TRADE LIBERALISATION, TECHNOLOGICAL CHANGE AND THE SKILL STRUCTURE OF EMPLOYMENT IN SOUTH AFRICA

LAWRENCE JAMES EDWARDS

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Abstract

Trade Liberalisation, Technological Change and the Structure of Occupational Employment in South Africa

Lawrence James Edwards

There has been considerable liberalisation of the South African economy since the early 1980s. During the 1990s, the liberalisation process coincided with rising skill and capital-intensity of production and substantial declines in the employment of less-skilled labour. This thesis draws upon a variety of empirical and theoretical methodologies to investigate the contributory impacts of trade liberalisation and technological change to the changing skill structure of employment in South Africa since the early 1980s.

The thesis consists of 9 chapters. Chapter 1 introduces the work. Chapter 2 presents an analysis of the trade liberalisation process in South Africa since the early 1980s using different data sources and protection measures. Chapter 3 critically reviews the theoretical relationship between trade, technology and labour embodied within the Heckscher-Ohlin-Samuelson model. Particular emphasis is placed on the application of the Heckscher-Ohlin-Samuelson model in analysing the general equilibrium effects of skill-biased and trade-induced technological change in middle-income countries such as South Africa. In Chapter 4, the Heckscher-Ohlin-Samuelson model is empirically assessed for the case of South Africa. Chapters 5 and 6 present input-output decomposition analyses of the changing structure of production and occupational employment in South Africa between 1984 and 1997. As an alternative to the Heckscher-Ohlin-Samuelson framework, Chapter 7 uses a Ricardian model to analyse the impact of wages and labour productivity on South Africa's export performance. In Chapter 8, two firm level surveys for South Africa are used to interrogate the relationship between trade liberalisation, technological change and employment at the firm level. Chapter 9 concludes by reviewing key findings.

The numerous changes that have occurred during the 1990s make it difficult to ascertain the relative impact of trade liberalisation, technological change and factor market changes on employment patterns in South Africa. The thesis shows that that tariff liberalisation placed downward pressure on the returns to labour during the 1990s. Increased export orientation

also led to the shedding of labour to raise productivity and some induced technological innovation. Productivity and wages are shown to be important determinants of export performance. The adoption of skill-biased technology has also negatively affected the demand for less-skilled labour. Real wage rigidities have exacerbated all of these pressures leading to substantial reductions in employment levels.

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Acronyms and Abbreviations

Cosatu	Congress of South African Trade Unions
CPI	Consumer price index
CSS	Central Statistical Services
DFE	Dynamic fixed effects
DTI	South African Department of Trade and Industry
ERP	Effective rates of protection
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GEAR	Growth, Employment and Redistribution
GEIS	General Export Incentive Scheme
GJMA	Greater Johannesburg Metropolitan Area
GOS	Gross operating surplus
HOS	Heckscher-Ohlin-Samuelson model
HS	Harmonised System
IDC	Industrial Development Corporation
INSTAT	Industrial Statistics Database
IMF	International Monetary Fund
IO	Input-Output table
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification of all Economic Activities
MG	Mean group estimator
MIDP	Motor Industry Development Programme
NE	National Enterprise
OECD	Organisation for Economic Corporation and Development
OHS	October Household Survey
OLS	Ordinary least squares
PAM	Partial adjustment model
PMG	Pooled mean group estimator
PPI	Producer price index
PPP	Purchasing Power Parity
QR	Quantitative restriction

RBQB	Reserve Bank Quarterly Bulletin
RSA	Republic of South Africa
RULC	Relative unit labour costs
SACU	South African Customs Union
SADC	Southern African Development Community
SES	Standardised Employment Series
SIC	Standard Industrial Classification of all Economic Activities
SITC	Standard International Trade Classification
SS	Stolper-Samuelson theorem
SSA	Statistics South Africa
STAN	OECD Structural Analysis Industrial Database
SU	Supply Use table
TFP	Total factor productivity
TIPS	Trade and Industrial Policy Strategies
UK	United Kingdom
US	United States of America
SASID	South African Standardised Industry Database
UNIDO	United Nations Industrial Development Organisation
WB	World Bank
WDI	World Bank World Development Indicators
WEFA	Wharton Econometrics Forecasting Association
WTO	World Trade Organisation

Chapter 1
Introduction

'The sad truth is that the social and economic cost of globalisation is being borne by the working class and the unemployed.'

Cosatu in Weekly Mail (2000)

1. Introduction

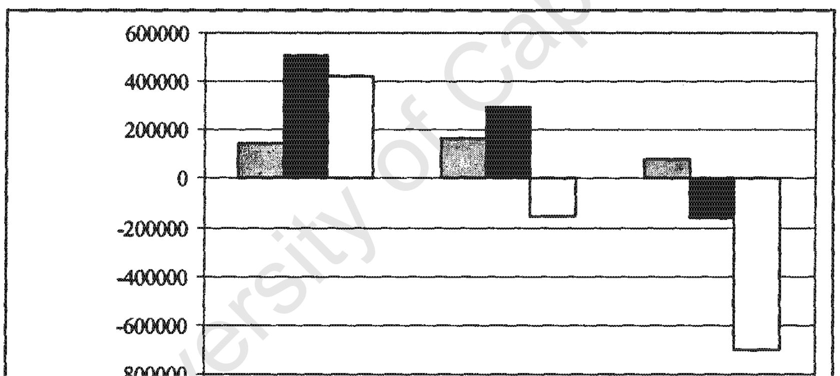
Concerns over the influence of international trade on domestic production structures and employment have grown with the extent of trade liberalisation and trade flows initiated by the World Trade Organisation (WT), previously the General Agreement on Trade and Tariffs (GATT), negotiations. Research on the impact of trade liberalisation on employment has been most active within the developed countries where concerns have been raised that increased trade flows with developing countries have 'de-industrialised' the manufacturing sector and/or raised wage inequality between skill levels (see Wood (1994), Slaughter (1998a) and Burtless (1995) for an overview).

Evidence is mixed, although the bulk of international research suggests that the impact, if any, of trade on employment is weak. Yet the public perception of the correlation between increased trade and rising wage inequality, or a decline in employment of less-skilled labour, make it a contentious debate (Lawrence, 1983). The significance of the debate is also evident in South Africa where employees from labour-intensive industries have been most vocal in their dislike of the trade liberalisation process (Independent Newspapers, 1998).

The democratic election of a new government in 1994 and the consequent rise in political certainty was expected to ease South Africa into a new growth phase. As part of the process of restructuring the economy the government has implemented a number of far reaching policy reforms. One such policy has been the acceleration of trade liberalisation that began in the early 1980s.

While GDP growth has recovered from the recession of the late 1980s and early 1990s, it has been at a much lower level than was expected and forecast by the Growth, Employment and Redistribution (GEAR) macroeconomic policy. More worrying, however, has been the continued decline in employment that has accompanied the recovery in output growth. As is clearly shown in Figure 1.1, much of the decline in employment has occurred amongst less-skilled labour, particularly during the 1990s. It is estimated that more than 700 000 semi and unskilled labour lost formal employment between 1990 and 1998.

Figure 1.1: Employment changes according to skill, total economy excluding agriculture and government.



	1970-80	1980-90	1990-98
highly skilled	146892	165512	80451
skilled	508116	297211	-157326
semi - unskilled	420251	-151839	-700908

Notes: The data are obtained from the Trade and Industry Policy Strategies' South African Industrial Database (SASID, 2003) and only includes formal sector employment. The data is available from www.tips.org.za.

In addition, research appears unanimous in its conclusion that production within South Africa has become more capital and skill intensive (Bhorat and Hodge, 1999). A paradox of increased capital intensity of exports and labour intensity of imports in the face of high unemployment is also apparent (Bell and Cattaneo, 1997; Tsikata, 1999). Tsikata (1999), for example, finds that South Africa has a high share of human capital and technology-intensive exports in total manufacturing exports relative to other middle-income countries.

The coincidence of 'jobless' (or rather 'job-shedding') growth, rising skill and capital-intensity of production and increased integration of South Africa into the international economy has led researchers and policy makers to question possible links between trade liberalisation, structural change and employment growth (Bell and Cattaneo, 1997; Nattrass, 1998). Given the economic and political ramifications of continued job losses, research on the impact of international trade on labour is growing (Bell and Cattaneo, 1997; Nattrass, 1998; Bhorat, 1999; Fedderke *et al.*, 1999; Birdi *et al.*, 2001).

Yet, there is still no consensus on the impact of trade liberalisation on the composition of production, trade and employment relative to other factors such as technological change and factor market changes. This thesis aims to provide a coherent assessment of the impact of these factors, particularly trade liberalisation, on production, trade and employment in South Africa.

There are a number of reasons for the lack of consensus regarding the impact of trade liberalisation on employment. One reason is that there is substantial disagreement over the extent to which South Africa has liberalised its trade. This debate has concentrated largely on the 1980s (Holden, 1992; Bell, 1992 & 1997; Belli *et al.*, 1993), but has continued into the 1990s, a period of tariff liberalisation (Fedderke and Vase, 2001; Van Seventer, 2001). Although nominal tariffs have fallen since 1994, evidence suggests that effective protection rates have risen or are still high for many sectors (Fedderke and Vase, 2001). Few studies provide a comprehensive analysis of the liberalisation process over a sustained period, which is essential if one wishes to link changes in the structure of production, trade and employment to trade liberalisation.[1] As a consequence, in many studies relationships between trade liberalisation, production, trade flows and employment are *inferred* from changing trends during the 1990s.[2] 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 programme and new labour legislation.

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[1] Fedderke and Vase (2001) analyse effective protection rates between 1988 and 1998.

[2] Bhorat (1999), Fedderke *et al.* (1999) and Birdi *et al.* (2001) all infer a relationship between trade liberalisation and employment without testing the relationship directly. To my knowledge, no empirical analysis in South Africa has directly analysed the relationship between trade liberalisation and employment using tariff data.

This provides substantial scope for further research in this area. Firstly, a critical review of the trade liberalisation process in South Africa since the 1980s is urgently needed. The extent to which the economy has been influenced by trade liberalisation is dependent on the degree to which the economy has reduced protection. Secondly, changes in employment, factor payments and the structure of trade and production need to be directly linked to changes in protection, as revealed by nominal tariffs, effective protection rates and anti-export bias measures. An objective of this thesis is to present a coherent overview of the liberalisation process, but more importantly to incorporate protection data directly into the analysis of the impact of trade liberalisation on structural change and employment.

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. Most studies (domestic and international) draw upon the one-cone Heckscher-Ohlin-Samuelson (HOS) model and in particular the Stolper-Samuelson (SS) theorem. Within a developing economy, the SS theorem predicts that trade liberalisation reduces wage inequality. In contrast, the SS theorem predicts rising wage inequality in developed countries, a result that is consistent with observed trends in many OECD countries since the 1980s. However, middle-income countries like South Africa do not fit well in the one-cone two-product two-country HOS model of international trade between developed and developing regions. Middle-income countries compete in the international market against both developed and developing countries and the impact of trade liberalisation on employment is potentially ambiguous. An extensive gap in the theory is thus evident.

In empirical applications a disjuncture between empirical methodologies and testable hypotheses drawn from the HOS model frequently arise. For example, the Stolper-Samuelson theorem relates product price changes to factor returns and not to changes in employment. Yet, only two studies in South Africa (Browne, 1999; Fedderke *et al.*, 1999) directly analyse the relationship between product prices and factor returns. Most South African studies analyse changes in the structure of trade or the factor content of trade and then infer an impact on *employment* (Bell and

Cattaneo, 1997; Bhorat, 1999; Hayter *et al.*, 1999). None of these studies directly link trade liberalisation to the change in product prices or trade flows. The factor-content studies are also not a direct application of the Stolper-Samuelson theorem, although they generally support the results arising from the price studies (Slaughter, 1998b) and are useful when price data are poor (Wood, 1995). The two approaches are thus often complementary in providing insight into how trade flows and trade liberalisation have affected employment and factor returns. As a result, both methodologies are drawn upon to provide a comprehensive overview this relationship in South Africa.

Theoretical limitations of the HOS model also suggest the need for alternative theoretical frameworks in this field of analysis. One constraint in using the HOS model in the South African context is that it assumes full employment. In response to exogenous price shocks arising from tariff liberalisation, output and factor returns adjust endogenously. However, estimated levels of unemployment in South Africa range between 20 % and 32 % depending on whether the broad or narrow definition of unemployment is used.[3] Further, new labour legislation has been enacted since 1994. The new legislation includes the Labour Relations Act (1996), the Basic Conditions of Employment Act (1997), the Employment Equity Act (1998) and the Skills Development Levy (1998). It is frequently argued that the new legislation has reduced labour market flexibility and increased real wages (Nattrass and Seekings, 2000). This suggests that employment, not wages, respond endogenously to exogenous price shocks

Exogenous changes in real wages also affect international trade patterns. Wood (1994) argues that labour skills and costs have become central in determining comparative advantage resulting in a shift of low-productivity sectors to low-wage countries and skill-intensive sectors to high-productivity countries. Rising real wages could therefore have a significant negative impact on employment created through export expansion. A useful framework for the analysis of labour cost competitiveness on export performance is the Ricardian model. The model is also useful in that employment changes can be modelled as endogenous responses to wage or labour

[3] The data are for 1995 and are obtained from the Statistics South Africa October Household Survey.

productivity movements. Further use of the Ricardian model in empirical analysis on the impact of trade on labour may provide some useful insights.

Skill-biased technological change is a further factor influencing the demand for skilled labour relative to less-skilled labour. Internationally, there is much empirical support for the hypothesis that rising wage inequality and declining employment of less-skilled labour reflect the impact of skill-biased technological change (Berman *et al.*, 1994; Berman *et al.*, 1998). Within South Africa the shift towards more skill-intensive production techniques (Bhorat and Hodge, 1999) and the relatively high investment in information technology at the firm level (Hodge and Miller, 1996) also suggest the presence of skill-biased technological change. However, most of the analysis in South Africa is conducted using a partial equilibrium framework where skill-biased technological change reduces relative employment and wages of less-skilled labour. In a general equilibrium framework, skill-biased technological change does not necessarily raise wage inequality (Haskel and Slaughter, 1998). Changes in relative wages are dependent on the sector bias and not the factor-bias of technological change (Leamer, 1996; Haskel and Slaughter, 1998).

A further weakness in South African (and international) studies is that they assume that the choice of technology is unrelated to foreign trade or trade liberalisation. 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). Increased integration of South Africa in the world economy, induced by trade liberalisation and the ending of sanctions, may have accelerated the adoption of skill-intensive technology. This contention still needs to be tested empirically, although preliminary analysis suggests that export growth is correlated with Total Factor Productivity growth (Belli *et al.*, 1993; Fallon and Pereira de Silva, 1994; Hayter *et al.*, 1999). An important contribution of this thesis is thus a deeper analysis of how trade liberalisation has influenced technological change amongst South African firms.

The thesis consists of 9 chapters including this introduction. Chapter 2 presents an analysis of trade liberalisation in South Africa since the early 1980s. Different data sources and protection measures are used to assess the extent to which protection has declined in South Africa. The best data from this analysis is also used in subsequent chapters where trade liberalisation is linked to changes in employment or factor remuneration.

Chapter 3 critically reviews the theoretical relationships between trade, technology and labour embodied within the Heckscher-Ohlin-Samuelson model. This model provides the theoretical framework for most international empirical research in this area. The model is also extended to the case of middle-income countries. Chapter 3 also reviews the empirical methodologies and results of international research on trade, technology and labour.

In Chapter 4, theoretical insights derived from the Heckscher-Ohlin-Samuelson model are empirically assessed in the case of South Africa. Unlike most other South African research in this area, this chapter focuses directly on the relationship between product price movements due to trade liberalisation and factor returns. The impact of technological change on factor returns is also estimated.

Chapter 5 and 6 use input-output decomposition techniques to explore the impact of trade on the structure of South African production and employment from the early 1980s. Although changes in production and employment as a result of trade flows are not directly linked to the reduction in protection, as in Chapter 4, changes during the 1990s are suggestive of the effect of trade liberalisation.

Chapter 5 uses a decomposition technique to decompose changes in gross output between 1984 and 1997 into domestic demand expansion, export expansion and import penetration. While other South African studies have pursued similar analyses, none have attempted to include the indirect effects of these changes. This chapter investigates the extent to which trade flows lie behind the rising capital intensity of production in South Africa and whether increased international competition has negatively affected the size of the manufacturing sector.

In Chapter 6, the decomposition technique used in Chapter 5 is extended to analyse the impact of trade and output growth on occupational employment in South Africa. This is essentially a factor-content analysis, which is the dominant approach followed in the analysis of trade liberalisation and employment in South Africa. The results of this chapter thus avail themselves to a comparison with other research on trade and labour in South Africa. Further, the factor-content analysis provides additional insights to the price-effect analysis presented in Chapter 4.

As emphasised earlier, rigidities in the South African labour market suggest that employment and not wages respond to exogenous price shocks. Further, changes in labour cost competitiveness, not trade liberalisation, may account for the rising skill and capital-intensity of South Africa's trade patterns. Chapter 7 thus uses a Ricardian model to assess the impact of labour cost competitiveness on South African export performance. Although the effects of trade liberalisation are not analysed directly, this chapter provides an alternative explanation (to trade liberalisation) for the rising capital intensity of South Africa's trade flows. In addition, the chapter provides useful insight into the possible impact of wage and productivity changes on employment via export competitiveness.

Chapter 8 returns to an analysis of the effect of trade liberalisation on labour, but at a micro-level using two firm level surveys conducted during the late 1990s. The focus at the firm level again enables a direct analysis of the impact of trade liberalisation on firm behaviour, as well as overcomes some of the aggregation problems associated with using sector level data. A further feature of this chapter is its focus on the effect of technological change (skill-biased and trade-induced) on employment in South African firms. This chapter thus extends the aggregate analyses of Chapters 4 and 6.

Chapter 9 integrates the various results of each chapter into a consistent conclusion. The appendices from each chapter follow Chapter 9.

Chapter 2
Has South Africa Liberalised its Trade?

1. Introduction

The impact of trade liberalisation on employment will depend on the extent to which the economy has liberalised its trade. This issue is particularly relevant in South Africa as there is substantial disagreement on the extent to which protection has fallen since the 1980s (Holden, 1992; Bell, 1992 & 1997; Belli *et al.*, 1993; Fedderke and Vase, 2000; Van Seventer, 2001). Bell (1992), in contrast to Holden (1992), argues that protection declined during the 1980s. Fedderke and Vase (2000) argue that effective rates of protection rose for many sectors during the 1990s. Van Seventer (2001), in contrast, finds substantial reductions in nominal tariffs during the late 1990s.

Trade liberalisation, as defined by the World Bank and used by Bell (1992, 1997), includes any act that reduces the bias towards production for the domestic market and against exports. This can be achieved through a variety of measures such as the relaxation of quantitative restrictions (QRs), tariff reductions, devaluation of the currency and direct export promotion. Given the range of protection measures it becomes extremely difficult to assess changes in the level of protection within an economy over time.

In this chapter, various protection measures and data sources are used to investigate the extent to which the South African economy has liberalised its trade, particularly during the 1990s. These data are also used in subsequent chapters where the impact of trade liberalisation on labour is analysed directly. Section 2 provides a brief schematic outline of the progress made in liberalising trade in South Africa since the 1970s. Section 3 presents nominal tariff protection rates and effective protection rates for various sectors from the late 1980s. In section 4, the progress of trade liberalisation in South Africa is compared with a range of developing and developed economies. Section 5 concludes the chapter.

2. The progress of trade liberalisation in South Africa

Prior to the 1980s, South Africa's trade and industrial policies were aimed primarily at encouraging import substitution industrialisation. During the 1920s, South Africa was one of the first countries to adopt explicitly import substitution as a vehicle for industrialisation (Belli *et al.*, 1993; Jenkins *et al.*, 1997). Protection was initially used to encourage the substitution of imports of consumer goods by domestic manufactures. However, once this 'easy phase' had been completed the focus shifted towards import replacement in upstream industries, particularly the chemical and basic metals sub-sectors (Fallon and Pereira de Silva, 1994). Strategic intervention (Mossgas, Sasol) to reduce the dependence of South Africa on imports of products such as liquid fuels further shaped the composition of domestic production.

While import substitution was an important source of growth during the 'easy phase' of import substitution industrialisation, its contribution declined as the focus shifted towards import replacement in upstream industries (Fallon and Pereira de Silva, 1994). Protection also raised the anti-export bias, which discouraged export growth and diversification. By the 1970s, South Africa remained highly dependent on gold as a source of foreign exchange (Jenkins *et al.*, 1997). Concerns regarding this dependency led to the "Reynders Commission of Inquiry" in 1972 which emphasised the need to diversify into non-gold exports through export promotion methods. Further, rapid growth through exports in some of the newly industrialised countries of South East Asia helped diminish the export pessimism of the 1950s and 1960s (Jenkins *et al.*, 1997). These forces, amongst others, initiated a shift in trade policy in the early 1970s towards a more open regime. A chronology of the trade liberalisation process that followed is shown in Table 2.1.[4]

Protection during the import substitution industrialisation phase was largely achieved through a wide-ranging system of quantitative restrictions rather than tariff-based protection (Belli *et al.*, 1993). The first shift away from import substitution industrialisation in 1972 thus began with the relaxation of quantitative restrictions (QRs) and the introduction of an Export Development Assistance scheme. Although

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

increases in tariffs compensated for the relaxation of QRs, Bell (1992, 1997) argues these were not fully compensatory resulting in a net decline in protection. However, the overall trade policy remained protectionist as the incentives introduced were an attempt to redress some of the anti-export bias rather than shift the economy towards export orientated growth (Jenkins *et al.*, 1997: 7).

Table 2.1: Chronology of trade liberalisation

1972-1976	• Export Development Assistance scheme introduced. • Substitution of tariffs for QRs resulting in net decline in protection (Bell, 1997).
1979-80	• Rise in gold price resulting in the appreciation of rand.
1980	• Reinforced system of export incentives.
1983-85	• Proportion of value of imports subject to QRs fell from 77% to 23% over period. • Relaxation of import permits by switching from a positive list to a negative list. • Real depreciation of rand .
1985-1992	• Proportion of tariff items subject to QRs fell from 28% in 1985 to less than 15% in 1992.
September 1985	• Introduction of 10% import surcharge on all imported goods not bound by GATT.
August 1988	• Differential surcharge rates applied to Luxury goods (60%), Capital goods (10%), Motor vehicles (20%) and Intermediate goods (10%). • Increased applications for *ad valorem* and formula duties by businesses (Bell, 1992)
1989	• "Structural adjustment programmes" involving a system of duty free imports for exports implemented for motor vehicles and textiles and clothing.
1990	• General Export Incentive Scheme (GEIS) introduced. Provided a *tax free* financial export subsidy to exporters based on the value of exports, degree of processing and local content of the exported product.
1990-91	• Reduction of import surcharges to 40%, 5%, 15% and 5% for Luxury, Capital, Motor vehicles and Intermediate goods, respectively.
23/6/1994	• Import surcharges abolished for Capital and Intermediate goods.
1/10/1995	• Remaining import surcharges abolished.
1994	• SA's GATT offer during Uruguay Round: (1) bound about 98% of all tariff lines at the Harmonised System (HS) eight-digit level as against 18% before the round (2) Reduction in the number of tariff rates to six: 0%, 5%, 10%, 15%, 20% and 30% (3) Rationalisation of the over 12000 tariff lines (4) Tariffication of QRs on agricultural products (5) Special provisions (extensions of the adjustment period and raised maximum tariff rates) for textile, clothing and motor vehicle industries granted. • Decision taken to phase out GEIS.
1995	• Payments under GEIS became taxable, range of eligible products reduced.
1996	• New Tariff Rationalisation Process (TRP) formulated. Tariff lines and peaks to be reduced, Formula and specific duties to be converted into *ad valorem* rates, Imports that have no "suitable substitutes" are to be duty free, *ad valorem* rates of 30% on final products, 20% on intermediate goods and 10% on primary goods are generally not to be exceed. • GEIS limited to manufacturing goods.
Aug 1996	• Signing of the SADC Free Trade Protocol
1997	• Termination of export subsidies provided under GEIS.
1 Jan 2000	• EU free trade agreement

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

During the 1980s, the picture becomes more confusing. While the relaxation of QRs continued into the 1990s, import surcharges implemented in response to balance of payments pressures arising from the debt crisis in the mid-1980s raised protection. Furthermore, there was an increase in the number of applications for protection in the form of *ad valorem* and formula duties as businesses experienced the effects of the economic downturn (Bell, 1992). Evidence suggests that by 1988 the economy had become more protected than in 1984. Using effective protection rates, Holden (1992: 187) estimates a 30 % weighted average effective protection rate in 1984 with a range between 7 % and 143 %. By 1988 the average had risen to 70 % while the range had widened to between 9.9 % and 348 %.[5] Belli *et al.* (1993) also note that by the end of the 1980s South Africa had the most tariff rates, the widest range of tariffs and the second highest level of tariff dispersion compared to a range of developing countries.

During the following 6 years, the implementation of the 'structural adjustment programmes' for motor vehicles, clothing and textiles, the introduction of GEIS and the reduction of import surcharges substantially reduced the level of protection. By 1994 the process of reducing QRs was largely complete and the focus of trade reform shifted to import liberalisation through tariff reductions.[6] Using various indicators of protection, Table 2.2 presents a cursory outline of changes in the tariff regime during the 1990s.

In accordance with its Uruguay Round commitment in 1994, South Africa made considerable progress in rationalising the tariff regime and reducing tariff levels.[7] Average nominal protection (including non-*ad valorem* equivalents) for the whole economy fell from 29 % in 1990 to 15.1 % in 1997, while the range declined from a maximum of 1389 % to 72 %. By 2000 the unweighted average tariff and maximum tariff had fallen to 10.6 % and 55 %, respectively. The total number of tariff lines fell from over 13000 in 1990 to around 7800 in 1997. Since 1997, however, there has been little change in the number of tariff lines.

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[5] These estimates do not include the protectionist impact of quantitative restrictions. It is not clear for example whether the changes in effective protection rates reflect the replacement of quantitative restrictions with tariff equivalents or increases in protection.

[6] QRs on agricultural products were still prevalent.

[7] Bell (1997: 76) notes that the tariff reduction proposed exceed those required by the commitments entered into by South Africa in the Uruguay round. While concessions in the cases of "sensitive" industries such as textiles and clothing, and motor vehicles were negotiated the government subsequently reduced the long adjustment period and high maximum tariff levels initially agreed upon (Roberts, 1998).

The tariff structure has also been simplified, although much of this occurred during the mid-1990s. The number of Harmonised System (HS) 8-digit lines bearing formula duties declined from 1900 to 28 between 1993 and 1997, while the number of lines bearing specific tariffs fell from 500 to 227 lines over the same period (WTO, 1998: 38). However, non-*ad valorem* tariffs still accounted for 26 % of all tariff lines in 1997 and this share has not fallen since. The number of *ad valorem* tariff rates has also remained high. In 2000 there were 35 *ad valorem* tariff rates, which is still far in excess of the 6 tariff rates proposed in South Africa's GATT/WTO Uruguay Round offer. If one includes non-*ad valorem* tariffs the number of tariff rates rises to 211. This is similar to the number of rates in the early 1990s. The average *ad valorem* equivalent of these non-*ad valorem* tariff rates is also relatively high (22.8 %) and raises the average unweighted tariff rate from 6.5 % to 10.6 % in 2000.

Table 2.2: Tariff statistics

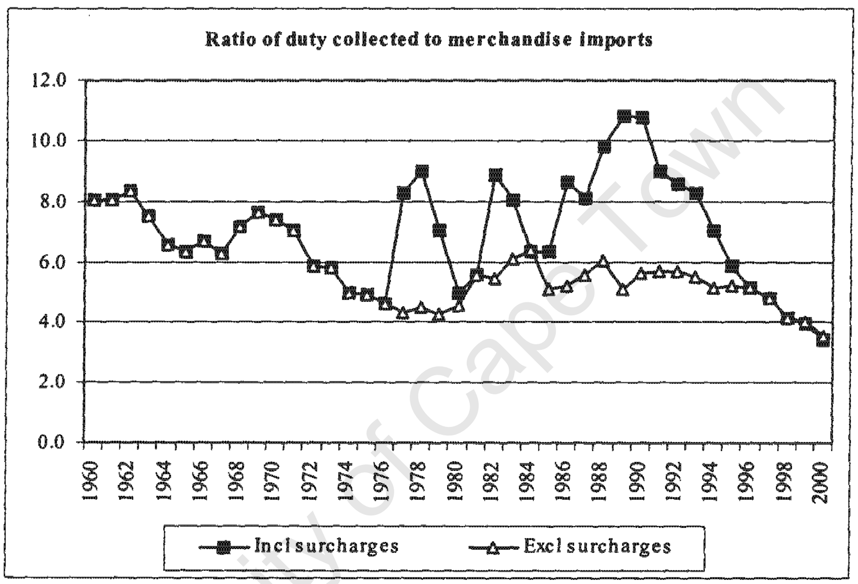
	1990[b]	1992[b]	1993/4[c]	1997[d]	2000[e]
Number of tariff lines	> 13000[f]	12681	12600	7814	7824
Number of tariff rates	200 (incl AVE[j])			45[h]	35[h]
Max	1389	500		72	55
Min	0	0		0	0
Non-ad valorem tariffs as % all tariffs	28[f]	30[g]		25.6	24.9
% lines zero rated	24		22.9	44	44.5
% lines with tariff rate (incl AVE[j]) > 30 %	14.3[i]		25.2	23	6.7
Unweighted mean (incl AVE[j])	29	20.6	21.2	15.1	10.6
Unweighted mean incl surcharges	35 (est)	26.8		15.1	10.6
Mean collection rate[a]	5.6	5.7	5.5	4.8	3.5
Mean collection rate incl surcharges[a]	10.8	8.6	8.3	4.8	3.5
Coeff of variation	159.8		1.4	1.2	1.5

Notes and sources:

a. Reserve Bank Quarterly Bulletin (various years). Calculated as total customs revenue as share of merchandise imports. Note that this is effectively a weighted (by imports) mean value.
b. WTO (1993) unless otherwise indicated.
c. 1994 data obtained from IDC and includes non-*ad valorem* equivalents. 1993 data obtained from WTO (1998).
d. WTO (1998)
e. Calculated from the raw data used in Van Seventer (2001).
f. IMF (2000)
g. Estimated using the pre-Uruguay Round tariff lines for agriculture and industry (incl mining) obtained from WTO (1998: 41).
h. Excludes non-*ad valorem* bands. If non-*ad valorem* tariffs are included the number of bands rises to 211 in 2000.
i. The % tariffs > 30 % for 1990 is estimated from WTO (1993). This value appears relatively low. The bulk of these are from formula duties. Specific duties (approx 500) have not been included in the estimate.
j. AVE stands for *ad valorem* equivalents.

These results suggest that South Africa has made reasonable progress in liberalising tariff protection with average tariffs halving between 1992 and 2000. However, the focus on average statutory tariff rates (weighted or unweighted) does not necessarily reflect actual protection as exemptions or rebates are frequently granted. Statutory tariff rates also do not include the effect of surcharges that raise overall protection. A more appropriate indicator of protection may be duties collected as a proportion of import values. The ratio of duty collected (including and excluding surcharges) to merchandise imports is shown in Figure 2.1.

Figure 2.1: Ratio of duty collected to merchandise imports



Source: Own calculations using Reserve Bank data (Reserve Bank, various years).

As shown in Figure 2.1, collection rates excluding surcharges were substantially lower than the scheduled tariff rates and ranged between 4 % and 6 % during the 1980s and 1990s. Since 1992, collection rates have gradually declined from 5.7 % to 3.5 % in 2000 resulting in a 2.2 % decline in merchandise prices.[8] This is substantially lower than the price reductions estimated using the statutory tariffs (8.3 %), implying that reductions in statutory tariffs exaggerate the decline in domestic protection. However, because high tariffs within certain sectors discourage imports of these products, the collection rates underestimate the level and possibly the decline in protection. Duty rebates granted to exporters lead to further biases downwards.

The decline in protection becomes more noticeable once surcharges are included. The main motivation for the use of surcharges was to protect the balance of

[8] Assuming import tariff reductions are fully transferred onto domestic prices, i.e. a small open economy with competitive markets is assumed. The changes in domestic prices are calculated as $((1+t_2)/(1+t_1)-1)$.

payments. They were first used in April 1977 to 1979 in response to the cessation of capital inflows in response to the Soweto riots in 1976 (Aron *et al.* 1997). Surcharges were reintroduced in 1982 to 1983, and then again in 1985. Between 1985 and 1990, collection rates including surcharges rose from approximately 6 % to nearly 11 % of the value of merchandise imports. With the subsequent reduction and abolishment of surcharges, collection rates fell sharply and by 1996 surcharge based protection had been eliminated entirely. When surcharges are included, trade liberalisation between 1992 and 2000 is estimated to have reduced domestic prices by 4.8 % using collection rates or 12.8 % using statutory tariff rates. Again the decline in protection is substantially greater when using statutory tariffs.

There have also been substantial changes in policy with respect to export assistance. In terms of the GATT and WTO rules it was decided in 1994 to phase out GEIS. In the following year GEIS payments became taxable and the range of products eligible for the subsidy were reduced. In 1996 eligibility for GEIS subsidies was reduced to cover only fully manufactured products, although the local content requirement for the maximum subsidy was reduced from 75% to 65% (WTO, 1998, 72). By July 1997 the phasing out of GEIS was complete.

Alternative export incentive schemes (rebates, refunds and drawbacks of import duties on goods produced for exports) are available. In 1996 exported goods that received rebates or duty drawbacks in their production, accounted for more than 20% of the total value of South Africa's exports (WTO, 1998: 74). More than 45 % of the accepted applications, however, directly concerned goods imported for export purposes. The drawback and exemption policies contain strong conditions regarding the preference of domestic substitutes and extensive proof is required that domestic substitutes are not available prior to the drawback or exemption being granted (Belli *et al.*, 1993). As a result of the complexity and delays related to refunds, the number of firms that make use of duty drawbacks and exemptions is low (WTO, 1998: 74). The low usage of special facilities for exporters is also found by Chandra *et al.* (2001a, 2001b) using firm level survey data.

Various other WTO friendly supply-side export promoting schemes are also available. The Export Marketing and Investment Assistance Schemes (EMIAs) provide assistance relating to the development of new export markets. Credit facilities with attractive interest rates are provided by the state-owned Industrial Development Corporation (IDC) for the promotion of exports of capital goods and services. Other technical, technological and marketing support schemes such as the Support Programme for Industrial Innovation (SPII), the Export Credit and Foreign Investment Reinsurance scheme and the Export Guarantee scheme are also available (DTI, 1998). Specific schemes for small medium and micro-enterprises exporters include the Small/Medium Manufacturing Development Programme (SMMDP), the Short-Term Export Finance Guarantee Facility and special terms in the EMIAs (WTO, 1998). Awareness and usage by small, medium and micro-enterprises (SMMEs) of these facilities is extremely low. Chandra *et al.* (2001b) find that less than 4 % of small manufacturing firms use export promotion programmes, with the exception of forward foreign exchange cover and tax exemptions (including VAT).

3. Sectoral incidence of protection

So far the analysis has concentrated on changes in the aggregate level of protection. In this section a more in-depth analysis of protection at the sector level is presented using nominal and effective protection rates. The impact of tariffs on the profitability of export production is also discussed.

3.1 Nominal protection rates

Table 2.3 presents the sectoral incidences of protection using unweighted nominal tariff rates. As noted, estimation of protection over time is highly problematic given the existence of non-tariff barriers, the granting of exemptions and the multiplicity of applied customs duties (*ad valorem*, specific, mixed, compound, formula duties and their combinations). For example, tariff protection within agriculture (and food and clothing) during the early 1990s is understated because of the existence of numerous quantitative restrictions and other import controls. In 1992, 74 % of tariff lines in agriculture, forestry and fishing were under import control (WTO, 1993: 78). Non-tariff barriers in manufacturing were found mainly in the food and clothing subsectors. With the tariffication of these QRs in accordance with South

Africa's 1994 WTO agreement, the values for the late 1990s are more reflective of nominal tariff protection. The calculation of *ad valorem* equivalents for non-*ad valorem* duties and the weighting procedures used to aggregate tariff rates induce further biases into the estimates of protection.[9]

Table 2.3: Unweighted nominal rates of protection, %

	1988[a]	1992[b]		1997[c]	2000[d]		Change 1992-2000[e]	
		Excl surcharge	Incl surcharge		Schedule tariff	Duties	Excl surcharge	Incl surcharge
Whole Economy	22.0	20.6	26.8	15.1	10.6	7.8	-8%	-13%
Agriculture	12.6	7.0	14.6	5.6	4.6	2.8	-2%	-9%
Mining and Quarrying	...	2.4	2.5	1.4	0.9	0.4	-1%	-2%
Manufacturing	22.5	20.6	26.9	15.6	11.0	8.1	-8%	-13%
Food	14.4	11.5	20.2	14.5	12.1	7.9	1%	-7%
Beverages	22.1	10.6	33.8	10.3	12.9	8.6	2%	-16%
Tobacco	53.3	27.8	64.3	35.6	31.1	29.1	3%	-20%
Textiles	43.8	48.4	54.4	34.9	21.0	14.2	-18%	-22%
Wearing apparel	58.7	50.2	65.5	59.0	33.7	31.4	-11%	-19%
Leather & leather products	19.7	16.0	24.8	14.9	13.1	10.9	-2%	-9%
Footwear	37.5	34.5	46.5	24.9	21.9	18.7	-9%	-17%
Wood & wood products	15.0	13.0	17.3	10.0	8.9	7.8	-4%	-7%
Paper & paper products	10.0	10.0	11.3	7.5	6.8	5.8	-3%	-4%
Printing & publishing	8.4	10.5	16.2	7.9	4.9	4.1	-5%	-10%
Coke & refined petroleum	11.9	14.6	15.3	5.6	4.7	4.1	-9%	-9%
Basic chemicals	19.5	16.7	23.8	4.8	1.6	1.3	-13%	-18%
Other chemicals	19.5	23.1	27.6	6.3	4.3	3.4	-15%	-18%
Rubber products	21.7	28.8	36.4	15.7	12.4	9.8	-13%	-18%
Plastic products	28.8	43.7	56.7	12.3	9.9	7.8	-24%	-30%
Glass & glass products	13.2	10.9	20.3	8.1	7.6	6.6	-3%	-11%
Non-metallic minerals	15.9	12.7	15.4	7.9	5.3	4.5	-7%	-9%
Basic iron & steel	8.8	8.3	9.0	4.3	4.3	3.4	-4%	-4%
Basic non-ferrous metals	15.3	8.8	9.7	3.0	2.4	2.0	-6%	-7%
Metal products	14.8	12.4	19.4	9.0	8.1	7.0	-4%	-10%
Machinery & equipment	8.4	7.6	12.9	3.7	3.7	2.6	-4%	-8%
Electrical machinery	16.9	15.9	25.4	6.6	3.9	2.9	-10%	-17%
Motor vehicles	31.3	28.7	36.6	18.8	17.3	7.0	-9%	-14%
Other transport equipment	9.7	7.3	12.8	12.3	0.8	0.7	-6%	-11%
Furniture	20.1	21.3	34.3	20.8	17.7	13.1	-3%	-12%
Other industries	21.4	11.8	22.3	7.7	6.3	4.8	-5%	-13%

Source: Belli *et al.* (1993), WTO (1993, 1998), Tsikata (1999), Van Seventer (2001) and own calculations.
Notes:

a. The estimates include *ad valorem* equivalents of the formula duties. The duty collected was used to calculate the ad valorem equivalent. However, these can only be calculated if imports occur. The values also do not take rebates into account.
b. The IDC uses the lowest recorded import prices to calculate *ad valorem* equivalents of formula duties, a method that can drive upward bias to the *ad valorem* equivalents (WTO, 1998: 64). See Bell (1997: 75) for a critique of these estimates.
c. Specific and compound duties have been ignored. The *ad valorem* maximum or minimum is used in the formula and other duties to calculate protection for these categories. A downward bias in estimates is likely.
d. Calculated from the raw data used in Van Seventer (2001). Includes *ad valorem* equivalents for non-*ad valorem* tariffs. See Van Seventer (2001) for details on the construction of the *ad valorem* equivalents.
e. Calculated as (tariff 2000-tariff 92)/(1+tariff 92).

[9] Usually import values are used to construct weighted average tariff rates for aggregated industrial sectors. While this procedure gives more weight to sectors with large import values, products with prohibitively high tariffs are under-represented.

In Table 2.3 an attempt is made to utilise data that includes *ad valorem* equivalents of non-*ad valorem* duties. However, because different procedures were followed, care must be taken when comparing values across years. Specific notes regarding the assumptions are presented below Table 2.3. A further limitation of the data presented is that tariff equivalents of non-tariff barriers are not included. These primarily affect estimated levels of protection prior to 1994, particularly within the agricultural, food and clothing sectors.

Protection across broad economic sectors is uneven with manufacturing the most protected and mining the least protected. A comparison of protection in 1992 and 2000 reveals that nominal tariff protection fell from 20.6 % to 10.6 % in manufacturing and from 2.4 % to 0.9 % in mining. Although protection has also fallen in agriculture, the decline is underestimated, as the removal of import controls, which accounted for most protection in agriculture during the early 1990s, has not been included. Finally, the decline in protection is more pronounced once the removal of surcharges, which raised protection by approximately 6 percentage points in manufacturing, agriculture and mining, is included.

Within the manufacturing sub-sectors, reductions in tariff levels have been uneven with plastic products (-24 %), textiles (-18 %), chemical related products (-13 % to –15 %) and wearing apparel (-11 %) experiencing the largest percentage declines in protection (excluding surcharges) between 1992 and 1998. When the removal of surcharges is included, electrical machinery, beverages and footwear can be included in this category. Many of these sectors are labour intensive, suggesting a possible relationship between trade liberalisation and the decline in employment during the 1990s. Nominal tariff levels in 2000 remain strongest in clothing (33.7 %), tobacco (31 %), footwear (21.9 %) and textiles (21 %) and weakest in basic non-ferrous metals (2.4 %), electrical & non-electrical machinery (3.7 % to 3.9 %) and basic chemicals (1.6 %).

These average tariffs mask a high degree of variability at the commodity level. Tariffs of over 40 % (*ad valorem* or *ad valorem* equivalent) are found in numerous HS 8-digit commodity lines within the processed foods, motor vehicles & components thereof, rubber products, tobacco products and clothing and textiles sectors (Van

Seventer, 2001). The clothing and textile sectors are particularly complex. Of the 24.9 % of HS 8-digit commodity lines that have non-*ad valorem* tariffs, 85 % are found within clothing and textile sectors. The standard deviation of *ad valorem* tariffs is 1.5 times the mean tariff rate in 2000.[10] This is similar (or higher) than earlier years suggesting that variability of tariff rates is still problematic.

Collection rates also vary and are generally 20 % to 30 % lower than scheduled tariffs, as is shown in Table 2.3 for 2000. Protection is relatively high for motor vehicles, parts & accessories (17.3 %), but because of the duty credit schemes and exemptions under the Motor Industry Development Plan (MIDP) programme, actual duty collected is substantially lower (7 %). At the HS 8-digit commodity level, the collection efficiency rate is particularly low for sectors with *ad valorem* tariffs in excess of 40 %. Only 11 % of potential duties for these products are collected (Van Seventer, 2001). In contrast the collection efficiency rate is 99 % for commodities with tariff protection rates less than 5 % (Van Seventer, 2001). The granting of exemptions, particularly for imported commodities with high scheduled tariff rates, adds further complexity to the tariff structure.

The analysis of nominal protection rates suggests that substantial progress has been made in reducing tariff protection, but that further advances can be made in reducing the complexity of the tariff schedules.

3.2 Effective rates of protection

Much of the decline in manufacturing protection during the mid-1990s arose from strong tariff reductions in intermediate and capital goods (Tsikata, 1999). A reduction in input costs without an equivalent reduction in output prices (via declining tariffs) raises *net* protection, i.e. protection provided to *value added*. Effective Rates of Protection (ERP) provide appropriate indicators of protection to value added. There are various estimates of effective rates of protection in South Africa for the 1990s (Kuhn and Jansen, 1997; Tsikata, 1999; Fedderke and Vase, 2000; Van Seventer,

[10] Although this declines to 1.14 once non *ad valorem* equivalents are included.

