipment investment and computer investment as shares of total investment were used to capture pervasive skill biased technological change which is unrelated to trade liberalisation. Relatively high investment in machinery & equipment and computers is expected to raise the demand for skilled labour. Because some of this investment may be trade induced these technology variables were interacted with a number of trade liberalisation related dummy variables. A stronger relationship between in machinery & equipment and computer investment and demand for skilled labour within firms negatively affected by trade liberalisation can be interpreted as evidence of 'defensive innovation'.

Other variables to capture trade induced technological change were also included. As emphasised by Pissarides (1997) most innovations occur abroad and are imported in the form of new machinery and equipment or blueprints for the manufacture of the good. We follow Hanson and Harrison (1995) and include import content variables such as the imported share of raw material purchases and the domestic share in machinery and equipment investment. The latter was dropped as the coefficient was insignificant and its inclusion reduced the sample size substantially. A positive coefficient on the imported share of raw material purchases would reflect trade induced technological change that raises the relative demand for skilled labour.

The ratio of training expenditure to investment and the percentage of employees receiving in-house or outside training were also used in the NE and GJMA regressions, respectively. These capture the extent to which firms invest in order to raise labour productivity. The sign of these coefficients are ambiguous as training expenditure may substitute or complement skilled labour. In the former case we would expect a negative coefficient for this variable. Finally, a dummy variable for firms prioritising investment in new technology in order to raise product quality or efficiency was included. A positive coefficient is expected. This variable was also interacted with trade liberalisation variables to capture the extent to which trade liberalisation may have induced the product quality and efficiency improving investment.

Technology transfers through foreign ownership is also expected to have an impact on the occupational employment structure. A dummy variable for firms with greater than 10 % foreign ownership was included to capture this effect. A positive coefficient, as found by Hanson and Harrison (1994) and Harrison and Hanson (1999) for Mexico, is expected. Efficiency gains and technology transfers through exporting is also expected to affect employment patterns in export oriented firms.[26] Efficiency

[26] Firms may be required to follow certain production procedures in order to realise foreign quality requirements. Technology transfers can take place either through the leasing of foreign technology,

differences have been shown to exist within exporting firms with more efficient South African firms being more likely to export outside of SADC than less efficient firms (Rankin, 2001). To capture these effects a dummy variable for exporting firms was included.

To capture the direct impact of trade liberalisation on employment dummy variables indicating whether a firm's product price or domestic market share was significantly, moderately or not affected were included. Dummy variables for the impact of trade liberalisation on export competitiveness (NE survey) or domestic competitiveness (GJMA survey) were also included. To avoid the dummy variable problem, the dummy variable for firms significantly affected was omitted in each case. Because these dummy variables only capture the direct effects on employment and not the indirect effect via trade induced technological change they were also interacted with the technology related variables.

Finally, sector and size dummy variables were used to capture size and industry specific effects.

4.3 Estimation results

The results for the level estimations of the labour demand functions are presented in Table 12 and 13 while the estimates for the changes in employment are presented in Tables 14 and 15. In the level estimations both the CES and Cobb-Douglas derived labour demand functions are presented, although we have shown that the former is better suited to the analysis of trade and skill biased technological change. In the case of the NE survey based estimations relative wage is omitted as no wage data was available. Only the IRLS results are presented as the OLS results are qualitatively similar.

In the performing the estimations the sample size varied as variables were excluded or included in the estimated labour demand functions. This problem arises as result of missing data points for many of the variables. The change in sample size frequently had an impact on the regression results. The approach followed was to restrict the sample size to that set of firms for which a complete set of data was available. Insignificant variables could then be excluded without affecting the sample size. As a consequence of missing data the number of observations in most estimates are significantly less than the total number of firms surveyed.

A number of diagnostic tests were also performed to assess the models. In the OLS results the Cook-Weisberg test was used to test for heteroskedasticity. The null of constant variance could not be rejected in any case. The Ramsey RESET test was used to check the specification of the labour demand functions. The null of no omitted variables could not be rejected in the GJMA results where relative wage data was available. In the NE survey results the null could not be rejected in the relative demand function, but was rejected for the other labour demand functions. As expected, the exclusion of relative wages has resulted in omitted variable bias.

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access to blueprints for the manufacture of the good and direct transfers of technology from a foreign partner. As shown earlier, foreign owned firms are more likely to export than domestic firms.

4.3.1 Trade liberalisation and employment

In general the results suggests that less skill intensive firms are negatively affected by trade liberalisation. This relationship is shown in the NE survey based level estimates for unskilled labour demand where the coefficients on the dummy variables for the impact of trade liberalisation on market share are negative. The omitted dummy variable is "significantly affected" indicating that firms moderately or not affected by import penetration employ fewer unskilled labour than firms significantly affected. Similar results are found in the GJMA based estimates (Table 13) where firms whose prices are not affected by trade liberalisation demand fewer numbers of unskilled and less skilled labour relative to firms whose prices are significantly affected by trade liberalisation. Consistent results are also found in the relative labour demand functions. In the NE survey firms whose market share is not affected by trade liberalisation tend to be more skill intensive than those significantly affected. In the GJMA survey, firms whose prices are moderately affected are more skill intensive than those whose prices are significantly affected. This is not the case with firms whose prices are not affected, highlighting some inconsistencies in the results. Further, the GJMA results for less skilled labour show that firms not affected by tariffs are larger demanders of less skilled labour. This contradicts the coefficients on the price effect dummies in the same regression. Thus, some uncertainty remains.

Further insight into the impact of trade on employment is provided by the estimates of the changes in labour demand shown in Tables 14 and 15. The NE survey is used to analyse why firms increased or decreased full time employment for each occupational category between the beginning of 1998 to the end of 1999. The coefficients of these estimates show the change in probability of a firm increasing employment in response to a unit change in the independent variable given the mean characteristics of all firms. In the case of dummy variables the coefficient is for discrete change of the dummy variable from 0 to 1. The GJMA survey is used to analyse change in total full time employment between 1997-98 and 1994-98. Both the OLS and the IRLS estimated coefficients are shown.

The results using the GJMA survey are poor with very few significant coefficients in the IRLS estimation. More attention will thus be placed on the NE survey which gave slightly better results. The NE survey results show a negative correlation between employment growth and the impact of trade liberalisation on the firm for some of the occupational categories. Firms moderately or not affected by trade liberalisation (in terms of market share) had a higher probability (between 0.28 to 0.44) of increasing semi-skilled, skilled-technical and highly skilled employment relative to firms significantly affected. This result was robust to the exclusion of the insignificant variables. No relationship between loss of market share and the change in unskilled employment was found. However, the negative coefficient on the moderate price effect dummy in the unskilled labour demand indicates that firms whose prices were moderately affected by trade liberalisation were more likely to reduce employment than those firms significantly affected. This contradicts the negative impact of trade liberalisation found for the other occupational categories. The result, however, was not robust to the exclusion of the insignificant variables when the sample size was permitted to increase.

4.3.2 Export competitiveness and employment

In order to assess the overall impact of trade liberalisation on employment it is important to analyse employment creation through improved export competitive. Looking at the level results for unskilled and less skilled labour within the GJMA survey (Table 13), we note that the coefficient on the dummy variables for firms whose raw material prices were moderately or not affected by trade liberalisation is negative and significant. Because the omitted dummy variable is "significant raw material price reductions" the results suggests that the competitiveness of unskilled and less skilled labour intensive firms has improved through trade liberalisation. This is also shown in the estimates of the high skilled labour demand function using the NE survey (Table 12) where the skill intensity of production is lower in firms experiencing significant improvements in export competitiveness relative to experiencing moderate improvements. These improvements in competitiveness via the impact of trade liberalisation on input costs will alleviate some of the negative impacts of trade liberalisation on less skilled employment shown earlier.

The first difference regressions support this view, although they show that the greatest benefit accrues to skilled technical workers. Within the NE survey results firms experiencing significant improvements in competitiveness had a higher probability of increasing skilled technical employment than other firms. There were no interpretable significant results for the other occupational categories. This could indicate a rising skill intensity of production within exporters, a result consistent with the rising skill intensity of exports shown by Edwards (2001a). The cause of this relationship is unclear. The rising skill intensity of exports may reflect South Africa's comparative advantage in the face of increased trade by less skill abundant developing economies. It may also reflect the assimilation of foreign skill biased technology by domestic firms as they compete in the international export market.