2001).[11] Tsikata (1999) finds that the effective rate of protection for aggregate manufacturing fell from 30.2 % to 22.2 % between 1990 and 1996, but was characterised by rising dispersion at the 4 digit SIC level. Fedderke and Vase (2000) use collection rate data and find that sectors for which effective protection *increased* between 1988 and 1998 accounted for nearly 50 per cent of total GDP. This exaggerates the change in protection as this category includes agriculture, where tariffication of non-tariff barriers (such as quotas) took place, gold & uranium ore mining, where protection is extremely low (0.02 %), and finance & insurance, where effective protection is negative.

Van Seventer (2001) uses the recently available 1998 Supply-Use table for South Africa to estimate ERP for 2000 using both the Balassa (1965) and the Corden (1966) method (see later discussion on these two methods). These two approaches yield economy-wide (including services) ERP of 12 % and 7.6 %, respectively, when using scheduled tariffs. The collection rate based ERP are lower at 7 % and 4.5 %, respectively. These estimates, however, exclude non-*ad valorem* tariff protection, which biases the estimates downwards.

In order to compare effective protection over the 1990s, ERP are re-estimated using the nominal tariff data in Table 2.3 that is inclusive of non-*ad valorem* equivalents. Effective rates of protection measure the protection provided to domestic value added relative to value added in international prices (see Greenaway and Milner, 1993) , i.e.

Eq 2.1: $$ERP_j = \frac{\left(V_j' - V_j\right)}{V_j}$$

where V_j' is the value added to final product j at tariff distorted prices and V_j the value added under free trade. By imposing a number of restrictive assumptions (fixed international prices, perfect substitutability between domestic and imported products, fixed coefficients of production in physical terms and a price wedge equal to the tariff between domestic and import prices) ERP can be calculated as

[11] See also Holden and Holden (1975) for earlier comparisons of effective protection rates.

Eq 2.2: $$ERP_j = \frac{t_j - \sum_i a_{ij} t_i}{1 - \sum_i a_{ij}}$$

where t_j is the tariff on outputs, t_i is the tariff on inputs and a_{ij} is the quantity of intermediate input i used in the production of one unit of j. ERP increase with a rise in output tariffs, a decline in intermediate good tariffs and a rise in the share of intermediate inputs in total production, $\sum_i a_{ij}$.

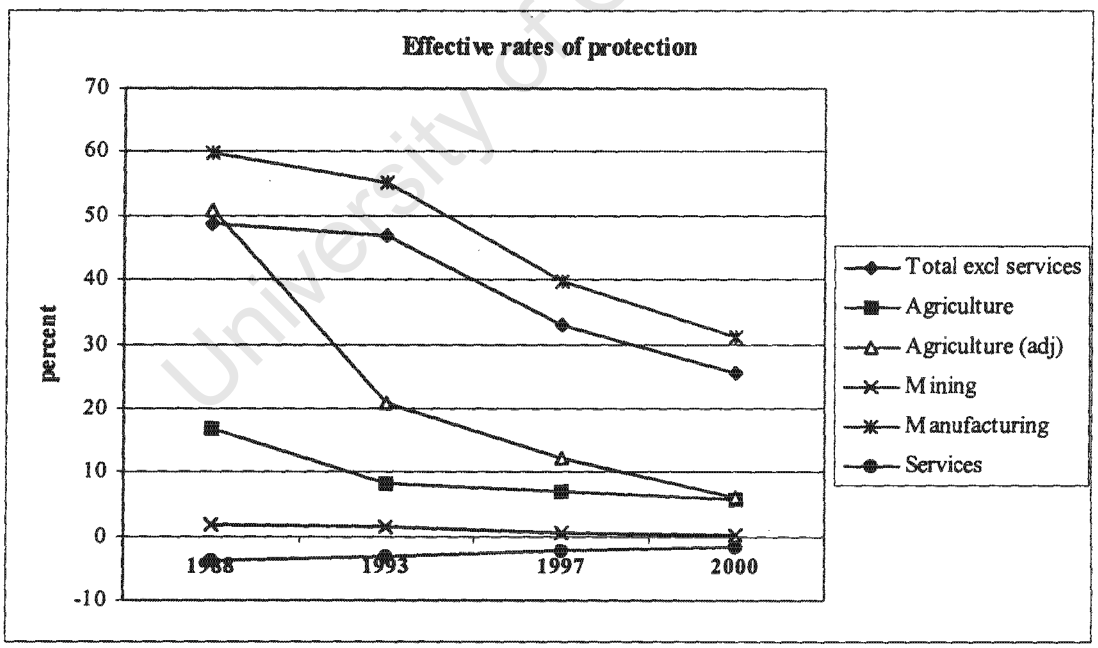
There are numerous measurement problems associated with effective protection analysis. Many of these are outlined in more detail in Holden and Holden (1975), Greenaway and Milner (1993) and Holden (2001). The first problem is that post protection input-output tables are used to estimate the technology coefficient, a_{ij}. This is not problematic so long as a_{ij} is not affected by protection. If, however, substitution between value added and intermediate inputs occurs, the estimation of a_{ij} and consequently the ERP will be biased (Holden and Holden, 1978).

A second problem relates to the decision whether to use scheduled tariffs or collection duties. Scheduled tariffs overestimate protection as exemptions are frequently granted. On the other hand, collection rates underestimate protection as highly protected goods may not be imported. If quantitative restrictions are present, the tariff equivalents also need to be estimated. This is a particular problem for the estimation of ERP during the early 1990s as agriculture was predominantly protected through non-tariff barriers. Subsidies can also be incorporated (see Greenaway and Milner, 1993: 83). There appears to be no consistency in dealing with these criticisms within domestic or international research and frequently data availability dictates the approach followed.

Different approaches to the treatment of non-traded inputs also arise. In the traditional Balassa (1965) approach, non-traded inputs are treated *as if* they were traded inputs with an infinitely elastic supply. A tariff rate of zero for these products is assumed. Corden (1966) treats non-traded inputs in a similar manner to primary factors. In one variant of this approach, non-traded inputs are aggregated with value added. Generally, the Corden approach yields lower estimates of ERP than the Balassa method.

Figure 2.2 presents the weighted (by output) average ERP for manufacturing, agriculture, mining and services for various years from the late 1980s. The ERP are calculated according to the Balassa (1965) method using scheduled tariff rates inclusive of *ad valorem* equivalents. To account for the impact of non-tariff barriers within agriculture, agricultural tariffs were raised by a factor of 2.5 in 1988, 2 in 1993 and 1.5 in 1997 (see variable 'Agriculture (adj)'). These are arbitrary adjustments, but are sufficient to determine the sensitivity of the results to increased protection within agriculture. Table 2.4 presents the level, rank and percentage change in ERP for economic sub-sectors.

Figure 2.2: Weighted average effective rates of protection



Notes: Total production levels are used as weights. Results are based on a 71 sector SU table. Results using the 42 sector Supply Use (SU) table are very similar.
In the Agriculture (adj) case agricultural tariffs were raised by 2.5 times in 1988, 2 times in 1993 and 1.5 times in 1997. Raising agricultural protection reduces protection in manufacturing by 3 % in 1988 and 1 % in 1997.
The change in total protection excluding services was less than 0.2 %. Meat products are excluded from the weighted averages as ERP of over 1700 were obtained for each year. This is entirely due to the low protection in the unadjusted agriculture sector.

All estimates are based on the 1993 Supply-Use (SU) table obtained from Statistics South Africa and deflated using 1993 tariff data obtained from Kuhn and

Jansen (1997).[12] This implicitly assumes that the production structure, as reflected in the technical coefficients, a_{ij}, did not change during the 1990s.[13] The data in Table 2.4 are estimated using a 42 sector aggregation of the SU table, while the weighted average values in Figure 2.2 are based on a 71 sector aggregation (see Appendix 1). No attempt is made to include the effect of substitution between traded and non-traded goods. Therefore, the measured ERP will understate actual effective protection (Greenaway and Milner, 1993: 85).

Unlike Van Seventer (2001), scheduled tariff rates inclusive of non-*ad valorem* equivalents are used. ERP are also estimated using collection rates, but these are not presented. As found in Van Seventer (2001), ERP using collection rates are lower, but the rank correlation coefficients are very high (above 0.76 for all years). Finally, the impact of surcharges prior to 1995 on effective protection is only calculated for 1992. The exclusion of surcharges in 1988 and 1993 biases effective protection downwards as surcharges fell relatively heavily on finished products. Because of the assumptions made in estimating ERP, due caution is required when analysing these results.

The results in Figure 2.2 suggest that ERP have declined sharply during the 1990s, but are still high for many manufacturing sectors. Between 1988 and 2000, ERP for manufacturing declined from approximately 60 % to 30 %, roughly a 50 % decline. Most of this decline occurred after 1993 as tariff liberalisation took hold. ERP are very low for mining (1 % to 2 %) and are negative for services (-2 % to -4 %). Low levels and declines in ERP are found for agriculture if protection through non-tariff barriers is unaccounted for. ERP in agriculture, in this case, fell from 17 % in 1988 to 6 % in 2000. Once adjustments for non-tariff barriers are made, ERP in agriculture rise sharply to around 50 % during the early years of this sample. However, the economy-wide effective rate of protection (excluding services) *falls* by 2 % in 1988 and 1 % in 2000. Increased protection in agriculture is offset by reduced

[12] Some adjustments to the 1993 tariff data were made using 1994 tariff data provided by Gena Krasnik from the Economic Research division in the Industrial Development Corporation. This affected knitting mills, wearing apparel and leather products where the very high 1993 tariffs were reduced to reflect more realistic tariff rates (as suggested by 1992 and 1994 values) in 1994.

[13] Fedderke and Vase (2000) use the 1993 input-output table, which is a RAS updated version of the 1988 Use table.

effective protection in manufacturing as agricultural inputs become more expensive. In the simulations presented here, ERP in manufacturing declines by 3 % in 1988 and 1 % in 1997. Substantial declines in ERP are experienced in the food & beverages sectors within manufacturing once non-tariff barriers in agriculture are accounted for.

Table 2.4: Effective rates of protection

	Effective Rates of Protection						Ranks		% Change in ERP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sector	1988	1992	1992 incl. surcharge	1993	1997	2000	1988	2000	1988-93	1993-00	1997-00
Agricultural products	13.7	4.6	14.7	6.6	5.2	4.6	22	22	-6.2	-1.9	-0.6
Mining & quarrying	-0.4	0.3	-0.9	1.2	0.4	0.0	27	26	1.6	-1.1	-0.4
Food	31.4	31.2	51.4	43.0	52.1	43.6	15	6	8.8	0.4	-5.6
Beverages & tobacco	47.6	18.2	74.0	28.5	20.9	28.4	8	10	-12.9	-0.1	6.2
Textile products	176.6	203.1	218.3	194.1	156.1	93.9	2	2	6.3	-34.1	-24.3
Wearing apparel	257.7	182.9	266.5	329.9	294.7	163.5	1	1	20.2	-38.7	-33.2
Leather products	60.8	45.0	69.0	67.8	41.0	40.7	6	7	4.3	-16.1	-0.2
Footwear	115.0	104.8	139.6	122.0	74.5	68.5	4	4	3.3	-24.1	-3.5
Wood products	29.5	27.8	33.1	23.4	22.7	20.7	18	12	-4.7	-2.2	-1.6
Paper products	12.8	14.3	12.0	17.0	14.3	13.8	23	14	3.7	-2.7	-0.4
Printing & publishing	11.1	16.2	29.4	16.4	13.8	6.6	25	20	4.7	-8.4	-6.3
Petroleum products	31.2	38.6	40.1	23.5	14.1	12.2	16	15	-5.9	-9.2	-1.7
Basic chemical products	49.0	40.1	58.7	9.6	10.2	1.7	7	25	-26.5	-7.2	-7.8
Other chemical products	40.7	51.7	57.8	27.5	11.7	8.0	11	19	-9.4	-15.3	-3.3
Rubber tyres	45.7	74.1	90.6	52.5	42.2	36.1	9	8	4.6	-10.8	-4.3
Plastic products	71.5	126.5	161.7	51.7	34.0	30.0	5	9	-11.6	-14.3	-3.0
Glass products	24.6	18.8	38.5	21.7	16.0	15.3	20	13	-2.3	-5.3	-0.6
Other non-metallic products	35.4	26.7	32.3	25.9	17.6	11.5	12	16	-7.0	-11.5	-5.2
Iron & steel products	19.2	18.5	16.3	15.6	9.0	10.1	21	17	-3.0	-4.7	1.0
Non-ferrous metals	30.5	15.6	16.3	14.2	4.8	3.8	17	24	-12.5	-9.1	-1.0
Metal products	35.1	28.8	51.6	39.0	25.1	22.2	13	11	2.9	-12.1	-2.3
Machinery & equipment	8.9	7.9	18.1	4.2	3.7	4.6	26	23	-4.3	0.4	0.9
Electrical machinery	29.4	28.3	49.8	27.8	11.6	5.7	19	21	-1.2	-17.3	-5.2
Motor vehicles	130.9	116.2	147.1	169.5	81.8	76.8	3	3	16.7	-34.4	-2.7
Other transport products	12.7	8.5	17.3	17.8	20.6	-1.1	24	27	4.6	-16.1	-18.0
Furniture	41.1	46.0	82.2	54.6	53.3	46.4	10	5	9.5	-5.3	-4.5
Other manufacturing	34.3	15.0	33.7	25.8	11.3	9.7	14	18	-6.3	-12.8	-1.5
Electricity	-1.3	-1.3	-1.8	-1.2	-0.7	-0.5					
Water	-2.4	-2.3	-3.2	-1.7	-1.1	-0.8					
Buildings	-16.2	-15.4	-20.6	-13.2	-8.3	-6.3					
Other constructions	-15.8	-15.1	-19.5	-12.7	-8.1	-6.4					
Trade services	-2.2	-2.5	-3.3	-2.0	-1.5	-1.2					
Accommodation	-6.2	-4.3	-8.8	-4.8	-4.4	-4.0					
Transport services	-5.4	-5.9	-7.1	-4.8	-3.1	-2.3					
Communications	-2.5	-2.5	-3.6	-2.2	-1.4	-1.0					
Insurance services	-0.4	-0.5	-0.7	-0.4	-0.3	-0.2					
Real estate services	-1.2	-1.3	-1.7	-0.9	-0.6	-0.4					
Other business services	-2.6	-2.7	-3.8	-2.4	-1.6	-1.3					
Government services	-3.0	-2.9	-4.1	-2.6	-1.8	-1.1					
Health & social work	-6.8	-7.4	-9.6	-5.0	-3.1	-2.1					
Other services / activities	-2.8	-2.9	-3.9	-2.4	-1.7	-1.3					

Notes: Own calculations using nominal tariff data presented in Table 2.3. Estimates are based on a 42 sector SU table for 1993.

These results suggest that the failure to properly account for protection within agriculture during the early 1990s may actually bias the economy-wide weighted average effective rate of protection upwards and not downwards as is frequently expected.

At the sector level (Table 2.4), effective rates of protection are generally higher than nominal protection, although the structure of protection across sectors is similar. The rank correlation coefficient between nominal and effective rates of protection is in excess of 0.95. As found by Tsikata (1999), effective rates of protection declined during the 1990s for most sectors, but dispersion remains high. The coefficient of variation was 1.5 in both 1988 and 2000. Very high ERP (above 60 %) are found for textile products, wearing apparel, footwear and motor vehicles. Of these, wearing apparel had the highest ERP equalling 163.5 % in 2000. Much lower ERP are found for motor vehicles when using collection rates (20 % as opposed to 76.8 % in 2000) as result of the duty rebate system of the MIDP programme. Services are characterised by negative ERP reflecting the negative impact of protection on intermediate inputs.

Most of the decline in protection has taken place since 1993. For many sectors effective protection rose between 1988 and 1993. Because the impact of relatively high surcharges in 1988 are not included, the increase in protection may be exaggerated. As shown in column (3) in Table 2.4, effective protection in 1992 rises by on average 50 % once surcharges are included. The strongest reductions in effective protection between 1993 and 2000 occurred within the wearing apparel (-38.7 %), textiles (-34.1 %) and motor vehicles (34.4 %) sectors.

These estimates of ERP are substantially higher than those estimated by Fedderke and Vase (2000) where the maximum ERP of 54 % in 1997 occurred within the paper & paper products sector. The difference partially reflects their use of collection duties, but differences in the input-output tables will also have affected the estimates. The ranking of protection across sectors appears similar, although wearing apparel is characterised by very low levels of ERP (11 % in 1997) in their study. In contrast to this study, Fedderke and Vase (2000) also find that ERP have not declined substantially between 1988 and 1998. The estimates of Tsikata (1999) and Van

Seventer (2001) are closer to the results of this study, although their levels of ERP are lower. As in this study, they find high levels (over 60 %) of protection in the textile, wearing apparel, footwear and motor vehicle sectors and a decline in overall protection between 1993 and 1996.

3.3 Anti-export bias

The analyses of nominal and effective rates of protection reveal changes in protection for domestic import-competing producers. This section analyses the effect of trade liberalisation on the competitiveness and profitability of export production.

Tariff protection raises the cost of intermediate inputs, which reduces the profitability of exports that are sold at world prices. This was one of the reasons for the introduction of the General Export Incentive Scheme (GEIS) in 1990. While GEIS did not fully compensate for the anti-export bias arising from more expensive domestic inputs, Belli *et al.* (1993) point out that it played a key role in making exports profitable.[14] Further liberalisation will have enhanced export competitiveness even more.

To analyse the impact of tariff liberalisation on export competitiveness, the indirect tax effect of tariff protection on the profitability of export production is estimated. Following Van Seventer (2001), the tax on export production can be measured as

Eq 2.3:
$$XRP_j = \frac{\sum_i a_{ij} t_i}{1 - \sum_i a_{ij}}.$$

The numerator reflects the additional costs to domestic exporters from paying tariff inclusive prices for intermediate inputs as opposed to tariff-free international prices. The denominator measures value added in international prices. XRP_j thus measures the costs associated with protection on intermediate goods as a share of world value

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[14] The anti-export bias measures the extent to which trade policies increase value added when a firm sells goods on the domestic market compared to export markets (Tsikata, 1999). The IDC (1997) note that the reduction in the anti-export bias through tariff liberalisation between 1993-96, however, was insufficient to offset the negative impact of the removal of GEIS on export competitiveness.

added and a value of zero reflects an open economy. Subsidies, tax rebates and exemptions lower the estimated XRP_j.

Table 2.5 presents the weighted average tax on exports calculated using the 71 sector SU table. GEIS and other forms of export support or exemptions are not taken into account. This will exaggerate the indirect tax on exports, particularly during the early 1990s. Estimates of the anti-export bias are shown in Table A1.1 in Appendix 1.

Table 2.5: Indirect export tax rate (%)

	Agriculture	Mining	Manufacturing	Total
1988	5.7	3.2	44.6	35.8
1993	4.4	2.7	36.0	28.1
1997	3.0	1.8	23.3	18.2
2000	2.5	1.5	18.8	15.7

As shown in Table 2.5, tariff liberalisation has substantially reduced the implicit tax on export production. In 1988 import taxes on intermediate goods reduced South African export competitiveness by 35.8 % compared to open economies. By 2000 this had fallen to 15.7 %. Most of this decline occurred within the manufacturing sector where the implicit tax declined from 44.6 % of value added in 1988 to 18.8 % in 2000.[15] Unfortunately data on export subsidies and rebates are not available at the sector level prohibiting the inclusion of these variables into the analysis. Nevertheless, these results suggest that improvements in export competitiveness through tariff liberalisation have contributed significantly towards improved export growth during the 1990s.

4. International comparison

Table 2.6 presents trends in average tariff rates for a number of developed and developing economies. The data are obtained from the World Bank web site: http://www1.worldbank.org/wbiep/trade/TR_Data.html. The difficulties surrounding the analysis of protection within a single country are compounded when comparing protection across various countries. Extreme care must be taken when comparing such

[15] A similar downward trend in the anti-export bias is also found (see Table A1.1 in Appendix 1).

data. This is clearly shown in the World Bank estimate of the average tariff for South Africa, which is substantially lower than the estimates used within this chapter. Nevertheless, some insight on the relative level of protection and trend over time can be obtained through such comparisons.

As shown in Table 2.6, average tariffs in South Africa are similar to the average for less-developed countries, but are substantially higher than the average for developed countries. While tariffs have declined in South Africa, they have not declined at a faster pace than less-developed countries on average. Of the 112 less-developed countries, South Africa had the 69th highest average tariff rate in 1999. In relation to a number of comparator countries the IMF (2000) and Lewis (2001) find that the South African trade regime is still highly complex in terms of the number of tariff rates and the percentage tariff lines carrying non-*ad valorem* tariffs. Zambia, Uganda and Mozambique, for example, have fewer tariff lines, number of tariff rates and number of zero rated items, which 'artificially' lowers the average (Lewis: 2001: 4). These results suggest that the liberalisation process in South Africa has not been 'excessive' in comparison to other developing economies.

Table 2.6: Trends in average tariff rates for developing and industrial countries, 1980-99 (Unweighted in %)

Country	1988	1990	1993	1995	1999
Brazil	41.0	32.2	14.2	11.1	13.6
Chile	15.0	15.0	11.0	11.0	10.0
China	39.5[a]	40.3	39.9	36.3[a]	
India	98.8[a]	81.8	47.8	41.0	32.2
Indonesia		20.6	19.4	13.2[b]	10.9
Korea	18.9	13.3	8.9	13.4[b]	8.7
Nigeria	33.7	35.7	32.8	29.0	21.8
South Africa (WB)	12.7	11.0	10.0	6.2	8.5
South Africa (own sources)	22.0	29.0	20.0[a]	15.1[c]	10.6[b]
Taiwan	12.6	9.7		11.2	8.8
Turkey	22.7		26.7		8.2
Zimbabwe	8.9[a]	10.1[a]	17.2	15.6	21.8
Australia	14.2[b]	14.2[a]	9.8	6.5	5.0
European Union	8.7	8.7	7.7	6.8	5.6
New Zealand	14.5[b]	14.5[a]	8.5	7.2[a]	3.8
United States	6.6	6.3	6.4	5.9	4.8
Average LDCs (129)	23.4	23.2	19.4	16.1	11.3
Average DCs (23)	7.1	7.9	6.8	6.3	4.0

Source: See: http://www1.worldbank.org/wbiep/trade/TR_Data.html for international data.
Notes:

a. Tariff value from previous year
b. Tariff value from following year
c. Tariff value for 1997
d. Tariff value for 2000

5. Conclusion

This chapter uses various different data sources and measures of protection to assess the progress made in liberalising the trade regime in South Africa. The question is of direct relevance to the trade and labour debate. If the economy has not substantially liberalised its trade, changes in employment cannot be attributed to trade liberalisation.

Gauging progress made in liberalising trade is made difficult by the complexity of protection measures used (ad valorem tariffs, specific tariffs, compound tariffs, non-tariff barriers) and the vast number of scheduled tariff rates and lines. The measured decline in nominal protection is strongly influenced by the choice between scheduled tariffs and collection rates and the inclusion of *ad valorem* equivalents and surcharges. *Ad valorem* equivalents increase the level of protection, particularly within clothing and textiles. Surcharges significantly increase the level of protection during the late 1980s, but as result give rise to a faster decline in protection rates during the 1990s. The exclusion of tariff equivalents for non-tariff barriers lowers nominal protection prior to the mid-1990s.

Overall, South Africa has made considerable progress in liberalising its trade regime during the 1990s. Between 1992 and 2000 average economy wide scheduled tariffs fell by half from 20.6 % to 10.6 % when excluding surcharges, or 26.8 % to 10.6 % when including surcharges. Collections rates, calculated from SA Reserve Bank customs and merchandise trade data, are substantially lower (8.6 % in 1993 and 3.5 % in 2000 including surcharges). Assuming a perfect pass-through of tariff changes onto domestic prices, tariff liberalisation (including surcharges) between 1992 and 2000 reduced domestic prices by 4.8 % according to collection rates or 12.8 % according to statutory tariff rates. These values ignore the high levels of protection provided by non-tariff barriers within agriculture (and textiles) during the early 1990s and thus underestimate the decline in nominal protection.

Substantial variation in the level and change of tariff rates is evident at the sector level. Plastic products (-24 %), textiles (-18 %), chemical related products (-13

% to –15 %) and wearing apparel (-11 %) experienced the largest reductions in product prices due to declining protection (excluding surcharges) between 1992 and 1998. Textiles and wearing apparel are labour-intensive sectors suggesting a possible link between trade liberalisation and the decline in employment during the 1990s. The substantial sector variation in tariff rates and changes in tariffs during the 1990s provide scope for an analysis of the impact of trade liberalisation on South African labour.

Alternative measures of protection and the costs associated with protection are also calculated. Effective rates of protection (ERP) are high, but have declined from approximately 60 % in 1998 to 30 % in 2000 for manufacturing. The level and decline in the effective rate of protection for agriculture is biased downwards because non-tariff barrier equivalents are not included. Simulations adjusting existing protection in agriculture upward during the early 1990s indicate substantial reductions in ERP within agriculture between 1992 and 2000. However, adjusting agricultural protection upwards lowers ERP in the overall economy and manufacturing, as the high tariff associated costs of agricultural inputs reduce profitability in downstream industries. Despite large declines during the 1990s, very high ERP are still found within the clothing and textile sectors.

Indirect taxes on exports arising from tariff protection on intermediate goods are also calculated. Tariff liberalisation reduced the indirect tax on exports from 44.6 % of value added in 1988 to 18.8 % in 2000. These values, however, exclude the important contribution of GEIS and duty rebates towards the profitability of export production. Nevertheless, the results suggest that tariff liberalisation substantially enhanced the profitability of export production during the 1990s. As predicted by trade theory, employment lost within import-competing sectors may be matched by employment gained within export sectors.

While substantial progress has been made in liberalising South Africa's trade regime, further progress can be made. The decline in average protection is similar to other less-developed economies. The number of tariff lines and rates remain very high and a high percentage of these (25 %) are non-*ad valorem* rates. These are found mainly within the clothing and textile sectors. Further, tariffs of over 40 % are still found within the processed foods, motor vehicles & components thereof, rubber products, tobacco products and clothing and textiles sectors. Finally, the variation in nominal tariffs and ERP remains high, as reflected in the constant coefficient of variation since the mid-1990s. There is scope for further rationalisation of the tariff schedules, even if there is no desire to reduce average protection.

In the following chapters, the tariff data presented in this chapter are used to assess the impact of trade liberalisation on labour in South Africa.

Chapter 3

Trade, Technology and Labour: Theory and International Evidence

1. Introduction

Interest in the impact of international trade on labour markets has arisen out of attempts to explain the rising income inequality in the United States (US) and the United Kingdom (UK), and the rising unemployment amongst less-skilled labour in many other Organisation for Economic Cooperation and Development (OECD) countries. Between 1979 and 1995, the premium for male college educated workers over high-school educated workers in the US rose from 30% to 70%. Amongst male high school educated workers, the 90th percentile to 50th percentile gap rose from 60% in 1979 to 83% in 1995 (Blanchflower and Slaughter, 1998: 2). The growth of US average hourly compensation also declined from a steady 2.7% a year between 1947 and 1973 to a 0.4% per year afterwards (Burtless, 1995). The stagnation of wages fell particularly on those workers at the lower end of the skill spectrum. The real wages of full-time US workers with 12 or less years of education fell by between 13.4% and 20.2% between 1979 and 1995. During the same period, the real wage of workers with 16 or more years of education rose by 3.4% (Feenstra and Hanson, 2001).

The rise in inequality is most prominent in the US and UK with many other OECD countries experiencing milder or no increases in wage inequality. For most European OECD countries wages at the bottom of the distribution rose rather than fell (Freeman, 1995). However, as Slaughter (1998b) notes, many of the countries that experienced smaller increases in wage inequality suffered from higher rates of unemployment and/or slower rates of employment growth for less-skilled workers. This may reflect differences in labour market institutions between US and European OECD countries. In so far as institutional structures reduce wage flexibility (as in European OECD countries compared to the US) the pressures for wider skill differentials emerge in other forms such as higher unemployment among the low skilled (Wood, 1994). Although relative labour supply shifts also affect labour markets, the concurrent widening of skill differentials in wages, unemployment of less-skilled and rising skill intensity of production are symptomatic of an upward shift in the demand for skilled relative to unskilled labour (Katz and Murphy, 1992).

These labour market trends have occurred at roughly the same time US and OECD countries rapidly expanded trade, in particular trade with less-developed countries. In the US, the ratio of exports plus imports to gross domestic product rose from 0.12 in 1970 to 0.22 in 1990. Imports from less-developed countries grew particularly strongly and rose from 14% to 35% of total US imports between 1970 and 1990 (Freeman, 1995). In the European community, the share of imports from less-developed countries in total imports rose from 5% to 12 % over the same period (Freeman, 1995). The apparent association between rising imports from less-developed countries and wage inequality and/or unemployment of less-skilled labour has led many to view "globalisation" as the primary force behind these changes.

The removal of many restrictive trade policies together with reductions in natural trade barriers through falling transportation and communication costs have exposed producers of goods and services to greater competition with foreign producers. Through the interlinking of product markets, labour markets too have become more closely linked. The concern within developed countries is "*whether in a global economy the wages or employment of low-skilled workers in advanced countries have been (or will be) determined by the global supply of less-skilled labor, rather than by domestic labor market conditions*" (Freeman, 1995: 16). Or as Freeman (1995) succinctly puts it: "Are your wages set in Beijing?"

Although there is a strong consensus that rising relative demand for skilled labour is an important factor driving increasing wage inequality in developed countries, there remains no consensus as to what caused the demand shift (Slaughter, 1998a). A variety of explanations have emerged ranging from trade (Wood, 1994; Borjas *et al.*, 1992), the composition of aggregate demand (Lawrence, 1983) and skill-biased technological change (Berman *et al.*, 1994; Berman *et al.*, 1998; Machin and Van Reenen, 1997).

In the remainder of this chapter the theoretical and empirical relationship between trade, technology and labour is explored using the general equilibrium framework of the Heckscher-Ohlin-Samuelson (HOS) model. This theoretical framework has guided most empirical work in this area and a review of the model holds many lessons for the structure and content of the South African debate. Section 2 presents the theory underlying the relationship between international trade, technology and labour. Section 3 then critically reviews the empirical methods and international evidence within developed and developing economies. This review feeds into the empirical analysis presented in subsequent chapters of this thesis. Section 4 concludes the chapter.

2. International trade, technology and labour: Economic theory

2.1 International trade and labour: The Stolper-Samuelson (SS) effect

The theoretical framework guiding much of the analysis is the one-cone Heckscher-Ohlin-Samuelson (HOS) model. Central to the debate on the impact of international trade on labour has been the Stolper-Samuelson (SS) theorem which links product price changes to factor price changes. Various interpretations of the Stolper-Samuelson theorem exist (see Slaughter, 1998a), but the theorem generally states that:

> *An increase in the relative price of a commodity raises the real return to the factor used relatively intensively in the production of that commodity and lowers the real return to the other factor.*

Within developed countries the implication is that increased trade with developing countries has lowered the relative price of less-skill-intensive products, which through SS linkages has lowered the relative return to less-skilled labour. In contrast, in accordance with the SS theorem, wage inequality in developing economies should decline.

This relationship can be shown more explicitly using the standard two-goods two-factors two-country (2x2x2) Heckscher-Ohlin-Samuelson model. Two factors, skilled and less-skilled labour, are used to produce two products, skill-intensive machinery (M) and less-skill-intensive footwear (F), according to constant returns to scale technology. Factors are mobile between sectors, but are completely immobile internationally. The home country is skill abundant relative to the foreign country, which represents labour abundant less-developed economies. Home is also a small open country such that its production and consumption decisions do not influence world relative prices. To ensure Factor Price Equalisation, factor endowments ratios of the two regions are assumed to be similar enough such that each falls within the same cone of diversification. Preferences are identical and homothetic and both product and factor markets clear competitively.[16]

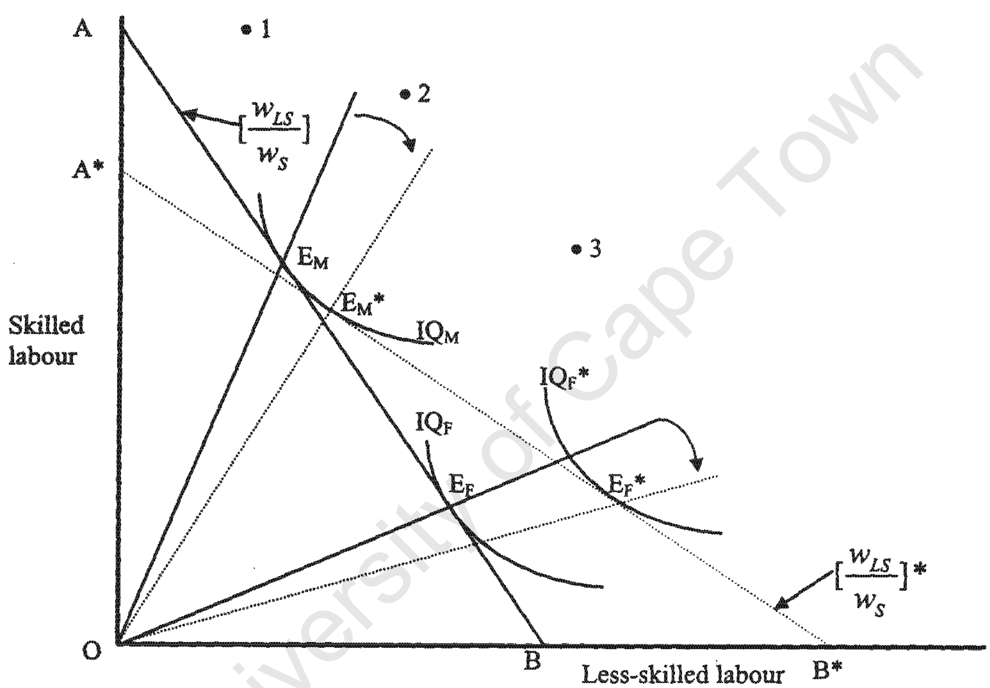
Equilibrium in the home country is represented in Figure 3.1 using Lerner diagrams. *Unit-value isoquants* for machinery (IQ_M) and footwear (IQ_F) represent the minimum set of capital and labour combinations that are required to produce a unit value of output. Equilibrium occurs when zero profits are earned in both sectors of the economy, i.e. when the *unit-isocost* line is tangent to both the unit-value isoquants. If the unit-isocost line is not tangent to both unit-value isoquants, profits (losses) will arise in one sector causing a re-allocation of factors of production to the profitable sector and away from the loss-making sector. Because factor intensities differ between sectors factor returns adjust such that such that any profits or losses are eliminated. The equilibrium wage of less-skilled labour relative to skilled labour (w_{LS}/w_S) is given by the absolute value of the slope of the unit-isocost line AB. The equilibrium relative wage ratio determines the equilibrium factor intensities of production, namely OE_M for machinery and OE_F for footwear.

Now assume that the price of the less-skill-intensive footwear product declines in the home country. This can be due to the home country's trade liberalisation programme or international price movements driven by, amongst others, changes in technology, tastes, foreign endowments and trade barriers. The reduction in the price of footwear shifts the unit-value isoquant outwards to IQ_F* as more footwear production is required in order to generate a unit value of output. At existing factor prices losses are made in the footwear sector causing production resources to shift out of footwear and into machinery production. Given the relatively high-skill-intensity of machinery production changes in the commodity composition of production raise the demand for skilled labour relative to less-skilled labour. As a consequence the wage of skilled labour rises and the wage of less-skilled labour falls resulting in a new

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

equilibrium factor price ratio $[w_{LS}/w_S]^*$; the slope of A*B*. The slope of line A*B* is less than the slope of AB, which implies that wage inequality has risen. Finally, in response to the rising relative wage of skilled labour, firms substitute skilled labour for less-skilled labour reducing the skill intensity of production in both machinery and footwear firms.[17]

Figure 3.1: Stolper-Samuelson effects



Some central insights into the relationship between trade and labour can be derived from the Stolper-Samuelson theorem. Firstly, the theorem predicts a winner-loser outcome in the country. Trade liberalisation reduces the price of less-skill-intensive products in developed countries, which raises the real wage of skilled labour, but reduces the real wage of less-skilled labour. In contrast, an equivalent analysis of a developing country shows that trade liberalisation raises the relative price of less-skill-intensive products, which increases the real (and relative) wage of less-skilled labour, i.e. wage inequality declines.

Evidence of falling wage inequality in less-developed countries is, however, weak. While wage inequality fell in East Asia during the 1960s and 1970s (Wood,

[17] This is not a necessary outcome of the Stolper-Samuelson theorem. There is no change in factor intensity ratios if Leontief fixed factor coefficients are assumed.

1997), it rose in subsequent decades for many less-developed economies (see Hanson and Harrison, 1995 & 1999; Robbins, 1996; Berman *et al.*, 1998; Berman and Machin, 2000).[18] Rising wage inequality within developing economies contradicts the predictions made by the standard HOS model. This combined with the pervasiveness of rising wage inequality across developed and developing countries is used as evidence for the impact of skill-biased technological change (Berman *et al.*, 1994; Berman *et al.*, 1998; Machin and Van Reenen, 1998; Berman and Machin, 2000).

A second observation, which has particular relevance for the South African debate, is that no reference is made to trade flows or employment levels. According to the Stolper-Samuelson theorem "*price shocks cause price reactions*" (Leamer, 1996: 8). The fact that manufacturing imports from developing countries constitutes a very small share of US GDP (2.7 % in 1990) is unimportant. Prices are set at the margin and lower prices of less-skill-intensive products raise wage inequality within developed economies, irrespective of the volume of trade flows. In this model the 'tail wags the dog'.

Thirdly, under free-trade factor prices equalise for countries falling within the same cone of diversification (area between the rays OE_M* and OE_F*). Assuming no transport costs, common technology and international prices ensure that factor prices converge. However, if an economy specialises in the production of a particular good, factor price equalisation does not occur. For example, an economy at point 1 in Figure 3.1 will specialise in the production of machinery. Relative wages will equal the slope of the manufacturing isoquant passing through point 1 which will be lower than the relative wage of economies at point 3.

2.2 Extensions to the standard model

The predictions of the simple model that trade liberalisation raises wages of less-skilled labour in developing countries, but reduces wages of less-skilled labour in developed countries, are outcomes of the assumption that the endowment ratios of all countries fall within the same cone of diversification. As soon as the model is

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[18] See the more detailed discussion later.

extended to include more products, and thus more cones of diversification, these predictions change.

To pursue this analysis the simple 2x2x2 model is extended to include more products.[19]

Figure 3.2: Three-goods two-factor model

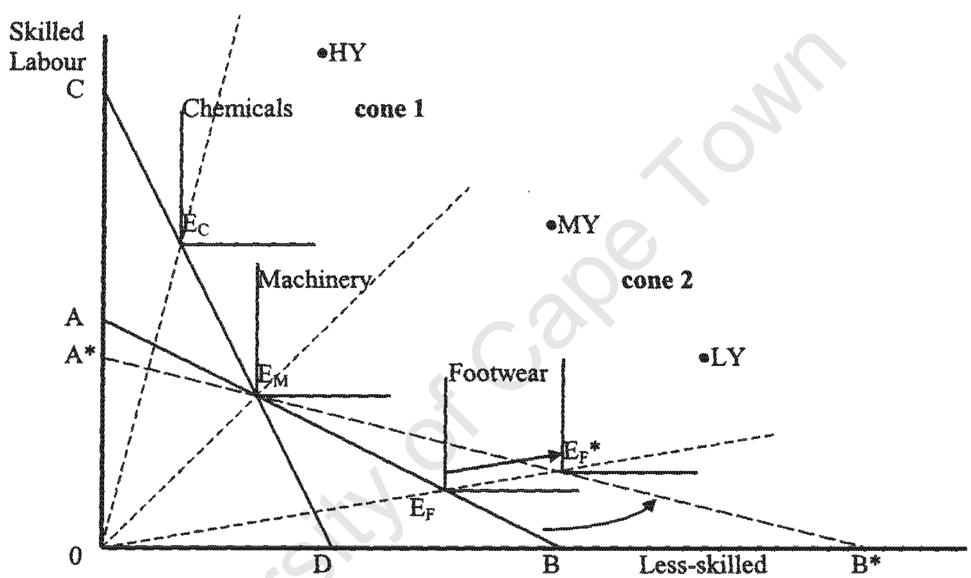

Figure 3.2 depicts a Heckscher-Ohlin world consisting of three products: chemicals, machinery and footwear. Chemical products are the most skill-intensive commodities followed by machinery and footwear. For simplification purposes constant return to scale Leontief production functions (i.e. constant factor coefficients) are assumed.[20] The results are not dependent on the substitutability of skilled and less-skilled labour, which can easily be incorporated into the model. It is further assumed that there are three countries with different relative factor endowments. High-income countries (HY) are relatively abundant in skilled labour and their relative endowments place them in cone 1. Middle-income (MY) countries are relatively abundant in less-skilled labour compared to high-income countries, but are relatively abundant in skilled labour compared to low-income economies. Low-income (LY) countries are relatively abundant in less-skilled labour compared to both

[19] For equivalent discussion using different diagrammatical representations see Leamer (1996).

middle and high-income countries. The endowments of both low and middle-income countries place them in the same cone of diversification (cone 2). Each country is small such that changes in production or tariffs do not affect world prices. World equilibrium is assumed to hold, but one that does not replicate the integrated world equilibrium.[21]

High-income countries produce both chemical and machinery products while middle and low-income countries produce machinery and footwear products. Assuming homothetic identical preferences and balanced trade, high-income countries will export chemicals to low and middle-income countries and will import footwear from low-income countries. High-income countries may also export or import machinery, but the dimensionality of the model (3 products and 2 factors) prevents a unique determination of trade in products. The relationship between trade flows and endowments is nonlinear, unlike the simple 2x2 case (Leamer, 1984). Drawing on the Heckscher-Ohlin-Vanek theorem, high-income countries will be net exporters of skilled labour while low-income countries will be net exporters of less-skilled labour. Middle-income countries can either be net exporters or importers of skilled labour depending on their endowments relative to world endowments. Of primary importance to this analysis, however, are not trade flows, but the failure of factor price equalisation when countries are not all in the same cone of diversification. In this model the relative wage of less-skilled labour in high-income countries (slope of CD) exceeds those of middle and low-income countries (slope of AB). Factor price equalisation still occurs between all countries within the same cone of diversification, that is between middle and low-income countries.[22]

Using this model it is easy to show how a reduction in prices of less-skill-intensive products arising from greater integration of low-income economies into the world trading system does not necessarily reduce the relative wage of less-skilled labour in high-income countries. A reduction in the price of footwear products shifts the unit-value isoquant for footwear outwards (from the perspective of high-income

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[20] Note that these figures assume the absence of factor intensity reversal.

[21] Prices adjust to ensure equilibrium holds. If substitution is permitted, price adjustments change the cones of diversification. This ensures that all products are produced and that there is no excess demand for any product.

[22] Factor price equalisation could occur across all countries if endowments are not too dissimilar. Exactly what

countries[23]). Because footwear is a non-competing product for high-income economies, relative factor payments in these economies are not affected. However, real incomes for both skilled and less-skilled labour in high-income economies increase as the price of footwear declines (i.e. w_S/P_F and w_{LS}/P_F rise). Thus, "... *if the countries are sufficiently dissimilar in their factor supply ratios, and if the integrated equilibrium has one or both countries fully specialized, then both factors in both regions can be made better off from economic integration of the product markets*" (Leamer, 1996:10). The argument that increased trade with less-developed countries reduces the relative wage of less-skilled labour in developed economies rests in part on factor endowment similarity.