Despite the positive impact on export competitiveness, overall employment still declined within export firms. In the NE survey results (Table 14) exporters, relative to non-exporters, had a higher probability of reducing employment of unskilled (-0.61) and highly skilled (-0.45) workers since the beginning of 1998. A negative relationship for total employment also emerges over the longer time period, 1994-98, when using the GJMA survey. This is a qualitatively similar result to the UK results of of Greenaway *et al.* (1999) who interpret the sign as evidence of trade induced efficiency gains. In contrast Birdi *et al.* (1999), who use a similar methodology, find a positive relationship between employment growth and export orientation for South Africa between 1972-97.

4.3.3 Trade and technological change

There is also evidence of the impact of skill biased technological change on the skill intensity of production. In the level estimates (Tables 12 and 13) the share of investment in computers and the imported share of raw materials are positively related to the relative demand for high skilled labour within the NE survey results. These variables are not significant in the GJMA results, but a significant positive correlation between the relative demand for skilled labour and the percentage workforce trained is found. Consistent results are also found in the individual labour demand functions.

In the GJMA results, training is positively correlated with the employment of high skilled labour, but is negatively related to the employment of less skilled labour. Within the NE survey results, the share of investment in computers is negatively correlated with employment of unskilled and less skilled labour. The imported share of machinery & equipment is also negatively related to employment of unskilled labour. No clear relationships emerge from the difference results in Tables 14 an 15. In the NE survey results, training expenditure is negatively related to the change in employment of skilled labour suggesting that training is a substitute for skilled labour.

These results are similar to those of Harrison and Hanson (1999) and Görg and Strobl (2001) who find a positive relationship between the use of imported raw materials and machinery and the skill intensity of production in Mexico and Ghana, respectively. A relationship between investment in computers and the skill intensity of production is also found by Berman *et al.* (1994), Berman *et al.* (1997) and Machin and Van Reenen (1998). This they regard as evidence in support of skill biased technological change.

To test whether trade liberalisation had any impact on the adoption of skill biased technology the technology variables were interacted with a dummy for firms significantly affected by trade liberalisation. In the NE survey level results, the coefficient for the interaction term including share computers in investment was negative for the less skilled regression (-1.4) and positive for the highly skilled regression (0.997). Both were significant at the 5 % level. These coefficients indicate that the relationship between skill intensity and investment in skill biased technology was much stronger in firms experiencing a significant loss in market share due to trade liberalisation. Although causation cannot be inferred from this result, the relationship is consistent with the view of Wood (1994) that firms respond to increased import competition by adopting skill biased technology.

Finally, the skill intensity of production is positively related to foreign ownership, a result also found in Mexico by Hanson and Harrison (1994) and Harrison and Hanson (1999). Technology transfers via foreign direct investment encourage increases in the skill intensity of production. Like export firms, foreign firms also reduced employment since 1994 (see GJMA results). The coefficient on the variable is however small and is not significant in the IRLS regression.

4.3.4 Other results

A number of other interesting relationships emerge from the results. The elasticity of substitution of skilled and less skilled workers ranges between 0.408 to 0.47. This suggests that a 1 % rise in the relative wage of skilled workers results in a 0.408 % to 0.47 % decline in the skill intensity of production. This falls in the low end of the range surveyed by Hammermesh (1993, Table 3.7), but is not directly comparable as the surveyed estimations use production and nonproduction workers for which there is a large overlap in earnings (Hammermesh, 1993: 65). The signs of the coefficients on relative wages are significant and of the expected sign (positive) for the unskilled and less skilled labour demand functions. The coefficient is not significant for high skilled, but becomes significant and negative once the insignificant variables, which constrain the sample size, are eliminated.

4.4 Discussion

Overall the results are broadly consistent with international trade theory that trade liberalisation causes a shift in the structure of employment away from import competing firms towards export competing firms. There is some weak evidence of a rise in the skill intensity of production as result of trade liberalisation. The level regressions indicate that less skill intensive firms are the most negatively affected by trade liberalisation. In the growth equations, increased export competitiveness as result of lower input costs benefits skilled technical employment the most. Despite the improved export competitiveness, employment fell relatively strongly amongst exporters. This result is consistent with Hayter *et al*. (1999) who find that export oriented firms shed more labour during the early 1990s than other firms. This suggests trade induced efficiencies in the use of labour within export orientated firms.

Table 11: Demand for labour functions using IRLS, NE survey

	High skilled/unskilled		**Unskilled**		**Low skilled**		**Skilled**		**High skilled**	
	CES		**CD**		**CD**		**CD**		**CD**	
	Coeff	**P>|t|**	**Coeff**	**P>|t|**	**Coeff**	**P>|t|**	**Coeff**	**P>|t|**	**Coeff**	**P>|t|**
Log sales			**0.674**	0.000	**0.687**	0.000	**0.712**	0.000	**0.633**	0.000
Foreign	**0.533**	0.014	**-0.508**	0.013	-0.149	0.311	-0.154	0.225	-0.009	0.936
Exporter	-0.007	0.973	0.128	0.495	0.042	0.754	0.044	0.702	0.127	0.232
share M&E in I	0.179	0.472	-0.249	0.291	0.085	0.611	-0.152	0.292	-0.145	0.276
share computers in I	**0.951**	0.006	**-0.958**	0.005	**-0.401**	0.083	-0.056	0.780	0.073	0.694
% M in raw materials	**0.006**	0.051	**-0.010**	0.001	-0.002	0.272	-0.001	0.417	0.001	0.739
share training in I	-0.018	0.789	0.011	0.862	-0.004	0.657	-0.004	0.620	-0.008	0.266
age	-0.002	0.669	0.005	0.163	**0.007**	0.007	**0.004**	0.084	0.002	0.448
Mkt share-moderate	0.375	0.157	**-0.416**	0.098	0.105	0.555	0.026	0.865	-0.129	0.367
Mkt share-None	**0.427**	0.094	**-0.564**	0.016	-0.199	0.226	-0.041	0.770	-0.030	0.821
Mkt share-unknown	0.253	0.502	**-0.708**	0.046	-0.263	0.278	-0.069	0.746	-0.110	0.575
Price-moderate	0.049	0.866	-0.134	0.617	-0.176	0.347	-0.042	0.794	0.022	0.884
Price-none	-0.073	0.793	-0.006	0.98	-0.054	0.763	0.145	0.346	0.004	0.976
Price-unknown	-0.409	0.386	0.101	0.815	-0.127	0.680	-0.157	0.557	-0.375	0.130
Export-moderate	0.226	0.463	0.430	0.129	0.189	0.343	0.188	0.275	**0.281**	0.083
Export-none	0.238	0.43	0.253	0.355	0.144	0.446	0.116	0.480	0.177	0.252
Export-unknown	0.344	0.462	0.191	0.657	0.272	0.334	0.165	0.496	**0.381**	0.092
50 < employ ≤100	-0.264	0.284								
100<employ≤200	**-0.541**	0.028								
200 <employ	**-0.737**	0.002								
Wood	-0.463	0.187	**0.657**	0.046	0.369	0.122	**0.745**	0.000	0.104	0.580
Chemical	**0.580**	0.074	-0.380	0.2	-0.077	0.720	**0.399**	0.033	0.117	0.500
Auto	**1.039**	0.003	**-0.783**	0.017	0.233	0.315	**0.824**	0.000	0.225	0.228
Textile	0.429	0.236	-0.195	0.568	**0.733**	0.003	**0.381**	0.072	0.047	0.809
Metal	0.386	0.224	-0.257	0.395	0.072	0.741	**0.750**	0.000	0.095	0.587
Furn	-0.407	0.259	**0.723**	0.035	**0.691**	0.006	**1.103**	0.000	0.051	0.801
Machine	0.344	0.304	-0.062	0.846	-0.026	0.911	**0.800**	0.000	0.126	0.493
Print	**1.045**	0.003	-0.495	0.138	**-0.516**	0.029	**1.092**	0.000	**0.403**	0.032
obs	289		273		304		306		305	
F-stat	3.12		16.85		35.61		42.91		40.22	
Prob > F	0		0		0		0		0	