The model is also useful in explaining how trade liberalisation and the integration of large low-wage economies such as China and India into the world economy may have caused an increase in wage inequality within many middle-income economies (Davis, 1996; Wood, 1997). Davis (1996) argues that countries that are labour abundant in a *global* sense may see wages decline through integration if they are capital abundant in a *local* sense. Similarly, countries less-skill abundant in a global sense may experience rising wage inequality through integration if they are skill abundant in a local sense. To show this, the additional assumption is made that middle-income countries export machinery to both high and low-income countries and import footwear from low-income countries and chemicals from high-income countries. In the model, middle-income countries are less-skill abundant in a global sense as they are net exporters of less-skilled labour to the rest of the world. However, they are skill abundant in a local sense as they are net exporters of skilled labour to low-income economies.

Trade liberalisation within a middle-income country lowers the price of both footwear and chemical products relative to machinery products. Because chemicals are non-competing products, lower prices of imported chemical products do not affect relative factor payments, but raise real factor returns (not shown in Figure 3.2). In contrast, the reduction in the import price of footwear shifts the middle-income

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goods each country produces cannot be determined in this equilibrium (Leamer, 1984; Deardorff, 1999).

[23] Whether the unit-value isoquant shifts out from the perspective of middle-income economies depends on whether they are importers or exporters of footwear.

country's unit-value isoquant for footwear outwards (E_F to E_F*). Footwear firms respond to the decline in the price of footwear by shifting factor inputs towards the production of relatively skill-intensive machinery products. The relative demand for skilled labour rises and raises the wage of skilled labour relative to less-skilled labour. This is reflected in the decline in the slope of the unit-cost line from AB to A*B*. As Davis (1996) shows, the impact of trade liberalisation on factor returns through Stolper-Samuelson linkages is not dependent on factor abundance in a global sense, but in a local sense. Rising wage inequality within middle-income economies is not necessarily inconsistent with the Heckscher-Ohlin model. Wood (1997) uses a similar framework to explain how the entry of China and India into the world market may have raised wage inequality within Latin American economies during the 1980s.[24]

As soon as multiple products and cones are introduced, the linear relationship between product prices and factor payments breaks down. A decline in the relative price of a less-skill-intensive product lowers the wage of less-skilled labour relative to skilled labour, so long as the country continues to produce it (i.e. remains within the cone of diversification). If the country does not produce less-skill-intensive products, the decline in price merely raises the real return of all factors. Further, if substitution between factors is allowed, the impact of a decline in the relative price of less-skill-intensive products on wage inequality may be marginal, even if the country produces the product. In response to rising relative wages of skilled labour, firms reduce the skill intensity of production which shifts the cone of diversification towards the less-skilled labour axis (from the region bordered by OE_M and OE_F in Figure 3.1 to the region bordered by OE_M* and OE_F*). A country with relative endowments at point 2 in Figure 3.1 will find that its comparative advantage has shifted into a new range of more skill-intensive products (into a new cone of diversification). If the decline in the price of less-skill-intensive products is substantial, the real return to both skilled and less-skilled labour may rise, despite the rise in wage inequality. "*By shifting outputs to more capital and/or skill-intensive products, countries can insulate themselves from*

[24] The entrance of China into the world market really has two effects. Firstly, by increasing the supply of less-skilled labour intensive products in the world market, the relative price of these products falls. Through the Stolper-Samuelson linkages this will raise wage inequality in relatively skill abundant economies so long as the countries are in the same cone of diversification. Secondly, the effective world endowment of less-skilled labour rises noticeably (given the size of China), which may shift a country's comparative advantage towards more skill-intensive products (see Deardorff, 1999). The effect on relative factor payments may be minimal, whereas the impact on the composition of trade may be substantial.

competition from low (unskilled) wage products countries" (Robbins, 1996: 38). In doing so, they insulate themselves from large changes in relative factor payments.

2.3 Technology and labour

The impact of technological change on labour markets depends on the nature of the technological change. Within the trade, technology and labour debate three forms of technological change can be identified: Hicks-neutral technological change, skill-biased technological change and trade-induced technological change. Each of these is briefly discussed.[25]

2.3.1 Hicks-neutral technological change

The standard HOS trade model assumes that technology is constant and identical across countries. Findlay and Grubert (1959) have shown that the sector bias of Hicks-neutral technological change, whereby the productivity of all factors increase equivalently, can give rise to changes in relative wages. This is most clearly shown using the Lerner diagrams in Figure 3.3. A Hicks-neutral technological improvement in the production of machinery shifts the unit-value isoquant for machinery (IQ_M) inward to IQ_M*. Because the technological improvement is Hicks-neutral, the new unit-value isoquant is parallel to the original, i.e. the ratio of skilled to less-skilled labour does not change at the original wage ratio.

Technological improvements in the machinery sector lower production costs and profitability at fixed product prices and initial factor prices. Producers respond to this profit opportunity and shift production resources away from footwear production towards machinery production. Because machinery is relatively skill-intensive, the relative demand for skilled labour rises, which under fixed labour supplies raises the relative wage of skilled labour. This is shown in the new equilibrium factor price ratio $[w_{LS}/w_L]^*$ which is tangent to IQ_M* and IQ_F. The relative wage of less-skilled labour falls and is reflected in the shallower slope of the unit-isocost (A*B*) compared to the original wage ratio (AB). In response to changes in relative wages, firms substitute

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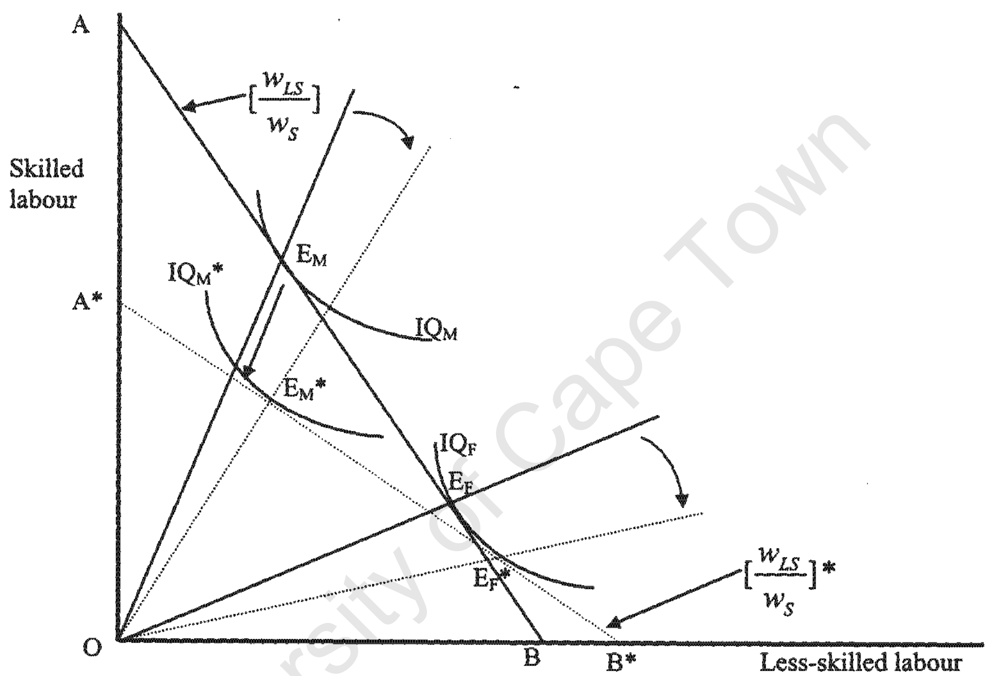
[25] Unless otherwise stated, the small country assumption that changes in domestic consumption and production do not affect world prices, holds.

less-skilled labour for skilled labour and reduce the skill intensity of production in each sector. In the general equilibrium framework, the sector bias of Hicks-neutral technological change drives relative wage shifts and benefits the factor used intensively within the relevant sector.

Figure 3.3: Hicks-neutral technological change



2.3.2 *Skill-biased technological change*

While Hicks-neutral technological change within skill-intensive sectors can cause rising wage inequality, the decline in skill intensity within each sector is at odds with empirical evidence that shows rising skill intensity of production within all sectors. An alternative explanation is that rapid advances made in the development and distribution of microelectronic, microprocessor and automation technology are skill biased and have raised the relative demand for skilled labour within all sectors (Krueger, 1993; Berman *et al.*, 1994; Berman *et al.*, 1998).

One problem with this view is that there is insufficient clarity on how skill-biased technological change raises the skill intensity of production, i.e. by (a) augmenting skilled labour, (b) directly replacing less-skilled labour or (c) increasing the number of less-skilled tasks being taken over by skilled labour?[26] Technological change does not always complement and increase the demand for skilled labour, as was evident during the 19th century when improvements in machinery led to the replacement of skilled artisans by unskilled labour (Acemoglu, 2002). Improved machinery embodying skill-biased technology may enable less-skilled labour to perform functions previously performed by skilled labour, thus reducing the skill intensity of production.

Even if skill-biased technology augments rather than substitutes skilled labour, the skill intensity of production within an individual firm may not rise. The impact on the skill intensity of production depends on whether skilled and less-skilled labour are substitutes or complements (Acemoglu, 2002). This is easily shown using the constant elasticity of substitution (CES) production for sector i

Eq 3.1: $$Y_i = [(A_{i,LS}(t)LS_i(t))^{\rho} + (A_{i,S}(t)S_i(t))^{\rho}]^{1/\rho}$$

where $\rho \leq 1$, and $A_{i,LS}$ and $A_{i,S}$ are factor-augmenting technology terms which are sector specific. The elasticity of substitution between skilled and less-skilled workers is given by $\sigma \equiv 1/(1-\rho)$. Less-skilled and skilled labour are gross substitutes if $\sigma > 1$ and gross complements if $\sigma < 1$.

In this function technology either increases the productivity of skilled or less-skilled workers. Technology does not directly replace skilled or less-skilled labour, although Acemoglu (2002: 19) draws reference to a more general formulation where direct replacement does occur. Depending on the elasticity of substitution (σ), skill augmenting technological improvements (a rise in $A_{i,S}$) can either complement or 'replace' skilled workers. This is most clearly shown by analysing the change in the slope of the production isoquant ($MP_{i,LS}/MP_{i,S}$) in response to skill-augmenting technological progress, i.e. a decline in the ratio $A_{i,LS}/A_{i,S}$. The marginal product of less-skilled labour ($MP_{i,LS}$) is calculated as

[26] Berman *et al.* (1998) define skill-biased technological change as an exogenous change in the production function that raises the unit labour demand of skilled relative to less-skilled labour at the current wage ratio. This definition is circular.

Eq 3.2: $$MP_{i,LS} = \frac{\partial Y_i}{\partial LS} = [\cdots]^{\rho-1}(A_{i,LS})^{\rho} LS_i^{\rho-1}$$

where [...] equals $(A_{i,LS}(t)LS_i(t))^{\rho} + (A_{i,S}(t)S_i(t))^{\rho}$. Similarly, the marginal product of skilled labour is calculated as

Eq 3.3: $$MP_{i,S} = \frac{\partial Y_i}{\partial S} = [\cdots]^{\rho-1}(A_{i,S})^{\rho} S_i^{\rho-1}.$$

The (negative of) the slope of the isoquant is given by the ratio of marginal productivities ($MP_{i,LS}/MP_{i,S}$), which in natural logarithms can be expressed as

Eq 3.4: $$\ln\left(\frac{MP_{i,LS}}{MP_{i,S}}\right) = \frac{\sigma-1}{\sigma}\ln\left(\frac{A_{i,LS}}{A_{i,S}}\right) - \frac{1}{\sigma}\ln\left(\frac{LS_i}{S_i}\right)$$

where $1/\sigma = \rho\text{-}1$ and $(\sigma\text{-}1)/\sigma = \rho$. Differentiating this by the ratio $A_{i,LS}/A_{i,S}$ yields the following relationship:

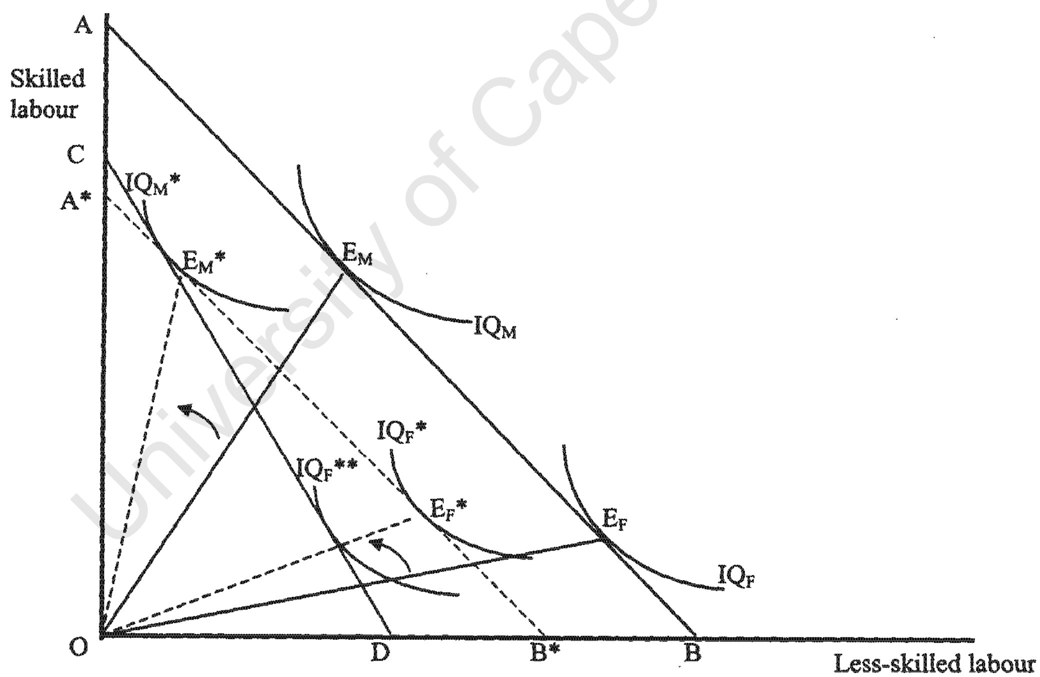
Eq 3.5: $$\frac{\partial \ln(MP_{i,LS}/MP_{i,S})}{\partial \ln(A_{i,LS}/A_{i,S})} = \frac{\sigma-1}{\sigma}.$$

If skilled and less-skilled labour are gross substitutes ($\sigma > 1$), then an improvement in skill augmenting technology (a decline in the ratio $A_{i,LS}/A_{i,S}$) flattens the slope of the isoquant at each factor combination. When firms adjust to their new profit maximising positions at fixed wage rates the new point of tangency between the isoquant and the wage ratio will be at a higher skilled/less-skilled ratio. However, if skilled and less-skilled labour are complements ($\sigma < 1$) then improvements in the productivity of skilled labour *increase* the slope of the isoquant and *reduce* the skill intensity of production within firms at constant wages. Because skilled and less-skilled labour are complements, the improvement in productivity of skilled labour raises the 'effective' supply of skilled labour within the firm. Firms then reduce the quantity of skilled labour used in conjunction with less-skilled labour per unit of output. Most estimates of σ are greater than 1 suggesting that skilled and less-skilled labour are gross substitutes (Hamermesh, 1993). Therefore, improvements in skill augmenting technology will generally, but not necessarily, be skill-biased in the sense used by Berman *et al.* (1998). In the remainder of the chapter it will be assumed that

$\sigma > 1$ such that skill-biased technological change raises the skill intensity of production at given wages.

The relationship between skill-biased technological change and *wage inequality* is also ambiguous. In a one-sector economy, skill-biased technological change raises the relative wage of skilled labour (see Haskel and Slaughter, 1998 and Acemoglu, 2002). However, this result does not generalise to the two- or more-sector case. This is most clearly shown by Leamer (1994, 1996) and can be replicated using the Lerner diagrams for a small open economy presented in Figure 3.4.

Figure 3.4: Skill-biased technological change



Sector neutral, skill-biased technological change that raises the productivity of skilled labour in both the skill-intensive and less-skill-intensive sectors shifts the unit-value isoquant inwards for each sector at initial product and factor prices. In the case where skill-biased technological change is sector neutral, in the sense that the unit costs of producing each product are reduced by the same amount, the unit-value isoquants shift inwards by equivalent amounts.[27] As a result, the new equilibrium

[27] This occurs when the absolute reduction in less-skilled labour per unit output is equal in both sectors.

isocost line A*B*, which is tangent to the unit-value isoquants IQ_M* and IQ_F*, is parallel to the original line AB. Wage inequality has not risen, despite the presence of skill-biased technological change.

The increased productivity of skilled labour raises the marginal productivity of skilled relative to less-skilled labour (MP_{LS}/MP_S) for a given output, i.e. the slope of the unit isoquants flattens. As a result, the ratio of skilled to less-skilled workers increases in both sectors. In order to maintain full employment of factors, production of the less-skill-intensive footwear increases relative to machinery. This is because the rising skill intensity of production in both sectors releases less-skilled labour that is absorbed through increased production of less-skill-intensive products.

This is a particularly pointed critique of the view that skill-biased technological change in a small open economy raises the relative wage of skilled labour. What is critically important is the sector bias of the technological change, irrespective of whether it is Hicks-neutral or skill-biased.[28] The sector bias of technological change alters the relative profitability of production across sectors, which acts as an incentive for firms to re-allocate production resources to the relatively profitable sectors. Because of different factor intensities across sectors, the relative demand for factors change and through this relative factor payments adjust.

Haskel and Slaughter (1998) and Baldwin (1995) show that skill-biased technological change concentrated within the less-skill-intensive sector can actually *reduce* wage inequality. For example, if skill-biased technological change led to the same percentage (as opposed to absolute) decline in the quantity of less-skilled labour per unit output, the inward shift of the unit-value isoquant for footwear will exceed that of machinery. This is represented by the inward shift of the unit-value isoquants for footwear and machinery to IQ_F** and IQ_M*, respectively. The skill-biased technological change raises the skill intensity and profitability of production in both sectors (at existing wages), but the profitability of footwear increases relatively more. Producers respond to this profit opportunity by expanding production of footwear,

[28] Leamer (1996: 23) notes that this conclusion only applies to small changes and only if the technological change does not induce sector-biased price changes via second order effects.

which raises the relative demand for less-skilled labour and hence their wage relative to skilled-labour. This is reflected in the steeper slope of the equilibrium isocost line CD. As in the earlier example, output of footwear increases relative to machinery. This example highlights Leamer's (1994, 1996) argument that in a general equilibrium framework the sector bias, and not the factor bias, of technological change determines the change in relative factor returns. For skill-biased technological change to raise both the skill intensity of production and the relative wage of skilled labour, it is necessary that this technological change be concentrated within skill-intensive sectors. [29]

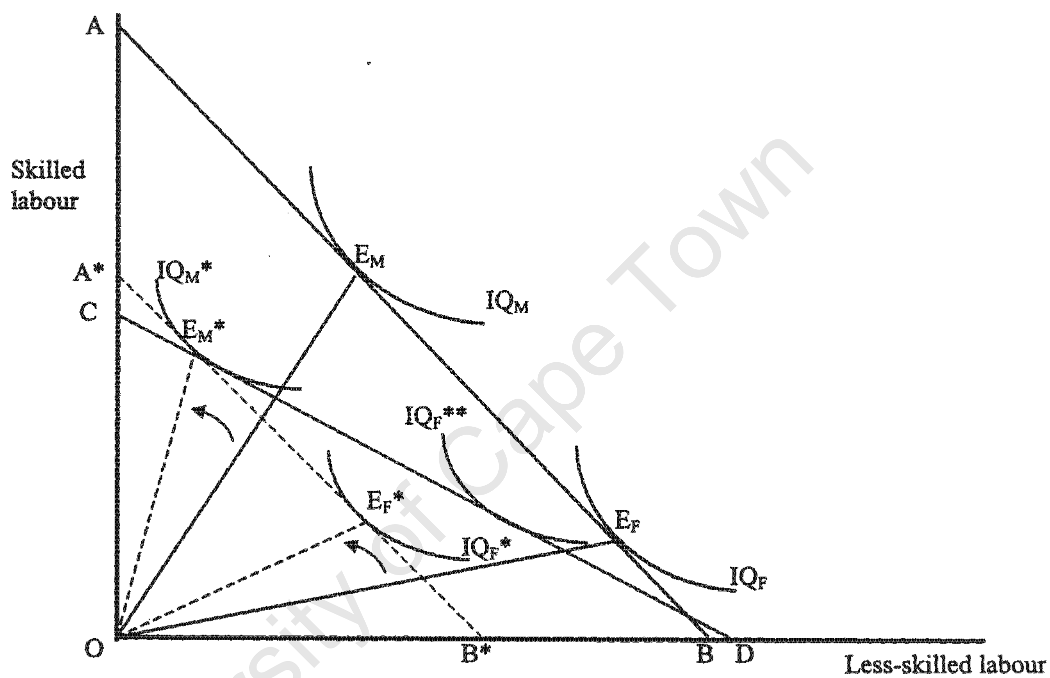
This result holds largely because relative product prices do not change in response to technological progress. Berman *et al.* (1998) argue that if skill-biased technological change occurs within a closed economy or is *pervasive* (i.e. occurs simultaneously in all economies) then relative product prices will change and the relative wage of skilled labour will rise. As shown in Figure 3.5, skill-biased technological change causes the unit value isoquants to shift inwards to IQ_F* and IQ_M*. The rising skill intensity of production 'releases' less-skilled labour that is then absorbed through relatively large increases in the production of less-skill-intensive goods (footwear). If this occurs across many countries, the price of footwear will decline shifting out the unit-value isoquant from IQ_F* to IQ_F**. The relative wage of skilled labour rises in response, as is reflected in the slope of the line CD that is flatter than A*B*. Thus, argue Berman *et al.* (1998), pervasive skill-biased technological change raises the relative wage of skilled labour *and* the skill intensity of production within all open economies.

However, Baldwin and Cain (2000) point out that the rising skill intensity of production depends on the substitutability between less-skilled and skilled labour. As the relative wage of less-skilled labour declines, firms substitute less-skilled for skilled labour. This may continue to such an extent that the final skill intensity of production is less than that prior to the change in skill-biased technology. Pervasive skill-biased technological change also does not necessarily raise wage inequality. If

[29] The sector bias may not be sufficient. Haskel and Slaughter (1998) argue that unless relative profitability changes the restructuring of production will not take place.

skill-biased technology improvements are strongly biased towards less-skill-intensive sectors, the relative profitability of less-skill-intensive production may improve, despite the reduction in the world price of these products. Wage inequality will then decline.

Figure 3.5: Pervasive skill-biased technological change



The impact of technological change on factor prices and factor intensities is ambiguous. In a partial equilibrium framework, skill-biased technological change may increase or decrease the skill intensity of production. In a general equilibrium framework, it is the sector bias and not the factor bias of technological change that drives changes in relative factor payments. Skill-biased technological change may actually reduce wage inequality if it is concentrated in less-skill-intensive sectors. In a global framework, skill-biased technological change that is not sector biased can increase wage inequality, but only if it is pervasive and results in a decline in the relative price of less-skill-intensive products.

2.3.3 Trade-induced technological change

A major problem with the use of the Heckscher-Ohlin framework to analyse the impact of technological change on labour is that the theory assumes technological change is exogenously determined. This has been criticised on a number of fronts.

Wood (1994, 1995) argues that increased international competition arising from trade liberalisation induces "unskilled labour saving technical progress" which he terms "*defensive innovation*". Wood (1995: 67) argues that a "*... common reaction of developed-country firms to low-wage competition has been to look for methods of production that economize on unskilled labour.*" The demand for less-skilled labour falls as a consequence and places upward pressure on wage inequality. These adjustments are frequently ascribed to technical change whereas they are trade related. This results in an underestimation of the impact of trade on wage inequality within many empirical studies.

Trade-induced technology flows can also explain the rising wage inequality within developing economies (Pissarides, 1997; Robbins, 1996). Trade increases technological transfers from developed to developing countries through direct technology transfers, 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). Robbins (1996) refers to this as "*skill-enhancing-trade*". The competitive pressures arising from trade liberalisation may also induce a reduction in x-inefficiency, particularly within oligopolistic sectors. In response to increased competition firms may attempt to increase efficiency by eliminating excess labour or introducing labour saving techniques (Baldwin, 1995: 17).

The theoretical framework surrounding these arguments is unclear. In a single sector model, defensive innovation raises the skill intensity of production causing the relative wage of skilled labour to rise. However, in a two sector general equilibrium model the impact is the opposite. As shown in Figure 3.1, trade liberalisation that reduces the relative price of less-skill-intensive footwear shifts the unit-value isoquant outwards, raising wage inequality in the process. If this induces technological change within the footwear sector, the unit-value isoquant will shift inwards, thus *reducing*, not increasing, wage inequality. If "*unskilled labour saving technical progress*" (defensive innovation) is to exacerbate the rise in wage inequality, it needs to be concentrated within skill-intensive sectors. This is not what Wood (1994) appears to be arguing.

There is a further problem associated with the view that 'defensive innovation' exacerbates rising wage inequality within developed economies. Relative price reductions in less-skill-intensive sectors do not raise wage inequality through Stolper-Samuelson linkages if they are 'non-competing', i.e. if they are not produced in the home economy. If defensive innovation results in the upgrading of products such that the home country moves up the ladder of comparative advantage, then the impact on wage inequality will be ameliorated. For example, if the home economy is at point 2 in the earlier Figure 3.1, a reduction in the price of footwear through trade liberalisation causes the home country to specialise in machinery products. Relative wages will decline (and will equal the slope of the isoquant through the endowment point 2), but by less than if the economy remained within the cone of diversification. As opposed to exacerbating rising wage inequality, defensive innovation may simply reflect a movement up the ladder of comparative advantage; a process that moderates the rise in wage inequality. If the price of footwear declines a lot, real wages in the home country may actually rise, despite the increase in wage inequality.

Similar problems apply to the 'skill-enhancing-trade' hypothesis used to explain rising wage inequality within developing economies. As discussed earlier, the impact of skill-enhancing technology flows on relative wages depends on the sector bias and not the factor bias of technological change. Direct technology flows or the importation of skill-complementing intermediate goods may raise the skill intensity of production within all sectors of the economy. However, if these technology flows substantially improve the competitiveness of the traditional less-skill-intensive export sector, export growth may boom which will reduce wage inequality according to the general equilibrium framework. In a general equilibrium framework with fixed product prices, trade-induced transfers of skill-biased technology will raise wage inequality only if concentrated in skill-intensive sectors.

2.4 Other

A change in the relative supply of skilled and less-skilled labour is a further factor that can influence relative wages. A rise in the relative supply of skilled labour will not, however, always lead to a reduction in wage inequality. Wages are linked to

This section also shows that the impact of technological change, whether Hicks-neutral, skill-biased or trade-induced, depends on the sector bias and not the factor bias of the technological change.

These theoretical insights have implications for the empirical methodologies used to analyse the relationship between trade, technology and factor returns. The following section analyses the empirical methodologies and international evidence in this field of research.

3. Empirical methods and international evidence

International empirical research is characterised by different empirical methodologies, data sources and regional foci. This section briefly overviews the empirical methodologies and evidence on the impact of trade and technology on labour in developed and developing countries. The evidence for developing countries is presented separately in Section 3.3.

3.1 International trade and labour

Two approaches to measuring the impact of trade on labour have dominated international research: (a) factor-content studies and (b) price studies.

3.1.1 Factor-content studies

The factor-content approach involves the estimation of the implicit change in factor endowments that arise through exports and imports. Using labour coefficients of production, the domestic equivalent of skilled and less-skilled labour embedded in imports and exports can be calculated. Labour imbedded in imports reduce the demand for domestic labour while labour imbedded in exports increase the demand for domestic labour.[31] The differences between the labour content of exports and imports are then interpreted as the impact of trade on the demand for skilled and less-skilled workers (Wood, 1995). The influence on relative wages between skill

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[31] Borjas *et al.* (1992) use the factor content of trade to estimate the impact on the 'effective' supply of labour, rather than the impact on the demand for workers. Labour embodied in imports increase supply, while labour embodied in exports decrease supply.

categories can then be inferred from net changes in the demand for each category of labour.

Most factor-content studies of the US find that trade between 1970 and the mid-1990s negatively affected labour, particularly less-skilled labour, but the size of the impact is moderate to low (Lawrence, 1983; Borjas *et al.* 1992;.Katz and Murphy, 1992; Sachs and Shatz, 1994; Borjas *et al.* 1997). Estimates of the impact of trade on labour in the UK, using decomposition approaches, are similarly low (Gregory and Greenhalgh, 1997; Greenhalgh *et al.*, 1998).

Borjas *et al.* (1992) estimate that 15-25 % of the rise in earnings of college graduates relative to school graduates between 1980 and 1985 is accounted for by the increase in the US trade deficit. Lower estimates of the impact of trade on the skilled wage differential (10 %) are found in their later study (1997). Sachs and Shatz (1994), in their study of US manufacturing between 1978 and 1990, find that trade with developing countries reduced employment of production (less-skilled) workers (-6.2 %), but only moderately more than non-production (skilled) workers (-4.3 %). Wood (1994: 98) surveys a range of factor-content studies covering several developed countries and finds that the trade impact on employment was negative, but tiny. In no cases did the impact exceed one percent of all manufacturing employment. Those studies focussing on skills find negative impacts of trade on lower skilled occupations and positive impacts on higher skilled occupations, but again the size of the impact was negligible (Wood, 1994: 104).

However, Wood (1994, 1995) argues that most factor-content studies underestimate the full trade impact. These studies assume that imports from the South compete with identical goods made in the North and hence that the labour content of imports can be estimated using Northern production techniques. However, many of the imported goods are 'non-competing' as they are no longer produced in the North. "*The conventional method of calculation, using domestic input coefficients, is bound to* ***understate*** *the impact of trade on factor markets*" (Wood, 1994: 73). After adjusting the labour content of imports to reflect those of the source country more closely, Wood (1994) concludes that the decline in relative demand for unskilled labour is really 10 times the conventional estimates.[32]

Wood (1994, 1995) further argues that the conventional studies, in particular the decomposition studies, fail to account for the impact of defensive innovation on employment and he (1995: 67) suggests a doubling of the modified factor-content estimates to take defensive innovation into account.[33] Using data in Table 1 of Wood (1995: 66), this implies that trade with developing countries reduced employment of unskilled workers in many developed countries by approximately 40 % relative to what it would have been had there been no increased competition from developing countries.

The large compensatory adjustments made by Wood (1994) have in turn drawn criticism from Baldwin (1995), Burtless (1995) and Freeman (1995). Baldwin (1995) argues that Wood's (1994) classification of all manufactures other than processed primary products as non-competing and his assumption of common technology lead to an overcompensation of the labour coefficients. Thus, while the direction of adjustments is agreed upon, disagreement remains regarding the extent of the adjustments.

A more fundamental critique of the factor-content approach is the lack of theoretical foundations (Leamer, 2000). The factor-content approach is not a strict application of the Stolper-Samuelson theorem that draws a relationship between product prices and factor payments. Rather, the approach is an application of the Heckscher-Ohlin-Vanek theorem that links relative factor endowments to the factor content of net trade. However, the relationship between changes in the factor content of trade and relative factor prices is ambiguous and depends on restrictive assumptions regarding the nature of the production and consumption functions (see Deardorff and Staiger, 1988 and Deardorff, 2000).

[32] Wood (1994, 1995) also adjusts the labour coefficients of the non-competing imports to account for the more skill-intensive production techniques used in developed countries.
[33] See Baldwin (1995: 18) for further criticisms of the decomposition studies.

For example, in response to international competition workers may reduce their wages leading to a less than otherwise increase in the volume of imports (Lawrence and Slaughter, 1993). If the feedback of wage changes into trade volumes is not captured, the impact of trade on factor payments may be underestimated. Alternatively, increases in domestic expenditure financed by inflows of foreign capital will raise consumption of both import and export goods. If the country is small and the terms of trade do not change, then factor prices will not be influenced. Yet, factor-content calculations may show a change in relative factor demands leading to the erroneous conclusion that factor returns have changed (Baldwin and Cain, 2000). Trade volumes are an endogenous outcome of changes in numerous factors such as domestic macroeconomic expansion, exchange rate shocks, government expenditure and changes in the structure of demand (Lawrence, 1983). Because these variables are not constant, it is difficult to identify the effect of trade liberalisation on trade flows.

3.1.2 Price-effect studies

The price-effect studies directly analyse the Stolper-Samuelson relationship between product prices and factor returns.[34] Following Leamer (1996), the key equation is the zero-profit condition

Eq 3.6: $P = AW$

where P is an (N x 1) vector of N domestic product prices, W is an (M x 1) vector of M domestic factor prices and A is an (N x M) matrix of input intensities whose A_{ij} element is the share of factor i per unit output j. Differentiating these zero-profit conditions produces[35]

Eq 3.7: $\hat{P} = \theta \hat{W} - \hat{TFP}$

which can be rewritten as

Eq 3.8: $\hat{P} + \hat{TFP} = \theta \hat{W}$.

$\hat{P}$, $\hat{W}$ and $\hat{TFP}$ represent the percentage change in prices, wages and total factor productivity, respectively. θ is an (N x M) initial cost-share matrix whose θ_{ij} element

[34] See Slaughter (1998a) for a comprehensive review of price-effect studies.

[35] See Leamer (1996) for the detailed algebraic manipulations yielding Eq 3.7. Leamer (1996) also includes the

is the share of factor i in the average cost of producing one unit of product j. Equation Eq 3.8 links changes in product prices and TFP to factor cost changes such that the zero-profit conditions are retained.

In order to separate out effects arising from 'globalisation' and technological change it is necessary to define the relationship between product price changes and TFP growth. In a large country setting, an improvement in TFP growth may reduce prices giving rise to Stolper-Samuelson effects. In the price-taking small-country case, there is a zero pass-through of technology onto product prices. Without an understanding of the relationship between product price changes and TFP growth it is impossible to separate out globalisation from technology induced effects on factor prices. For expediency purposes Leamer (1996) assumes that all sectors have the same rate of technological pass through to product prices, namely $\hat{P} = -\lambda \hat{TFP}$ where λ is the pass-through rate. It is thus possible to separate out the globalisation impact

Eq 3.9: $\hat{P} + \lambda \hat{TFP} = \theta \hat{W}$

from the technology impact

Eq 3.10: $(1-\lambda)\hat{TFP} = \theta \hat{W}$.

For a small open economy $\lambda = 0$. The globalisation equation specifies how exogenous changes in product prices filter down to factor payments through the Stolper-Samuelson linkages. The technology relationship specifies how sector-biased technological change affects factor payments. It is also possible to include intermediate goods into the equations.[36]

There are a number of empirical applications of the globalisation relationship. The first are **consistency-check** analyses (Lawrence and Slaughter, 1993; Sachs and Shatz, 1994; Baldwin and Cain, 2000) that analyse whether the sector bias of price changes is consistent with changes in relative factor payments. These studies estimate

impact of second order effects for discrete changes in the variables.

[36] Eq 3.7 becomes [illegible] where ψ is a (N x N) matrix of intermediate input shares.

Eq 3.11: $$\hat{P}_j = \alpha + \beta \left(\frac{S}{LS} \right)_j^{initial\ year} + \varepsilon_j$$

where $(S/LS)_j^{initial\ year}$ is the employment ratio of skilled to less-skilled labour in industry j during the initial period. Sometimes the skill intensity ratio is calculated as the share of skilled labour in total employment. A negative estimated β reflects a bias in price increases towards less-skill-intensive sectors, which is consistent with declining relative wages of skilled labour. If $\beta > 0$ price increases are biased towards skill-intensive sectors, which is consistent with rising relative wages of skilled labour. Often weighted average price indices for skill and less-skill-intensive sectors are also constructed to complement the regression analysis.

The results are largely inconclusive and appear sensitive to the selection of price variable, industry and time period (Slaughter, 1998a). Lawrence and Slaughter (1993) find no association between relative price changes and labour intensities during the 1980s for US manufacturing sectors. In contrast, Sachs and Shatz (1994) and Krueger (1997) find that price increases in the US were biased towards skill-intensive sectors during the 1980s and early 1990s, which is consistent with rising wage inequality. However, the Sachs and Shatz (1994) result is only found when using domestic price data and is dependent on the exclusion of computers. The Krueger (1997) result is robust to the inclusion or exclusion of the computer dummy, but is sensitive to changes in the sample size (see Slaughter, 1998a).

Weighted average relative price trends also show no consistent bias towards skill or less-skill-intensive sectors. Lawrence and Slaughter (1993) and Baldwin and Cain (2000) find that the weighted average domestic price of skill-intensive sectors declined relative to less-skill-intensive sectors in the 1980s for US manufacturing. Bhagwati (1991) and Krugman and Lawrence (1993) find that the US terms of trade fell during the 1970s and 1980s, which is consistent with a decline in the relative price of skill-intensive traded goods. Similar trends in relative prices were obtained for Japan and Germany during the 1980s (Lawrence, 1994). According to the SS theorem, these price trends will have reduced wage inequality. In contrast, Wood (1997: 51) finds that the price of developing country manufactured exports fell relative to developed country exports of machinery, transport equipment and services between 1980 and 1995. Feenstra and Hanson (1995) also argue that the data of Lawrence and Slaughter (1993) and Lawrence (1994) show that the price of domestic products rose relative to imported products in the US, Germany and Japan. These price trends are consistent with their hypothesis that increased outsourcing of low-wage production processes raised wage inequality in these countries.

A problem with these consistency-check studies is that they do not give insight into how much product price changes may have contributed to actual factor price changes (Slaughter, 1998a). The studies by Lawrence and Slaughter (1993) and Sachs and Shatz (1994) also analyse the impact of product price changes on factor employment levels, which, Slaughter (1998a) argues, uncomfortably mixes the levels and changes versions of the SS theorem's zero-profit condition.

An alternative approach, initiated by Leamer (1996), is to estimate the zero-profit conditions (Eq 3.7) directly. Assuming a zero transfer of technological change onto product prices (the small country assumption) this entails the estimation of[37]

Eq 3.12: $\hat{P}_j = \sum \theta_{ij}\beta_i + \varepsilon_j.$

The approach here is to utilise information on price changes and factor shares to estimate 'mandated' changes in factor payments, β_i. These are changes in factor payments "*that are needed to keep the zero profits condition operative in the face of changes in technology and product prices*" (Leamer, 1996: 23). If the mandated wages conform with actual wages, then price changes have "*provided an accurate explanation of the trends in wages*" (23).

Leamer (1996) estimates mandated-wage equations for the US for three decades: the 1960s, 1970s, and 1980s. The results vary depending on his measurement of skills and the pass-through rates of technology onto prices. Overall he argues that the 1970s was the Stolper-Samuelson decade with product price changes causing increases in inequality. Baldwin and Cain (2000) estimate a similar

[37] There are various forms this equation can take. For example some studies (Leamer, 1996; Krueger, 1997) adjust the zero-profit condition to account for intermediate input requirements. There is also no consistency in the inclusion of exclusion of the constant term. Baldwin and Cain (2000) and Krueger (1997) include a constant, but Leamer (1996) does not.

countries (except Sweden). Finally, Greenaway *et al.* (1999) find that increases in imports and exports cause reductions in the level of derived labour demand in the UK, but that the strongest impact comes from trade with the EU and US rather than East Asia.

3.1.4 Discussion

The results of both the factor-content and price-effect studies are inconclusive. The factor-content studies suggest that trade flows have negatively affected the returns to less-skilled labour in developed countries, but marginally. Some debate remains as to the size of the downward bias arising from not accounting for noncompeting goods and trade-induced technological change. The results from the price-effect studies are inconclusive and are sensitive to the choice of prices, measurement of skills, weighting procedures and selection of industries (Slaughter, 1998a). Although many of these studies fail to link product price changes to exogenous shocks in the international market, the evidence suggests trade is not the primary source of rising wage inequality within developed economies. Changes in employment and wage inequality appear too large to be fully accounted for by trade and price patterns (Katz and Murphy, 1992; Sachs and Shatz, 1994). This conclusion is corroborated by rising employment of skilled labour within firms despite wage increases (Krugman and Lawrence, 1993; Slaughter, 1998a; Berman *et al.* 1994; Berman *et al.*, 1998). If trade were the cause of rising wage inequality then one would expect a decline in the skill intensity of production as firms substitute less-skilled for skilled labour. The failure of this to occur gives credence to the view that technological change lies behind rising wage inequality within developed (and developing) economies. The following section analyses this relationship in more detail.

3.2 Technology

Lawrence and Slaughter (1993) and Sachs and Shatz (1994) test for the influence of Hicks-neutral technological change by analysing whether the sector bias of TFP growth ($\hat{TFP}$), is consistent with the rising relative wage of skilled labour in the US. They estimate the following equation:

Eq 3.13: $$\hat{TFP}_j = \alpha + \beta\left(\frac{S}{LS}\right)_j^{\substack{initial\\year}} + \varepsilon_j$$

where an estimated $\beta > 0$ is consistent with rising wage inequality induced by Hicks-neutral technological change. However, a positive coefficient β is also consistent with skill-biased technological change concentrated in skill-intensive sectors. To solve the identification problem the suggested bias in factor payments needs to be analysed in conjunction with other variables such as the adoption of computers, R&D, changes in the skill intensity of production and the actual change in relative wages.

An alternative approach is to estimate factor returns mandated by TFP growth. This is the approach initiated by Leamer (1996) who estimates the function

Eq 3.14: $$(1-\lambda)\hat{TFP}_j = \sum \theta_{ij}\beta_i + \varepsilon_j .$$

If the estimated coefficient for skilled labour is significantly greater than the coefficient for less-skilled labour, then TFP growth has mandated a rise in wage inequality.

Lawrence and Slaughter (1993) and Sachs and Schatz (1994) find no significant sector bias in TFP growth in the US.[39] When using weighted average indices of TFP growth, Lawrence and Slaughter (1993) find that technical progress was concentrated in the skilled-labour-intensive industries, which is consistent with rising wage inequality during the 1980s. Leamer (1996), in contrast, finds that the sector bias of TFP growth mandated rising wage inequality during the 1970s and declining wage inequality during the 1980s. The results are inconsistent with each other. None of the studies analyse whether the sector bias of TFP growth is due to Hicks-neutral, trade-induced or skill-biased technological change.

Feenstra and Hanson (1997) and Haskel and Slaughter (2001) extend the Leamer (1996) approach and model TFP as a function of a number of structural variables (outsourcing, technology indicators, foreign prices, industry concentration

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[39] Sachs and Shatz (1994) argue that TFP growth was biased towards skill-intensive sectors between 196-78 and towards less-skill-intensive sectors between 1978-89. However, in neither case was the coefficient significantly different from zero.

indicators, union membership). They also allow for possible endogeneity of TFP growth and prices. They then estimate, via the impact on the sector-bias of TFP growth, the change in factor returns that is attributable to each structural variable. Feenstra and Hanson (1997) find that outsourcing (share of imported intermediate inputs in total costs) and expenditure on high-technology equipment and computers are important sources of increased wage inequality in the US. Haskel and Slaughter (2001) apply the approach to the UK and find that innovations and changes in unionisation mandated rising wage inequality during the 1980s. Changes in the gross-output price relative to import prices of newly industrialised countries mandated rising inequality during the 1970s, but not during the 1980s. These two studies provide strong support for the hypothesis that skill-biased technological change has raised wage inequality, but mixed support for the hypothesis that trade-induced TFP growth has raised wage inequality.

Berman *et al.* (1994) also argue that the rising skill intensity of production within all industries in the US is evidence of skill-biased technological change. Berman *et al.* (1994) and Berman *et al.* (1998) decompose the rise in share of skilled labour (non-production workers) in total employment into shifts in employment shares *between* industries and *within* each industry. Trade, by influencing the sectoral distribution of prices, causes changes in employment and output between sectors. Skill-biased technological change, in contrast, raises the skill intensity of production within all industries. Their results suggest that the within-industry effects dominate the between-industry effects in all periods and all OECD countries studied. For example, the within-industry shifts account for 70% and 82 % of the aggregate increase in the US and UK share of non-production workers in total employment during the 1980s, respectively (Berman *et al.*, 1998).