Note: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively
Estimation uses national weights.
Low skilled consist of semi and unskilled labour. Skilled consist of professional, managerial and skilled technical labour. High skilled consists of professional and managerial labour. All dependent variables are in logarithmic form.
The following dummy variables have been omitted: Food & beverages sector, small firms less than 50 employees, significant loss in market share due to trade liberalisation (Mkt share-significant), significant price reduction due to trade liberalisation (Price-significant) and significant improvement in export competitiveness due to trade liberalisation (Export-significant).
Dummy variables capturing whether trade liberalisation lowered equipment costs significantly, moderately, not at all and don't know were included in preliminary regressions. These were not significant and have been excluded in subsequent regressions.
The results of the relative labour demand function do not change if the insignificant results are removed, although the coefficient on the share computers in investment is only significant at the 10 % level. The sample size increases to 367.

Table 12: Demand for labour functions using IRLS, GJMA survey

	Skilled/less skilled				**Unskilled**		**Low skilled**		**Skilled**	
	Coef.	**P>|t|**	**Coef.**	**P>|t|**	**Coef.**	**P>|t|**	**Coef.**	**P>|t|**	**Coef.**	**P>|t|**
Log relative w	**-0.470**	0.002	**-0.408**	0.000	**0.666**	0.003	**0.239**	0.033	-0.189	0.274
Log sales 98					**0.496**	0.000	**0.498**	0.000	**0.547**	0.000
Foreign	0.001	0.640			**-0.007**	0.012	0.000	0.716	-0.002	0.426
Export	**0.395**	0.039	**0.295**	0.012	-0.337	0.202	0.099	0.462	**0.369**	0.080
share machinery in I	0.015	0.954			-0.267	0.456	-0.265	0.150	-0.260	0.362
Imported M&E as share M&E investment	-0.023	0.903			0.249	0.355	0.012	0.929	-0.214	0.295
% workforce trained	**0.408**	0.002	**0.119**	0.011	-0.287	0.130	**-0.199**	0.035	**0.315**	0.032
Age	0.000	0.930			0.004	0.484	**0.011**	0.001	0.007	0.161
Tariff effect-moderate	0.043	0.902			0.361	0.478	0.103	0.698	0.121	0.769
Tariff effect-None	0.237	0.596			0.645	0.315	**0.683**	0.040	0.560	0.276
Tariff effect-unknown	-0.036	0.930			0.765	0.219	**0.596**	0.065	0.184	0.711
Price-moderate	0.358	0.341	**0.367**	0.055	-0.922	0.101	-0.279	0.322	0.247	0.572
Price-none	-0.190	0.691	-0.004	0.989	**-1.401**	0.054	**-0.962**	0.008	-0.529	0.338
Price-unknown	0.120	0.757	0.115	0.421	**-1.065**	0.070	**-0.700**	0.019	-0.063	0.891
Material P-moderate	0.526	0.281			**-1.306**	0.059	**-0.891**	0.007	-0.034	0.946
Material P-none	0.631	0.244			-0.967	0.194	**-0.739**	0.039	0.344	0.531
Material P-unknown	0.477	0.320			**-1.531**	0.026	**-0.833**	0.009	0.150	0.758
100<employ<=200	**-0.365**	0.062	**-0.305**	0.010						
200 <employ	-0.236	0.193	-0.125	0.274						
Chemicals	-0.398	0.211	-0.171	0.433	-0.010	0.983	0.184	0.436	-0.082	0.824
Automotive	-0.574	0.116	**-0.491**	0.043	0.009	0.987	0.239	0.381	-0.611	0.151
Textiles	**-1.014**	0.015	**-0.827**	0.004	**-2.301**	0.000	**0.620**	0.051	-0.310	0.526
Metal products	-0.312	0.313	-0.317	0.140	-0.168	0.720	0.256	0.257	-0.234	0.503
Furniture & paper	-0.334	0.333	**-0.551**	0.021	-0.411	0.432	0.358	0.163	-0.024	0.951
electrical products	-0.167	0.619	-0.052	0.813	-0.498	0.318	-0.207	0.391	0.011	0.977
Iron & steel	-0.516	0.102	-0.321	0.137	-0.168	0.720	0.173	0.453	-0.347	0.332
cons	-2.159	0.002	-1.647	0.000	-3.098	0.116	-3.417	0.001	-7.049	0.000
obs	150		247		111		122		122	
F-stat	1.92		4.98		3.63		9.04		5.18	
Prob > F	0.010		0		0		0		0	

Note: *, ** and *** reflect significance at the 1%, 5% and 10% significance level, respectively
Estimation uses national weights.

Low skilled consists of semi and unskilled labour. Skilled consists of professional, managerial and skilled technical labour. Less skilled consists of low skilled plus clerical, service workers (marketing, sales, etc.) and craft and related tradesmen. All dependent variables are in logarithmic form.

The following dummy variables have been omitted: Food & beverages, firms with between 50 to 100 employees, significant effect on business due to trade liberalisation (Tariff effect-significant), significant price reduction due to trade liberalisation (Price-significant) and significant improvement in competitiveness due to trade liberalisation (Material P-significant).

Table 13: Change in labour demand according to occupational category using probit model, NE survey

	Unskilled		**Semi-skilled**		**Skilled-technical**		**Highly skilled**	
	dF/dx	**P>|z|**	**dF/dx**	**P>|z|**	**dF/dx**	**P>|z|**	**dF/dx**	**P>|z|**
Expected sales down	**-0.452**	0	**-0.443**	0	**-0.479**	0	**-0.492**	0
Expected sales same	**-0.383**	0	**-0.243**	0.042	-0.260	0.101	**-0.286**	0.099
			-0.079	0.801				
Foreign	-0.190	0.11	-0.099	0.374	**-0.242**	0.052	-0.071	0.632
Exporter	**-0.609**	0	-0.146	0.25	-0.018	0.916	**-0.452**	0.006
I/assets	**0.117**	0.004	0.028	0.408	**0.188**	0	0.066	0.227
Techno	0.032	0.781	-0.006	0.954	0.162	0.202	0.016	0.914
share M&E in I	-0.106	0.518	-0.073	0.603	**-0.322**	0.053	0.123	0.524
share computers in I	0.129	0.562	-0.159	0.424	-0.198	0.384	-0.396	0.111
% M in raw materials	-0.003	0.104	0.001	0.398	-0.002	0.471	-0.004	0.219
share training in I	**0.082**	0	0.035	0.105	**0.077**	0.003	**-0.230**	0.082
age	**-0.004**	0.045	-0.001	0.596	-0.001	0.597	**-0.006**	0.059
Mkt share-moderate	-0.137	0.391	**0.283**	0.093	0.149	0.456	**0.404**	0.03
Mkt share-None	-0.073	0.631	**0.378**	0.025	**0.324**	0.077	**0.439**	0.015
Mkt share-unknown	**0.506**	0.063	**0.513**	0.028	0.184	0.574	**0.621**	0.006
Price-moderate	**-0.365**	0.009	-0.085	0.625	-0.191	0.368	-0.250	0.227
Price-none	-0.210	0.221	-0.140	0.408	0.005	0.985	-0.208	0.334
Price-unknown	0.013	0.96	-0.009	0.974	**0.510**	0.08	0.005	0.989
Export-moderate	-0.026	0.879	0.076	0.648	**-0.400**	0.043	0.083	0.649
Export-none	-0.114	0.501	-0.054	0.702	**-0.549**	0.009	0.115	0.565
Export-unknown	**-0.344**	0.015	-0.110	0.62	**-0.435**	0.034	-0.266	0.467
50<Medium<=100	**-0.214**	0.096	0.143	0.355	-0.195	0.254	**0.538**	0.01
100<Medium<=200	**-0.298**	0.016	-0.062	0.684	0.154	0.428	0.325	0.131
Large>200	**-0.321**	0.004	-0.189	0.136	-0.059	0.725	0.143	0.502
Wood	**0.665**	0	0.174	0.34	**0.428**	0.049	0.225	0.336
Chemical	**0.677**	0	-0.003	0.984	0.143	0.476	0.059	0.791
Auto	**0.640**	0.001	**0.353**	0.062	0.173	0.435	0.075	0.733
Textile	0.375	0.1	-0.035	0.866	0.104	0.692	-0.316	0.169
Metal	**0.340**	0.083	0.044	0.819	**0.489**	0.009	0.129	0.59
Furn	**0.734**	0	**0.429**	0.039	0.387	0.119	0.293	0.423
Machine	**0.757**	0	0.094	0.598	**0.370**	0.082	-0.089	0.738
Print	**0.496**	0.009	-0.056	0.783	0.203	0.326	0.059	0.826
Obs		171		182		143		119