Further evidence in support of skill-biased technological change is provided by the close correlation between indicators of technological change and increased demand for skills. Krueger (1993) finds that workers who use computers on their job earn 10 % to 15 % higher wages. Between 1978 and 1990, US manufacturing sectors with high R&D expenditures as a proportion of sales reduced production workers relative to non-production workers (Sachs and Shatz, 1994: 26). Close within-sector correlations between indicators of technological change (the fraction of investment devoted to computers and R&D) and increased demand for skills have also been shown by Berman *et al.*, (1994), Haskel and Slaughter (1998) and Feenstra and Hanson (2001). For example, Feenstra and Hanson (1995a, 2001) estimate that investment in computers accounts for up to 30 % of the rising share of non-production workers in the US wage bill between 1979 and 1990. Similar relationships between R&D expenditure to value added and the skill intensity of production have been found within Denmark, France, Germany, Japan and Sweden (Machin and Van Reenen, 1997).

The rising skill intensity of production also appears pervasive across OECD members (Berman *et al.*, 1998; Machin and Van Reenen, 1997). Berman *et al.* (1998) show that the substitution towards skilled labour within industries occurred in all the ten developed countries that they studied in the 1970-90 period.[40] They also find that the shift towards increased use of non-production workers has largely occurred within the same industries in different countries. Further, the rising skill intensity of production is concentrated within four industries: machinery (including computers), electrical machinery, printing & publishing and transportation. All these industries underwent significant technological changes associated largely with the assimilation of microprocessors (Berman *et al.*, 1998).

These sectors are all relatively skill-intensive, which suggests that it is the sector bias of skill-biased technological change that is driving rising wage inequality and not *pervasive* skill-biased technological change in the sense used by Berman *et al.* (1998) (see Figure 3.5). The latter requires a relative decline in the price of less-skill-intensive products, which was not found earlier. Support for skill-biased technological change that is also sector biased is found by Haskel and Slaughter (1998). In a sample of 10 OECD countries[41] they find a strong correlation between changes in skill premia and the sectoral bias of skill-biased technological change during the 1970s and 1980s. For example, the adoption of computers is strongly biased towards skill-intensive sectors in the US and UK. The sector bias of skill-biased technological change also 'mandated' declining wage inequality in the US and UK during the 1970s and rising

[40] The countries are: US, UK, Luxembourg, Sweden, Australia, Japan, Denmark, Finland, Austria and Belgium.
[41] Australia, Austria, Denmark, Finland, Ireland, Japan, Portugal, Sweden, UK and US.

wage inequality during the 1980s. These results are consistent with the direction of actual factor price changes.

Relatively strong skill-biased technological change in skill-intensive sectors also contradicts Wood's (1994) hypothesis of 'defensive innovation'. For this hypothesis to be correct we would expect to see especially large increases in the skill intensity of production in sectors that have been affected by developing country trade (Sachs and Shatz, 1994). Alternatively, we would expect to see significant adoption of computers and/or increased R&D in these sectors. In both cases the opposite is found.

In conclusion, there is strong evidence to suggest that rising wage inequality in developed economies is positively associated with technological change. This is reflected in the close correlation between indicators of skill-biased technological change and the increased demand for skilled labour. More importantly, however, the bias of this technological change towards skill-intensive sectors appears to be driving much of the relationship (Feenstra and Hanson, 1997; Haskel and Slaughter, 1998; Haskel and Slaughter, 2001). This relationship is consistent with predictions made using the general equilibrium framework. In the following section, evidence from developing countries is presented.

3.3 Developing country results

According to the standard two-country HOS model, trade liberalisation should reduce wage inequality in developing countries. Empirical research on this relationship in developing countries is scarce, but is growing. However, as in the developed country case, the empirical evidence is at best mixed.

Krueger (1983) co-ordinated one of the first comprehensive studies which looked at trade and employment in 12 (initially 15) developing countries during the 1960s and 1970s.[42] Employing an empirical methodology similar to the factor-content approach, the study finds that exports from developing countries have higher labour coefficients than imports and that export sectors are less skill-intensive than import-

[42] The countries studied include: Argentina, Brazil, Chile, Hong Kong, Colombia, Indonesia, Pakistan, South

competing sectors. The implication drawn is that export-oriented policies encouraged through more open trade policies would benefit employment growth. However, this relationship is not analysed directly (Harrison and Hanson, 1999: 135). Further, their selection of non-competing import goods is based on individual researcher's judgements, which affects the estimated labour coefficients (Baldwin, 1995).

A similar multi-country study was completed by Michaely *et al.* (1991), who focus on liberalisation within 9 developing countries.[43] This study concludes that liberalisation did not give rise to substantial structural change, or the consequent transitional unemployment. Further, the perceived relationship between the creation of unemployment and trade liberalisation did not give rise to strong backlashes against the policy. In terms of factor payments, they find that in some countries income distribution improved during the course of liberalisation while in others it worsened.

Substantial variation in the relationship between trade and employment is also found in other individual country studies. Wood (1994) finds an inverse correlation between changes in income inequality and changes in the ratio of North-bound manufacturing exports for developing economies during the 1960s and 1970s. This is consistent with the view that the expansion of manufacturing exports reduces inequality. For example, in Taiwan, Korea, Hong Kong and Singapore, inequality declined during the first decade of their rapid export growth during the late 1960s and early 1970s (Wood, 1994). However, the evidence in Wood (1994, 1997) suggests that the decline in inequality ceased or even reversed during the 1980s.

Milner and Wright (1998) study Mauritius during the 1980s and find evidence of improved wages and employment in exportable sectors as resources were re-allocated from the importable sectors. However, they also find rising employment and wages in importable sectors which is inconsistent with the re-structuring hypothesis, but is consistent with the large increases in labour supply as women entered the labour market. Beyer *et al.* (1999) find that the skill premium rose in Chile between the early

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Korea, Taiwan, Thailand, Tunisia and Uruguay.

[43] The countries include: Argentina, Brazil, Chile, Korea, Peru, Philippines, Singapore, Sri Lanka and Turkey.

1970s and late 1980s in contrast to expectations for developing countries, but that declining relative prices of labour intensive goods are an important contributory factor. This is consistent with the Stolper-Samuelson theorem. They also find that openness (volume of trade/GDP) raises wage inequality, but the theoretical link between openness and wage inequality is ambiguous.[44]

Harrison and Hanson (1999) find that output and employment were not highly correlated with changes in quotas and tariffs for both Morocco and Mexico during the 1980s. Hanson and Harrison (1995) also perform a consistency-check analysis for Mexico and find no relationship between the sectoral distribution of manufacturing product price changes and relative wage changes. In contrast, Revenga (1997) finds that trade liberalisation in Mexico negatively affected manufacturing wages by reducing the demand for industry products and by reducing the rents available to be captured by firms and workers. A reduction in tariffs of 20 percentage points is estimated to reduce wages by 5 % to 6 %. In a specific study on Morocco, Currie and Harrison (1997) find that trade reform had no impact on employment for the majority of firms. A minor relationship was evident amongst the most highly affected industries where a 10 % reduction in tariffs was associated with a 1.6 % decline in employment. Rather than reducing employment many firms cut profit margins and raised productivity instead.

More problematic for the trade-wage relationship than the mixed results, is the rising wage inequality combined with increased employment of skilled labour in many developing countries. Robbins (1996) finds that wage inequality rose in many Latin American and East Asian countries during periods of trade liberalisation.[45] In Mexico the relative wage of skilled labour rose during the 1980s, a period of trade liberalisation (Hanson and Harrison, 1995, 1999). Berman *et al.* (1998) use United Nations data and find that a number of developing countries experienced an increase in the relative wages of non-production (skilled) workers in manufacturing between

[44] They argue that this may be due to increased exports of natural resource based products. There is no mention of the relative skill intensity of this sector.

[45] Robbins' (1996) study focuses on Argentina, Chile, Costa Rica, Colombia, Malaysia, Mexico, Philippines, Taiwan and Uruguay.

1980 and 1990.[46] Within Africa, Teal (2000) finds rising relative wages of skilled labour in Ghana between 1991 and 1995.

Wood (1997) argues that rising wage inequality within South American economies may be due to the entry of China and India into the world trading environment. However, using the earlier review of the developed countries, an alternative explanation could be skill-biased and trade-induced technological change. Berman and Machin (2000) find that the demand for skilled labour accelerated in a group of 18 middle-income countries in the 1980s. Further, in 15 of the 16 countries studied, the increased demand for skills is driven by within-sector shifts. There is also a close correlation between those sectors upgrading skills in the 1960s, 1970s and 1980s in OECD countries and those upgrading skills in middle-income countries during the 1990s. From Berman *et al.* (1998) these are the relatively skill-intensive sectors, suggesting that skill-biased technological change concentrated in skill-intensive sectors is driving increased wage inequality in many middle-income countries.

There is also some evidence of trade-induced technological change that is skill biased. Robbins (1996) finds that imported capital stock/GDP is positively correlated with rising relative labour demand in his sample of countries. The trade variables are not significant. In firm level relative labour demand and wage regressions for Mexico, Hanson and Harrison (1995) find that the share of equipment in investment and the imported share of total machinery purchases are negatively related to skill intensity, which they argue is evidence *against* skill-biased technological change. However, in a subsequent study on Mexico, Harrison and Hanson (1999) find royalty payments, the imported share of total machinery purchases and the imported share of total materials purchases are positively related to the employment of skilled labour. In their wage equations only royalty payments are positively related to the relative wage of skilled labour. The variance in results across regressions suggests that these relationships are not robust. Finally, Görg and Strobl (2001) find a positive relationship between the use of imported raw materials and machinery and the skill intensity of production in Ghana.

[46] These countries include: Fiji, Hungary, Bangladesh, Poland, Bulgaria, Malta, Cyprus and Uruguay.

As in the developed country analysis, there is no conclusive evidence for or against trade liberalisation driving changes in wage inequality within developing economies. Technology appears to have played an important role in raising wage inequality within many developing countries since the 1980s, but the relationship between the sector bias of technological change and wage inequality has not been adequately studied. The diversity in results across countries, suggest that country-specific factors such as labour market institutions, market concentration, natural resource endowments, regional location, etc. also play an important role in the adjustment of the economy to international trade shocks.

4. Conclusion

This chapter uses a general equilibrium framework to analyse the theoretical relationship between trade, technology and factor incomes in a small open economy. The standard model used for this purpose is the two-sector two-factor two-country Heckscher-Ohlin-Samuelson model. However, this model faces a number of shortcomings. Firstly, the model exaggerates the impact on factor incomes arising from changes in relative product prices. A reduction in protection on non-competing products has no affect on relative wages, but raises real wages as imported prices fall. Further, in response to lower product prices within less-skill-intensive sectors, firms shift production towards more skill-intensive products, i.e. they move up the ladder of comparative advantage. In doing, so the economy insulates itself from competition from low wage countries and the impact on wage inequality is moderated.

A second problem associated with the standard HOS model is that is fails to adequately account for the impact of trade liberalisation on middle- income countries such as South Africa. Trade liberalisation can either increase or decrease wage inequality depending on the country's local or global factor abundance. While the model is easily adapted to account for these effects (see Davis, 1996), it becomes difficult to apply empirically. This implies that trade liberalisation in South Africa may have ambiguous outcomes on factor returns.

The chapter also uses the HOS model to analyse the general equilibrium impact of technological change on factors. A strong result that emerges from the analysis is that the sector bias and not the factor bias of technological change drives changes in wage inequality. In a general equilibrium framework skill-biased technological change does not necessarily raise wage inequality. If skill-biased technological change is concentrated within less-skill-intensive sectors, wage inequality may decline.

This has important repercussions for the view that defensive innovation exacerbates rising wage inequality within developed economies (as in Wood, 1994). The adoption of more productive skill-biased technology within less-skill-intensive sectors in response to lower prices, raises competitiveness within these sectors and thus moderates the negative impact of trade liberalisation on wage inequality. Similarly, within developing economies, the adoption of skill-biased technology induced by increased openness can reduce wage inequality if it improves the competitiveness (and profitability) of the traditional less-skill-intensive export sectors.

This chapter also presents a brief overview of the international empirical literature. Of the two approaches generally used to analyse the impact of trade on labour, the price-effect studies are theoretically more sound. However, the factor-content studies in general support the outcomes of the price-effect studies (Slaughter, 1998b). Factor-content studies are also useful when price data is poor (Wood, 1995: 7). Therefore, empirical analyses using both approaches are generally complementary.

The overview finds that the relationship between product price changes and wage inequality within developed and developing economies is ambiguous. Part of this relates to the sensitivity of the estimations to the choice of prices, measurement of skills, weighting procedures and selection of industries (Slaughter, 1998a). A more severe criticism of the estimations is that they ignore other effects such as demand shifts, institutional changes, labour market institutions and labour supply that may influence sector prices. "*Finding relative price declines in sectors that intensively use less-skilled labor may be necessary to establish a trade effect that works through prices, but it is not sufficient to establish a trade effect in a world where many forces influence relative prices*" (Freeman, 1995: 29). A more rigorous analysis of the relationship between trade and labour requires specific reference to the exogenous shock that gives rise to changes in international trade flows and product prices that are endogenous outcomes of the international market (see Slaughter, 1998a: 4). Unless this is done it becomes very difficult to separate out trade related influences from various other consistent explanations for factor price changes.

This criticism pertains to the analysis of the impact of skill-biased technological change on factor payments. Although widespread evidence of large within-sector shifts towards skilled labour is consistent with the effect of skill-biased technological change, it is not necessarily consistent with rising wage inequality. Within a general equilibrium framework wage inequality will rise if technological change is concentrated in skill-intensive sectors. Greater focus on the sector bias of technological change as well as the sources of this technological change is required. This approach has been pursued by Feenstra and Hanson (1997), Haskel and Slaughter (1998), Haskel and Slaughter (2001), but can be extended to developing countries.

In the remainder of the thesis, some of these insights are incorporated into the empirical analysis of the relationship between trade liberalisation and labour in South Africa. Chapter 4 applies the price-effect methodology to South African data, but explicitly uses tariff data to draw a clearer link between trade liberalisation and factor returns than is evident in many international and domestic studies. Chapter 5 and Chapter 6 use a decomposition technique to separate the impact of trade on production and employment from other factors such as domestic demand and technological change. As shown in the empirical review, the impact of trade on employment is often small relative to these other factors. The impact of technological change on labour is also analysed in Chapter 4 and Chapter 8. The latter chapter is a firm level analysis that involves a partial equilibrium assessment of the impact of trade and technology on employment. Finally, Chapter 7 uses a Ricardian based model to analyse the impact of wages and labour productivity on export performance.

Chapter 4

Technology, Prices and Factor Returns in South Africa: Insights from the Heckscher-Ohlin-Samuelson Model

1. Introduction

General equilibrium trade models, such as the Heckscher-Ohlin-Samuelson (HOS) model, are the preferred analytical frameworks used by trade economists to assess the impact of trade related changes on the domestic economy. In this chapter the general equilibrium linkages between output prices, technology and factor returns, as implied by the HOS model, are analysed in the context of South Africa. The empirical methodology closely follows those of the price-effect studies by Lawrence and Slaughter (1993) and Leamer (1996) reviewed in Chapter 3.

The objective is to establish the extent to which **trade liberalisation** and **technological change** have contributed towards the decline in employment of labour, particularly less-skilled labour, in South Africa. Although the zero-profit conditions relate prices and technology to factor returns, not employment, the sector-biases of price and technology changes can be used to *infer* the direction of the impact on employment.

The analysis and results of this chapter are *strictly* guided by insights obtained from the Heckscher-Ohlin-Samuelson model and do not take into account other possible explanations of changes in employment or factor returns. As a result, the conclusions may reflect some of the assumptions (such as full employment) associated with the HOS model. Subsequent chapters of this thesis therefore utilise alternative methodologies in an attempt to complement the insights derived in this chapter.

The structure of this chapter is as follows. Section 2 presents a critical analysis of earlier empirical literature on the impact of trade liberalisation and technological change on employment in South Africa. Insights from this analysis feed into Section 3 and 4 where the factor market impact of changes in prices and technology, respectively, are estimated using various data and empirical methodologies. Section 5 concludes the chapter.

2. Trade, technology and employment in South Africa: Empirical evidence from earlier studies

This section consists of two sub-sections. Section 2.1 presents a critical review of earlier South African empirical research analysing the impact of trade liberalisation and international price movements on factor returns. Section 2.2 reviews the literature analysing the impact of technological change on factor returns in South Africa.

2.1 Price-effect studies

As seen in Chapter 3, price-effect studies are based on the link between product prices and factor prices imposed by the "zero profit condition". This condition equates price with average cost that must hold in all perfectly competitive industries (Slaughter, 1998: 3) (see Eq 3.6 in Chapter 3). Shifts in output prices arising from changes in political trade barriers, natural trade barriers (information and transportation costs), foreign tastes, technology and/or endowments, affect factor prices in accordance with the Stolper-Samuelson linkages.

Price-effect studies are scarce in South Africa. Hayter *et al.* (1999) find that the relative price of capital-intensive products rose after 1994. They argue that this is consistent with the rising capital intensity of exports experienced during the 1990s, but do not formally estimate the impact on employment or trade patterns. Browne (1999) follows Revenga (1997) and estimates wage and employment equations for the clothing and textile sectors in South Africa for the period 1974-93. His results are generally poor, but he finds a positive correlation between employment and import prices in the clothing sector. The fall in the import price of clothing during the 1990s may explain the significant decline in employment during this period. However, he finds that wages are negatively related to import price changes, which is inconsistent with the Stolper-Samuelson theorem as labour is the abundant factor in these sectors.

Further, the wage data for the clothing sector presented in his paper shows a significant rise during the late 1980s and early 1990s, suggesting that real wage increases, and not falling import prices, are the dominant cause of the decline in employment. No consistent relationships between import prices, employment and wages are found in the textile sector.

The most extensive research in this area is that of Fedderke *et al.* (1999) who follow Leamer (1996) and estimate wage changes mandated by product price changes. They combine observations on 28 three-digit Standard Industrial Classification (SIC) sectors over the period 1970-97 and use dynamic heterogeneous panel data techniques to obtain the long-run relationship.[47] They also estimate the long-run relationship between price changes and the capital or skill intensity of production to determine the sector bias in price changes, i.e. a consistency-check analysis. Relatively large price increases in skill-intensive sectors would be consistent with the view that trade has positively benefited skilled labour.

In their 'consistency-check' analysis they find a negative long-run coefficient for the ratio of skilled to less-skilled labour. They also find a negative long-run relationship between price changes and the capital-labour ratio. This they argue is evidence that "*trade liberalization has had the effect of strengthening the demand for labor relative to capital in South Africa via the price effect*" (Fedderke *et al.*, 1999: 14). According to this argument, trade liberalisation will have reduced wage inequality and/or increased employment.

These conclusions are also inferred from their estimates of the mandated-wage equations. In their estimates with zero technology pass-through, they find that output price changes 'mandated' rising returns to both labour and capital. The magnitude of the former exceeds the latter, which is consistent with the Stolper-Samuelson theorem as applied to trade liberalisation in developing countries. However, given the standard errors presented in the tables, the labour share coefficients do not appear to be significantly greater than the capital share in any of the three estimators. They also

[47] Fedderke *et al.* (1999) use dynamic fixed effects, mean group and pooled mean group estimators to estimate the relevant coefficients.

find that technology mandated relatively large declines in earnings for both factors. The net effect of trade and technology is a mandated decline in earnings for labour and capital. Given real wage increases over the 1972-97 period, they conclude that "*... the evidence suggests that an important possible source of the persistent and high levels of unemployment in South Africa's labor markets may well lie with relative factor prices*" (19).

Their conclusion that **trade liberalisation** stimulated the demand for labour in South Africa is tenuous. Factor returns are affected by price changes irrespective of whether they are trade-induced. Fedderke *et al.* (1999) estimate their consistency-check and mandated-wage equations using product prices (value added deflator) and not trade prices. The link between changes in tariffs and domestic price changes is not shown directly, but assumed on the basis that that (a) South Africa is a developing country, and (b) that South Africa is a small price taking country with competitive markets. Under these assumptions the results are possibly consistent with the view that trade liberalisation has positively affected labour.

The problems with these assumptions are extensive. Firstly, the small price taking country with competitive markets does not hold in cases where quantitative restrictions, as used extensively prior to the 1990s, preserve the market power of monopolistic firms. If markets are imperfect, rents accrue to capital or labour depending on their market power and prices may not necessarily follow international price movements. The mandated factor returns, as shown by Fedderke *et al.* (1999), may reflect changes in monopolistic power since 1970 rather than the impact of international trade.

Secondly, the assumption that South Africa is a developing country that is relatively well endowed with less-skilled labour is questionable. South Africa is more similar to Latin American countries where trade liberalisation in the 1980s was associated with rising skill premiums (Robbins, 1996). As seen in Chapter 3, the impact of trade liberalisation on middle-income countries is ambiguous. For example, Wood (1997) argues that the rising skill premium in Latin America may be due to their skill abundance relative to the less-skilled labour abundant countries such as India and China that have entered into the world market.

Further, even if South Africa were classified as a developing country, world prices (and thus domestic prices) have not necessarily shifted in favour of less-skilled labour. For example, Wood (1997: 57) shows a dramatic decline (25 %) in the price of developing country exports relative to developed country exports between 1980 and 1995). This will have raised wage inequality in developing countries. Bell *et al.* (1999) also note that the world price of natural resource intensive products rose relative to more downstream non-commodity manufacturing products during the 1970s, but fell from the mid-1980s. According to Bell *et al.* (1999), these shifts in relative prices explain why the share of non-commodity products in total South African manufacturing exports fell during the 1970s and rose from the mid-1980s. If factor intensities differ across these sectors, then, according to the Stolper-Samuelson theorem, relative factor payments will also have changed. The implicit assumption by Fedderke *et al.* (1999) that the relative price of less-skill-intensive products rose continuously from the 1970s appears flawed.

More importantly, the long-run impact of openness or trade on factor returns is not necessarily the same as the impact on factor returns arising from trade liberalisation. The reduction of barriers to trade can give rise to relative price changes that are distinct from the long-run trends in international prices. If the impact of trade liberalisation on factor returns is to be estimated, then price changes due to tariff or quota reductions ought to be used directly. This point is frequently not recognised in domestic and international empirical research. As Slaughter (1998a: 3) notes:

> "*... more work needs to link the various exogenous forces attributable to international trade to actual product-price changes*"

Problems also arise in the interpretation of the long-run relationship between relative factor intensities and product price changes estimated in the consistency-check and mandated-wage regressions of Fedderke *et al.* (1999). In the consistency-check regressions, the objective is to determine the sector-bias of product price changes (through a simple correlation) and then infer whether the bias is consistent with changes in relative factor returns during the relevant period (see Eq 3.11). The objective is not to estimate the extent to which factor ratios 'explain' price changes. However, the estimated long-run coefficients in Fedderke *et al.* (1999), and in particular the adjustment coefficient (the error correction coefficient), imply feedback from factor intensities to product price changes such that deviations from the long-run relationship are eliminated over time. Feedback of this sort is theoretically inconsistent with the Stolper-Samuelson theorem as applied to a small price taking country.

Similarly, in mandated-wage regressions, the exogenous variable (price) is the regressand while the dependent variable (factor price changes) is estimated. Thus, the mandated-wage regressions "... *can be interpreted as an accounting exercise rather than one identifying causation in the way regressions are usually presumed to*" (Slaughter, 1998a: 25). The long-run relationships estimated by Fedderke *et al.* (1999), however, imply causation with the adjustment term representing feedback from factor shares to product prices.[48]

The implication is that existing price-effect studies show **no conclusive relationship** between trade liberalisation and employment or wages. Further, the studies fail to adequately interrogate the Stolper-Samuelson linkages during the various sub-periods of the trade liberalisation process. In Section 3 of this chapter, an attempt is made to extend the earlier price-effect studies by:

(a) using prices that explicitly reflect international price movements and trade liberalisation, and
(b) interrogating the Stolper-Samuelson linkages during the various sub-periods of 1988-2000.

However, prior to this analysis, the following sub-section presents a review of South African empirical research on the impact of technological change on labour.

[48] There also appear to be major errors in the interpretation of the results. For example, in the pooled mean group (PMG) estimates they find that value added prices mandate returns to labour and capital of 0.33 and 0.18, respectively. Given a mean dependent variable of 0.12 they argue that the mandated real annual return to labour and capital is 0.21% and 0.18 %. However, average inflation between 1972-97 was 12 %, which suggests that these results imply a mandated real annual return to labour and capital is 21 % and 18 %, respectively. These values are infeasible.

2.2 *Technological change studies*

An alternative explanation for the rising skill intensity of production is technological change. Evidence in support of this is provided by the decomposition studies of Bowles (1995), Bhorat and Hodge (1999) and Edwards (2002b). These studies decompose changes in the economy-wide average skill or capital intensity of production into *between-* and *within-sector* employment shifts and are thus similar to the studies of Berman *et al.* (1994) and Berman *et al.* (1998) discussed in Chapter 3.

Bowles (1995) deconstructs growth in capital-intensity between 1976 and 1992 into sectoral shifts and technological change (within-sector shifts) and finds that the latter effect dominates.[49] His results suggest that within-sector shifts account for 70 % of the rise in the economy-wide average capital intensity of production. Similarly, Bhorat and Hodge (1999) find that within-sector shifts in the occupational structure of employment explain most of the rising skill intensity of employment in manufacturing and services between 1975 and 1995.

Edwards (2002b) extends these studies and decomposes the within-sector shifts into changes arising from increased employment of skilled labour and reductions in less-skilled labour. These results for the entire economy (48 economic sectors) and manufacturing (28 sectors) are replicated in Table 4.1. The formulae are presented in Appendix 2.

As Table 4.1 shows, the results are consistent with Bhorat and Hodge (1999) and show that the rising skill intensity of production is increasingly being driven by changes in employment patterns within sectors. The impact of the within-sector component is particularly strong in manufacturing where it accounts for over 80 % of the rise in the average skill intensity of employment in manufacturing for all periods. When agriculture, mining, and services are included with manufacturing, the between-sector share rises to 40 %. This reflects structural changes in production

[49] Bowles (1995) really decomposes the change in employment into capital accumulation, within-sector changes in capital intensity and between-sector changes in the distribution of capital. This is easily reconfigured such that the change in capital intensity of production is decomposed into the within and between-sector effects.

away from the less-skill-intensive mining and agriculture sectors towards the manufacturing and services sectors. This trend is analysed in more detail in Chapter 5.

Table 4.1: Within- and between-sector shifts in the skill intensity of employment in South Africa (%)

	1970-80	1980-90	1990-94	1994-98
Entire economy (48 sectors)				
Within-sector effects	*41*	*54*	*55*	*58*
due to Δskilled labour	107	85	34	41
due to Δless-skilled labour	-66	-31	20	17
Between-sector effects	*59*	*46*	*45*	*42*
Total	100	100	100	100
Ave annual growth skill intensity	3	3	3	2
Manufacturing (28 sectors)				
Within-sector effects	*90*	*95*	*83*	*101*
due to Δskilled labour	165	103	36	52
due to Δless-skilled labour	-74	-8	47	49
Between-sector effects	*10*	*5*	*17*	*-1*
Total	100	100	100	100
Ave annual growth skill intensity	3	4	4	3

Note: Data are obtained from the Trade and Industrial Policy Strategies' (TIPS) South African Standardised Industry Database (SASID, 2002). The entire economy consists of 48 sectors and manufacturing of 28 sectors.

Changes in employment of less-skilled labour are an important component of the within-sector shifts. During the 1970s and 1980s rising employment of less-skilled labour reduced the skill intensity of production. This is shown in the negative values in the less-skilled labour rows of Table 4.1. In contrast, 47 % to 49 % of the rise in the aggregate skill intensity of production within manufacturing during the 1990s was due to a decline in employment of less-skilled labour. Increased employment of skilled labour contributed between 36 % and 52 % of the rising skill intensity of manufacturing during this period.

Overall the results are consistent with international studies of developing countries that also find strong within-sector shifts in the composition of employment within manufacturing (Hanson and Harrison, 1995; Berman and Machin, 2000). As found in Berman and Machin (2000), the rise in aggregate skill intensity of production accelerated during the 1980s (from 3 % to 4 % per annum). The similarity in trends in South Africa compared to other middle and high-income countries is consistent with the impact of skill-biased technological change. In contrast, the sectoral shifts in employment appear inconsistent with the hypothesis that trade liberalisation has negatively affected less-skilled labour. Since 1994, a period of accelerated tariff liberalisation, sectoral changes in employment shifted in favour of less-skilled labour.

While Bhorat and Hodge (1999) and Edwards (2002b) suggest that skill-biased technological change is the primary factor influencing employment in South Africa, their results are not conclusive. These studies are based on aggregated data, which implicitly assumes that all firms within the aggregated sectors are homogeneous. As a result, intra-sectoral shifts in production towards more skill-intensive products in response to international competition can be erroneously interpreted as skill-biased technological change. For example Bernard and Jensen (1997) find larger between-sector shifts in the skill composition of employment for the US in the 1980s when using plant level data (45 %) than industry level data (34 %). In contrast, Harrison and Hanson (1995) find that within-sector shifts account for over 80 % of the rise in the skilled wage share in Mexico using both firm and sector level data. Detailed analysis at the firm level may provide further insights into the relationships between technological change and employment in South Africa.

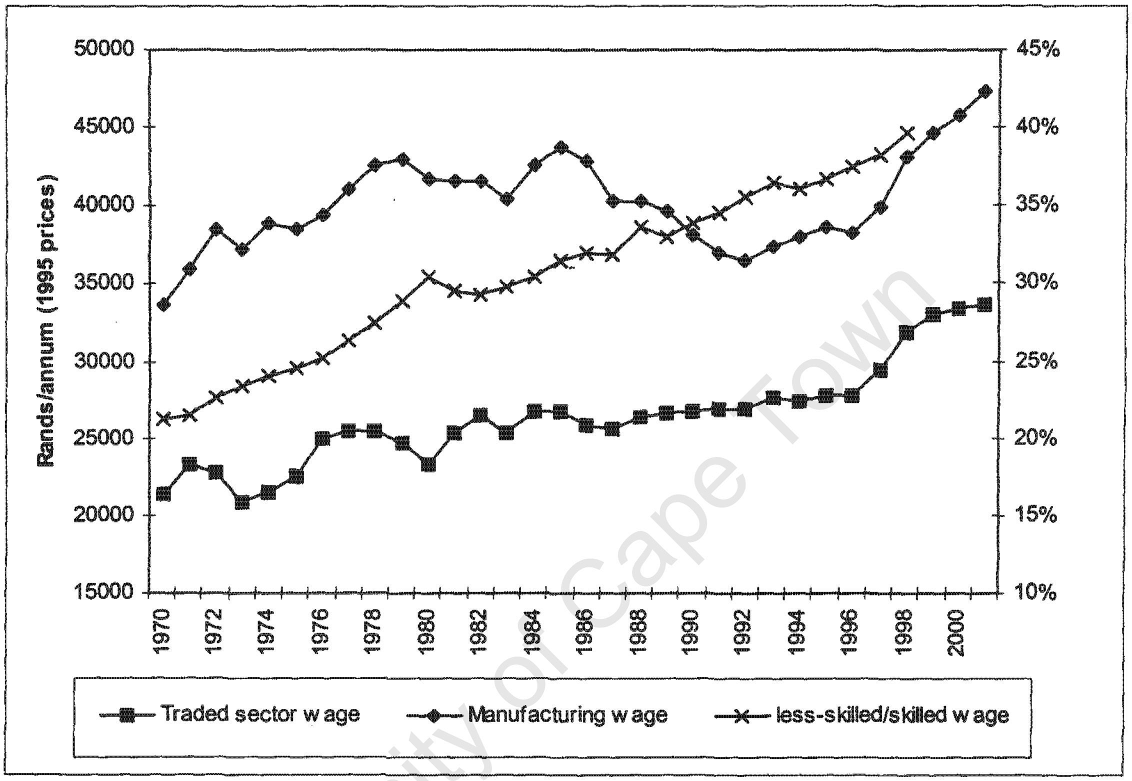
These studies also do not relate changes in the skill composition of employment to changes in the use of skill-biased technology. Bhorat and Hodge (1999) argue that the rising skill intensity of production in manufacturing and services is related to the large capital investments in information technology products since the 1970s. Hodge and Miller (1996) find a high rate of adoption of information technology (IT) as well as increased IT penetration into lower levels of company organisation during the 1990s, which is consistent with skill-biased technological change. However, none of these studies estimate the relationship between the adoption of the new technology and changes in the composition of employment.

More importantly, the decomposition studies ignore the general equilibrium effects of skill-biased technological change on factor returns. As seen in Chapter 3, in a general equilibrium model the sector bias of technological change determines the effect on relative factor payments. Fedderke *et al.* (1999) use the more appropriate general equilibrium framework of the HOS model to estimate the 'technology' relationship identified by Leamer (1996), $(1-\lambda)T\hat{F}P_j = \sum \theta_{ij}\beta_i + \varepsilon_j$, under the assumption of zero pass-through ($\lambda = 0$). They find that the impact of TFP growth on mandated factor earnings is negative for both capital and labour, which reflects the very poor productivity growth between 1972 and 1997. The negative impact on capital is stronger than it is on labour, but the difference does not appear to be significant. This suggests that, on average, TFP growth between 1992 and 1997 has not been characterised by any sustained sector bias. What is not clear from their analysis is whether the impact of technology on labour and capital has differed in the various phases of the economic and political development of South Africa. For example, their analysis provides no insight into the extent to which the shedding of unskilled labour during the 1990s is due to technological change.

A further problem with the importance ascribed to the impact of technological change on employment is that the relative wage of skilled labour has not risen, as it has in other middle-income countries experiencing skill-biased technological change (Berman and Machin, 2000). As shown in Figure 4.1, relative wages of less-skilled to skilled labour rose from 0.21 in 1970 to 0.40 in 1998 for the total economy excluding agriculture, government domestic servants.[50] The trend within manufacturing is similar. Alternative data in Du Toit and Moolman (2003) also show rising relative wages of less-skilled labour over this period. The significant within-sector shifts towards more skill-intensive production techniques discussed earlier may reflect factor substitution responses and the adoption of skill-biased technology to the rising relative wage of less-skilled labour. The substantial decline in less-skilled employment during the 1990s is consistent with this view.

[50] Edwards and Abdi (2002) compare the wage data for skilled and less-skilled labour used in this analysis with alternative data obtained from the national censuses and the October Household Surveys. They find no unambiguous trend in relative wages during the late 1990s.

Figure 4.1: Real manufacturing wages and the relative wage of less-skilled to skilled labour



Source: Manufacturing wage data is obtained from SASID (2003). Quantech produced the wage data used to construct the relative wage variables. These estimates are based on census data and the October Household Surveys.

Notes: Traded sectors consist of manufacturing, agriculture and mining. Manufacturing wages per worker are calculated by dividing the total wages & salaries by number of workers.

The relative wages are for the total economy excluding government, agriculture and domestic servants. Skilled labour consists of (a) Professional, semi-professional and technical occupations, (b) Managerial, executive and administrative occupations and (c) certain transport occupations e.g. pilot, navigator. Less-skilled labour includes all the remainder.

A problem with all these studies is they assume that technological change is unrelated to trade liberalisation and foreign competition and do not account for the possibility of 'defensive innovation' or 'skill-enhancing-trade' (see Chapter 3). There is growing evidence of a link between trade and technology within South Africa. Belli *et al.* (1993) and Fallon and Pereira de Silva (1994) find a correlation between export growth in South Africa and Total Factor Productivity growth. Hayter *et al.* (1999) note 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 negatively related to tariff protection. Finally, Birdi *et al.* (2001)

argue that import penetration between 1993 and 1997 induced improvements in the efficiency of labour. They, however, find no clear skill bias associated with the improvement in labour efficiency.[51]

The extent to which technological change in South Africa is being driven by skill-biased technological change (as argued by Berman *et al.*, 1998), sector-biased technological change or trade-induced technological change (Wood, 1994; Pissarides, 1997) is thus unclear. It is likely that all these factors play a role, but the relative impact of each of these has not been determined.

To conclude, this section critically evaluates earlier empirical research on the impact of technological change on the skill composition of employment and relative wages in South Africa. As in the price effect studies, no conclusive link has been shown between technological change and the changing skill composition of employment or wages. Substantial within-sector shifts in employment are *suggestive* of skill-biased technological change, but the aggregated nature of the data precludes a definitive conclusion. Further, domestic evidence has not taken into account the possibly varied impacts of the various forms of technological change (skill-biased, trade-induced, sector-biased). In particular, the possible relationship between trade liberalisation and technological change has not been fully explored. Finally, the impact of technological change on labour during the 1990s, a period of accelerated decline in employment of unskilled labour, has not been adequately covered.

Section 4 of this chapter attempts to deal with some of these shortcomings. The Leamer (1996) methodology is used to assess the impact of sector biased TFP growth on factor returns, particularly during the 1990s. This provides some insight into how sector-biased technological change has affected the relative returns of capital and labour, and of skilled and unskilled labour. In Chapter 8, a more detailed interrogation of the impact of technological change, including trade-induced technological change, on employment at the firm level is presented.

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

In the following section, a price-effect approach is used to further explore the impact of trade liberalisation on labour. In Section 4, the technology relationship is explored.

3. Further analysis of Stolper-Samuelson effects in South Africa

Section 2.1 identified a number of shortcomings in earlier applications of the Stolper-Samuelson theorem in the South African context. In this section, this research is extended by focussing on the sensitivity of the Stolper-Samuelson relationship to the choice of prices, the period of analysis and the sample of industries. In particular, this section focuses on the relationship between price changes due to tariff liberalisation and the labour market. In doing so, the effect of tariff liberalisation on labour is estimated directly.

The analysis is conducted using data at three levels of industry aggregation. In the first, 3-digit Standard Industrial Classification (SIC) data covering 28 sectors in agriculture, mining and manufacturing are obtained from the Trade and Industrial Policy Strategies' South African Standardised Industrial Database (SASID, 2003).[52] Secondly, SIC 4-digit data (80 agriculture, mining and manufacturing sectors) are obtained from the 1993 Supply-Use table constructed by Statistics South Africa (SSA, 1999b). The final source of data is the 1998 manufacturing firm survey conducted by the World Bank and the Greater Johannesburg Metropolitan Council. This survey consists of 325 large (50 or more employees) firms sampled from the Greater Johannesburg Metropolitan Area.

The services sectors are excluded in all cases as focussing on tradable industries is more appropriate when investigating changes in factor returns attributable to international trade (Slaughter, 1998a: 26). Tariff data and international price data are also not readily available for the services sectors. To assess whether the impact of trade liberalisation on labour differs during the 1990s, the analysis is completed for three periods: the early 1990s (1988-92), the mid-1990s (roughly 1992-97) and the late-1990s (1997-2000). Finally, the analysis is completed by assessing

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

the sensitivity of the estimations to the choice of price variable by making use of various prices (output, export and import), in addition to price changes arising from trade liberalisation.

3.1 *Empirical methodology*

Drawing on international literature, two approaches are used to assess the impact of price changes on factor returns. Firstly, following the consistency-check approach, product price changes are regressed on various factor ratios, i.e. the function

Eq 4.1: $$\hat{P}_j = \alpha + \beta(FR)_j^{\substack{initial \\ year}} + \varepsilon_j$$

is estimated, where $\hat{P}_j$ is the annualised change in prices and $(FR)_j^{initial\ year}$ is either the initial period share of skilled labour in total employment (*S/(S+LS)*), the ratio of labour to capital (*L/K*) or the wage bill in total factor remuneration in industry *j*. The latter is a tighter application of the Stolper-Samuelson theorem which relates price changes to factor cost shares as opposed to factor-employment levels (Slaughter, 1998a). In the *S/(S+LS)* case, a positive coefficient for β reflects relatively strong price increases in skill-intensive sectors, which is consistent with declining relative wages of less-skilled labour. Under downward wage rigidity this would lead to decline in employment of less-skilled labour, a trend evident in the South African labour market. A negative coefficient in the (*L/K*) case is consistent with declining relative returns to labour.

In the second approach, Leamer's (1996) mandated-wage regressions are estimated. Imposing the small country assumption of zero pass-through of technological change to product prices (see Section 3 in Chapter 3), the function

Eq 4.2: $$\hat{P}_j = \delta_M\theta_{Mj} + \delta_L\theta_{Lj} + \delta_K\theta_{Kj} + \eta_j.$$

is estimated, where θ_{Mj} ,θ_{Lj} and θ_{Kj} are, respectively, the initial shares of materials (intermediate goods), labour and capital in the average cost of producing one unit of

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level.

product j. This regression is estimated using the SIC 3-digit and firm level data where it is not possible to deduct intermediate good price changes from product price changes to give the change in value added. The coefficient on the cost share of materials in effect provides the weighted price change of intermediate goods that is consistent with the zero-profit condition.[53] As the shares add up to 100 %, the regression has to be estimated without an intercept term.

Because the SIC 4-digit data are obtained from a detailed Supply-Use table, intermediate good price changes can be deducted from product price changes. In this case the function

Eq 4.3: $$\hat{P}_j - \sum_{i=1}^{N} a_{ij} \hat{P}_j = \delta_L \theta_{Lj} + \delta_K \theta_{Kj} + \eta_j$$

is estimated, where a_{ij} is the number of units of intermediate inputs i required to produce one unit of product j.

In all regressions price changes mandate rising returns to labour relative to capital if $\delta_L > \delta_K$. In the firm survey it is also possible to estimate mandated-wage regressions for production (less-skilled) and non-production (skilled) workers. This advances the work of Fedderke *et al.* (1999) who only estimate mandated returns to labour and capital. Note that in all mandated-wage regressions it is assumed that the product mix does not change during the period under analysis, i.e. the country does not shift into a new cone of diversification (Haskel and Slaughter, 2001). Evidence presented in Chapter 5 suggests that this assumption may not hold as there have been substantial changes in the composition of exports and imports during the 1990s.

3.2 Data

Table 4.2 presents variable names and the processes followed in constructing the factor ratios and cost shares for each database. The relative skill ratio, (*S/(S+LS)*), used in the consistency-check regression is measured as the share professional &

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[53] The inclusion of intermediate goods differs from Fedderke *et al.* (1999) where ℓ_j and k_j are measured as the share of labour and capital in value added, respectively. Although, to avoid the dummy-variable trap, they use net operating surplus rather than gross operating surplus.

managerial labour in total employment. The labour-capital ratio is calculated as the share labour remuneration in total factor payments when using the SIC 3-digit and 4-digit data, and the ratio of total employment to replacement capital in the firm survey. In all regressions using the firm survey, the factor ratios and cost shares are for the year 1998. In all other cases, the values are for the initial year of the period under analysis.

Table 4.2: Independent variable names and descriptions

Independent variables	Description
Consistency-check regressions	
SIC 3-digit data	
Skill ratio ($\beta_{S,LS}$)	(professional & managerial employment)/(total employment)
L/K ratio ($\beta_{L,K}$)	(wage bill)/(wage bill + gross operating surplus(GOS))
Supply-Use data (SIC 4-digit)	
L/K ratio ($\beta_{L,K}$)	(wage bill)/(wage bill + GOS)
Firm level	
Skill ratio ($\beta_{S,LS}$)	(professional, managerial and skilled technical employment)/(total employment)
L/K ratio ($\beta_{L,K}$)	(total employment)/(value replacement capital)
Mandated-wage regressions	
SIC 3-digit data	
L-share (δ_L)	(wage bill)/(wage bill + GOS + intermediate costs) measured in 1995 prices
K- share (δ_K)	(GOS)/(wage bill + GOS + intermediate costs) measured in 1995 prices
M-share (δ_M)	1 - δ_L - δ_K; i.e. derived as a residual
Supply-Use data (SIC 4-digit)	
L-share (δ_L)	wage bill)/(wage bill + GOS + intermediate costs)
K- share (δ_K)	(GOS)/(wage bill + GOS + intermediate costs)
Firm level	
L-share (δ_L)	(wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)
K- share (δ_K)	(0.1*replacement capital)/(wage bill + 0.1*replacement capital + material costs + utility costs)
M-share (δ_M)	1 - δ_L - δ_K; i.e. derived as a residual
LS-share (δ_{LS})	(production worker wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)
S-share (δ_S)	(non-production worker wage bill)/(wage bill + 0.1*replacement capital + material costs + utility costs)

The SIC 3-digit and the SIC 4-digit databases contain information on the value of output, labour remuneration and gross operating surplus (return to capital). The factor cost shares used in the mandated-factor-return regressions are calculated as the share of factor payments in the total value of output.

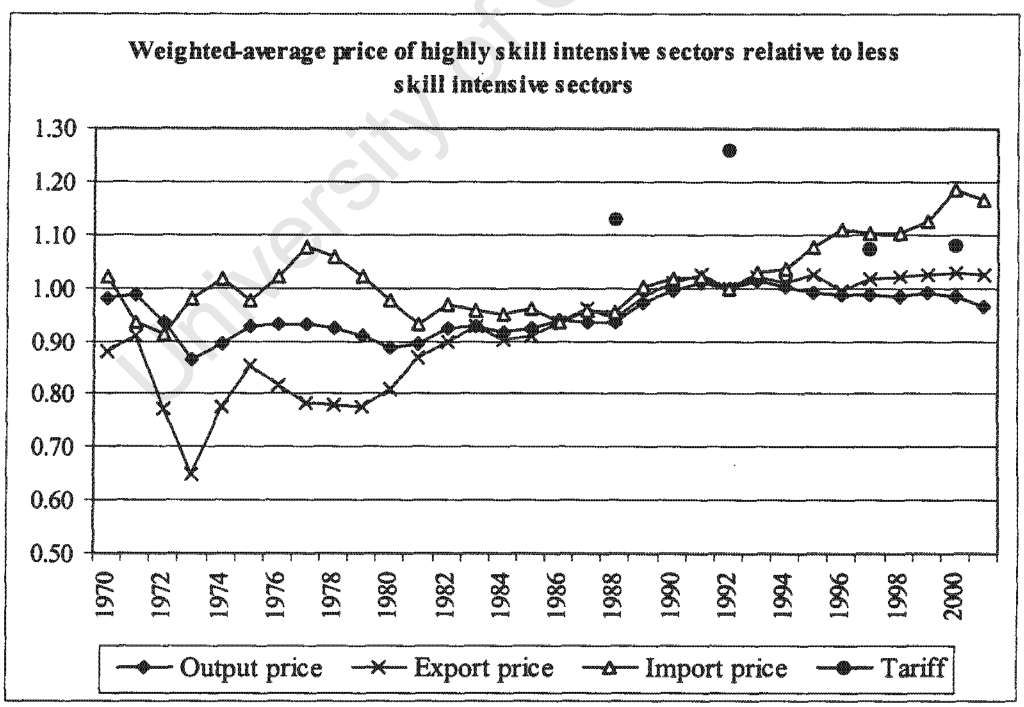
Calculating factor cost shares using the firm survey is more complex as there are no data on the returns to capital.[54] Following Leamer (1996), the return to capital is estimated as 10 % of the replacement value of the capital stock. This is slightly lower than the real interest rate during the late 1990s. The 10 % imposed on all sectors implicitly assumes that depreciation rates do not vary across sectors (Leamer, 1996). Total expenditure for each firm is calculated as the estimated return to capital plus expenditures on material inputs, utilities and wages (including allowances and benefits). Other indirect input costs relating to transport, rental, telecommunications, financial fees and licences fees are omitted, as many firms did not provide this data. Wages for production workers are also available, although the occupational breakdown of this group is not specified. How close an indicator production workers are of less-skilled labour is thus indeterminate. The share production workers, non-production workers, capital and other material costs in total expenditure are calculated using this data. Missing data resulted in only 57 % of the firms being included in the firm analysis.

Various price variables are used to investigate the robustness of the results. As in Lawrence and Slaughter (1993) and Baldwin and Cain (2000), export, import and output prices (measured in domestic currency) are used and were obtained from SASID (2003). These price variables are only available for the aggregated SIC 3-digit database. More importantly, tariff data are obtained from Kuhn and Jansen (1997), WTO (1998), Van Seventer (2001) and from the Industrial Development Corporation (IDC). The tariff data do not capture the effect of quotas or surcharges that were prevalent during the early 1990s. This is potentially a severe limitation for the analysis that follows. The data does, however, contain *ad valorem* equivalents for *non-ad valorem* rates. In the SIC 3-digit and 4-digit databases, unweighted average tariff rates are assigned to each industry. In the firm survey, average SIC 4-digit tariff rates are assigned to each firm according to the products manufactured. Annualised product price changes due to trade liberalisation are then calculated for the relevant periods.

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

Figure 4.2 and Figure 4.3 present trends in the weighted average price of skill-intensive sectors relative to less-skill-intensive sectors and labour-intensive sectors relative to capital-intensive sectors, respectively. The relative price indices are constructed using output prices, export prices, import prices and tariff rates. The highly skilled price index is constructed by weighting each industry's price by its share of total professional and managerial employment in 1992. This is the approach followed by Lawrence and Slaughter (1993). The less-skilled industry price index is constructed using the industry's share of employment of clerical, sales, service, machine operator, artisan and labourer occupations in 1992 as the relevant weights. In the labour and capital price indices, the sector's share in total labour and capital payments in 1992, respectively, are used as weights. Only traded good sectors (agriculture, mining and manufacturing) are included.

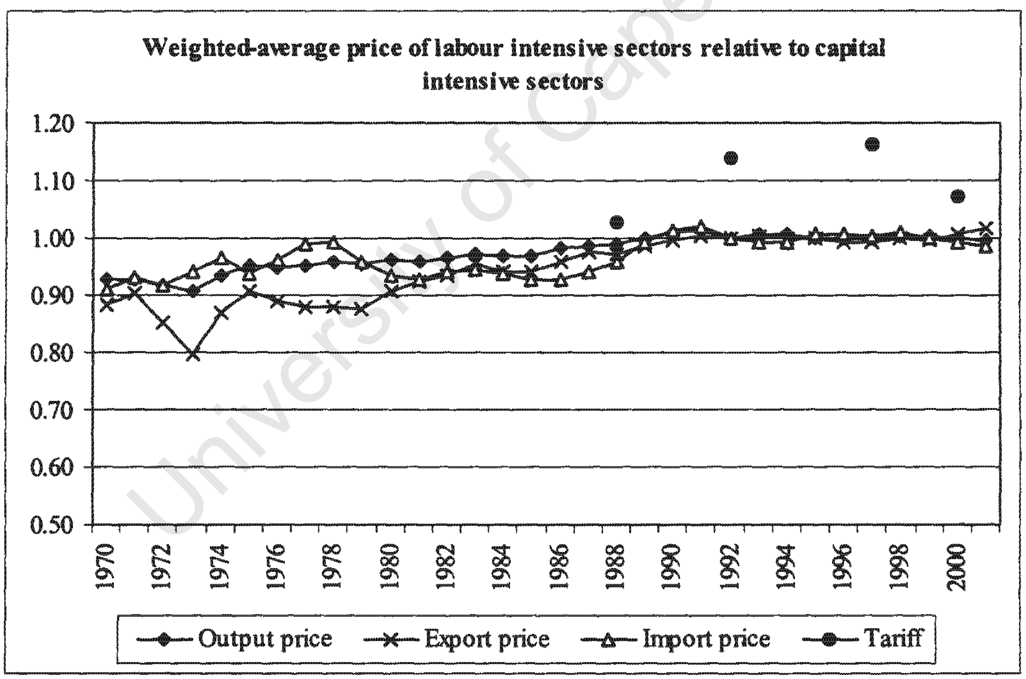
Figure 4.2: Employment-weighted-price of skill-intensive industries relative to less-skill-intensive industries.



The figures show that during the 1980s the weighted average price of skill-intensive sectors rose relative to less-skill-intensive sectors for output, export and import prices. At the same time, weighted average prices (output, export and import price) of labour-intensive sectors rose relative to capital. These results suggest that international and domestic price trends during the 1980s raised the return to labour relative to capital, but also increased wage inequality.

During the 1990s, the trends in weighted average relative prices diverge. The relative price of skill-intensive and labour-intensive sectors showed no sustained trend in terms of export and output prices. In contrast, the weighted average import price of skill-intensive sectors rose by almost 20 % relative to less-skill-intensive sectors between 1992 and 2000. According to the Stolper-Samuelson theorem, import price trends will have increased wage inequality during the 1990s.

Figure 4.3: Weighted-price of labour-intensive industries relative to capital-intensive industries



Looking at tariff rates, the weighted average tariff in skill-intensive sectors rose relative to less-skill-intensive sectors between 1988 and 1992, but fell in the subsequent period. This suggests that tariff liberalisation raised wage inequality between 1988 and 1992, but reduced wage inequality between 1992 and 2000. In terms of the labour-capital categorisation, the impact of tariff liberalisation fell relatively heavily on capital-intensive sectors between 1988 and 1997, but on labour-intensive sectors subsequently.

In conclusion, the preliminary data analysis suggests the following:

- International and domestic price trends during the 1980s raised the return to labour relative to capital, but also increased wage inequality.
- During the 1990s, import price trends raised wage inequality, but output and export price trends had no clear impact on relative factor returns.
- Tariff liberalisation raised wage inequality between 1988 and 1992, but reduced wage inequality in subsequent periods.
- Tariff liberalisation raised the return to labour relative to capital between 1988 and 1997, but reduced the relative return in subsequent periods.

These relationships are explored using more robust econometric techniques in the following section.

3.3 Empirical results: Trade liberalisation and factor returns

Table 4.3 presents the results of the consistency-check regressions using product price changes arising from trade liberalisation as the dependent variable.[55] To simplify the analysis only the coefficients and their level of significance are presented. The results for the mandated-factor-returns regressions using the SIC 3-digit data are presented in Table 4.4 and those using the SIC 4-digit and firm level data are presented in Table 4.5. In estimating the functions, observations in the SIC 4-digit and 3-digit data are weighted by gross output and employment, respectively. This is the approach followed by Baldwin and Cain (2000). White's heteroscedasticity-robust standard errors are presented in cases where heteroscedasticity is prevalent. These cases are noted in the results presented.

3.3.1 1988-92

The period 1988-92, for which only SIC 3-digit data are available, is analysed first. As shown in the consistency-check regressions (Table 4.3), tariff reductions were concentrated in less-skill-intensive sectors during this period. This is shown by the significant positive coefficient (0.086) on the highly skilled factor ratio ($\beta_{S,LS}$),

[55] Trade liberalisation induced changes in product prices between t0 and t1 were calculated as $(\ln(1+tariff_{t1})-\ln(1+tariff_{t0}))/(t1-t0)$.

which is consistent with the trend shown in Figure 4.2. According to the Stolper-Samuelson theorem, the reduction in the relative price of less-skill-intensive products will have reduced the relative wage of less-skilled labour, i.e. increased wage inequality.

Table 4.3: The factor bias of price changes due to trade liberalisation: A consistency-check analysis, all databases

Factor ratio	Database	Obs	1988-92 Coef.	1992/93-97 Coef.	1997-2000 Coef.	1992/93/94-2000 Coef.
Highly skilled/total employment ($\beta_{S,LS}$)	*SIC 3-digit*	28	0.086 *	-0.106 **	-0.002	0.007
			0.049	*0.043*	*0.038*	*0.006*
	Firm	308		-0.001	0.009	0.003
				0.005	*0.007*	*0.005*
Wage bill/total factor payments ($\beta_{L,K}$)	*SIC 3-digit*	28	0.001	0.001	-0.009 ***	0.000
			0.001	*0.001*	*0.001*	*0.000*
	SIC 4-digit	80				-0.011 **
						0.005
	Firm	319		-2.176	-6.852	-4.180
				5.871	*8.496*	*4.925*

Notes:
The coefficients for the SIC 4-digit results were not significant in the unweighted regression.
Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for the 1997-2000 and 1993-2000 firm level results.
*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.
The firm level results are for 1993-97 and 1993-2000. The SIC 4-digit results are from 1994-2000. The SIC 3-digit results are from 1988-92, 1992-97, 1997-2000 and 1992-2000.

However, the mandated-wage regressions (but not the consistency-check regressions) suggest that labour as a whole benefited relative to capital. Price changes due to tariff liberalisation mandated a 2.2 % annual decline in the return to capital between 1988 and 1992 (Table 4.4). The average annual decline in prices due to trade liberalisation was 0.5 %, implying a 1.7 % real decline in the return to capital. The mandated return to labour is positive, but is not significantly different from zero. However, the mandated return capital is significantly (weakly) less than the mandated return to labour.

Thus tariff liberalisation between 1988 and 1992 positively affected labour, particularly skilled labour, relative to capital. This result, however, does not take into account the effects of quota reductions and surcharges, and hence the conclusion is made cautiously. The exclusion of non-tariff barriers is less of a problem during the subsequent period.

Table 4.4: Mandated factor returns to changes in tariffs, SIC 3-digit database

	1988-92 Coef.	1992-97 Coef.	1997-2000 Coef.
M-share (δ_M)	-0.006	-0.013	-0.012
	0.008	*0.009*	*0.009*
L-share (δ_L)	0.019	0.012	-0.035
	0.023	*0.031*	*0.028*
K-share (δ_K)	-0.022 ***	-0.004	0.027 *
	0.005	*0.014*	*0.014*
L-share – K-share	0.042 *	0.016	-0.063
F-stat	2.37	0.15	2.77
Mean P change	-0.005	-0.005	-0.007
F(3, 25)	3.07 **	9 ***	5.57 ***
R-squared	0.269	0.519	0.401
Number of obs	28	28	28

Notes:
Values in italics below the coefficients are standard errors. White's heteroscedasticity-robust standard errors are reported for the 1988-92 results.
*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

3.3.2 1990s

The impact of tariff liberalisation on labour differed during the remainder of the 1990s. According to the consistency-check regressions using the SIC 3-digit data (Table 4.3), price reductions due to tariff liberalisation were strongest in skill-intensive sectors between 1992 and 1997. A similar relationship is found using the firm level data, but the coefficient is not significantly different from zero. Strong declines in prices also occurred in labour-intensive sectors relative to capital-intensive sectors in 1994-2000, when using SIC 4-digit, and in 1997-2000, when using SIC 3-digit data. In both cases, the coefficient on the wage bill/total factor payment coefficient ($\beta_{L,K}$) is negative and significant. These results are consistent with the trends in weighted average relative prices shown in Figure 4.2 and Figure 4.3. According to the results, trade liberalisation lowered the return to labour relative to capital, but raised the return to less-skilled labour relative to skilled labour. Whether the return to less-skilled labour exceeded the return to capital cannot be determined from the consistency-check results presented.

Further insights are provided by the mandated-factor-return regressions in Table 4.4 and Table 4.5. According to the firm survey results (Table 4.5), tariff liberalisation between 1993 and 1997 mandated a 2.1 %, 0.8 % and 1.4 % annual decline in the return to skilled labour, less-skilled labour and capital, respectively. The average annual decline in prices due to tariff liberalisation was 1.3 %, implying a real increase in incomes for less-skilled labour, but real declines for skilled labour and capital.

Table 4.5: Mandated factor returns to changes in tariffs, SIC 4-digit and firm level data

	Firm level data			SIC 4-digit (SU) data
	1993-97 Coef.	**1997-2000 Coef.**	**1993-2000 Coef.**	**1994-2000 Coef.**
Less-skill (LS), Skilled (S) and capital (K)				
S-share (δ_S)	-0.021 ***	-0.018 **	-0.020 ***	...
	0.005	*0.007*	*0.005*	
LS-share (δ_{LS})	-0.008 **	-0.012 **	-0.010 ***	...
	0.004	*0.005*	*0.003*	
K-share (δ_K)	-0.014 **	0.017 *	-0.001	...
	0.007	*0.010*	*0.006*	
M-share (δ_M)	-0.013 ***	-0.001	-0.008 ***	...
	0.001	*0.002*	*0.001*	
				...
δ_S - δ_K	-0.007	-0.035 ***	-0.019 **	
δ_{LS} - δ_K	0.006	-0.029 **	-0.009	...
δ_S - δ_{LS}	-0.013 *	-0.006	-0.010	
Mean P change	-0.013	-0.004	-0.009	...
Adj R2	0.688	0.092	0.569	
Number of obs	187	187	187	...
F-stat	104.16 ***	5.74 ***	62.70 ***	
Labour (L) and capital (K)				
L-share (δ_L)	-0.011 ***	-0.014 ***	-0.012 ***	-0.077 ***
	0.004	*0.006*	*0.003*	*0.025*
K-share (δ_K)	-0.017 ***	0.015	-0.003	0.022
	0.007	*0.010*	*0.007*	*0.024*
M-share (δ_M)	-0.015 ***	-0.003	-0.010 ***	
	0.001	*0.002*	*0.001*	
δ_L - δ_K	0.006	-0.029 **	-0.009	-0.100 **
Mean P change	-0.013	-0.004	-0.009	-0.006
Adj R2	0.663	0.070	0.531	0.144
Number of obs	186	186	186	80
F-stat	135.02 ***	5.69 ***	82.84 ***	7.75 ***

Notes:

The dependent variable in the SIC 4-digit database is the annualised change in value added obtained by subtracting intermediate input price changes from output price changes arising from trade liberalisation.

Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for the 1993-97 and 1993-2000 firm level results using capital and labour.

*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

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

Consistent results are obtained from the SIC 3-digit data between 1997 and 2000 and the SIC 4-digit data over the period 1994-2000. According to the SIC 3-digit results, tariff liberalisation mandated a 2.7 % (3.5 % real) annual increase in the return to capital, although this was not significantly different from the mandated return to labour. In the SIC 4-digit results, tariff liberalisation mandated a 7.7 % (7.1 % real) average annual decline in returns to labour between 1994 and 2000.[56] This is significantly less than the mandated return to capital. These results are also consistent with the weighted average price trends shown in Figure 4.2 and Figure 4.3.

In summary, the weighted average price trends, consistency-check regressions and mandated-factor-return regressions yield similar results to each other. The results suggest that trade liberalisation positively benefited labour, particularly skilled labour, relative to capital between 1988 and 1992. In contrast, tariff liberalisation negatively affected labour, particularly skilled labour, relative to capital during the remainder of the 1990s. These latter results differ substantially from those of Fedderke *et al.* (1999) who argue that trade liberalisation positively benefited the returns to labour relative to capital.

3.4 Empirical results: Other price changes and factor returns

International price movements, changes in domestic policies and changes in market power also affect product prices, which through Stolper-Samuelson linkages affect relative factor returns. This section analyses the impact on factor returns arising from changes in effective rates of protection and changes in the price of exports, imports and output. The sensitivity of the results to different price variables is thus

[56] The very high coefficient reflects the large impact of tariff reductions on value added. As shown in the analysis of effective rates of protection in Chapter 2, changes in nominal protection often lead to amplified changes in effective protection (protection of value added). If product price changes due to trade liberalisation, rather than changes in value added, are used as the dependent variable (i.e. Eq 4.2) tariff liberalisation mandates 3.4 % (2.5 % real) annual decline in labour income. This is closer to the results obtained using the other databases.

tested. Output, export and import price data are only available at the SIC 3-digit level precluding an analysis using the SIC 4-digit and firm level data.

Table 4.6 and Table 4.7 present the consistency-check and mandated-factor-return results, respectively, using the various price variables. The results are based on 28 manufacturing, mining and agriculture sectors and are estimated using employment as weights.

Table 4.6: The sector bias of changes in effective rates of protection and output, export and import prices: A consistency-check analysis, SIC 4-digit database

	Change in effective rate of protection	Change in output price	Change in export price	Change in import price
	Coef.	Coef.	Coef.	Coef.
Highly skilled/total employment ($\beta_{S/LS}$)				
1988-92	0.145	0.457 ***	0.375 *	0.271
	0.140	0.140	0.194	0.175
1992-97	-0.249 **	-0.060	0.084	0.475 ***
	0.124	0.113	0.171	0.154
1997-2000	-0.012	-0.015	0.181	0.473 ***
	0.109	0.226	0.150	0.136
Adj R-square	0.033	0.245	0.390	0.325
Number of ob	84	84	84	84
F	1.570	10.660 ***	11.610 ***	9.010 ***
Wage bill/total factor payments ($\beta_{L/K}$)				
1988-92	-0.003	0.015 ***	0.007	0.022 ***
	0.003	0.004	0.005	0.005
1992-97	0.005	-0.003	-0.001	0.009
	0.004	0.003	0.007	0.006
1997-2000	-0.024 ***	-0.002	0.002	0.004
	0.003	0.006	0.006	0.005
Adj R-square	0.399	0.276	0.363	0.323
Number of ob	84	84	84	84
F	12.010 ***	10.660 ***	10.440 ***	8.900 ***
Mean P change	-0.009	0.077	0.056	0.073

Notes:

Results are obtained by estimating

$\hat{P}_j = \alpha + TD9297 + TD9700 + \beta_1 FR_j \times TD8892 + \beta_2 FR_j \times TD9297 + \beta_3 FR_j \times TD9700 + \varepsilon_j$ where $\hat{P}_j$ measures the annualised change in price between the periods, FRj is a sector level factor ratio measure for the start-of-period (either 1988, 1992 or 1997), TD8892, TD9297 and TD9700 are time dummies for the periods 1988-92, 1992-97 and 1997-2000, respectively and εj is an error term. The coefficients of the time dummies are not presented.

Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for the results using the change in output price as the dependent variable.

*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

Table 4.7: Mandated factor returns to changes effective rates of protection and output, export and import prices, SIC 3-digit database

	Change in effective rate of protection	Change in output price	Change in export price	Change in import price
1988-92	**Coef.**	**Coef.**	**Coef.**	**Coef.**
M-share (δ_M)	-0.004	0.112 ***	0.104 ***	0.023
	0.026	0.024	0.039	0.040
L-share (δ_L)	0.011	0.124	-0.089	0.342 ***
	0.075	0.085	0.113	0.116
K-share (δ_K)	-0.025	0.035	-0.067 **	-0.081 **
	0.020	0.025	0.030	0.031
L-share – K-share	0.036	0.089	-0.022	0.423 ***
F-stat	0.16	0.89	0.03	9.29
Mean P change	-0.007	0.092	0.013	0.061
F(3, 25)	1.31	36.72 ***	8.69 ***	34.36 ***
R-squared	0.136	0.917	0.510	0.805
1992-97	**ERP**	**Output price**	**Export price**	**Import price**
M-share (δ_M)	-0.013	0.066 ***	0.092 ***	0.139 ***
	0.026	0.024	0.011	0.021
L-share (δ_L)	0.030	0.170	0.075 *	-0.112
	0.088	0.116	0.037	0.074
K-share (δ_K)	-0.010	0.040	0.071 ***	0.044
	0.040	0.038	0.017	0.034
L-share – K-share	0.041	0.130	0.004	-0.156
F-stat	0.11	0.74	0.01	2.36
Mean P change	-0.003	0.083	0.083	0.060
F(3, 25)	0.17	143.11 ***	446.36 ***	66.71 ***
R-squared	0.020	0.961	0.982	0.889
1997-2000	**ERP**	**Output price**	**Export price**	**Import price**
M-share (δ_M)	-0.031	-0.019	0.026	0.198 ***
	0.024	*0.039*	*0.049*	*0.023*
L-share (δ_L)	-0.092	0.355 *	0.396 *	-0.147 *
	0.076	*0.178*	*0.218*	*0.074*
K-share (δ_K)	0.085 **	-0.034	-0.083	0.079 **
	0.038	*0.055*	*0.084*	*0.037*
L-share – K-share	-0.177 *	0.388 ***	0.479 *	-0.226 **
F-stat	3.05	13.68	3.09	5.31
Mean P change	-0.016	0.054	0.075	0.100
F(3, 25)	4.65 ***	27.25 ***	17.97 ***	94.35 ***
R-squared	0.358	0.766	0.796	0.919
Number of obs	28	28	28	28

Notes:

In the unweighted regression the mandated return to capital between 1997 and 2000 is positive and significant for export price changes while the mandated return to labour is insignificantly different from zero. With product price changes mandated returns are insignificantly different from zero during this period.

Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for all the results using the output price as well as the 1997-2000 results using ERP and the export price.

*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

3.4.1 1988-92

Between 1988 and 1992, output and export prices rose strongly in skill-intensive sectors relative to less-skill intensive sector. This is shown by the significant positive coefficient for ($\beta_{S,LS}$) in the consistency-check regression (Table 4.6). Strong increases in output and import prices were also experienced in labour-intensive sectors relative to capital-intensive sectors. These price increases mandated a substantial decline in the earnings of capital. Import prices in particular mandated strong increases in the returns to labour relative to capital, although the mandated average annual increase in labour earnings (34.2 % per annum) appears excessively high (Table 4.7).

The factor market impacts of these alternative prices are similar to those arising from tariff liberalisation and suggest that output, export and import price shifts reinforced factor payment trends arising from tariff liberalisation. Price changes between 1988 and 92 appear to have raised wage inequality, but at the same time raised the return to labour relative to capital. The relative price trends in Figure 4.2 and Figure 4.3 suggest that equivalent factor market effects were also experienced between 1980 and 1988.

3.4.2 1990s

The results in the remainder of the 1990s are less consistent and in most cases no significant coefficients are estimated. As shown in Figure 4.2 and Figure 4.3, most relative prices showed no sustained trends, so the poor results are expected. The consistency regression results show no bias in export and output prices towards any sector. However, import prices rose relatively strongly in skill-intensive sectors in 1992-97 and 1997-2000 (see Table 4.6) and will have raised wage inequality. Import prices appear to be inclusive of tariffs (SASID, 2003), suggesting that the relative decline in world prices of less-skill-intensive products exceeded the relative decline in tariffs within skill-intensive sectors. The implication is that import price trends during the 1990s raised wage inequality, but that tariff liberalisation moderated some of the negative impact of import prices on less-skilled wages.

The consistency-check results using capital and labour were very poor throughout the 1990s, but some significant results were obtained using the mandated-factor-return regressions between 1997-2000 (Table 4.7). Import prices mandated significant annual increases in the return to capital (7.9 %) relative to labour (-14.7 %)

between 1997 and 2000. Changes in ERP also mandated significant returns to capital. In contrast, export and output price changes mandated very strong increases in the return to labour during this period, which is consistent with the results found by Fedderke *et al.* (1999). These results, however, are only weakly significant (10 % significance level) and are sensitive to the weighting procedure. In unweighted regressions (not shown), export prices mandate significant positive returns to capital (9.4 % per annum), which is consistent with the rising capital intensity of production shown by Bell and Cattaneo (1997), Hayter *et al.* (1997) and Tsikata (1999).

In summary, output, export and import price trends positively affected labour, particularly skilled labour, relative to capital between 1988 and 1992. In contrast, during the 1990s import prices mandated declining earnings for labour relative to capital and less-skilled labour relative to skilled labour.

3.5 Summary and concluding remarks

This section used various different data sources and empirical methodologies to analyse the impact of trade liberalisation and product price movements on factor returns since the late 1980s.

The results of the consistency-check and mandated-wage regressions are shown to be sensitive to the selection of industries, time periods and price variables. During the late 1980s trade liberalisation mandated rising wage inequality, but increased the return to labour relative to capital. Changes in output, export and import prices reinforced these trends. During the 1990s tariff liberalisation reduced the return to labour relative to capital, but also reduced wage inequality. The relatively poor return to labour was exacerbated by changes in import prices (inclusive of tariffs) that mandated positive returns to capital relative to labour. Import price increases were also concentrated in skill-intensive sectors, which according to the Stolper-Samuelson theorem will have raised wage inequality.

A number of conclusions regarding the relationship between trade liberalisation and employment can be drawn from the results. The results show that tariff liberalisation (and import price trends) from 1992 had a negative impact on the wages of South African labour relative to the return to capital. In an economy with sticky wages, downward pressure on wages will have negatively affected employment. However, trade liberalisation alone cannot account for the full decline in employment during the 1990s. As opposed to declining, real wages grew by 2.7 % on average per annum during the 1990s (see Figure 4.1). New labour legislation enacted since 1994 has also raised the non-wage costs of employing labour (Chandra *et al.*, 2001a). The failure of real wages to adjust downwards has exacerbated the negative impact of trade liberalisation and import price movements on employment. The primary cause of the employment problem in South Africa appears to be excessive increases in the cost (both direct and indirect) of employing labour. This is a similar conclusion to that reached by Fedderke *et al.* (1999).

A second conclusion of relevance to this thesis, is that trade liberalisation during the 1990s did **not** mandate rising wage inequality. According to the firm survey, trade liberalisation mandated a 0.1 % annual increase in the relative wage of less-skilled to skilled labour between 1994 and 2000. Trade liberalisation therefore cannot account for the rise in skill intensity of employment during the 1990s that was achieved largely through the shedding of less-skilled labour.

The results highlight an alternative source of the decline in employment of less-skilled labour. Changes in import price, inclusive of tariffs, were biased against less-skilled labour during the 1990s. The negative impact of import prices on less-skilled labour may reflect increased competitive pressures on less-skill-intensive products arising from the entry of China and India into the world market.

Real wage growth has also exacerbated the negative impact of import prices on less-skilled labour. According to the data presented in Figure 4.1, the average economy-wide wage (excluding government, agriculture and domestic servants) of less-skilled labour grew by 2 % per annum between 1990 and 1999 relative to skilled labour. Excessive real wage growth has contributed towards the significant decline in employment of less-skilled labour during the 1990s. This conclusion is made tentatively, as data on occupational wages over time are difficult to obtain.[57]

[57] See the relative wage trend data in Abdi and Edwards (2002) and Du Toit and Moolman (2003).

These conclusions relate to the impact of price changes on relative factor returns. As shown in Chapter 3, technological change also affects relative factor payments. The following section uses the general equilibrium framework of the HOV model to analyse the impact of technological change on factor payments.

4. Further analysis of technological change and labour in South Africa

An alternative explanation for the changing employment patterns in South Africa is technological change. As outlined in Chapter 3, there are various forms of technological change (skill-biased, trade-induced and Hicks-neutral). However, in a general equilibrium framework the form of technological change does not matter for wage inequality. What matters for relative wages is the sector bias of technological change. Section 4.1 therefore uses total factor productivity (TFP) growth data to explore the impact of sector-biased technological change on labour in South Africa. Section 4.2 briefly explores the contributory role of trade liberalisation towards this productivity growth. As in the price studies, the discussion is grounded in the general equilibrium frameworks presented in Chapter 3.

4.1 The sector-bias of technological change

The impact of sector-biased technological change on factor returns in South Africa is explored using two approaches. Firstly, as in Lawrence and Slaughter (1993) and Sachs and Shatz (1994), total factor productivity growth ($\hat{TFP}$) is regressed on the share of skilled labour in total employment,

Eq 4.4: $$\hat{TFP}_j = \alpha + \beta\left(\frac{S}{LS+S}\right)_j^{initial\ year} + \varepsilon_j .$$

A positive coefficient estimated for β is consistent with rising wage inequality induced by technological change concentrated in skill-intensive sectors. To assess the impact of technological change on the return to labour relative to capital $\hat{TFP}$ is regressed on the share labour remuneration in total factor payments. A positive coefficient is consistent with rising return to labour relative to capital.

In the second approach, Leamer's (1996) mandated-factor-return regressions are estimated. Assuming a zero-pass through of $\hat{TFP}$ onto product prices, the following regression is estimated:

Eq 4.5: $$\hat{TFP}_j = \delta_M \theta_{Mj} + \delta_L \theta_{Lj} + \delta_K \theta_{Kj} + \eta_j .$$

As in the earlier regressions, θ_{Mj} ,θ_{Lj} and θ_{Kj} are the initial cost shares of materials (intermediate goods), labour and capital in the average cost of producing one unit of product *j*, respectively. The coefficients represent the mandated returns to each input that are consistent with total factor productivity growth. This approach is equivalent to that of Fedderke *et al.* (1999), although the function is estimated for sub-periods during the 1990s: 1988-92, 1992-97 and 1997-2000. Unfortunately, estimation is only possible using the SIC 3-digit data, which implies a maximum of 28 sectors are included in the analysis.

Average annual TFP growth for manufacturing, mining and agriculture together was –0.38 % during the 1970s, -0.17 % during the 1980s and 0.09 % during the 1990s.[58] This upward trend is largely driven by rising TFP growth within the mining sector. In manufacturing, average annual TFP growth declined from 0.51 % in the 1970s to –0.06 % in the 1990s.[59] The very low TFP growth during the 1990s implies that that the impact of productivity enhancing technological change on factor payments during this period will be small.

Table 4.8 presents the coefficients of the consistency-check regressions estimated using weighted least squares with employment as the weights. The results using the mandated-factor-return regressions are presented in Table 4.9. Only the coefficients, standard errors and level of significance are presented in each case.

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[58] $\hat{TFP}_j$ is calculated as $\hat{TFP}_j = \Delta \log(Y_j) - \alpha_j \Delta \log(L_j) - (1-\alpha_j)\Delta \log(K_j)$ where Y_j is the sectoral value added, L_j the sectoral labour employed, K_j the sectoral stock of capital and α_j is the share labour remuneration in value added. TFP growth rates were calculated using data obtained from SASID (2003).

[59] These values are slightly higher than those estimated by Fedderke *et al.* (1999), but the trends are the same.

The results are generally weak. TFP growth showed no significant bias towards capital or labour-intensive sectors in any of the periods analysed (Table 4.8). Further, TFP growth mandated no significant (at 5% or better) change in the earnings of capital relative to labour in any period between 1988 and 2000. Thus, according to the theory, the sector bias of technological change has had no impact on the returns to labour relative to capital between 1988 and 2000. These results differ substantially from those of Fedderke *et al.* (1999) who find that TFP growth mandated negative returns to capital and labour between 1972 and 1997.

Table 4.8: The sector bias of total factor productivity growth (agriculture, mining and manufacturing)

	Highly skilled/total employment ($\beta_{S/LS}$) Coef.	Wage bill/total factor payments ($\beta_{L/K}$) Coef.
1988-92	-0.043	-0.003 *
	0.085	*0.002*
1992-97	-0.118	-0.004
	0.075	*0.003*
1997-2000	-0.231 ***	-0.003
	0.066	*0.003*
1992-2000	-0.165 **	-0.003
	0.062	*0.003*

Notes:
The dependent variable is the annualised growth rate of total factor productivity.
Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for the results using the wage bill/total factor payments.
The 1997-2000 coefficient for highly skilled/total employment is significant at only the 10 % level in the unweighted regression. The coefficient for 1992-2000 is insignificant in the unweighted regression.
*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

Table 4.9: Mandated factor returns from TFP growth

	1988-92 Coef.	1992-97 Coef.	1997-2000 Coef.	1992-2000 Coef.
M-share (δ_M)	-0.017	-0.026	-0.022 *	-0.030 **
	0.021	*0.021*	*0.012*	*0.012*
L-share (δ_L)	0.026	0.033	0.049	0.062 *
	0.057	*0.057*	*0.042*	*0.035*
K-share (δ_K)	0.011	0.034 *	0.045	0.027
	0.011	*0.018*	*0.028*	*0.016*
L-share – K-share	0.015	-0.001	0.004	0.035
Average TFP growth	-0.009	0.008	0.002	0.006
F-stat	0.050	0.000	0.000	0.570

Notes:
The dependent variable is the annualised growth in total factor productivity.
Standard errors are in italics below the coefficients. White's heteroscedasticity-robust standard errors are reported for all the results.
*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

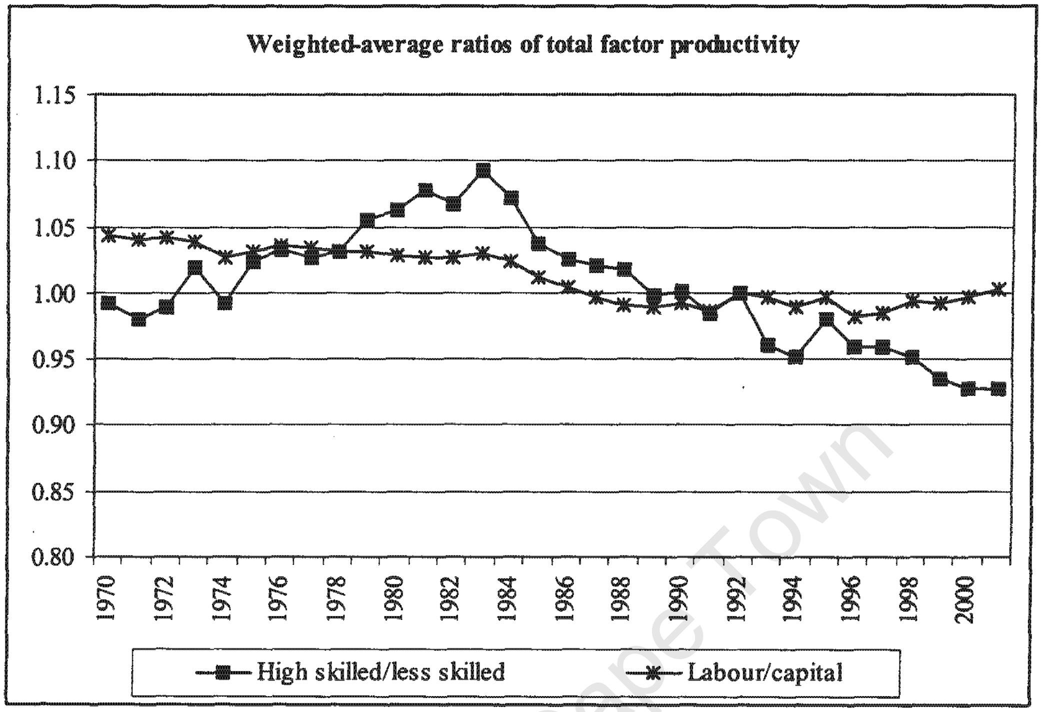
Similarly, TFP growth showed no significant (at 5 % level) bias towards skill-intensive or less-skill-intensive sectors in the sub-periods between 1988 and 1997. However, TFP grew relatively faster in less-skill-intensive sectors between 1997 and 2000. The sector bias during this period was sufficiently strong to result in a bias towards less-skill-intensive sectors over the longer 1992-2000 period. The implication drawn from theory, is that technological change raised the relative return to less-skilled labour (reduced wage inequality) during the 1990s.

Weighted average trends in total factor productivity corroborate these results. Weighted average TFP growth rates are calculated for high-skill-intensive sectors, less-skill-intensive sectors, labour-intensive sectors and capital-intensive sectors following the approach used to construct the relative price indices in Figure 4.2 and Figure 4.3. These weighted average TFP growth rates are then used to construct TFP indices with the base year 1992 set equal to 100. Relative TFP indices constructed using these indices are presented in Figure 4.4.

As shown in Figure 4.4, TFP growth was biased towards capital-intensive sectors during the 1970s and 1980s, but shows no clear bias during the early 1990s. During the latter part of the 1990s, TFP growth appears to be mildly concentrated in labour-intensive sectors, which will have raised the return to labour relative to capital. This impact is likely to be small as the trend is not strong and the TFP growth rates are low.

The sector bias of technological change is more prominent when using the high-skilled/less-skilled sector categorisation. TFP growth was relatively strong in skill-intensive sectors during the 1970s and in a general equilibrium framework will have raised the relative wage of skilled labour. However, since the early 1980s TFP growth has been relatively strong in less-skill-intensive sectors. The relative TFP index fell by 18 % from 1.09 in 1983 to 0.93 in 2001. As found in the regression results presented in Table 4.8, this will have raised the relative wage of less-skilled labour. These results suggest that technological progress benefited rather than harmed less-skilled labour, although the poor TFP growth rates suggest that the impact, if any, is small.

Figure 4.4: Relative weighted average total factor productivity indices



4.2 Trade-induced technological change

There are a number of shortcomings associated with using TFP as the measure of technological change that affect the interpretation of the results in the previous section. TFP growth is calculated as a residual and the value provides no insight into the cause of the productivity change. For example, skill-biased technological change and trade-induced technological change can both improve TFP growth. Although the general equilibrium impact on relative wages may be equivalent, the policy implications may differ. The calculation of technological progress, as followed in this chapter, is also subject to a number of methodological limitations (see Domar, 1961). These are, amongst others, the failure to account for the quality of factors, the assumption of perfectly competitive markets, and the assumption of constant returns to scale. These assumptions are unlikely to hold, giving rise to potentially severe biases in the estimates of technological progress.

A further problem with the analysis in Section 4.2 is that it fails to account for the possible interaction between trade liberalisation and technological change. Sachs and Shatz (1994), for example, argue that in response to increased import competition firms may shed labour, particularly low productive workers who are less-skilled, and thus raise overall productivity. Alternatively, less-skill-intensive firms may close in response to increased import competition. This will raise the average productivity of the broad industrial sectors in which these firms are aggregated. TFP growth in these cases does not reflect more efficient production, but changes in the composition of employment and production within the aggregated industrial sectors.

Such a relationship is suggested by the simultaneous decline in the relative TFP index and rise in the relative import price index for skilled/less-skilled-intensive sectors shown in Figure 4.2 and Figure 4.4, respectively. Jonsson and Subramanian (2000) also find negative relationship between TFP growth and tariff protection in their cross-section analysis. These results suggest the presence of trade-induced technological change.

To analyse this relationship in more detail, TFP growth rates from 1988-92, 1992-97, 1997-2000 and 1992-2000 are correlated with price changes due to tariff liberalisation and changes in import prices. The pairwise correlation coefficients are presented in Table 4.10. This approach is similar to that of Feenstra and Hanson (1997) and Haskel and Slaughter (2001), who regress TFP growth on a number of structural components (outsourcing, technology indicators, foreign prices, industry concentration).

Table 4.10: Pairwise correlation coefficients

	TFP growth rate			
	1988-92	1992-97	1997-2000	1992-2000
Import price	-0.0213	0.1445	-0.5034**	-0.1818
Tariff liberalisation	0.5903**	-0.053	-0.0233	-0.1025

Note: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively. The results are based on 28 sectors including manufacturing, mining and agriculture.

A negative correlation is consistent with the view that increased import competition raised TFP growth. In most cases a negative coefficient is found, but only the coefficient for import prices between 1997 and 2000 is negative and significant. This suggests that rising import competition, as revealed in low relative increases in import prices, is closely associated with increased TFP growth. In contrast, TFP growth was strongest in sectors experiencing low declines in protection between 1988 and 1992. This result contradicts the finding by Jonsson and Subramanian (2000). While these results suggest the presence of trade-induced technological change, the data are too aggregated to explore this relationship in more detail. Nevertheless, they highlight the possibility that changes in productivity within sectors are trade related.

4.3 Summary and concluding remarks

This section draws upon the HOS model to assess the impact of technological change, as revealed by TFP growth, on relative factor payments. The results are inconclusive. TFP growth rates are very low and show no bias towards either capital or labour-intensive sectors. TFP growth has been strongest in less-skill-intensive sectors since the 1980s, which in a general equilibrium framework will have reduced wage inequality. However, the improvement in TFP growth within less-skill-intensive sectors may be the result of trade-induced reductions in low productive workers or firms within the broadly defined sectors. In this case, wage inequality may have risen. Because the data are too aggregated, it is not possible to explore these hypotheses in more depth.

In conclusion, the sector bias of TFP growth ***suggests*** that technological change has raised the relative return to less-skilled-labour from the mid-1980s. This is inconsistent with the shedding of less-skilled labour during the same period, again pointing to the possibility that other exogenous forces (such as real wage increases) are the primary cause of the employment problem. However, methodological problems associated with the calculation of TFP growth, the short period over which the analysis is conducted, and the highly aggregated nature of the data, preclude a definitive conclusion on the impact of technological change on labour in South Africa.

A more in-depth firm-level analysis of the impact of technological change on labour in South Africa is left for Chapter 8.

5. Conclusion

An objective of this chapter is to assess whether trade liberalisation and technological change can account for the significant decline in employment of less-skilled labour in South Africa from the mid-1980s. The general equilibrium framework of the Heckscher-Ohlin-Samuelson model is used as the guiding theoretical framework. Following international empirical literature, the impact of trade liberalisation and technological change on factor returns are estimated using consistency-check and mandated-factor-return regressions. Unlike earlier studies, price changes due to tariff liberalisation are explicitly used within this analysis.

As shown in the results, the general equilibrium impact of trade liberalisation on labour differs according to the period analysed. Between 1988 and 1992, tariff liberalisation raised wage inequality, but also raised the returns of labour relative to capital. These trends were reinforced by changes in the price of exports, imports and outputs. The evidence presented therefore suggests that tariff liberalisation between 1988 and 1992 cannot account for the decline in employment experienced during this period. Because the effects of non-tariff barriers are not accounted for, this conclusion is made tentatively.