Wald chi2	101.53	60.74	100.49	64.78
Prob > chi2	0.000	0.002	0.000	0.000
Pseudo R2	0.549	0.280	0.418	0.407
obs. P	0.386	0.410	0.449	0.461
pred. P	0.286	0.355	0.413	0.406

Note: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively
Dependent variable is a binary variable with employment increase =1 and employment decrease = 0.
The sample size has diminished substantially as only firms that did not change employment have been excluded.
The coefficients show the change in probability of a firm increasing employment in response to a unit change in the independent variable given the mean characteristics of all firms.
Expected sales up is the omitted dummy variable in the expected sales variables. All other assumptions as in the earlier table.

Table 14: Change in labour demand using total employment, GJMA

	1997-98				**1994-98**			
	OLS		**IRLS**		**OLS**		**IRLS**	
	Coef.	**P>|t|**	**Coef.**	**P>|t|**	**Coef.**	**P>|t|**	**Coef.**	**P>|t|**
Δ Log sales	**0.462**	0.002	**0.353**	0.000				
Foreign	**-0.002**	0.002	0.000	0.459	**-0.008**	0.001	-0.002	0.187
Export	-0.030	0.629	-0.019	0.634	**-0.436**	0.042	**-0.266**	0.077
Log I/assets	**-0.039**	0.020	-0.006	0.589				
share machinery in I	0.011	0.915	**0.117**	0.048	0.029	0.907	-0.112	0.549
Imported M&E as share M&E investment	**-0.116**	0.064	0.029	0.467	-0.096	0.608	-0.039	0.786
% workforce trained	0.020	0.561	-0.004	0.869	0.226	0.113	-0.045	0.628
Age	**-0.004**	0.007	0.000	0.744	**-0.007**	0.014	**-0.005**	0.087
Tariff effect-moderate	0.005	0.957	0.005	0.954	**-0.848**	0.024	-0.162	0.551
Tariff effect-None	**0.316**	0.038	0.025	0.802	-0.315	0.456	-0.179	0.606
Tariff effect-unknown	**0.256**	0.034	-0.006	0.953	0.009	0.980	-0.201	0.510
Price-moderate	-0.173	0.317	0.057	0.511	**1.097**	0.021	0.343	0.353
Price-none	**-0.642**	0.003	-0.007	0.944	-0.212	0.613	0.180	0.640
Price-unknown	**-0.280**	0.040	0.058	0.525	0.115	0.762	0.193	0.533
Material P-moderate	-0.042	0.737	-0.016	0.875	0.491	0.101	0.389	0.323
Material P-none	**0.238**	0.037	-0.005	0.964	0.229	0.480	0.271	0.582
Material P-unknown	**-0.270**	0.004	-0.047	0.637	0.559	0.119	0.259	0.519
100<employ<=200	0.116	0.098	-0.033	0.421	**0.672**	0.014	0.142	0.357
200 <employ	**0.132**	0.031	-0.051	0.196	**0.419**	0.032	-0.015	0.910
Chemicals	**-0.204**	0.015	-0.049	0.521	0.165	0.571	-0.181	0.455
Automotive	**-0.216**	0.022	-0.103	0.216	-0.145	0.658	-0.194	0.458
Textiles	**-0.284**	0.004	-0.094	0.302	-0.071	0.800	**-0.691**	0.016
Metal products	-0.081	0.317	-0.032	0.655	0.239	0.441	-0.149	0.510
Furniture & paper	0.042	0.629	0.071	0.360	0.209	0.477	-0.190	0.403
Electrical products	-0.101	0.364	-0.007	0.933	0.342	0.381	-0.285	0.248
Iron & steel	**-0.159**	0.056	-0.095	0.194	0.351	0.255	-0.133	0.559
cons	0.327	0.111	-0.075	0.620	-0.355	0.557	0.459	0.381
obs	113		113		96		96	
F-stat	2.27		2.62		5.1		1.32	
Prob > F	0.003		0.001		0		0.181	
R2	0.522				0.522			

Note: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively
All other assumptions as in the earlier table.