During the remainder of the 1990s, tariff liberalisation reduced wage inequality, but placed downward pressure on wages relative to capital. Tariff liberalisation, therefore, can account for some of the decline in employment experienced (assuming rigid wages) during this period. However, trade liberalisation cannot account for the full decline in employment during the 1990s. Real wages failed to adjust downwards and grew by 2.7 % on average per annum during the 1990s. The primary cause of the employment problem in South Africa thus appears to be excessive real wage growth.

Further, trade liberalisation during the 1990s cannot account for the significant rise in skill composition of employment. Trade liberalisation positively affected less-skilled-labour relative to skilled labour during this period. Again, excessive real wage growth of less-skilled labour appears to be the primary cause of the decline in employment of less-skilled labour.

Technological change is a further factor that can influence employment and relative factor returns. The increase in the average skill intensity of employment in South Africa is driven primarily by within-sector shifts in the skill structure of employment. The similarity of these results to international empirical evidence is strongly suggestive of the effect of skill-biased technological change. However, the data are too aggregated to determine this relationship unambiguously.

This chapter also analyses the effect of sector-biased technological change on relative factor payments in South Africa. No conclusive evidence is found. TFP growth showed no sector bias towards capital or labour-intensive sectors and mandated no significant changes in factor earnings between 1988 and 2000. TFP growth is found to be strongest in less-skill intensive sectors from the early 1980s, which according to the general equilibrium framework will have reduced wage inequality. This result suggests that technological change improved the welfare of less-skilled labour during the 1990s. However, the measure of technological change, TFP growth, used in this chapter is inadequate to conclusively isolate this relationship. Methodological limitations lead to potentially large biases in the estimates of productivity growth and the aggregated level of the data prevents the identification of compositional shifts, possibly due to trade liberalisation, occurring within sectors.

This chapter thus fails to isolate the impact of sector-biased technological change on relative factor payment and/or employment during the 1990s. Further analysis using alternative measures of technological change and more disaggregated level data is required to establish the impact.

Chapter 5

Trade and the Structure of South African Production, 1984-97*

1. Introduction

The previous chapter analysed the impact of trade liberalisation, international price movements and technological change on factor returns in South Africa. As discussed in Chapter 3, the sector bias of product price changes and technological change affect factor returns by altering the relative profitability of sectors. This induces changes in the sectoral structure of production, which, through differences in factor intensities across sectors, affects relative factor payments. Thus, an analysis of the impact of trade liberalisation and international price movements on the structure of production can complement the trade-employment debate.

Currently the trade-employment debate is most prominent (Bell and Cattaneo, 1997; Nattrass, 1998; Bhorat, 1999; Fedderke *et al.*, 1999) and is an extension of the Holden and Holden (1981), van Seventer (1988) and Holden and Holden (1989) debate during the 1980s. Research on the relationship between trade regimes, trade flows and production is less prominent and is dominated by a number of World Bank publications (Belli *et al.*, 1994; Fallon and Pereira de Silva, 1994; Tsikata, 1999). This chapter extends this line of research and analyses the changing structure of production and trade in South Africa between 1984 and 1997.

Two approaches have been followed in analysing the changing structure of South African production and trade flows. Belli *et al.* (1994), Fallon and Pereira de Silva (1994) and Tsikata (1999) use a Chenery (1960) style decomposition approach to decompose changes in gross output into domestic demand expansion, export expansion and import penetration. Their results, shown in Table 5.1, show that during the import substitution industrialisation phase of South Africa's development (1960s and 1970s), import penetration positively contributed towards manufacturing output

* A version of this chapter, titled "Trade and the structure of South African production, 1984-97", was published in 2001 in *Development Southern Africa*, 18, 4: 471-491.

growth (3 percentage points between 1972 and 1983). In contrast, liberalisation led to increased import penetration, but this was offset by improved export growth. Tsikata (1999: 12) thus argues that "*increased liberalization produces a larger contribution by exports and, simultaneously, a smaller contribution by import substitution at least in the short-run*". The implication for employment is that employment lost through increased import penetration is gained through increased export production. As shown in Table 5.1, domestic demand is also important and accounted for the dominant share of manufacturing output growth in most periods.

Table 5.1: South African sources of manufacturing growth, 1972-1996 (%)

	Output expansion	Export expansion	Import substitution	Domestic demand expansion
1972-83	50.1	2.5	3.0	44.6
1983-90	3.5	5.3	-3.3	1.6
1990-94	-9.3	-1.7	1.8	-9.6
1995-96	4.6	1.4	-0.8	4.1

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

A second approach followed is to analyse the changing commodity structure of South African exports and imports. The use of this approach in South Africa is widespread (Nordas, 1996; Bell and Cattaneo, 1997; Tsikata, 1999; IMF, 2000; Edwards and Schoer, 2002). Using a variety of classifications, these studies identify changes in the composition of South African trade and then infer conclusions regarding competitiveness or the impact of trade liberalisation on factors.

This approach implicitly draws upon the Heckscher-Ohlin theorem, which states that a country will export those products that use intensively its relatively abundant factor. For example, Tsikata (1999) classifies manufacturing exports by factor usage and finds that South Africa has a high share of human capital and technology-intensive exports relative to other countries such as China, Indonesia and Korea. The relatively human capital and technology intensity of exports of South Africa compared to other middle income countries is paradoxical and "*suggests that South Africa is failing to make effective use of the comparative advantage that an abundant supply of labor provides*" Tsikata (1999: 25). Using updated data, Lewis (2001) notes that this paradoxical structure persisted into the 1990s.

The paradoxical structure may not be inconsistent with the Heckscher-Ohlin theorem as South Africa has a dual structure of trade with respect to developed and developing countries. Net trade with high and middle-income countries is positive in natural resource and basic manufactures, but is negative in sophisticated products (IMF, 2000). In contrast, net trade with low-income countries is negative in natural resource goods, but positive in sophisticated products. Applying the Heckscher-Ohlin-Vanek theorem, the IMF (2000) shows that South Africa is revealed to be unskilled abundant relative to middle and high-income countries, but high skilled relative to low-income countries. The regional trade flows appear consistent with theory given endowments of skilled and less-skilled labour across regions. However, South Africa is revealed to be capital as opposed to labour abundant relative to all countries, which is inconsistent with theory, at least in the case of trade with developed countries.

This chapter extends these approaches and analyses the impact of trade on the structure of South African production in three periods: 1984-88, 1988-93 and 1993-97. A key difference to previous analyses is that an input-output methodology is used to decompose the sources of sectoral and aggregate output growth into domestic demand expansion, export expansion, import substitution and changes in intermediate input use. The analysis is thus similar to Chenery *et al.*'s (1986) multi-country industrialisation and growth study.

Of interest to this chapter is the extent to which trade flows and trade liberalisation lie behind the rising capital intensity of production and whether increased international competition has negatively affected the size of the manufacturing sector, i.e. the deindustrialisation effects of trade liberalisation. This is of relevance to the overall objective of this thesis, as the impact of trade liberalisation on employment works via its impact on the structure of production. The impact of trade liberalisation on employment can thus be deduced from the sectoral changes occurring within production. The employment effect of structural change in the South African economy is analysed in more detail in Chapter 6.

A severe limitation of the analyses in this chapter (and Chapter 6) is that changes in the structure of production are not directly linked to measures of trade liberalisation. Rather, as identified in Chapter 2, it is assumed that 1984-88 is a period of increased protection, 1988-93 is a period of moderate declines in protection and 1993-97 is a period of accelerated tariff liberalisation. The findings are thus suggestive of the impact of trade liberalisation on output.

The structure of the paper is as follows. First, the salient features of the changing structure of South African production and trade are presented in Section 2. An input-output (IO) decomposition methodology is then presented in Section 3. In Section 4, the sources of change in output growth, derived using the input-output decomposition methodology, are presented. These results are then compared with international empirical evidence in Section 5. Section 6 interrogates possible sources of the rise in capital intensity of net trade and Section 7 concludes the chapter.

2. Production and trade trends

Table 5.2 presents growth rates and changes in the composition of gross output between 1984 and 1997. Manufacturing is categorised according to capital intensity as has been done by Bell and Cattaneo (1997) and Hayter *et al.* (1998) (see Table A3.1 in Appendix 3 for a detailed breakdown of the factor-content categories). Given the preoccupation with the employment impact of changes in the capital intensity of production in South Africa (Kaplinsky, 1995; Bell and Cattaneo, 1997; Nattrass, 1998), this framework is useful for comparative purposes.

As shown in Table 5.2, output growth during the 1980s and early 1990s was dismal with all but the agricultural and services sectors showing a decline in real output between 1984 and 1993. These two sectors showed positive growth in all sub-periods, although the volatility of agricultural production precludes a judgement on the long-term production trend of this sector.[60] Since 1993 output growth has recovered in all but the mining and quarrying sector.

The second feature of output growth is a structural shift away from mining and quarrying production towards services. The share of total gross output of the former

[60] A severe drought during the 1983/84 season and good harvests during the 1996/97 season bias growth values upwards. Agriculture's contribution towards total GDP has declined from 20 % in the 1920s to between 5-6 % in the late 1990s.

fell from 8.6 % to 6.8 % between 1984 and 1997, while the share accounted for by services rose from 34.9 % to 38.1 % over the same period. Growth in the financial and other business services sector as well as the proliferation of communication and information technology related services have boosted growth of this sector.

Table 5.2: Production structure and growth, (%)

Growth rates of real sectoral gross output, 1990 prices				
	1984-88	**1988-93**	**1984-93**	**1993-97**
Agriculture, Forestry and Fishing	7.8	0.1	3.5	5.0
Mining and Quarrying	-1.5	0.0	-0.7	-1.5
Total Manufacturing[a]	0.6	-2.5	-0.9	3.2
Capital-intensive	*2.1*	*-2.4*	*-0.2*	*4.7*
Intermediate-K-intensive	*0.6*	*-3.0*	*-1.1*	*0.9*
Labour-intensive	*-1.4*	*-2.2*	*-1.6*	*3.9*
Ultra-labour-intensive	*-1.0*	*-2.1*	*-1.4*	*2.0*
Social Overhead	-1.3	-0.2	-0.7	2.6
Services	1.1	0.5	0.7	3.3
TOTAL	0.7	-0.9	-0.1	2.9
Sectoral share of total gross output (%)				
	1984	**1988**	**1993**	**1997**
Agriculture, Forestry and Fishing	3.5	4.7	4.8	5.2
Mining and Quarrying	8.6	7.9	8.1	6.8
Total Manufacturing[a]	40.3	40.1	37.5	37.9
Capital-intensive	*37.6*	*39.9*	*40.1*	*42.4*
Intermediate-K-intensive	*30.7*	*30.7*	*30.1*	*27.5*
Labour-intensive	*23.0*	*21.3*	*21.6*	*22.2*
Ultra-labour-intensive	*8.7*	*8.1*	*8.3*	*7.9*
Social Overhead	10.4	9.6	9.8	9.7
Services	34.9	35.5	37.5	38.1
TOTAL	2.2	2.4	2.2	2.2

Source: Output data are obtained from input-output tables (CSS, various years). Data are deflated using National Productivity Institute gross output deflators (NPI, 1997, 1998).

Notes:

a. Export and import shares for the manufacturing factor-content sub-sectors are for manufacturing alone.

A third feature of production is the relatively poor performance of manufacturing.[61] The share of gross output accounted for by manufacturing fell from 40.3 % to 37.5 % between 1984 and 1993, although this has shown a moderate rise subsequently. Of interest, however, is the rise in the share of capital-intensive sector output in manufacturing output from 37.6 % in 1984 to 42.4 % in 1997. In contrast, the share of ultra-labour-intensive products in manufacturing output fell from 8.7 % to 7.9 %. This shift appears to have accelerated since 1993, a period of increased trade liberalisation.

[61] Internationally South Africa's manufacturing performance was also poor with significantly lower growth than both developed and developing countries during the 1980s (Kaplinsky, 1995).

A cursory analysis of trade flows suggest that trade and trade liberalisation may have played a considerable role in inducing the structural shift in manufacturing production. As shown in Table 5.3, trade in manufactures has grown rapidly since the 1980s. Export orientation (exports/gross output) rose for all but the mining sector and was particularly strong within the manufacturing sector where it increased from 9.2 % in 1984 to 17.6 % in 1997. Although declining domestic demand stimulated exports during the 1980s, continued growth since 1993 suggests that the export market has become a permanent source of demand and is no longer primarily a 'vent-for-surplus' market (as noted by Belli *et al.* (1993) during the late 1980s).

Table 5.3: Structural changes in trade flows, 1984-97, (%)

	1984		1988		1993		1997	
	Export share	**Export orientation**	**Export share**	**Export orientation**	**Export share**	**Export orientation**	**Export share**	**Export orientation**
Agriculture, Forestry and Fishing	2.7	7.2	1.7	5.1	2.0	6.1	4.6	17.7
Mining and Quarrying	59.0	83.1	54.9	90.6	43.9	78.3	37.5	81.0
Total Manufacturing[a]	26.0	9.2	29.6	11.8	40.4	15.6	42.3	17.6
Capital-intensive	*58.5*	13.6	*59.3*	17.4	*56.1*	21.9	*58.0*	25.0
Intermediate-K-intensive	*19.3*	6.1	*17.0*	6.8	*17.9*	9.3	*17.4*	10.0
Labour-intensive	*10.3*	4.0	*13.3*	7.0	*17.0*	12.3	*17.8*	15.0
Ultra-labour-intensive	*11.8*	14.9	*10.3*	15.3	*8.9*	16.9	*6.8*	15.0
Social Overhead	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Services	12.1	5.6	13.6	7.2	13.5	5.2	15.4	6.6
TOTAL	100.0	14.2	100.0	16.3	100.0	14.5	100.0	16.1

	Import share	**Import penetration**	**Import share**	**Import penetration**	**Import share**	**Import penetration**	**Import share**	**Import penetration**
Agriculture, Forestry and Fishing	4.2	9.7	2.1	4.9	1.2	3.0	2.0	8.4
Mining and Quarrying	12.4	47.5	12.6	64.0	12.5	45.6	10.9	54.3
Total Manufacturing[a]	75.6	20.4	76.8	21.6	76.2	22.2	72.7	25.9
Capital-intensive	*22.9*	13.5	*27.1*	16.6	*26.6*	17.0	*23.5*	18.1
Intermediate-K-intensive	*22.9*	16.3	*24.0*	17.6	*22.4*	16.5	*23.0*	19.5
Labour-intensive	*45.9*	32.0	*41.3*	32.6	*44.2*	36.0	*45.7*	42.7
Ultra-labour-intensive	*8.3*	23.6	*7.5*	21.3	*6.9*	19.5	*7.8*	24.8
Social Overhead	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Services	7.7	3.0	8.4	3.5	8.7	2.7	12.3	4.8
TOTAL	100.0	12.7	100.0	13.5	100.0	12.2	100.0	15.5

Source: Calculations use nominal data drawn from the input-output tables (CSS, various years).

Notes: Export share reflects the sectoral export share of total exports. Export orientation reflects the share of exports in total gross output. Import share is the sectoral import share of total imports while import penetration is calculated as the share of imports in domestic consumption. Domestic consumption is measured as gross output+imports-exports.

a. Export and import shares for the manufacturing factor-content sub-sectors are for manufacturing alone.

The composition of total exports has also changed with manufacturing displacing mining & quarrying as the major export sector. Very strong export growth occurred within the labour-intensive sector pushing up its share of total manufacturing exports from 10.3 % in 1984 to 17.8 % % in 1997. The bulk of this shift is due to rising exports of electrical and non-electrical machinery and equipment, particularly to African countries.

At a glance it appears that the structural shift towards capital-intensive production is not due to a rise in capital-intensive exports, but rather a decline in ultra-labour-intensive exports. Between 1984 and 1997, the capital-intensive share of total manufacturing exports remained roughly at 58 %, while the ultra-labour-intensive share fell from 11.8 % to 6.8 %. The concern, however, is that since 1993 the capital-intensive share of manufacturing exports rose from 56.1 % to 58 % in 1997; reversing the downward trend since 1988.

It is really from the import side that structural shifts in trade are most evident. Between 1984 and 1993, import penetration gradually rose in all manufacturing sectors, except for the ultra-labour-intensive sector, where it fell. Since 1993, import penetration has accelerated pushing import penetration for manufacturing as a whole from 22.2 % to 25.9 % in 1997. The strongest increases in import penetration occurred in the ultra-labour-intensive sector where it rose from 19.5 % to 24.8 % between 1993 and 1997. As in Bell and Cattaneo (1997), these results suggest a rising capital intensity of net trade, which is possibly detrimental to trade-induced employment growth.

While this analysis suggests that trade flows have been a major factor in inducing structural shifts and growth within manufactures, a number of shortcomings are evident. First, the impact of trade may be small relative to other factors such as technology, real wages and investment flows. Levy (1992), for example, argues that the rise in manufacturing capital-intensity is primarily due to a shift in investment away from labour-intensive sectors and towards highly capital-intensive chemical sectors. Fallon (1992) argues that real wage growth during the 1980s raised the capital intensity of production while Kaplinsky (1995) emphasises the role of political uncertainty and the failure to invest in labour-intensive sectors.

Secondly, trade flows are not independent of changes in domestic demand. The export market often served as a residual market during the 1980s (Belli *et al.*,

1993) and capital and intermediate goods account for a high share (over 70 %)[62] of total imports, i.e. the volume of imports is closely related to changes in demand. When analysing the changing structure of production, it is important to include the effect of trade as well as domestic demand. International evidence also suggests that domestic demand flows play a dominant role in influencing the structure of the economy (Chenery *et al.*, 1986).

Finally, an analysis of *direct* trade flows ignores the significant *indirect* effects on the intermediates sectors. A rise in exports in one sector indirectly raises output of other sectors from which the export sector draws inputs for production purposes. These sectors in turn have spill-over effects on other sectors. The sectoral bias of these indirect effects is not known.

A useful unified approach to dealing with many of the problems identified above is Syrquin's (1976) extension of the Chenery (1960) decomposition methodology. Using input-output tables, sectoral changes in production can be explained in terms of four demand side factors: domestic demand expansion, export expansion, import substitution and changes in intermediate input usage. This approach is similar to Belli *et al.* (1993) and Tsikata (1999), but includes the indirect effects through the use of input-output tables.

3. Input-output decomposition methodology

The standard gross input-output identity can be written as

Eq 5.1: $$X = A^{d}X + D^{d} + E$$

where X is a vector of sectoral gross output, $A^{d}X$ is a vector of domestically produced intermediate goods, A^{d} is the matrix of domestic inter-industry purchases per unit of sectoral gross output, vector D^{d} is the flow of domestic goods (household consumption, government consumption and capital expenditure) to final domestic demand and E is the vector of exports by sector. Using diagonal domestic content

[62] This value is calculated using data provided in the input-output tables.

ratio matrices for intermediate goods (h) and domestic demand (f) this expression can be written as

Eq 5.2: $$X = hAX + fD + E$$

where AX and D are vectors of domestic plus imported intermediate and final demand goods, respectively.

Letting subscripts 2 and 1 reflect final and initial periods, respectively, changes in output ($X_2 - X_1$) can be expressed as

Eq 5.3: $$\Delta X = h_2 A_2 X_2 + f_2 D_2 + E_2 - (h_1 A_1 X_1 + f_1 D_1 + E_1).$$

Adding and subtracting $h_2A_2X_1$, $h_2A_1X_1$ and f_2D_1 in the right hand side and then simplifying yields

Eq 5.4:
$$\begin{aligned} \Delta X = \; & R(f_2 \Delta D) && \textit{\{row 1\}} \\ & + R(\Delta h A_1 X_1) + R(\Delta f D_1) + R(\Delta E) && \textit{\{row 2\}} \\ & + R(h_2 \Delta A) X_1 && \textit{\{row 3\}} \end{aligned}$$

where $R = (I - h_2A_2)^{-1}$ captures the indirect and direct effects of changes in final consumption of domestic goods by government and households (ΔD) (row 1); the effect of international trade through changes in exports (ΔE) and import penetration in the supply of final goods (Δf) and intermediate goods (Δh) (row 2); and changes in input requirements of intermediate goods (ΔA) (row 3).[63] The treatment of import substitution varies widely across the literature (Chenery, 1960; Chenery *et al.*, 1962; Morley and Smith 1970; Syrquin, 1976). In the approach used here import substitution is defined sectorally as arising from changes in the ratio of imports to intermediate and final demand.[64]

The inclusion of the Leontief inverse, which captures the indirect effects of changes in demand, trade and input-output coefficients, extends the decomposition studies of Belli *et al.* (1993) and Tsikata (1999). In addition, differentiating the impact

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[63] An analogous Laspeyres and Paasche index problem exists with regard to the choice of IO coefficients and volume weights. The decomposition can be defined either using the final year structural coefficients and initial year volume weights (Paasche index) or using the initial year structural coefficients and final year volume weights (Laspeyres index). The arithmetic averages are presented.

[64] Greenhalgh *et al.* (1998) utilise a more complex method where cell-by-cell domestic supply ratios are defined for the A matrix.

of import penetration into changes in the domestic coefficient of final demand (Δf) and intermediate goods (Δh) allows a more nuanced understanding of how changing import patterns are affecting (or being affected) by production changes.

A particular shortcoming of this methodology, however, is that it fails to take into account the interactions between final demand, trade and technology (Baldwin, 1995). While the approach facilitates a description of the changing patterns of trade and production, the possible interactions between these variables are ignored. Speculations on the causes of the changes in the structure of production identified by the decomposition techniques will have to be made outside of the model.

4. Sources of change in production

Input-output tables for South Africa are available for 1984, 1988, 1993 and 1997. These enable a structuring of the analysis to coincide with a period of rising protection, 1984-88, and an acceleration of liberalisation from 1993. The 1984, 1988 and 1993 input-output tables are obtained from Statistics South Africa, formerly Central Statistical Services (CSS, 1989, 1990, 1995). Wharton Econometrics Forecasting Association (WEFA)[65] constructed the 1997 table. The 1993 and 1997 tables are RAS updated versions of the 1988 table which can induce distortions into the results (Parikh, 1979).[66] McDonald *et al.* (1997) further argue that all these tables are 'use' tables and not full input-output tables. Care must thus be taken when interpreting the results.

Deflating input-output tables is a data intensive exercise and requires deflators for both domestic and imported output. Appendix 3 deals with the approach utilised. To test the rigour of the results a variety of alternative deflators were used. No large deviations were evident suggesting that the results are robust to the choice of deflator. Given available data, the input-output tables were aggregated up to 29 industrial sectors defined utilising the 4th edition Standard Industrial Classification system (CSS, 1988). The list of sectors is provided in Table A3.1 in Appendix 3.

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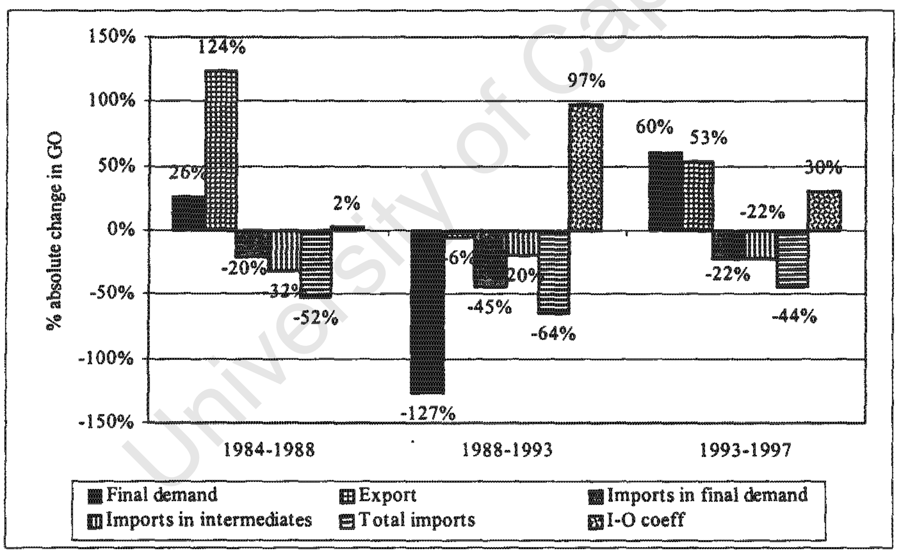
[65] WEFA is now called Global Insight (see www.globalinsight.co.za).

[66] Subsequent to the completion of this study, Statistics South Africa released Supply-Use tables for 1993 and for

4.1 Sources of total gross output growth

Figure 5.1 and Table 5.4 present the decomposition results for the major economic sectors expressed as a percentage of the absolute change in total gross output. Hence, the row and column totals of Table 5.4 sum to either + or - 100 (any differences are due to the exclusion of 'other goods & services' from the table) and the sign reflects the direction of influence. For example, net trade (column 7) in manufacturing accounted for 41.7 % of the total rise in output in 1984-1988 and 21.1 % of the decline in output in 1988-1993. For comparative purposes the total direct effects, excluding the indirect effects, are included in Table 5.4.

Figure 5.1: Sources of growth in total gross output



As shown in Figure 5.1, the relative importance of the factors influencing growth varied considerably across the periods. The results for the growth periods 1984-88 and 1993-97 are fairly typical of results in other decomposition studies, while those for the recessionary period 1988-93 are more volatile. As in other decomposition studies (Chenery *et al.*, 1986; Gregory and Greenhalgh, 1996), domestic demand dominates changes in output growth. This is particularly evident between 1988 and 1993 when declining real incomes depressed demand for final

1998.

goods and accounted for 127 % of the decline in total gross output. Between 1993 and 1997 improved domestic demand has led the recovery contributing 60.5 % of the increase in total gross output. Much of this is due to growth in demand for manufactures, although a recovery in construction and the continuation of Eskom's electrification drive (DTI/IDC, 1998) have raised the contribution by social overhead to 9.2 % (Table 5.4).

Table 5.4: Sources of growth in gross output: Major Sectors, (Percentage absolute value of change in total gross output)

	Average annual growth	Final demand	Export expansion	Import substitution			Net trade	Change in IO coefficient	Total growth contribution
				Final Demand	Intermediates	Total			
	(1)	(2)	(3)	(4)	(5)	(6)=(4+5)	(7)=(6+3)	(8)	(9)
1984-1988									
Agriculture, Forestry and Fishing	7.8	31.2	0.7	3.2	6.0	9.2	9.8	1.6	42.6
Mining and Quarrying	-1.5	15.0	8.9	-4.0	-19.8	-23.8	-14.8	-17.6	-17.5
Total Manufacturing	0.6	-60.1	63.6	-13.2	-8.6	-21.9	41.7	51.1	32.7
Social Overhead	-1.3	-31.2	5.8	-0.8	-2.3	-3.1	2.7	9.8	-18.7
Services	1.1	72.3	41.5	-4.8	-4.7	-9.5	32.0	-50.2	54.0
TOTAL	**0.7**	**25.6**	**123.9**	**-20.1**	**-31.5**	**-51.7**	**72.2**	**2.2**	**100**
Direct effects	0.7	31.2	69.2	-12.7	-19.1	31.8	37.4	31.4	100
1988-1993									
Agriculture, Forestry and Fishing	0.1	-9.1	3.6	-0.2	1.1	1.0	4.6	5.1	0.5
Mining and Quarrying	0	0.7	-27.9	0.4	12.2	12.7	-15.2	14.2	-0.3
Total Manufacturing	-2.5	-49.8	36.7	-35.5	-22.4	-57.9	-21.1	-42.1	-113.0
Social Overhead	-0.2	-29.2	-1.3	-1.1	-0.6	-1.7	-3.0	29.9	-2.3
Services	0.5	-29.1	-16.5	-7.2	-4.9	-12.0	-28.5	79.5	21.9
TOTAL	**-0.9**	**-127**	**-5.9**	**-44.6**	**-19.6**	**-64.3**	**-70.2**	**97.0**	**-100**
Direct effects	-0.9	-60.5	-11.3	-22.6	-7.3	-29.9	-41.1	1.7	-100
1993-1997									
Agriculture, Forestry and Fishing	5	7.5	6.3	-0.1	-0.5	-0.6	5.7	-4.6	8.6
Mining and Quarrying	-1.5	0.5	0.0	-0.3	-5.1	-5.4	-5.4	1.0	-3.9
Total Manufacturing	3.2	34.1	27.2	-11.3	-6.9	-18.2	9.0	-1.7	41.4
Social Overhead	2.6	9.2	2.2	-0.7	-1.1	-1.8	0.4	-0.8	8.8
Services	3.3	9.9	16.3	-8.0	-7.6	-15.6	0.7	32.3	42.9
TOTAL	**2.9**	**60.5**	**53.5**	**-21.7**	**-22.1**	**-43.8**	**9.7**	**29.8**	**100**
Direct effects	2.9	30.5	30.1	-11.7	-12.9	-24.6	5.6	63.8	100

Notes: 'Change in IO coefficient' refers to the change in gross output due to ΔA.

Export growth also played a significant role and alleviated much of the impact of the depressed domestic demand between 1984 and 1993. With declining domestic demand and increased unused capacity, many firms utilised the export market as a 'vent for surplus'. As a result, exports accounted for 123.9 % of the rise in total gross output between 1984 and 1988, with manufactures and services contributing the major share (Table 5.4). During the subsequent period, an appreciating real exchange rate between 1988 and 1992 and the effect of economic sanctions slowed manufacturing export growth. Tsikata (1999) finds both these variables significant in her econometric estimation of an export function for South Africa. Nevertheless, manufacturing exports continued to rise, boosted by continued excess capacity within firms (Belli *et al.*, 1993). The net decline in total exports in 1988-93 is almost entirely due to a decline in mining and service exports. Between 1993 and 1997, export growth recovered accounting for 53.5 % of the rise in total gross output.

On the import side, South African firms were unable to retain domestic market share with negative import substitution occurring within final demand and intermediate goods during all periods. Import penetration was strongest between 1988 and 1993 and accounted for 64.3 % of the decline in gross output. For the other sub-periods, import penetration accounted for between – 43.8 % and – 52.7 % of the rise in total gross output.

Although import penetration appears high, this does not suggest that trade liberalisation has been de-industrialising. Firstly, the negative effect of import penetration was not confined to the period of liberalisation between 1988 and 1997, but was also negative during 1984-88 when protection rose. Secondly, the relatively low effect of import penetration since 1993, a period of re-investment in import intensive machinery & equipment as output growth recovered, suggests that domestic production has remained relatively resilient in the face of trade liberalisation.[67] For example, the decline in growth of total gross output through rising import penetration within manufacturing fell from close to 60 % in 1988-93 to less than 20 % in 1993-97. In the latter period, much of the negative contribution to gross output growth by imports occurred within the transport, storage and communication sector. Within the communications sector this is expected as greater international communication and data flows are a by-product of the spread of information technology.

Thirdly, output growth due to exports has kept pace with losses due to import penetration. In contrast to the 1988-93 period, net trade has positively affected growth

[67] Net investment in machinery and equipment by the manufacturing sector rose 62 % between 1993 and 1997. These values are based on data obtained from SASID (2003).

since 1993 and accounted for 9.7 % of the rise in total gross output in 1993-97. This is even more significant when considering that domestic demand recovered and suggests a rise in export orientation brought about by trade liberalisation.

A further factor influencing growth is technological change, which is captured by changes in the input-output coefficients. A rise in input-output coefficients reflects a 'deepening' of the economy or, put differently, a rise in intensity of intermediate goods used in the production of final goods. From Figure 5.1, it is evident that technological innovations greatly increased inter-sector purchases during the latter two sub-periods. This shift is consistent with the restructuring of production techniques as firms have increasingly adopted the use of information technology and micro-electronic equipment in production (Bhorat and Hodge, 1999). This in turn has helped develop a growing services sector that focuses on the sale and maintenance of information technology equipment. This professional services sector grew at an annual real rate of 10.9 % between 1991 and 1995 (Hodge and Miller, 1999). A contributing factor may have been the increased contracting out of services such as catering, maintenance and cleaning services (Business Day, 2000), as well as certain production activities, as occurred within the clothing industry (DTI, 1997: 61).

The rapid growth and integration into the economy of finance and other business services has enhanced inter-sector linkages further. Deregulation of the financial sector has resulted in a proliferation of microlenders, insurance services and other urban-based consumer-orientated services. The result is a 42.9 % contribution to gross output growth of rising intersectoral service linkages since 1993 (Table 5.4). The expansion and integration of the services sector into the rest of the economy signal a deepening of the economy and is entirely consistent with the pattern of industrialisation outlined by Chenery and Syrquin (1975). Evidence from the United Kingdom also indicates a large positive contribution to growth by the Leontief technology coefficient for financial services (Gregory and Greenhalgh, 1997).

The importance of inter-sector linkages is exemplified further in Table 5.4 in the comparison of the total and direct effects of the various factors influencing growth. In almost all cases, the inclusion of the indirect effects widens the impact of each factor on gross output growth. This is most prevalent within the services sector where, in most cases, the indirect effects more than double the direct effects.

4.2 Sources of output growth in manufacturing

Growth in the economy has been characterised by a rising importance of the service sector, a diminishing importance of the primary sector and a rising capital intensity of manufacturing production. This section takes a closer look into the sources of growth that lie behind the rising capital intensity of manufacturing production.

Table 5.5 disaggregates the sources of manufacturing gross output growth according to the factor-content categories. The results are presented as the percentage absolute change in sectoral gross output, i.e. the row totals equal + or – 100 % and the sign reflects the direction of change in sectoral gross output. For example, net trade (column 7) accounted for 127.7 % of the rise in total manufacturing output between 1984 and 1988.

Table 5.5: Sources of growth in manufacturing
(Percentage absolute sectoral change in gross output)

	Change in gross output	Final demand	Export expansion	Import penetration			Net trade	Change in IO coefficient	Total
				Final Demand	Intermediates	Total			
	(1)	(2)	(3)	(4)	(5)	(6)=(4+5)	(7)=(6+3)	(8)	(9)
1984-1988									
Total manufacturing	**2.4**	**-184.0**	**194.6**	**-40.5**	**-26.5**	**-67.0**	**127.7**	**156.3**	**100**
Capital-intensive	8.5	6.7	96.7	-10.8	-32.7	-43.6	53.2	40.2	100
Intermediate-K-intensive	2.4	-33.8	87.2	-145.1	139.7	-5.4	81.8	52.0	100
Labour-intensive	-5.4	-272.6	79.3	24.9	-43.3	-18.4	60.9	111.7	-100
Ultra-labour-intensive	-3.8	-298.1	-27.8	44.7	-23.3	21.4	-6.3	204.5	-100
1988-1993									
Total manufacturing	**-9.6**	**-44.1**	**32.5**	**-31.4**	**-19.8**	**-51.2**	**-18.7**	**-37.2**	**-100**
Capital-intensive	-9.2	-19.9	44.0	-16.4	-36.4	-52.8	-8.8	-71.3	-100
Intermediate-K-intensive	-11.5	-78.4	17.0	-32.5	11.6	-20.9	-3.9	-17.7	-100
Labour-intensive	-7.9	-14.6	52.7	-65.5	-53.8	-119.3	-66.6	-18.8	-100
Ultra-labour-intensive	-8.2	-73.9	-1.9	-17.6	-4.6	-22.2	-24.1	-2.0	-100
1993-1997									
Total manufacturing	**13.4**	**82.5**	**65.7**	**-27.2**	**-16.8**	**-44.0**	**21.7**	**-4.2**	**100**
Capital-intensive	20.0	40.2	75.0	-5.4	-16.7	-22.1	52.9	6.9	100
Intermediate-K-intensive	3.7	289.7	74.2	-99.3	-39.0	-138.3	-64.1	-125.6	100
Labour-intensive	15.2	99.3	51.4	-41.7	-5.8	-47.5	3.9	-3.2	100
Ultra-labour-intensive	8.2	150.6	16.5	-88.9	-39.0	-127.9	-111.4	60.8	100

Two key features are evident from Table 5.5. Firstly, the relationship between manufacturing demand and exports prior to 1993 provide support for the vent-for-surplus argument. In both sub-periods prior to 1993, declining demand for final products reduced manufacturing performance, but strong export growth alleviated most of the negative impact. This relationship was particularly strong between 1984 and 1988 when export expansion accounted for 194.6 % of the rise in manufacturing gross output. Between 1988 and 1993, a slowdown in world imports and an appreciating real exchange rate reduced export performance. The relatively poor export performance also reflects the inward orientation of South African manufacturing in which domestic market conditions dictate investment decisions. Declining domestic demand negatively affected investment resulting in a 10 % decline in total capital stock in 1984-88, and a 27.8 % decline in the capital stock of machinery and equipment in 1984-91. Thus, as capacity fell, so too did the ability to export.

Since 1993, a mild recovery in growth boosted domestic demand, which accounted for 82.5 % of manufacturing gross output growth. In contrast to the negative relationship between exports and final demand prior to 1993, export expansion also recovered and accounted for 65.7 % of manufacturing growth in 1993-97. This suggests a rising outward orientation of the manufacturing sector.

The second feature of manufacturing output growth is a structural shift towards capital-intensive sectors. The following sub-sections interrogate this development, with an emphasis on the role of trade in inducing these shifts.

Capital-intensive sectors

Relative to the other factor-content categories, the capital-intensive sector has performed well, showing the least decline in output over the entire 1984-93 period and the strongest growth between 1993 and 1997. As a result this sector was the major contributor towards total manufacturing growth, accounting for 134 % and 60 % of total manufacturing growth in 1984-88 and 1993-97, respectively.

A dominant factor underlying this structural shift is the strong growth in capital-intensive exports, particularly of chemicals and chemical products. In the periods 1984-93 and 1993-97, export growth contributed between 75 % and 96.7 % of total output growth of capital-intensive sectors. Between 1988 and 1993, export growth alleviated much of the negative impacts on output growth arising from declining domestic demand and increased import penetration. Capital-intensive sectors are also the only sectors to have consistently shown a positive net *direct* trade effect in all periods. It was only due to significant import penetration in downstream industries between 1988 and 1993, that the net *total* trade effect became negative. The competitiveness of this sector is further reflected in the declining import penetration since 1993. Prior to 1993, import penetration reduced output growth by upwards of 45 percentage points. This fell to 22 % between 1993 and 1997. With continued growth in exports, the contribution of net trade to capital-intensive output growth has risen to 52.9 %.

<u>Ultra-labour-intensive sectors</u>

It is not only the strong performance of the capital-intensive sectors that has induced a change in the structure of domestic production, but also the poor performance of the ultra-labour-intensive sector. This sector experienced negative output growth rates between 1984 and 1993 and relatively low growth rates since 1993. While stagnating real incomes between 1984 and 1993 may account for much of the decline in final demand for these high-income elastic products (see Loubscher, 1990), the poor performance on the trade front suggests more endemic problems during this period.

In contrast to other sectors, exports declined between 1984 and 1993, reflecting the inability of this sector to utilise the export market as a vent for surplus capacity. Two exceptions are evident; the wood & wood products and furniture sub-sectors display very strong export growth over the whole period. The lack of competitiveness of many industries within the ultra-labour-intensive sector is further reflected by the decline in the domestic share of consumption since 1988. Import penetration has accelerated since 1993, with much of the growth in final demand for ultra-labour-intensive products being satisfied through imports. In total, import penetration of final goods accounted for – 88.9 % of growth in ultra-labour-intensive gross output between 1993 and 1997 (- 17.6 % between 1988 and 1993).

The poor export performance in all sub-periods, as well as strong import penetration in final and intermediate goods, suggest severe quality and competitive problems within many of the sub-sectors (leather products, footwear and wearing apparel) that existed prior to trade liberalisation. Trade liberalisation may merely have accelerated the decline of these sectors.

Intermediate-capital-intensive sectors

Trends in the intermediate-capital-intensive sector are largely driven by changes within the motor industry. Poor vehicle sales during 1988-93 lowered output growth, but the recovery in domestic demand for vehicles since 1993 positively affected output growth.

Between 1988 and 1993, import substitution in intermediate goods positively affected output growth, largely as result of the Phase VI programme for the motor vehicle manufacturing industry implemented in 1989. The high local content requirements of the programme effectively protected domestic producers of components (Tsikata, 1999: 54), thus raising the domestic share of motor vehicle related intermediate goods. Since 1993, substantial reductions in tariff rates on completely built-up vehicles and the introduction of the Motor Industry Development Programme (MIDP) in 1995 have raised exports of motor vehicles and led to rapid import penetration in final and intermediate goods. Between September 1994 and January 1996, tariff rates on completely built-up vehicles dropped from 75 % to 36 % for medium and heavy commercial vehicles, and from 115 % to 61 % for light commercial vehicles (Tsikata, 1999: 54). Tariffs on components also fell, but by less, resulting in a decline in the effective protection rate of motor vehicles from 341.8 % in 1994 to 148.4 % in 1998 (IDC, 1997).

The result is a negative contribution of net trade to growth in the intermediate-capital-intensive sector after 1993. This effect has been exacerbated by poor export expansion of food products, as rising domestic consumption has led to a substitution away from the export market and towards the domestic market. A further impact on growth since 1993 has been technological change that has reduced output growth significantly. This is almost entirely due to declines in the input-output coefficients within the food manufacturing sub-sectors.

Labour-intensive sectors

The labour-intensive sector has displayed much volatility during the period, with large declines in growth in 1984-88 and relatively high growth after 1993. As Table 5.5 indicates, much of this arises from fluctuations in demand for final products. Many commodities in this sector are highly income elastic (household electrical durables, televisions) (Loubscher, 1990), resulting in adverse demand effects as per capita income declined. In addition, demand for electrical machinery and non-electrical machinery is closely related to investment expenditure by the private sector, parastatals (Telkom, Eskom) and government (defence expenditure) (Goode, 1995; DTI/IDC, 1998). With the collapse in investment in the early 1980s, demand for these goods declined sharply. Since 1993, renewed investment and the electrification drive of Eskom have boosted demand for electrical machinery (DTI/IDC, 1998).

An interesting feature of this sector is the rapid growth of exports between 1984 and 1993, particularly within the electrical machinery, rubber and plastic products and metal products industries where growth exceeded 12 % per annum. This raised labour-intensive exports as a share of gross output from 4 % in 1984 to 15 % in 1997 (Table 5.3) and contributed to the diversification of the export base (Fallon and Pereira de Silva, 1994; Tsikata, 1999; Black and Kahn, 1998). Export growth has continued to be stimulated by rapid expansion into Southern African countries since sanctions ended. Zimbabwe for example accounts for approximately 19 % and 16 % of total SACU exports of machinery and electrical machinery, respectively.

Although these sectors are already characterised by high import penetration, sharp losses in domestic share reduced growth significantly during 1988-93. The bulk of this arose through increased import penetration within the machinery and equipment and metal products industries. A number of factors lie behind this rise:

- Investment in machinery and equipment within the manufacturing sector recovered in 1991 – this investment is highly import intensive.

- There has been rapid growth in the use of computers and software (Hodge and Miller, 1996), the bulk of which is imported.
- The shift in telecommunications from electromagnetic to more sophisticated digital technology has reduced local content compared to the 1980s (Kaplan, 1990).
- Much of the growth in exports to Africa may also be re-exports of imported high-technology products and other household electrical durables.

Since 1993, import penetration has continued, but strong export growth and weaker import penetration in intermediate goods resulted in a positive contribution of net trade towards growth.[68] This occurred despite the ending of the 'Bulk Supply Agreements' and a reduction in preference for local content by Telkom (DTI, 1997: 16). Interestingly, exports of textiles fell, but significant gains in domestic market share boosted output growth.[69] The increased competitiveness of domestic textile production may reflect the effects of the re-capitalisation of this sector under the World Player Scheme of the Industrial Development Corporation (IDC), which offers low-interest financing to those sectors facing increased global competition and reductions in tariffs. It is estimated that 40 % of new investment in the textiles sector has been underpinned by IDC funding (DTI, 1997: 73).

5. Trade regimes and structural change in manufacturing: An international comparison

Given the highly variable growth of total output during the periods under analysis, it becomes difficult to draw comparisons with other international decomposition studies that generally cover periods of sustained economic growth. Nevertheless, drawing on the extensive international comparative study done by Chenery *et al.* (1986), certain common characteristics of the growth pattern in South African can be discerned. As most of the countries presented in Chenery *et al.* (1986) have shifted from an import substitution to an export promotion trade regime, they are

[68] Import penetration, measured as imports over total domestic supply (gross output + imports – exports), rose from 28.7 % in 1984 to 36 % in 1993 and finally to 42.7 % in 1997 (Table 5.3).

[69] Care must be taken when interpreting the import penetration results for textiles and clothing as large quantities of these goods are smuggled into South Africa. The rise in import penetration may be under-estimated.

useful for a comparison of the effect of trade liberalisation within South Africa. However, because the analyses do not directly link measures of trade liberalisation to changes in the structure of output, the relationships are only suggestive of the effects of trade liberalisation *per se.*

Table 5.6 reproduces the sources of growth table in Chenery *et al.* (1986) and includes the results for South Africa. Values are presented as the percentage change in total manufacturing gross output. As shown in Table 5.6, the dominant source of manufacturing output growth in most countries is domestic final demand. In 23 of the 28 cases, domestic demand expansion accounted for over 50 % of the change in manufacturing output. The growth pattern within South Africa is consistent with these results.

Table 5.6: Sources of growth in manufacturing output for sample economies (Percentage change in manufacturing gross output)

Economy	Years	Growth rate	FD	EE	IS	IO	Comments
Colombia	1953-66	8.3	60.2	6.8	22.2	10.8	IS, Stop go, liberal becoming restrictive
	1966-70	7.4	75.7	4.7	4.2	15.3	IS, restrictive with reform after 1970, IS with EP in late 1960s
Mexico	1950-60	7	71.6	3.1	10.9	14.5	IS
	1960-70	8.6	86.1	4	10.9	-0.9	IS with rising protection
	1970-75	7.2	81.4	7.9	2.4	8.3	IS with rising QRs
Turkey	1953-63	6.4	80.9	2.4	9.1	7.6	IS with rising QRs
	1963-68	9.9	75.1	4.5	10.5	9.9	IS with QRs
	1968-73	9.6	76.2	10.4	-1.6	15	EP, liberalisation
Yugoslavia	1962-66	16.6	73.7	24.8	-5	6.5	EP
	1966-72	9.1	72.1	37.6	-22.1	12.4	EP
Japan	1914-35	5.5	70	33.6	4.7	-8.4	EP
	1955-60	12.6	76.2	11.9	-3.3	15.2	IS with falling import controls
	1960-65	10.8	82.4	21.8	-0.4	-3.8	EP, tariff liberalisation, export incentives
	1965-70	16.5	74.4	17.5	-1.5	9.6	EP, falling tariffs, becoming liberal trade regime
Korea	1955-63	10.4	57.4	11.5	42.2	-11.2	IS with high QRs
	1963-70	18.9	70	30.2	-0.6	0.4	IS becoming EP, export incentives introduced in late 1960s
	1970-73	23.8	39	61.7	-2.6	1.9	EP, export incentives
Taiwan	1956-61	11.2	34.7	27.5	25.5	12.3	IS, high QRs
	1961-66	16.6	49.1	44.6	1.6	4.7	EP, with increasing export incentives
	1966-71	21.1	34.8	57.1	3.8	4.3	EP moving into liberal
Israel	1958-65	13.6	57	26.5	11.7	4.8	IS, EP, rigid QRs gradually removed
	1965-72	11.3	75.8	50	-36.6	10.8	EP becoming liberal, no QRS
Norway	1953-61	5	65.1	36.5	-16.1	14.4	Liberal, low tariffs, QRs on agricultural goods
	1961-69	5.3	51	58.3	-19.4	10	Liberal, low tariffs, QRs on agricultural goods
South Africa	1984-88	0.6	-184.0	194.6	-67.0	156.3	IS, surcharges, QRs
	1988-93	-2.5	-44.1	32.5	-51.2	-37.2	EP, falling surcharges and QRs
	1984-93	-0.9	-108.0	101.8	-92.7	-1.1	
	1993-97	3.2	82.5	65.7	-44.0	-4.2	EP, trade liberalisation, few QRs

Source: Chenery *et al.* (1986) and own calculations.

Notes: FD stands for final demand expansion, EE for export expansion and I-O for input-output coefficients EP for export promotion, IS for import substitution, QRs for quantitative restrictions, A second common feature of the industrialisation process is the sizeable positive output effect of import substitution during the early phases of industrialisation. This has also been shown for South Africa where import substitution accounts for 3 percentage points of manufacturing output growth between 1972 and 1983 (see Table 5.1) (Belli *et al.*, 1993). More importantly, in almost all the countries (except Taiwan), the shift away from an import substitution regime towards a more open regime is accompanied by both a loss in output growth due to import penetration and a rise in output growth due to exports. South African manufacturing is no exception and displays very similar trade patterns in 1993-1997 to Israel in 1965-1972. In both countries significant shifts towards more open trade regimes occurred during these periods. The international evidence thus suggests that, in terms of total trade flows, South Africa's response to trade liberalisation is no different from other countries. Like these countries, the net effect on trade flows is positive, with export expansion exceeding import penetration.

There are differences in the composition of manufacturing trade, suggesting that trade liberalisation impacts on economies in different ways. Unlike Taiwan (1956-71) and Korea (1955-73), where labour-intensive exports initiated export expansion, recent export growth in South Africa has been dominated by capital-intensive-products. This pattern resembles that of developed countries, such as Norway during the 1950s and 1960s (Chenery *et al.* 1986). In a comparative analysis with China, Indonesia and Korea, Tsikata (1999) finds that South Africa has a relatively low share of unskilled-labour-intensive exports and a relatively high share of technology-intensive and human-capital-intensive exports. It appears that South Africa is, paradoxically, moving towards a high-skill and capital-intensive export structure.

6. Sources of the rise in capital intensity of net trade in manufacturing

The possible causes of the rise in capital intensity of net trade in manufacturing are numerous. On the trade front, increased competition with unskilled labour abundant economies such as China and India may be forcing manufacturing production within middle-income countries such as South Africa towards capital-intensive and high-technology sectors. This possibility is reflected in the positive returns mandated to capital by imported product price movements (not tariff liberalisation) shown in Chapter 4. Hayter *et al.* (1999) also find that the producer price for capital-intensive goods rose faster than for intermediate-capital-intensive and labour-intensive goods between 1994 and 1998. Given increased international competition in labour-intensive products, the opportunity for middle-income countries such as South Africa to engage in labour-intensive export strategies may be limited.

While trade liberalisation appears to have influenced the capital intensity of net trade, a number of factors suggest that structural changes in net trade have also been influenced by domestic policies:

- A history of past protection and support has created an economic production structure biased towards capital-intensive sectors.
- While government support, such as the Regional Industrial Development Programme (RIDP) and the Simplified RIDP (for SMMEs), have attempted to promote labour-intensive industries (DTI, 1997: 67), massive investment support programmes for large scale capital-intensive projects have continued. Between 1993 and 1997 the bulk of IDC funds were utilised in the basic metals sector and covered projects such as the Alusaf expansion, Columbus Stainless Steel and Saldahna Steel (DTI, 1997).
- Export subsidies through the General Export Incentive Scheme (GEIS), particularly during its final years, were biased towards capital and intermediate-capital-intensive sectors.

A further reason for the rise in capital intensity of production is the poor performance of the ultra-labour-intensive sector. Given the diversity within this sector it is not possible to draw consistent links between trade liberalisation and performance within this sector as a whole. For example furniture and wood & wood products performed well on the trade front, while 'other manufactures' and wearing apparel performed poorly. However, a number of other factors (poor output growth and export performance prior to 1988) suggest that inherent competitive problems already existed within some of these sectors and that trade liberalisation may merely have accelerated their decline.

7. Conclusion

The evidence presented above suggests that changes in the trade regime during the 1990s did not negatively effect output growth. Key evidence in support of this argument is that exports have continued to contribute towards growth and have exceeded losses in domestic production through import penetration. Although import penetration has risen, this experience is no different to other countries that liberalised trade and continued to grow. These changes reflect a restructuring of the economy as it integrates into the world market. Given continued export growth, it appears that the trade liberalisation process has been reasonably successful in shifting resources towards export production.

However, it appears that increased trade with the rest of the world has induced a structural change in manufacturing production towards capital-intensive sectors. This shift is paradoxical as the high unemployment and abundance of unskilled labour in South Africa suggests that the economy should become less capital intensive. The trend is in conflict with the labour-intensive export drive inherent within the Growth, Employment and Redistribution (GEAR) macroeconomic policy. Further, these structural shifts will have negatively affected employment or remuneration of labour relative to capital. The employment impacts are explored in the Chapter 6.

The extent to which trade liberalisation has induced the structural shifts in the composition of production is, however, uncertain. The analysis does not directly link measures of trade liberalisation to changes in the structure of trade or production. Rather, changes occurring during 1993-97, a period of increased trade liberalisation, are assumed to be the result of trade liberalisation. Nevertheless, the structural shifts towards capital-intensive sectors during the late 1990s are consistent with the positive returns to capital relative to labour mandated by tariff liberalisation (Chapter 4).

This chapter also highlights factors, other than trade liberalisation, that have affected the structure of production and thus employment in South Africa. Domestic supply-side policies have promoted the production of capital-intensive sectors. Endemic competitive problems within ultra-labour-intensive sectors reduced output growth in these sectors since the early 1980s. These trends are unrelated to the liberalisation programme.

The importance of relative factor prices also needs to be considered. Fallon (1992) argues that changes in relative factor prices, driven largely by rising real African wages, contributed towards the rising capital intensity of manufacturing prior to 1990. Since 1994, capital intensity of production may also have been encouraged by new labour legislation, particularly the extension to non-parties of industrial bargaining council wage agreements (Nattrass and Seekings, 2000). Further, wage increases can affect both the composition and growth of exports and imports. It is possible that excessive wage increases, as suggested by the relatively strong real wage growth of less-skilled labour, has contributed towards the rising capital-intensive structure of exports. Chapter 7 explores the relationship between labour cost competitiveness and export performance in more detail.

Chapter 6

Trade Liberalisation and the Occupational Structure of Employment in South Africa: A Factor-Content Analysis*

1. Introduction

Chapter 5 analysed structural changes in the economy and found that production and net trade rose relatively strongly in capital-intensive sectors. This has potentially severe implications for export-led employment growth, particularly of less-skilled labour. The analysis, however, was not directly linked to changes in employment. This chapter extends the input-output decomposition technique used in Chapter 5 to analyse the impact of trade and structural change on occupational employment in South Africa. The methodology used is a factor-content analysis similar to that applied to the United Kingdom by Greenhalgh *et al.* (1998). Although lacking rigorous theoretical foundations, international results using the factor-content approach generally complement price studies. Factor-content studies are also prevalent in South Africa. Unlike the price-effect studies in Chapter 4, tariff changes are not directly linked to employment changes. Therefore, the results are only suggestive of the impact of the tariff liberalisation process.

The chapter is structured in three parts. Section 2 provides a critical overview of existing factor-content based research on trade and employment within South Africa. This is followed in Section 3 by a brief overview of the input-output decomposition methodology used to estimate the impact of changes in production and trade on occupational employment. Section 4 presents the sources of change in occupational employment and Section 5 concludes the chapter.

* A version of this chapter, titled "Globalisation and the skill bias of occupational employment in South Africa", was published in 2001 in the *South African Journal of Economics*, 69, 1: 40-71.

2. Trade and employment in South African: existing evidence

2.1 Factor-content studies in South Africa

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 pattern of trade between 1972 and 1993. They argue that, although exports raised manufacturing employment between 1985 and 1993, reductions in the labour coefficient of exports relative to aggregate manufacturing and imports reduced the rate of growth of employment generated by export expansion.[70] 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 weighted average labour coefficient of imports rose relative to manufacturing between 1972 and 1985, suggesting relatively labour-intensive import-displacing effects. This trend levelled off between 1985 and 1993, but rising import penetration 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.

Their results suggest that, although not driving changes in employment, changes in the structure of trade "*tended to exacerbate the decline in total manufacturing employment which evidently occurred in 1985-93*" (Bell and Cattaneo, 1997: 10). Their conclusion is thus that "*trade liberalisation in particular is likely to have significant adverse effects on manufacturing employment, including employment in relatively low-wage sectors and regions*" (Bell and Cattaneo, 1997: 10).

A problem with this study is that their analysis only extends to 1993 and does not capture the impact of the tariff liberalisation process initiated in 1994. Using a

[70] 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.

similar factor-content approach, but one that analyses the net impact of trade (imports - exports) on employment, Edwards (1999) extends this analysis to 1997. The methodology is drawn from Borkakati (1997) and estimates the employment impact of changes in sectoral Net Import Penetration (NIP), calculated as the ratio of net imports (imports - exports) over total domestic supply (gross output + imports - exports), for each sector. The method first estimates employment, E^*_{t+n}, in period t+n assuming no increase in NIP from period t. The difference between estimated and actual employment in period t+n, $\Delta E_m = E^*_{t+n} - E_{t+n}$, is then a measure of change in employment at time t+n due solely to net import penetration between period t and t+n.[71]

These results are reproduced in Table 6.1, which displays the employment impact of changes in NIP for 25 sectors in 1984-93 and 1993-97. The employment effects are presented as the change in employment over final year employment, $\Delta E_m / E_{t+n}$. The results highlight the contrast in the employment impact of net import penetration between the two periods. Between 1984 and 1993, strong growth in exports relative to imports reduced NIP within most manufacturing sub-sectors and in agriculture, resulting in a net increase in total trade induced employment of 0.92 % of the 1993 employment level. Within manufacturing, strong positive employment impacts were experienced in capital-intensive sectors (4.95%), with slightly lower employment impacts within the intermediate-capital-intensive (1.73%) and labour-intensive (1.4%) sectors. In contrast, the ultra-labour-intensive sector experienced a decline in employment (-0.95%) as a result of rises in NIP.

A dramatic negative employment impact of rising NIP is experienced between 1993 and 1997. Total employment was 2.4 % lower in 1997 than it would have been if NIP had not risen from its 1993 value. This decline in employment was driven by a 28.63 % reduction in mining and quarrying employment as well as a 2.6 % fall in manufacturing employment. The former reflects significant declines in exports, rather than significant increases in imports. Within manufacturing, rising NIP fell hardest on

[71] Following Borkakati (1997), E^*_{t+n} is estimated in the following manner: $E^*_{t+n} = \alpha E_{t+n}$ where $\alpha = (1-NIP_t)/(1-NIP_{t+n})$. Using the definition of NIP, $(1-NIP_t)$ can be expressed as: $Q/(Q+M-X)_t$, i.e the share of domestic output in apparent consumption. α is thus the ratio of domestic output in apparent consumption for respective years. If $NIP_t = NIP_{t+n}$, then $\alpha = 1$ implying that $E^*_{t+n} = E_{t+n}$. If NIP rises such that $NIP_t < NIP_{t+n}$ then $\alpha > 1$

the ultra-labour-intensive sector where employment was 9.13 % lower in 1997 than if NIP not risen from its 1993 level. The relevant percentage reduction in employment values for the intermediate and labour-intensive sectors were 2.82 % and 1.65 %, respectively. Continued high export growth within the capital-intensive sectors positively affected employment, but only marginally. These results are broadly supportive of Bell and Cattaneo (1997) and point to a substantial rise in net labour displacing trade effects coinciding with increased trade liberalisation.

Table 6.1: Employment impact of net import penetration (NIP) (% final year)

	Net import penetration			Employment impact (%)	
	1984	1993	1997	1984-93	1993-97
Agriculture, forestry and fishing	0.03	-0.03	-0.16	6.14	10.85
Mining and quarrying	-1.92	-1.51	-0.95	-16.55	-28.63
Total manufacturing	0.11	0.08	0.10	3.16	-2.01
Capital-intensive	**-0.02**	**-0.06**	**-0.11**	**4.94**	**0.18**
Chemicals and chemical products	0.06	0.12	0.14	-5.96	-2.64
Iron and Steel basic industries	-0.28	-0.99	-0.67	35.65	-19.17
Beverages	0.01	-0.01	-0.01	2.07	0.08
Non-ferrous metal basic industries	-0.52	-0.78	-1.37	14.49	24.96
Paper, printing & publishing	0.07	0.10	-0.01	-2.64	10.18
Intermediate-capital-intensive	**0.11**	**0.08**	**0.11**	**1.73**	**-2.82**
Tobacco products	-0.01	-0.09	-0.07	7.39	-1.32
Transport equipment	0.26	0.27	0.31	-1.38	-5.92
Food manufacturing	-0.02	-0.04	-0.02	1.26	-1.97
Non-metallic minerals	0.06	0.00	0.01	5.74	-1.09
Labour-intensive	**0.27**	**0.27**	**0.31**	**1.40**	**-1.65**
Electrical machinery	0.34	0.33	0.33	1.53	1.18
Rubber and plastic products	0.11	0.10	0.04	1.15	6.99
Machinery and equipment	0.44	0.52	0.58	-15.78	-16.57
Textiles	0.10	-0.03	-0.04	12.96	1.24
Metal products	0.10	0.07	0.08	3.07	-0.89
Ultra-labour-intensive	**0.01**	**0.03**	**0.18**	**-0.95**	**-9.13**
Wood and wood products	0.02	0.00	-0.05	2.79	4.44
Other manufactures	0.16	0.26	0.48	-12.24	-43.26
Leather products	-0.29	0.00	0.16	-28.70	-19.11
Furniture	-0.03	-0.09	-0.03	5.28	-5.30
Footwear	0.10	-0.01	0.21	10.51	-27.60
Wearing apparel	-0.12	-0.09	-0.03	-2.81	-5.36
Social overhead	0.00	0.00	0.00	-0.03	-0.14
Services	-0.03	-0.03	-0.02	-0.09	-0.83
TOTAL	**-0.02**	**-0.03**	**0.00**	**0.92**	**-2.41**

Notes: Trade data are taken from the input-output tables while employment data are obtained from Statistics South Africa and WEFA. Estimates are calculated using real values of exports and imports deflated using gross output deflators and import price indices from SA manufacturing Statistics and Jansen and Joubert (1998) (see Appendix 3).

Bhorat (1999) applies the Katz and Murphy (1992) approach to South African trade data between 1970 and 1997. This approach uses a factor-content procedure to

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and $E^*_{t+n} > E_{t+n}$.

estimate shifts in relative demand due to changes in net exports. Bhorat (1999) finds that trade between 1970 and 1995 positively benefited all occupations, but disproportionately favoured skilled labour with a matric or tertiary education. Looking at shorter periods since the 1980s, Bhorat (1999) finds that trade raised overall employment within manufacturing during the early 1980s, but reduced employment from the late 1980s. Further, less-skilled labour benefited relative to skilled labour during the early 1980s, but was worse off during the late 1980s. His results complement those of Bell and Cattaneo (1997) and he (1999: 18) concludes: "*This changing tariff regime clearly had the impact of significantly reducing total manufacturing employment levels*".

These results *prima facie* suggest that trade liberalisation has had severe adverse effects on employment, particularly through its impact on ultra-labour-intensive sectors. A closer look at these studies casts some doubt on this conclusion.

2.2 Deficiencies in existing factor-content studies in South Africa

Other than the general methodological problems associated with the use of factor contents to estimate the impact of trade on factors, these approaches suffer some additional problems.

First, although these methodologies identify sectoral shifts towards capital-intensive exports and ultra-labour-intensive imports, it is not clear why these shifts occurred or to what extent trade liberalisation as opposed to changes in demand (domestic and international), labour productivity, technology and/or real wages lie behind these shifts. As a result, these methodologies implicitly assume a direct causation from trade flows to changes in the domestic production structure. This is particularly problematic in South Africa as imports and exports (vent-for-surplus hypothesis) are closely related to changes in domestic demand.

As reviewed in Chapter 3, international evidence on the relationship between trade and employment is mixed with the bulk of research finding that the impact of trade (if any) is small. By far the dominant force influencing the skill structure and level of employment appears to be domestic demand shifts and technology

(Lawrence, 1983; Lawrence and Slaughter, 1993; Baldwin and Cain, 2000; Berman *et al.*, 1997; Gregory and Greenhalgh, 1997; Greenhalgh *et al.*, 1998).

Indirectly the results of Bell and Cattaneo (1997) support the dominant role played by technology. While relative shifts in the sectoral composition of exports towards capital-intensive sectors accounted for 36 per cent of the decline in average weighted labour coefficient of exports, the remaining 64 per cent has arisen from declining labour coefficients (technology) within individual exporting sectors. On the import side, sectoral shifts in imports only accounted for 17.3 per cent of the decline in the average weighted labour coefficient with the remaining 82.7 per cent due to technological change.

The results of Bhorat (1999) also exaggerate the negative impact of trade on employment of less-skilled labour. In the estimation of relative demand shifts, Bhorat (1999: 15) assumes that imports only displace production (less-skilled) workers.[72] This is an approach followed by Katz and Murphy (1992), but is premised on the assumption that the economy is developed and that imports substitute less-skilled labour, but complement skilled labour. This assumption does not necessarily hold in a middle-income economy like South Africa. Further, the approach assumes that imports are perfect substitutes for domestic production. The strong growth in intermediate and capital good imports during the 1990s in response to output growth and investment exaggerates the negative impact on the demand for labour, particularly the less-skilled.

A further concern is that the estimations of Bell and Cattaneo (1997), Edwards (1999) and Bhorat (1999) focus only on the *direct* impacts of trade flows and ignore the extensive *indirect* affect of trade on intermediate sectors. A rise in exports in one sector indirectly raises output in other sectors through intermediate demand effects. These sectors in turn have spill-over effects on other sectors. These effects may be large in South Africa where industrial restructuring has resulted in the contracting out of processes and services previously conducted in-house. The direct losses in employment from this process are partially offset by expanded employment in the

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[72] Although it is not clear what categories of less-skilled workers are included in this category.

sector to which the input is contracted out. Further, inter-sectoral linkages have risen, as shown in Chapter 5, with the extensive diffusion of finance, information technology and other business services into the economy. It is, thus, imperative that these indirect effects be captured.

Finally, analysis of the impact of trade on the skill intensity of South African production has yielded contradictory results. Evidence by Bell and Cattaneo (1997), Tsikata (1999) and Bhorat (1999) suggest that trade flows are becoming more skill intensive.[73] In contrast, the econometric analyses of Dias (1998) and Fedderke *et al.* (1999) suggest that trade has positively affected the demand for unskilled labour.[74]

This discussion highlights some of the key areas of analysis not covered by existing research on trade and employment in South Africa. While no single methodology can cover all of these issues, an extension of the input-output decomposition approach used in Chapter 5 can overcome many of the shortcomings raised above. In the following section the input-output decomposition methodology, drawn from Greenhalgh *et al.* (1998), is presented.

3. Decomposition methodology

Using employment coefficient matrices, the employment impact of changes in gross output can be estimated as

Eq 6.1: $$\Delta N = n\Delta X + \Delta n X$$

where ΔN is change in total employment and n is a vector of employment coefficients per unit gross output (see Gregory and Greenhalgh, 1997). Changes in total employment are attributable to changes in sector gross outputs at constant labour use ($n\Delta X$) and to changes in labour use per unit output ($\Delta n X$). Greenhalgh *et al.* (1998) extend this analysis and decompose N into a vector of total employment according to occupational category. As a result, n becomes an occupation by industry matrix

[73] Bhorat and Hodge (1999) show a general rise in the skill intensity of production across all production sectors. Unfortunately the role of trade in inducing these shifts was not dealt with.

[74] Bell and Cattaneo (1997) and Dias (1998) use race as a proxy for skill. White labour is assumed to be skilled while African labour is assumed to be unskilled.

denoting the input of each occupation group (i.e. high skill, intermediate skill and low skill) required to produce one unit of gross output in each industry sector.

By substituting Eq 5.4 of Chapter 5 into Eq 6.1, the occupational employment impact of structural change (ΔN) can be expressed as:

Eq 6.2:

$$\begin{aligned} \Delta N = \ & nR(f\Delta D) && \textit{\{row 1\}} \\ & + nR(\Delta hA)X + nR(\Delta fD) + nR(\Delta E) && \textit{\{row 2\}} \\ & + nR(h\Delta A)X + \Delta nX && \textit{\{row 3\}} \end{aligned}$$

As in the gross output decomposition explanation, row 1 gives the occupational employment impact attributed to changes in final demand; row 2 the impact attributed to trade flows; and row 3 the impact attributed to "technological change". This approach interprets technological change as changes in labour embodied in intermediate goods purchased by firms as inputs, as well as changes in the labour coefficient of gross output (commonly regarded as an indicator of labour productivity).

The decomposition analysis in this section advances the work of Bell and Cattaneo (1997) and Bhorat (1999) by extending the analysis to sectors other than the manufacturing sector. Also, through the Leontief inverse, both the direct and indirect effects of changes in demand, trade and input-output coefficients are captured. Finally, imports only affect employment through changes in import penetration in final demand and intermediate good use. Imports associated with increased production or final consumption do not displace labour.

4. Occupational impact of economic growth

The details regarding the input-output tables used in the analysis have already been discussed in Chapter 5. To analyse the occupational employment impact of structural change, data on occupational employment by industry is required. At the time of this study this data were not available.[75] Considerable effort was thus

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[75] Subsequent to this study employment data for three skill categories (highly skilled, skilled and semi & unskilled) were made available by the Trade and Industrial Policy Strategies (TIPS) (SASID, 2003). The data

expended on creating occupation by industry matrices for years that corresponded to the respective input-output tables. Most of the data were obtained from the various censuses and the October Household Surveys (OHS). Nine occupation categories were defined according to the 1988 International Standard Classification of Occupations (ISCO88, 1990), as is currently the practice in the OHS and the 1996 Census.

The defining of disaggregated industrial sectors was more problematic. Not all sources of data had detailed breakdowns of manufacturing sub-sectors necessitating an aggregation and simplification of the occupation by industry matrices. As opposed to the 29 sector classification utilised to decompose production, a 13 sector industrial classification was utilised. The primary simplification occurred within the manufacturing sector in which sectors were classified into capital-intensive, intermediate-capital-intensive, labour-intensive and ultra-labour-intensive categories. Further details are provided in Appendix 3.

The occupation by industry matrices were then adjusted to ensure consistency with a range of national data sources. Employment data for agriculture, mining and quarrying, social overhead and services are taken from the Standardised Employment Series (SES) obtained from Statistics South Africa. Manufacturing employment is drawn from WEFA and closely follows employment trends within the Industrial Development Corporation (IDC) Sectoral Data Series database (IDC, 1995). The data differs slightly from the TIPS South African Standardised Industry database (SASID, 2003) that was used in Chapter 4. All these employment series are originally derived from CSS (re-named Statistics South Africa) surveys.

Much controversy surrounds the reliability of South African statistical series on employment (Standing *et al.*, 1998). Standing *et al.* (1996) argue that the long-run employment series underestimate new employment creation, as the firm-based surveys do not capture new and non-regular forms of employment such as sub-contracting and out-sourcing. In addition, these series only measure formal employment and ignore employment within the burgeoning informal sector. Shifts

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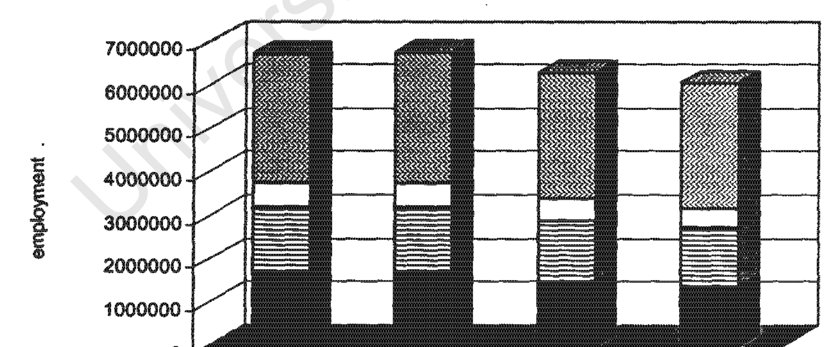
constructed here was used in the analysis as it provides more detail at the occupational level.

from formal to informal employment through outsourcing and sub-contracting are not captured in this analysis. Significant underestimation of employment is probable.[76]

4.1 *Rising skill intensity of production*

As Figure 6.1 shows, total non-government employment rose slowly during the 1980s, but then fell sharply to below pre 1984 levels during the 1990s. Whereas formal sector non-government employment in 1984 was 6.73 million, by 1997 it had fallen to 6.05 million. During the 1980s, expanding employment within the manufacturing and services sector raised overall employment, although this growth was tempered by negative employment growth within the primary and social overhead sectors. Since 1988, employment has declined in all sectors, but most severely within the primary sector where it fell from 1.67 million in 1988 to 1.39 million in 1997. This reflects the poor performance of the mining sector, but also significant labour shedding within agriculture.

Figure 6.1: Total employment according to economic sector



	1984	1988	1993	1997
Services	2968300	2978200	2880300	2869781
Social Overhead	566300	561200	497500	424688
Manufacturing	1476756	1532528	1409150	1364529
Primary	1716600	1670700	1493100	1392811

[76] Total employment estimated by the SES for 1995 is 7.723 million while the 1995 OHS estimates (after adjustments by Klasen and Woolard, 1999) total employment to be 10.178 million. Large differences appear in the estimation of Agricultural employment with the SES series measuring employment at 853 thousand in 1995 and the 1995 OHS giving a value of 1.27 million. Other significant differences exist with employment estimates within the Community Services and the Trade sectors.

Table 6.2: Occupational employment according to broad economic sector (% column total)

	Primary sector	Manufacturing	Capital-intensive	Intermediate-capital	Labour-intensive	Ultra-L-intensive	Social Overhead	Services	Total
1984									
Skilled	2.1	9.6	11.6	8.0	11.9	5.9	9.3	15.1	10.1
Semi-skilled	22.4	39.4	33.5	35.2	38.3	53.8	58.7	20.8	28.5
Unskilled	12.3	30.1	33.9	31.4	31.3	21.7	13.7	25.3	22.0
Elementary	62.5	16.2	15.9	21.1	12.9	15.0	14.6	36.8	37.0
Total	1716600	1476756	349685	390896	448475	287700	566300	2968300	6727956
1997									
Skilled	6.9	20.2	22.3	18.3	24.3	14.3	12.5	23.7	18.2
Semi-skilled	26.9	29.5	30.4	24.9	29.0	34.5	57.9	20.4	26.6
Unskilled	21.7	23.6	22.9	25.3	22.4	24.0	7.5	21.8	21.2
Elementary	43.2	21.0	18.9	27.4	17.6	20.6	20.3	31.2	30.9
Total	1392811	1364529	307335	341229	422258	293707	424688	2869781	6051808

Sources: See Appendix 3 for details on the data sources.

Notes: Skilled labour consists of professionals, technicians and managers (ISCO88 groups 1, 2 and 3). Semi-skilled labour consists of clerks, skilled agriculture and craft and related trades workers (ISCO88 groups 4, 6 and 7). Unskilled labour consists of service workers and plant and machine operators (ISCO88 groups 5 and 8). Elementary labour consists of elementary occupations such as mining, construction and agricultural labourers, domestic servants, sweepers, street vendors, etc. (ISCO88 group 9).

A noticeable characteristic of the employment structure is the skill bias associated with the decline in employment. Most of the reductions in employment have been achieved through the shedding of lower skilled labour while increases in employment have been concentrated amongst high skilled labour (Table 6.2). The share of elementary labour (ISCO88 category 9) in total employment fell from 37 % in 1984 to 31 % in 1997, largely as result of reductions in the number of agricultural and mining and quarrying labourers. As a share of primary sector employment, elementary employment fell from 62.5 % in 1984 to 43.2 % in 1997.

In contrast, the share of high skilled employment (professionals, technicians and managers – ISCO88 categories 1 to 3) rose in all sectors, with very strong growth occurring within the manufacturing sector. As a share of total employment, high skilled labour rose from 10.1 % to 18.2 % between 1984 and 1997. The shares of semi-skilled and unskilled labour in total employment have maintained relatively constant over time.

4.2 Sources of change in the structure of total employment

Table 6.3 shows the sources of change in employment for each major sector that are estimated using the input-output decomposition techniques. In this table, total employment changes are attributed to changes in final demand, exports, import penetration and technology. The impact of each factor on employment is expressed as a percentage of the level of total employment in the initial year.

Table 6.3: Sources of change in the structure of total employment (% initial year total SA employment)

1984-88	**Total**	**Final demand**	**Exports**	**Imports**	**Net trade**	**Technology**
Primary	-0.68	3.65	0.43	-0.08	0.35	-4.69
Manufacturing	0.83	-1.55	0.78	-0.23	0.56	1.82
Capital-intensive	*0.14*	*0.03*	*0.42*	*-0.19*	*0.23*	*-0.12*
Intermediate-K-intensive	*0.06*	*-0.05*	*0.12*	*-0.01*	*0.11*	*0.00*
Labour-intensive	*0.13*	*-1.01*	*0.29*	*-0.07*	*0.23*	*0.91*
Ultra-labour-intensive	*0.50*	*-0.52*	*-0.05*	*0.04*	*-0.01*	*1.03*
Social overhead	-0.08	-1.05	0.08	-0.04	0.04	0.94
Services	0.15	3.24	1.31	-0.22	1.09	-4.18
Total	0.22	4.29	2.60	-0.57	2.03	-6.10
Empl change	14673	288437	174986	-38337	136649	-410414
1988-93						
Primary	-2.63	-0.83	-0.94	0.67	-0.26	-1.54
Manufacturing	-1.83	-1.00	0.63	-1.17	-0.54	-0.29
Capital-intensive	*-0.24*	*-0.10*	*0.22*	*-0.27*	*-0.04*	*-0.09*
Intermediate-K-intensive	*-0.53*	*-0.53*	*0.12*	*-0.14*	*-0.03*	*0.03*
Labour-intensive	*-0.47*	*-0.08*	*0.30*	*-0.68*	*-0.38*	*-0.01*
Ultra-labour-intensive	*-0.60*	*-0.28*	*-0.01*	*-0.08*	*-0.09*	*-0.22*
Social overhead	-0.94	-1.17	-0.03	-0.02	-0.05	0.28
Services	-1.45	-1.63	-0.54	-0.52	-1.06	1.23
Total	-6.86	-4.63	-0.87	-1.04	-1.91	-0.32
Empl change	-462579	-312271	-58950	-70054	-129004	-21303
1993-97						
Primary	-1.60	2.43	1.96	-0.97	0.99	-5.01
Manufacturing	-0.71	2.56	1.46	-1.45	0.01	-3.28
Capital-intensive	*-0.57*	*0.38*	*0.72*	*-0.21*	*0.51*	*-1.46*
Intermediate-K-intensive	*-0.29*	*0.59*	*0.15*	*-0.28*	*-0.13*	*-0.76*
Labour-intensive	*-0.05*	*1.04*	*0.54*	*-0.50*	*0.04*	*-1.12*
Ultra-labour-intensive	*0.20*	*0.55*	*0.06*	*-0.46*	*-0.40*	*0.06*
Social overhead	-1.16	0.69	0.10	-0.10	0.00	-1.86
Services	-0.17	4.55	1.76	-1.80	-0.04	-4.67
Total	-3.63	10.23	5.28	-4.32	0.96	-14.82
Empl change	-228241	642176	331899	-271463	60436	-930853

Looking first at the total impact, it is apparent that final demand and technology are the primary sources of change in employment. This result is consistent with the input-output decomposition studies of Celasun (1983), Chenery *et al.* (1986), Lawrence (1993), Gregory and Greenhalgh (1997) and Greenhalgh *et al.* (1998). Between 1984 and 1988, reductions in employment were almost entirely driven by labour displacing technological change (- 6.1 %). However, positive growth in final demand within the agricultural and service sector aided by strong export growth offset this decline and gave rise to a net employment increase of 0.22 %.

For the rest of the 1980s and early 1990s, negative growth in final demand arising from falling incomes dominated and accounted for two thirds of the 6.86 % decline in employment. With the recovery in GDP growth in 1993, final demand for primary, manufacturing and service sector goods boosted employment by 10.23 %. However, this growth was still not sufficient to overcome technological change within all the sectors that reduced employment by 14.8 %. The net effect was a reduction in employment of 3.6 %.

While trade has not dominated, it has still played a significant role in influencing employment. Exports raised employment by 2.6 % in 1984-88, with much of this arising within the transport and communications services sub-sectors. Although services are not extensively traded, strong indirect effects arising from export growth within the manufacturing sector account for close to 50 % of export-led employment growth within the services sector. This again highlights the importance of including indirect effects.

Although export-generated employment was low between 1988 and 1993, it expanded rapidly raising total employment by 5.3 % between 1993 and 1997. The key sectors giving rise to this growth were the agricultural, manufacturing and, through the indirect effects, the services sector. Of interest is the continued strong export growth within manufacturing despite the recovery in final demand for manufactured products. This is a strong contrast to the 1984-93 period when the export market was used to offset declining domestic demand (Bell *et al.*, 1993). Also evident are the relatively strong employment impacts of export growth within the capital and labour-intensive sectors. Of concern are the very low levels of employment generated through ultra-labour-intensive exports.

While export generated employment appears favourable, the impact of net trade on employment is less so. Net trade (export-generated employment – employment lost due to rising import penetration) raised employment by 2.03 % in 1984-88, but by only 0.96 % in 1993-97. The primary cause is progressively rising losses in employment due to import penetration. Between 1993 and 1997, a period of increasing trade liberalisation, the losses in domestic share due to import penetration reduced employment by 4.32 %.

The effect of import penetration between 1993 and 1997 is more severe than is suggested by the results. The net trade effect is positive largely as result of the primary sector, which is characterised by strong export growth and low import penetration. If the primary sector is excluded, net trade becomes negative. Manufacturing only experienced a 0.01 % rise in employment due to net trade.

Although the employment impact of net trade is low, the results do not support the view that trade liberalisation has significantly reduced total employment. Firstly, although import penetration has risen, the negative employment impact has been offset by rising exports. This experience by South Africa is not unique, as is evident in the multi-country input-output decomposition study by Chenery *et al.* (1986), where in all countries that moved towards trade liberalisation, import growth was matched by export growth (see Chapter 5).

Secondly, a number of changes in the economy since 1993 may have exaggerated the level of import penetration and thus the loss in employment estimated. The recovery, albeit slow, in investment growth boosts imports relative to demand for domestic products and hence raises import penetration. Further, the partial deregulation of the telecommunications industry and the emergence of the cellular phone industry in 1994 has raised imports of technology-intensive telecommunication equipment (DTI/IDC, 1998). As much of these products were not initially domestically sourced, their importation will not have displaced domestic production.

Thirdly, the low net trade effect for manufacturing is largely due to problems within the ultra-labour-intensive sector where very poor export growth, combined with significant import penetration, reduced total employment by 0.4 % between 1993 and 1997 (or manufacturing employment by 1.8 %).[77] The ending of the 'structural adjustment program' for textiles and clothing in 1994, which encouraged low quality

[77] The intermediate-capital-intensive sector also experienced a negative net trade effect, largely as result of a rise in demand for imported motor vehicles.

finished clothing imports (Roberts, 1998: 58), and difficulties surrounding access to duty credits provided under the Duty Credit Certificate Scheme (DCCS) (WTO, 1998) may have exacerbated the negative employment impact within the ultra-labour-intensive sector. However, poor export performance, declining output and rising import penetration in sectors such as wearing apparel and leather products between 1984 and 1988, despite rising protection, suggest that these sectors were already experiencing competitiveness problems.[78] The poor performance of these sectors subsequent to 1993 may reflect inherent competitive problems that have been sharply exposed by declining tariff levels.

This does not imply that trade liberalisation has had no impact on production. A stipulated aim of the South African government's Growth, Employment and Redistribution policy is the promotion of export led employment growth. While exports generated 5.28 % employment growth between 1993 and 1997, this only translates into a 1.3 % annual average compound growth rate. This level of growth is clearly insufficient to reduce unemployment in South Africa while the population growth rate exceeds 2 % per annum. Further, declining export growth and rapid import penetration within ultra-labour-intensive sectors, combined with a shift towards capital-intensive exports, suggests a restructuring of the economy that has diminished the capacity of trade to generate employment.

Once again, however, the extent to which trade liberalisation lies behind the rise in capital intensity of net trade in South Africa is not clear. As discussed in Chapter 5, domestic policies have also encouraged structural shifts in production towards capital-intensive sectors.

4.3 Source of change in the occupational structure of employment

Turning to the occupational impact, Table 6.4 shows the total change in employment by occupation and the primary sources of change derived according to the decomposition methodology. For comparative purposes the total *direct* effect

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[78] The domestic share of final demand rose for wearing apparel between 1984-88. This does suggest that protection enabled a degree of import substitution during this period. When including import penetration in intermediate goods, though, a net loss in domestic share occurred.

(excluding the indirect linkages) is also included. The results are presented as the percentage change in initial year total employment. Table A4.1 in Appendix 4 presents the results according to a more detailed occupational breakdown.

As Table 6.4 shows, total employment change is characterised by an increasing skill bias against low skilled labour. Employment of high skilled labour (professional and managerial occupations) rose in all periods, but very strongly between 1993 and1997, when it raised total employment by 3.09 %. Elementary employment, in contrast, has consistently fallen and accounted for the bulk of the decline in employment experienced since 1988. Employment of semi-skilled and unskilled labour has also been poor since the early 1980s and is also characterised by an accelerated decline since 1993.

Table 6.4: Occupational impact of economic growth (% initial year total SA employment)

1984-88	**Final Demand**	**Exports**	**Import substitution**	**Net trade**	**Technology**	**Employment change**
Skilled	0.29	0.33	-0.12	0.21	1.37	1.87
Semi-skilled	-0.08	0.76	-0.44	0.32	-0.65	-0.41
Unskilled	0.33	0.82	-0.35	0.47	0.13	0.94
Elementary	3.78	0.62	0.36	0.98	-6.06	-1.30
Total	4.29	2.60	-0.57	2.03	-6.10	0.22
Employment change	288437	174986	-38337	136649	-410414	14673
Total direct effect	3.6	1.46	-0.24	1.22	-4.61	
1988-93						
Skilled	-0.49	-0.09	-0.22	-0.31	2.38	1.58
Semi-skilled	-1.33	-0.46	-0.25	-0.72	-0.41	-2.46
Unskilled	-0.95	-0.25	-0.40	-0.65	0.78	-0.82
Elementary	-1.78	-0.08	-0.13	-0.21	-2.43	-4.42
Total	-4.63	-0.87	-1.04	-1.91	-0.32	-6.86
Employment change	-312271	-58950	-70054	-129004	-21303	-462579
Total direct effect	-2.54	-1.11	-0.10	-1.21	-3.11	
1993-97						
Skilled	1.39	0.75	-0.74	0.01	1.70	3.09
Semi-skilled	1.91	1.20	-1.32	-0.12	-3.63	-1.84
Unskilled	1.77	1.23	-1.13	0.10	-5.18	-3.31
Elementary	4.97	2.01	-1.03	0.98	-9.66	-3.72
Total	10.23	5.28	-4.32	0.96	-14.82	-3.63
Employment change	642176	331899	-271463	60436	-930853	-228241
Total direct effect	7.20	3.40	-2.68	0.72	-11.56	

Once again the dominant source of employment changes is technology. A feature of this technological change is the striking skill bias that reduced elementary employment by 6.1 % in 1984 – 88 and a further 9.66 % in 1993 – 97. In the latter period, the impact of technological change on employment progressively worsens as one moves down skill levels. The bulk of employment losses due to technology have been through direct labour saving with increased use of intermediates positively contributing towards elementary employment growth prior to 1993. Since 1993 declining use of intermediate goods with high elementary labour contents reinforced the reduction in elementary employment through direct labour saving.

It is evident from Table 6.5, which displays the sources of occupational change according to sector for 1993-97, that the primary and services sector account for most of the decline in elementary employment arising from technological change (3.42% and 6.41 % of total South African employment in 1993, respectively). In the former sector, falling elementary employment arose from reductions in the number of domestic servants within the 'community services' sector, while in the latter, substantial retrenchments of agricultural labour are primarily responsible. This data ignores seasonal labour so these values exaggerate the effect of technological change.

Within manufacturing, technological change marginally raised employment of elementary labour. However, large declines in unskilled labour, consisting of service workers and plant and machine operators, occurred due to technology. Employment of semi-skilled labour also declined. The skill-bias of technological change is thus also evident within the manufacturing sector.