5. CONCLUSION

This paper uses two firm level surveys to analyse the relationship between trade liberalisation, technology and employment in South Africa. These relationships are explored using cross tabulations and estimated labour demand functions.

Overall the results are broadly consistent with international trade theory in that trade liberalisation causes a shift in the structure of employment away from import competing firms towards export competing firms. The NE survey cross tabulations show a significant relationship between large firms' decisions whether to increase or decrease employment and the impact of trade liberalisation on market share. No similar relationship was found for small firms. There is also some weak evidence of a rise in the skill intensity of production as result of trade liberalisation. As shown in the estimated labour demand functions, less skill intensive firms are the most negatively affected by trade liberalisation, particularly its impact on market share. In the change in labour demand functions, increased export competitiveness as result of lower input costs benefited skilled technical employment the most.

The results are, however, not conclusive. Given the nature of firm surveys, it is not clear whether declining market share and product price, particularly within less skill intensive firms is due to trade liberalisation or other general competitiveness problems such as the emergence of new firms, changes in consumer preferences towards more quality based products, poor management, etc. There is also substantial heterogeneity in the impact of trade liberalisation on market share and product prices across firms and sectors. A high percentage of large firms, particularly clothing & textile firms, were negatively affected by increased import penetration. Small firms, in comparison, were less affected. As result the relationship between trade liberalisation and employment changes is also complex. For example, there is no relationship between trade liberalisation and employment changes from 1998 to the end of 1999 for small firms. Also, many firms significantly affected by trade liberalisation increased employment.

Although a negative relationship between trade liberalisation and employment is found for large firms, the overall impact of trade liberalisation on employment is likely to be small. Using the GJMA survey, firms that were negatively affected by trade liberalisation can at most account for 20 % of the decline in employment between 1994-98. It is likely that many of these firms reduced employment in response to other factors such as diminished demand, labour market factors or new technology rather than trade liberalisation. However, the impact may also be underestimated as firms that have closed down as result of trade liberalisation will not have been captured in the survey. Nevertheless, the results suggest that other economy-wide or firm-specific impacts dominate the employment decision.

Export competitiveness has improved through trade liberalisation, but this has not led to increased employment. The regression results show that relative to other firms, exporters have reduced employment since 1994. This may be the result of export competition induced improvements in labour efficiency which have negatively affected employment within these firms. Exporters are also relatively skill intensive

indicating that growth in exports will not necessarily feed into substantial increases in less skilled employment. These results are short run and do not capture the long-term dynamic effects that may arise from improved labour productivity within the export sector. Further, a considerable constraint to export driven employment growth is the internationally low level of export orientation of South African firms as well as the low share of small firms that export.

The results also highlight the importance of technological change on employment. Evidence of skill biased technological change is shown in the positive correlation between skill intensity of employment and the share of computer expenditure in investment. Rapid diffusion of computer usage in all sectors of the economy (Hodge and Miller, 1996) during the 1990s will have raised the skill intensity of production. Skill biased technological transfers are also encouraged through foreign ownership and foreign direct investment. The rise in foreign direct investment during the 1990s will also have raised the overall skill intensity of manufacturing.

Skill biased technology transfers through trade are shown in the positive correlation between skill intensity of production and the share of imports in raw material input purchases. By encouraging the importation of good that complement skilled labour, trade liberalisation will have raised the skill intensity of South African manufacturing.

Finally, there is some evidence in support of defensive innovation occurring within firms. In the estimated labour demand function the correlation between skill intensity of production and investment in computers is much stronger for firms whose market share have been significantly affected by trade liberalisation. Firms that are negatively affected by trade liberalisation appear to be investing relatively heavily in order to raise the skill intensity of production. This is also shown in the cross tabulation results. Of the firms that reduced unskilled employment, those that were significantly affected by trade liberalisation invested more heavily in order to raise production efficiency and product quality. Those not affected reduced employment primarily in response to a decline in expected sales growth.

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