The impact of technology on skilled employment is in stark contrast to that of less-skilled labour as it contributed positively towards employment of skilled labour in all sub-periods. This growth arose through a rise in the skilled labour coefficient of production ($L_{skilled}/Q$) and an increase in skilled labour used directly and indirectly through intermediate good purchases. The rising skilled labour coefficient reflects the adoption of skill-biased technology in the production process.

The rise in skilled labour used in intermediate products (due to changes in input-output coefficients) is largely due to the expansion of electronic banking and other business services into the economy. As these sectors permeate through the economy, so intersectoral linkages that positively affect high skilled employment rise. Increased sub-contracting, particularly of information technology related services

(Hodge and Miller, 1996), has further boosted the skill bias of changing intersectoral linkages. In contrast, changing intersectoral linkages have negatively affected less-skilled employment. Growth in the economy since 1993 has been characterised by reductions in input-output coefficients for the agricultural sector, a pattern consistent with the industrialisation path outlined by Chenery (1979). The impact has been a reduction in demand for elementary skilled labour.

The skill bias of final demand and trade is less striking than in the case of technology, with elementary employment the most positively affected by changes in these variables during the growth periods 1984-88 and 1993-97. During the recession, declining demand reduced elementary employment the most. The elementary skill bias in demand is almost entirely due to final demand changes within the agriculture and community service sectors (Table 6.5). These sectors are highly intensive in elementary labour use (over 60 % of total sector employment) and, because they together account for approximately 30 % of total employment, small changes in final demand have large impacts on elementary employment. Within manufacturing, less of a bias is evident and most of the final demand impact falls on semi and unskilled labour (Table 6.5). Since 1993, semi-skilled employment has been largely boosted by positive growth in final demand for ultra-labour-intensive and capital-intensive products, which are large employers of craft and related trades workers.[79]

[79] The bulk of the change in final demand is accounted for by the 'other manufactures' sub-sector of the ultra-labour-intensive category. Relative to the average for ultra-labour-intensive sectors, this sector uses elementary labour less intensively and semi-skilled labour more intensively. The overall impact on semi-skilled labour may thus be exaggerated while the impact on elementary skilled employment may be under-estimated.

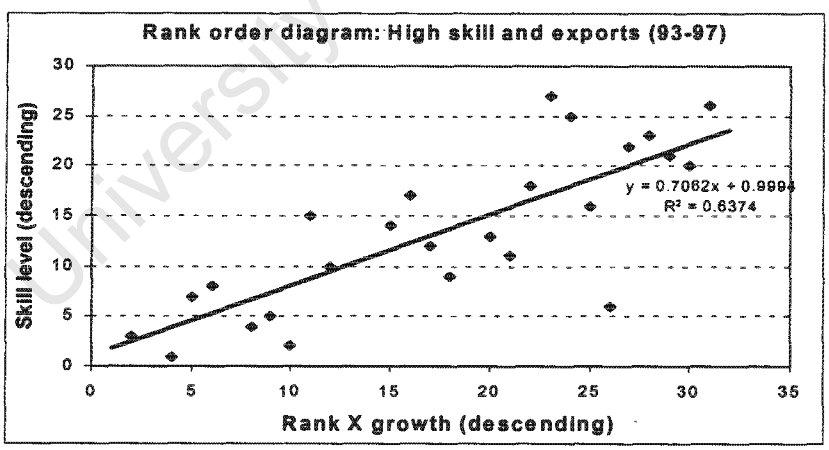
Table 6.5: Sources of occupational employment change according to sector, 1993-97 (% initial year total SA employment)

	Manufacturing						Services						Primary sector					
1984-88	**Total**	**Final demand**	**Exports**	**Imports**	**Net trade**	**Technol ogy**	**Total**	**Final demand**	**Exports**	**Imports**	**Net trade**	**Technolo gy**	**Total**	**Final demand**	**Export s**	**Imports**	**Net trade**	**Techno logy**
Skilled	0.56	-0.17	0.10	-0.03	0.07	0.66	0.92	0.52	0.20	-0.04	0.16	0.24	0.21	0.05	0.02	-0.04	-0.02	0.19
Semi-skilled	-0.39	-0.64	0.26	-0.07	0.19	0.05	-0.06	0.64	0.31	-0.07	0.24	-0.94	0.33	0.56	0.15	-0.28	-0.13	-0.09
Unskilled	0.74	-0.46	0.26	-0.08	0.18	1.01	-0.03	0.60	0.46	-0.10	0.37	-0.99	0.36	0.30	0.08	-0.17	-0.08	0.14
Elementary	0.34	-0.22	0.12	-0.03	0.09	0.48	-0.34	1.44	0.30	-0.01	0.29	-2.07	-1.53	2.73	0.18	0.41	0.59	-4.85
Total	**0.83**	**-1.55**	**0.78**	**-0.23**	**0.56**	**1.82**	**0.15**	**3.24**	**1.31**	**-0.22**	**1.09**	**-4.18**	**-0.68**	**3.65**	**0.43**	**-0.08**	**0.35**	-4.69
Empl change	55773	-104131	52652	-15197	37455	122448	9900	217754	87877	-14775	73102	-280956	-45900	245688	29054	-5401	23653	-315241
Total direct effect	*0.83*	*-1.19*	*0.45*	*-0.11*	*0.34*	*1.68*	*0.15*	*3.03*	*0.80*	*-0.03*	*0.77*	*-3.65*	*-0.68*	*2.70*	*0.21*	*-0.10*	*0.11*	*-3.87*
1988-93																		
Skilled	0.32	-0.11	0.09	-0.17	-0.08	0.51	1.07	-0.23	-0.10	-0.09	-0.18	1.48	0.09	0.00	-0.08	0.04	-0.04	0.14
Semi-skilled	-1.21	-0.35	0.21	-0.40	-0.19	-0.67	0.04	-0.26	-0.13	-0.10	-0.24	0.54	-0.62	-0.06	-0.52	0.26	-0.26	-0.29
Unskilled	-0.08	-0.33	0.22	-0.39	-0.18	0.43	-0.45	-0.44	-0.20	-0.14	-0.34	0.33	-0.02	-0.07	-0.26	0.14	-0.12	0.16
Elementary	-0.50	-0.19	0.10	-0.18	-0.08	-0.24	-1.86	-0.68	-0.10	-0.18	-0.28	-0.90	-2.03	-0.70	-0.07	0.23	0.17	-1.50
Total	**-1.83**	**-1.00**	**0.63**	**-1.17**	**-0.54**	**-0.29**	**-1.45**	**-1.63**	**-0.54**	**-0.52**	**-1.06**	**1.23**	**-2.63**	**-0.83**	**-0.94**	**0.67**	**-0.26**	-1.54
Empl change	-123379	-67332	42427	-78892	-36465	-19581	-97900	-109838	-36114	-35194	-71307	83245	-177600	-56131	-63282	45424	-17858	-103611
Total direct effect	*-1.83*	*-0.42*	*0.56*	*-0.85*	*-0.29*	*-1.12*	*-1.31*	*1.98*	*0.21*	*-0.09*	*0.12*	*-3.40*	*-2.63*	*-0.41*	*-1.17*	*0.80*	*-0.37*	*0.11*
1993-97																		
Skilled	1.19	0.44	0.27	-0.24	0.03	0.71	1.55	0.78	0.40	-0.41	-0.01	0.78	0.64	0.07	0.05	-0.07	-0.02	0.60
Semi-skilled	-1.13	0.81	0.46	-0.47	-0.01	-1.93	-0.50	0.40	0.45	-0.42	0.02	-0.93	0.14	0.32	0.24	-0.37	-0.14	-0.04
Unskilled	-2.64	0.75	0.43	-0.43	0.01	-3.40	-1.44	0.60	0.50	-0.48	0.02	-2.06	1.08	0.36	0.28	-0.22	0.07	0.66
Elementary	0.92	0.47	0.25	-0.26	-0.02	0.47	-0.80	2.70	0.37	-0.45	-0.08	-3.42	-3.67	1.67	1.38	-0.30	1.07	-6.41
Total	**-0.71**	**2.56**	**1.46**	**-1.45**	**0.01**	**-3.28**	**-0.17**	**4.55**	**1.76**	**-1.80**	**-0.04**	**-4.67**	**-1.60**	**2.43**	**1.96**	**-0.97**	**0.99**	-5.01
Empl change	-44621	160712	92000	-91271	729	-206062	-10519	285535	110403	-113108	-2705	-293349	-100289	152490	123220	-61106	62114	-314893
Total direct effect	*-0.71*	*1.69*	*0.91*	*-0.91*	*0.00*	*-2.40*	*-0.17*	*3.71*	*0.76*	*-0.88*	*-0.12*	*-3.76*	*-1.60*	*1.31*	*1.73*	*-0.88*	*0.85*	*-3.60*

Turning to a more in-depth analysis of trade since 1993, one is struck by the relatively strong and positive impact of net trade on elementary and unskilled employment. This suggests a rising comparative advantage in less-skill-intensive products. However these results are once again due to the agricultural sector, which experienced strong growth in exports combined with limited negative employment effects from import penetration (positive prior to 1993) during all periods (Table 6.5).

Within the manufacturing sector, a rising skill bias in net trade is evident with high skilled employment the least affected during 1984-88, but the most positively affected during 1993-97. Between 1993 and 1997 manufacturing net trade raised skilled employment by 0.03% of *total* employment, but reduced elementary employment by 0.02 % of total employment. Net trade in services also reduced elementary employment between 1993 and 1997.

Figure 6.2: Rank order diagram of export growth and skill intensity of production



Notes: Export growth is the real compound growth rate between 1993 and 1997. Sectors are ranked according to percentage high skill employment, which consists of professionals, technicians and managers. The sample includes the disaggregated sectors shown in Table A3.1 of Appendix 3. The following outliers: Agriculture, forestry & fishing (SIC 1), leather products (SIC 323) and furniture SIC 332) were excluded. The former is characterised by highly volatile production and exports while the latter two experienced very high export growth off very small bases. Although these sectors have a low percentage high skill employment, they use semi-skilled artisans intensively. The conclusions regarding the skill bias suggested above are thus not significantly affected by their exclusion.

To explore the skill bias of trade in more detail, rank order diagrams of growth in trade flows (exports and imports) and skill intensity of production were generated using 28 industrial sectors (including mining, social overhead and service sectors). As shown in Figure 6.2, a high positive correlation between export growth and skill intensity of production since 1993 is evident, implying that relatively skill intensive sectors are experiencing relatively high export growth. No relationship was evident between 1984 and 1993. Similarly, no relationship between skill intensity of production and import growth was evident during any of the sub-periods. This strongly suggests that export growth is raising the skill bias of net trade.

4.4 Trade and technology choice

The decomposition methodology has been criticised by Wood (1994) and Baldwin (1995) for failing to account for the interaction between final demand, export demand, import penetration and technological change. Wood (1994) argues that firms adopt labour saving technology in the face of increased import competition. Export firms may also adopt new technology as they orientate production towards the export market. This will bias employment gains through export production upwards and employment losses due to import penetration downwards. To assess this possibility, simple pairwise correlation coefficients between employment losses due to direct labour saving (ΔnX in Eq 6.1) and employment changes due to import, exports and net trade were calculated. These are presented in Table 6.6

Table 6.6: Pairwise correlation coefficients between employment changes due to direct labour saving and various trade variables

	1984-88	1988-93	1993-97
Exports	-0.41*	0.32	-0.63*
Imports	-0.40*	-0.29	0.34
Net trade	-0.10	0.34	-0.45*

Note: * reflects significance at the 5 % level. Correlations performed on data expressed as percentage change initial year sectoral employment.

The results in Table 6.6 provide evidence of trade-induced technological change. The negative coefficient for exports suggests that sectors experiencing large reductions in employment due to direct labour saving are those experiencing strong export growth, a result also found by Hayter *et al.* (1999). This relationship appears particularly strong during the 1993-97 period. Direct labour saving technological change is positively correlated with employment losses due to increased import penetration, but the coefficient is not significant. The correlation for net trade is negative and significant. Sectors experiencing large increases in net trade are those reducing employment.

These results suggest that the positive net trade impact on employment between 1993 and 1997 that is shown in Table 6.3 may be exaggerated. The losses, however, are not due to import penetration, as Wood (1994) argues, but have occurred within export sectors. These results are only suggestive and further interrogation using firm level surveys may give additional insight into the relationship between trade liberalisation and technological change. This direction will be pursued in Chapter 8.

5. Conclusion

Rapid growth of imports and exports since the early 1980s reflect an increased integration of South Africa into the world economy; a trend that has been encouraged by trade reform. With this 'globalisation' of the South African market, concerns have been raised that trade flows have been job destroying. Existing factor-content research in South Africa supports this contention.

Using an alternative methodology, this paper decomposes occupational employment changes into final demand, trade and technology effects. The results do not support the contention that trade liberalisation is responsible for the significant losses in employment experienced since the late 1980s. Employment generated through exports has matched employment lost due to imports and reflects a restructuring of the South African economy in the face of international competition and domestic policies.

Nevertheless, employment generated through export growth has been insufficient to reduce unemployment. The capacity of trade to generate employment has further been reduced by a structural shift in net trade away from ultra-labour-intensive sectors towards capital-intensive sectors. Export growth is also increasingly biased towards skill-intensive sectors. Again, however, the role of trade liberalisation in inducing the structural shift towards capital-intensive (and skill-intensive) net trade is not clear. As shown in Chapter 4, tariff liberalisation was more severe in capital-intensive and skill-intensive sectors between 1992 and 97. Import and export price trends are, however, consistent with structural shifts in production and employment outlined in this chapter. Government policies and investment subsidies between 1993 and 1997 also appear to have exacerbated an already capital-intensive production structure.

More interestingly, the chapter highlights a significant shift away from low-skilled elementary employment brought about almost entirely by technological change. This skill bias is showing up in manufacturing trade, particularly exports, and suggests that South African firms are gearing up their skills levels in order to effectively compete in international markets. Whether increased trade flows have induced the adoption of unskilled labour saving technology, a view put forward by Wood (1994), or whether these changes reflect other factors such as global skill-biased technological change or relative wage shifts is uncertain and highlights an area of much needed research. As Baldwin (1995) notes, this methodology fails to account for possible interactions between final demand, export demand, import penetration and technological change.

Simple correlation coefficients between direct labour saving technological change and employment changes through exports and imports suggests the presence of trade-induced technological change. However, the losses in employment appear to be concentrated within export sectors. This is a crude analysis and a more detailed interrogation of the possible interaction between trade liberalisation and technological change is pursued in Chapter 8.

The empirical methodology used within this chapter suffers some other shortcomings (in addition to their failure to link product price movements to factor returns). The study is a demand side analysis and fails to incorporate the effect of labour market institutions, labour supply and real wage movements. International evidence suggests that flexibility of the labour market affects the manner in which exogenous trade and technology shocks affect employment and wage inequality. In response to import competition labour may be willing to accept real wage cuts in order to remain competitive and retain employment. In cases where wages are rigid, the impact may show up in the form of unemployment. Similarly, the response of labour markets to skill-biased technological change will determine whether the impact shows up in the form of higher unemployment amongst elementary skilled or a rise in the skilled to less-skilled wage differential.

Real and relative wage rates for less-skilled labour have risen during the 1980s and 1990s, which suggests that labour market factors may lie behind much of the decline in employment of less-skilled labour. In response to increased wages firms may adopt new technology or re-organise production to adopt labour-saving production techniques. Real wage growth of less-skilled labour will also affect the export competitiveness of less-skill-intensive sectors thus reducing employment growth through export production.

The subsequent two chapters attempt to deal with some of the criticisms of the decomposition techniques used in this chapter and Chapter 5. Chapter 7 uses econometric techniques to identify the relationship between labour cost competitiveness and export performance in South Africa. Such a relationship may give insights into how the large real wage increases shown in Chapter 4 have affected export-generated employment and whether the rising capital and skill-intensity of trade shown in this chapter and Chapter 5 is due to excessive wage growth.

Chapter 8 uses firm level data to estimate the direct impact of trade liberalisation on employment, as well as the indirect impact via trade-induced technological change. In doing so, Chapter 8 overcomes the failure of the input-output decomposition methodology to account for interactions between trade, final demand, protection and technological change. Further, unlike the current chapter, tariff liberalisation data are used explicitly.

Chapter 7

Wages, Productivity and Export Performance in South Africa: A Dynamic Panel Analysis*

1. Introduction

The previous chapters have focussed on the demand side impact of trade liberalisation, technological change and trade volumes on employment and factor returns in South Africa. However, international evidence suggests that labour market institutions affect the manner in which demand shocks are transmitted through the economy to employment and factor returns (Blanchflower and Slaughter, 1998; Slaughter, 1998b). For example, trade liberalisation is associated with a decline in employment of less-skilled labour in Europe where wages are rigid, but a rise in wage inequality in the United States and United Kingdom where wages are more flexible (Blanchflower and Slaughter, 1998; Slaughter, 1998b).

The relationship between labour market institutions and employment or wage responses is of significant importance in the South African debate. Various new pieces of labour legislation have been enacted since 1994. These are: the Labour Relations Act (1996), the Basic Conditions of Employment Act (1997), the Employment Equity Act (1998) and the Skills Development Levy (1998). As a consequence of the new legislation, minimum wages, hours of work, retrenchment procedures and leave provisions are set for industries via collective bargaining agreements within the industrial councils. The obligatory extension of these agreements to non-participating firms within the industry ensures wide coverage of these agreements (Nattrass and Seekings, 2000), particularly amongst large firms (Chandra *et al.*, 2001a). Other labour regulations governed by the Basic Conditions of Employment Act limit the ability of firms to hire and fire labour or to utilise contractual labour.

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* This chapter formed part of a larger project commissioned by the South African National Treasury. The complete report (Edwards, L. and Golub, S., 2000. "*South Africa's International Cost Competitiveness and Productivity:*

This legislation has reduced the flexibility of the South African labour market (Nattrass and Seekings, 2000) and has led to real wage increases in excess of those mandated by trade liberalisation (see Chapter 4). The new labour market legislations thus appears to have played an important role in the adjustment of the economy to trade liberalisation.

Labour productivity, however, has risen during the 1990s offsetting some of the real wage increases (DTI, 2001). Particularly strong increases in labour productivity have occurred within export sectors, as shown by Hayter *et al.* (1999) and the negative correlation between direct labour saving technological change and export growth found in Chapter 6. A key unresolved issue is "*to what extent this process is associated with the increased imperative to become internationally competitive*" (Hayter *et al.* 1999). This chapter sheds some insight into this relationship.

Changes in labour cost competitiveness, a function of wages and labour productivity, may also explain the rising capital and skill-intensity of net trade shown in Chapter 5 and 6. Tsikata (1999) and UNCTAD (1998: 199, cited by Hayter *et al.*, 1999) find that South African unit labour costs in some labour-intensive manufacturing sectors were higher than many other developing *and* developed countries. Nordas (1996), in a comparison with the US, finds that South Africa is competitive in natural resource intensive industries, which conforms closely with South African export patterns during the 1990s. Finally, Golub (2000) finds that South African labour cost competitiveness in manufacturing has improved during the 1990s, but still lags behind many developing countries. Poor labour cost competitiveness is thus a possible reason for the failure of the South African economy to generate substantial employment through export growth, as was envisaged in the Growth, Employment and Redistribution (GEAR) macroeconomic strategy (RSA, 1996).

Most studies in South Africa analysing the impact of real wages on employment have focussed on the demand for labour by firms (Fallon and Lucas,

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A Sectoral Analysis") is available upon request.

1998; Fedderke and Mariotti, 2002). No studies have adequately analysed the impact of real wages (and productivity) on employment through changes in export and import competitiveness. This chapter contributes towards this debate by focussing on the impact of sector level wages and productivity on South Africa's export performance vis-à-vis a range of developed and developing countries. Although this chapter does not directly analyse the impact of trade liberalisation on employment, the analysis makes some other important contributions towards the debate. Firstly, by reducing the anti-export bias of production, trade liberalisation improves export performance. An integral part of the liberalisation process, is thus employment creation through export growth. This chapter explicitly focuses on factors affecting export growth. Secondly, the sensitivity of export performance to labour costs provides some insight into the impact of real wage growth shown in Chapter 4 on employment via export production. Labour cost competitiveness may thus explain the small, rather than large, net positive impact of trade on employment creation shown in Chapter 6. A second contribution is that changing labour cost competitiveness may explain the rising capital intensity of trade shown in Chapter 5.

The analysis in this chapter also differs from earlier chapters in using the Ricardian continuum of goods model as the theoretical framework. The Ricardian framework has particularl advantages over the Heckscher-Ohlin-Samuelson model in that it explicitly recognises differences in technology across countries. Evidence of technology gaps between countries is widespread (Harrigan, 1999) and the inclusion of technology differences improves the ability of the HOS model to predict trade flows on the basis of relative factor endowments (Trefler, 1995). The Ricardian model has also performed well in explaining export performance (MacDougall, 1951; Stern, 1962; Balassa, 1963; Golub, 1994; Golub and Hsieh, 2000).

A criticism of the model is that it makes the extremely simplifying assumptions that labour is the only factor of production and that countries specialise in the production of export products. However, increased international competition, brought about by greater information flows, lower transport costs and trade liberalisation, has heightened the importance of cost competitiveness. As capital and natural resources are internationally mobile, labour has become a key non-tradeable primary input and thus an important determinant of this cost competitiveness (Golub and Hsieh, 2000). The cost and quality of labour have also become important determinants of the geographical location of production processes (Gourevitch *et al.*, 2000). This is reflected in the relocation of the labour-intensive production processes within the US consumer electronics and hard disk drive industries to the South East Asian region (Lowe and Kenney, 1999; Gourevitch *et al.*, 2000). Nevertheless, the analysis remains circumspect on the importance of other factors such as infrastructure, other input costs and public policy on export performance.

The structure of the chapter is as follows: Section 2 presents the central features of the Dornbusch, Fischer, Samuelson (1977) Ricardian continuum of goods model relating labour cost competitiveness to export performance. Section 3 specifies a number of export functions that are used to estimate the impact of wages and labour productivity on export performance in South Africa. Section 4 discusses the dynamic panel econometric techniques that are used to estimate the wage, productivity and export relationship.[80] Section 5 discusses the data and presents a preliminary overview of the relationship between labour cost competitiveness and export performance in South Africa. Sections 6 and 7 present the cross-section and time series estimates, respectively, and Section 8 concludes the chapter.

2. The Ricardian continuum of goods model

2.1 Theory

The Dornbusch, Fischer and Samuelson (1977) (DFS) model provides a suitable framework with which to analyse the impact of changes in wages and productivity on trade performance. In the continuum of goods model constant returns to scale technology for commodity z in the interval $[0,1]$ can be represented in terms of its unit labour requirement, $a(z) = l(z)/y(z)$ where $l(z)$ is the labour used to produce output $y(z)$. The productivity of the home country relative to the foreign country is given by the relative unit labour requirement identity

[80] Golub (1994) uses panel data techniques (but not dynamic) to analyse the relationship between export performance and relative unit labour costs in the US.

Eq 7.1: $$A(z) \equiv \frac{a^*(z)}{a(z)}$$

where '*' depicts a foreign country variable. If the commodities z are indexed such that the unit labour requirements are ranked in terms of diminishing home country advantage, $A(z)$ can be represented as a downward sloping curve as z increases. This is shown by the A(z) curve in Figure 7.1 where the relative productivity of the home country diminishes as z increases.

Under the assumption of perfect competition and labour as the only one factor of production, the price of a unit product z will equal the labour cost of producing it, i.e.

Eq 7.2: $$P(z) = a(z)w$$

where w is the wage. Similarly, the price of foreign product, z, is given by $P^*(z) = a^*(z)w^*$. Under international trade with the costless transfer of goods a country will produce all goods for which the domestic price is less than the foreign price. In terms of unit labour costs this implies:

Eq 7.3: $$a(z)w \leq a^*(z)w^*.$$

Through simple algebraic manipulation this condition can be represented as

Eq 7.4: $$\frac{w}{w^*} \leq A(z) \equiv \frac{a^*(z)}{a(z)}.$$

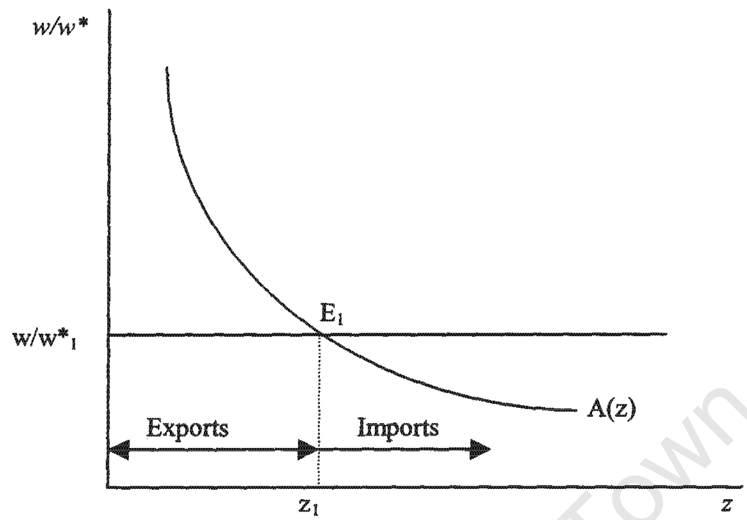
This condition states that the home country will produce all products for which its relative wage is less than or equal to its relative productivity. Alternatively this condition can be expressed in terms of relative unit labour costs (RULC)

Eq 7.5: $$RULC = \frac{wa(z)}{w^*a^*(z)} \leq 1.$$

The home country produces product z if its unit labour cost is less than or equal to the foreign unit labour cost, i.e. RULC $\leq$ 1.

The relationship between relative wages and relative productivity is more clearly depicted in Figure 7.1.

Figure 7.1: The continuum of goods model



At relative wages w/w^*_1, the home country produces and exports all products for which relative productivity is greater than w/w^*_1 ($z < z_1$) and imports the remaining products ($z > z_1$).

The standard DFS model is a full employment model and the A(z) curve together with a demand side equilibrium relationship (income equals expenditure or the value of exports equals imports) endogenously solve for equilibrium relative wage and z_1. This model, however, is not appropriate in countries where the level of employment responds to wages that are set by institutions. Wages are exogenous in these countries and this is reflected in the solid line in Figure 7.1 passing through w/w^*_1. A more detailed outline of the model including the demand side equilibrium relationship is presented in Appendix 5.

The model can be used to analyse the impact of exogenous changes in relative wages and labour productivity. If home wages rise (through union activity or labour regulation), the relative wage $(w/w^*)_1$ shifts upwards. The cost of production increases for all home country firms, which under perfect competition in the product market raises prices, $\Delta P(z) = a(z)\Delta w$. The increase in domestic prices reduces the competitiveness of all home country firms, but it is only those firms around the original equilibrium level, E_1, that are no longer able compete with foreign producers. The equilibrium point shifts along the A(z) curve to the left and the range of output produced and exported declines. Employment also declines, but by a greater proportion than the increase in wages. Real (and nominal) national income declines as a result. The process of adjustment is explained in more detail in Appendix 5.

A uniform rise in productivity across all sectors (*a(z)* declines for all *z*) causes the relative productivity curve *A(z)* to shift upwards by the same proportion. At fixed relative wages $(w/w^*)_1$, home country labour cost competitiveness improves as the labour cost of production declines, $\Delta P(z) = \Delta a(z)w$. The improved competitiveness of home producers boosts the number of home goods produced and exported. If wages were flexible, the increased demand for labour would place upward pressure on wages. However, as wages are sticky upwards, the increased demand for labour increases employment. A new equilibrium is attained with more employment and an increased range of output produced.

The model yields two testable hypotheses of relevance to this chapter:

- Improvements in labour productivity enhance labour cost competitiveness (RULC falls), which positively affects exports and employment.
- Relative wage increases reduce labour cost competitiveness (RULC rise), which negatively affects exports and employment.

Strictly speaking, in a Ricardian setting countries will specialise completely in those sectors in which they have comparative advantage, and a decline in competitiveness (rise in RULC) will only affect exports of products around the cut off point (z_1 in Figure 7.1). One would thus expect to find products at the margin switching from being exported to being imported as RULC change. In empirical analysis, however, the aggregation of sectors, the existence of product differentiation and diminishing marginal productivities imply that perfect specialisation does not occur.[81] The response to changes in RULC is likely to be smoother.

The following section derives functions used to estimate the relationship between exports and RULC. The section also reviews international empirical evidence.

3. Estimating the relationship between RULC and export performance

3.1 RULC and the structure of trade

Much of the empirical literature analysing the relationship between RULC and export performance has focussed on cross-sectoral data for a given year. These papers in effect test whether indicators of sectoral export performance (X_i) are negatively correlated with RULC for that given year, i.e. they estimate

Eq 7.6: $X_i = f_i(RULC)$.

Various specifications of the function have been used. MacDougall (1951) and Stern (1962), in their studies on US-UK trade, analyse the relationship between total export ratios, relative labour productivity and/or relative unit labour costs. Balassa (1963) also focuses on US-UK trade, but criticises the use of total trade on the grounds that bilateral trade between the countries is strongly affected by the relative size of US and UK tariff barriers.[82] He uses exports to third markets instead, but the use of this is questioned by Golub and Hsieh (2000). Golub and Hsieh (2000) use bilateral trade flows as the dependent variable and relative productivity and relative unit labour costs as explanatory variables. The results of all of these studies are consistent with each other and show a significant positive correlation between relative productivity and exports. However, the R^2 of these regressions are very low indicating low explanatory power.

Most of these studies do not decompose RULC into relative wages and relative productivity. They also only focus on developed-developed country trade, despite the applicability of the theory to developed-developing country trade. Labour cost competitiveness is particularly important to developing countries where labour-intensive manufactures constitute a relatively large share of manufactured exports. The estimation of equation Eq 7.6 in South Africa, including the case where RULC is

[81] I thank Stephen Golub for this point.

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

decomposed into relative productivity and relative wages, is thus a useful contribution to international empirical literature.

3.2 RULC and exports over time

Cross-section regressions do not directly analyse the relationship between changes in RULC and export performance within a particular sector over time. There is substantial evidence that exports are influenced by RULC over time. Golub (1994) finds that changes in sectoral trade balances of the G7 are quite well explained by the evolution of unit labour costs, but the levels of these balances are sometimes difficult to reconcile with the levels of unit labour costs. His results are particularly strong for the US and Japan.

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

To enhance the explanatory power of the model, other supply and demand side variables can also be included in the analysis. Insight into additional variables is provided in the comprehensive review of export demand and supply functions by Goldstein and Khan (1985).

Drawing on the imperfect substitutes model outlined by Goldstein and Khan (1985), log linear export demand (X_{it}^{d}) and supply (X_{it}^{s}) equations for sector i in period t are defined as[83]

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

Eq 7.7: $$\log X_{it}^{d} = \beta_0 + \beta_1 \log\left[\frac{P_x}{P*}\right]_{it} + \beta_2 \log Y_t^{*} \text{ and}$$

Eq 7.8: $$\log X_{it}^{s} = \alpha_0 + \alpha_1 \log\left[\frac{P_x}{P}\right]_{it} + \alpha_2 \log CU_{it}$$

In the export demand equation P_x is price of home country exports, $P*$ is the price of competing foreign products and Y_t* is real income of South Africa's trading partners.[84] An increase in the price of home exports relative to foreign prices reduces exports ($\beta_1 < 0$) while an increase in foreign income raises exports ($\beta_2 > 0$).[85] Because the variables are in logs, the coefficients represent elasticities.

In the export supply function, CU_{it} represents capacity utilization and P the price of domestic products. [86] Different demand elasticities in the home and export market, different cost structures for home and export production, market distortions and product differentiation give rise to differences in export and domestic prices (Goldstein and Khan, 1985). A rise in P_x or a decline in the domestic price (P) raises the relative profitability and hence production of exports ($\alpha_1 > 0$). A reduction in P can also reflect a reduction in overall production costs, which will boost export competitiveness. Capacity utilisation is included to capture the cyclical impact of domestic demand on export behaviour. As Goldstein and Kahn (1985: 1061) note, "*...when domestic demand pressure increases, selling in the home market becomes more profitable than selling abroad, and ... this effect is not fully captured by movements in the ratio of domestic to export prices*". Belli *et al.* (1993) argue that this effect was prevalent in South Africa during the recession in the late 1980s. The expected sign of α_2 is thus negative. Variables for overall production capacity (proxied by national income), export incentives and tariff associated input costs were not included.

Data constraints, particularly the lack of export prices at a sectoral level, often prohibit the simultaneous estimation of both export demand and supply functions. The

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84 A common β_1 is assumed as it is generally assumed that the demand function is homogenous of degree zero in prices, i.e. a doubling of P_x and of $P*$ has no effect on demand as relative prices have not changed.

85 If the product is inferior then β_2 may be less than zero. Wood (1995b) finds a negative coefficient in his estimation for some sectors in South Africa.

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

system of equations is then frequently solved for the two endogenous variables *X* and *Px* to obtain the reduced form equations. This is the approach followed here.

Normalising Eq 7.8 for the price of exports, *Px*, and then substituting into Eq 7.7 yields the following reduced form equation:

Eq 7.9: $$\log X_{it} = \left(1-\frac{\beta_1}{\alpha_1}\right)^{-1}\left[(\beta_0 - \frac{\beta_1\alpha_0}{\alpha_1}) + \beta_1 \log\left(\frac{P}{P*}\right)_{it} - \frac{\beta_1\alpha_2}{\alpha_1}\log CU_{it} + \beta_2 \log Y_t^*\right].$$

According to the signs of the individual demand and supply equation coefficients, a rise in (P/P^*), a rise in CU and a decline in Y* are expected to negatively affect exports.

The export relationship defined in Eq 7.9 is not particular to any theoretical framework. Within the Ricardian model, prices equal unit labour costs. Drawing on this relationship, relative prices $(P/P^*)_{it}$ are replaced with $RULC_{it}$ (= ULC_{it}/ULC_{it}^*) where unit labour costs are measured in a common currency.[87] This equation can be further refined by decomposing the log of $RULC_{it}$ into relative wages, relative productivity and exchange rates:

Eq 7.10: $$\log RULC_{it} = \log\left(\frac{a}{a*}\right)_{it} + \log\left(\frac{w}{w*}\right)_{it} + \log\left(\frac{1}{e_{R/For}}\right)_{it}$$

where a and a^* reflect labour requirements per unit real output in domestic and foreign industries, respectively, w and w^* reflect domestic and foreign wage per worker, respectively, and $e_{R/For}$ is the Rand value of foreign currency.[88] The first variable on the right hand side measures the productivity of foreign workers relative to South African workers while the second measures the relative wage of South African workers compared to foreign workers. Thus, a 10 % rise in RULC can be brought about by a 10 % rise in relative productivity of foreign workers, a 10 % rise in the relative wage of South African workers or a 10 % appreciation of the currency. The impact of these variables on exports can be estimated by substituting Eq 7.10 into regression Eq 7.9.

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

[88] See Appendix 5 for the calculation of RULC.

Given the signs of the structural parameters in the export supply and demand functions the expected signs of the reduced form equation Eq 7.9 coefficients are as follows

	RULC	Rel $Prod_{SA}$	Rel $wage_{SA}$	$e_{R/For}$	CU	Y^*
Equation (Eq 7.9)	-				-	+
+ Equation (Eq 7.10)		+	-	+	-	+

Note, however, that these are not necessarily estimates of the structural coefficients in the export demand equation and supply equations (Eq 7.7 and Eq 7.8). To obtain these it is necessary to estimate the export demand and supply equations simultaneously, or in the case of fully identified equations these can be 'retrieved' from the reduced form coefficient estimates directly.

Frequently studies ignore the export supply equation and estimate the export demand function in Eq 7.7 directly. The problem with this approach is that these models implicitly assume infinitely elastic export supply or stable demand functions with a supply function that shifts around it (Goldstein and Khan, 1985; Riedel, 1988). The estimates for β_1 and β_2 are interpreted as elasticities, but because these are weighted averages of the true demand and supply elasticities they tend to be biased downwards (Goldstein and Khan, 1985). More problematic is the correlation between the endogenous variable on the right hand side and the error terms in the regression as these violate the conditions for OLS and will yield inconsistent estimates (Gujarati, 1995). Nevertheless, because these models have dominated research in this area, and particularly research in South Africa, an export demand function similar to Eq 7.7 is estimated, but with *Px/Px** replaced by *RULC*.

4. Econometric methodology

The availability of repeated observations between 1970 and 1998 for 24 industrial sectors enable the use of dynamic panel data estimation techniques to identify the relationship between export performance and RULC. The dynamic panel estimation techniques used in this analysis closely follow Pesaran and Smith (1995) and Pesaran *et al.* (1999).

The advantage of using panel data estimation techniques is that if the data generating processes in the different sectors share common features, then combining the data will improve the efficiency of estimation of the parameters (Smith, 2001: 8). Further, because sector specific effects (or time specific effects) are easily incorporated into panel data models, the effect of omitted variable bias is reduced (Hsiao, 1986: 3). Finally, in the process of pooling the data problems arising from spurious coefficients between *I(1)* variables is attenuated allowing a consistent estimate of the parameter to be obtained (Smith, 2001). If, however, the data generating processes do not share common features and the parameters differ over groups, pooling of the data can give rise to inconsistent estimates. This is discussed in more detail later.

Drawing on Eq 7.9, the long-run export function is given by

Eq 7.11: $$X_{it} = \theta_{0i} + \theta_{1i} RULC_{it} + \theta_{2i} Y^{*}_{it} + \theta_{3i} CU_{it} + \mu_{it}$$

where $i = 1,...,N$, stand for industrial sectors and $t = 1,2,....T$, stand for time periods. The expected signs of the long-run coefficients are $\theta_{1i} < 0$, $\theta_{2i} > 0$ and $\theta_{2i} < 0$.

Often the presence of adjustment costs and incomplete information induces a lag in the response of demand to changes in the exogenous variable. This adjustment process is frequently introduced by imposing various distributed lag structures on the model. A common approach in the estimation of export demand equations is the use of the Partial Adjustment Model (PAM) where the actual change in exports in time period *t* equals a fraction of the desired change in exports.[89] Polynomial distributed lag structures and alternative dynamic specifications have also been used.[90] To estimate the long-run properties of this model a general first order autoregressive distributed lag model (ARDL(1,1,1,1)) is used. This nests a number of alternative restricted models, of which the PAM is one. The ARDL(1,1,1,1) export model is

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

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

Eq 7.12:

$$X_{it} = \alpha_i + \lambda_i X_{i,t-1} + \gamma_{1i} RULC_{it} + \gamma_{2i} RULC_{i,t-1} + \gamma_{3i} Y^*_{it} + \gamma_{4i} Y^*_{i,t-1} + \gamma_{5i} CU_{it} + \gamma_{6i} CU_{i,t-1} + \varepsilon_{it}$$

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

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

Eq 7.13:

$$\Delta X_{it} = \phi_i (X_{i,t-1} - \theta_{0i} - \theta_{1i} RULC_{i,t-1} - \theta_{2i} Y^*_{i,t-1} - \theta_{3i} CU_{i,t-1}) + \gamma_{1i} \Delta RULC_{it} + \gamma_{3i} \Delta Y^*_{it} + \gamma_{5i} \Delta CU_{it} + \varepsilon_{it}$$

where

Eq 7.14: $$\theta_{0i} = \frac{\alpha_i}{1-\lambda_i}, \quad \theta_{1i} = \frac{\gamma_{1i} + \gamma_{2i}}{1-\lambda_i}, \quad \theta_{2i} = \frac{\gamma_{3i} + \gamma_{4i}}{1-\lambda_i}, \quad \theta_{3i} = \frac{\gamma_{5i} + \gamma_{6i}}{1-\lambda_i}, \quad \phi_i = -(1-\lambda_i) \cdot$$

ϕ_i is the error correction coefficient and measures the speed of adjustment towards long-run equilibrium. The larger the value the greater the convergence to long-run equilibrium. Stability requires that $\phi_i < 0$.

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

Eq 7.15: $$\hat{\theta}_1 = \frac{\hat{\gamma}_1 + \hat{\gamma}_2}{1-\hat{\lambda}}, \quad \hat{\theta}_2 = \frac{\hat{\gamma}_3 + \hat{\gamma}_4}{1-\hat{\lambda}}, \quad \hat{\theta}_3 = \frac{\hat{\gamma}_5 + \hat{\gamma}_6}{1-\hat{\lambda}}.$$

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

In addition, the dynamic fixed effects estimator will only give consistent estimates of the average long-run coefficients for large *T* and *N* so long as homogeneity holds across sectors. If the true model is represented by Eq 7.12 and the true coefficients differ across sectors, then the fixed effects estimator gives inconsistent estimates of the coefficients (Pesaran and Smith, 1995; Smith, 2001). When the coefficients vary across sectors and the regressors are serially correlated, assuming homogeneity induces serial correlation in the errors. These in turn are not independent of the lagged dependent variable and give rise to inconsistent estimates, even if $T \to \infty$ (Pesaran and Smith, 1995). Pesaran and Smith (1995: 80) use a number of examples to show that when coefficients differ across sectors pooling of data can give "*potentially highly misleading estimates of the coefficients*". This is problematic as when tested the equality of coefficients over groups is frequently rejected (see Baltagi and Griffin, 1997).

A more appropriate approach in this case is to use the Mean Group Estimator (MG) of Pesaran and Smith (1995).[91] Eq 7.12 is estimated separately for each sector and the long-run coefficients are computed as averages of the individual sector coefficients. For example, the long-run elasticities for *RULC*, *Y** and *CU* for each industry *i* are defined as:

Eq 7.16: $$\hat{\theta}_{1i} = \frac{\hat{\gamma}_{1i} + \hat{\gamma}_{2i}}{1 - \hat{\lambda}_i}, \quad \hat{\theta}_{2i} = \frac{\hat{\gamma}_{3i} + \hat{\gamma}_{4i}}{1 - \hat{\lambda}_i}, \quad \hat{\theta}_{3i} = \frac{\hat{\gamma}_{5i} + \hat{\gamma}_{6i}}{1 - \hat{\lambda}_i}.$$

The Mean Group Estimator for each variable is then computed as[92]

Eq 7.17: $$\hat{\theta}_1 = \sum_{i=1}^{N} \hat{\theta}_{1i} / N, \quad \hat{\theta}_2 = \sum_{i=1}^{N} \hat{\theta}_{2i} / N, \quad \hat{\theta}_3 = \sum_{i=1}^{N} \hat{\theta}_{3i} / N, \quad \hat{\phi} = \sum_{i=1}^{N} \hat{\phi}_i / N.$$

As shown by Pesaran and Smith (1995), these averages are consistent estimates of the parameters for large *T*. If *T* is small, the existence of a lagged dependent variable will

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

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

cause the estimates of ϕ_i to underestimate their true value. Because a separate equation for each sector is estimated, it is possible to use different ARDL specifications in each case. This is particularly useful when the short-run dynamics differ from sector to sector. As is evident in the examples of Pesaran *et al.* (1999), the choice of lag structure appears to be more important when T is small. The MG estimator, however, appears to be sensitive to outliers (Pesaran *et al.*, 1999).

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

Eq 7.18: $$\overline{X}_{it} = \theta_{0i} + \theta_1 \overline{RULC}_t + \theta_2 \overline{Y}_t^* + \theta_3 \overline{CU}_i + \overline{\varepsilon}_i$$

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

This chapter presents the results of the Dynamic Fixed Effects estimator. To cater for problems associated with heterogeneity across sectors the Mean Group estimates are also presented. Finally, the cross-section relationship between export performance and RULC shown in Eq 7.1 is estimated for a number of sub-periods between 1970-98 using the approach outlined in Eq 7.18. The estimation over various periods will enable an analysis of the stability of the relationship between RULC, relative productivity, relative wages and export performance over time.

5. Data and preliminary analysis of exports and RULC

The calculation of RULC, relative wages and relative productivity for the vast range of countries and sectors against which South Africa is compared is a data intensive process. This section briefly outlines the data sources and the selection of industries and countries. A graphical analysis of export performance and RULC is also undertaken.

5.1 Data

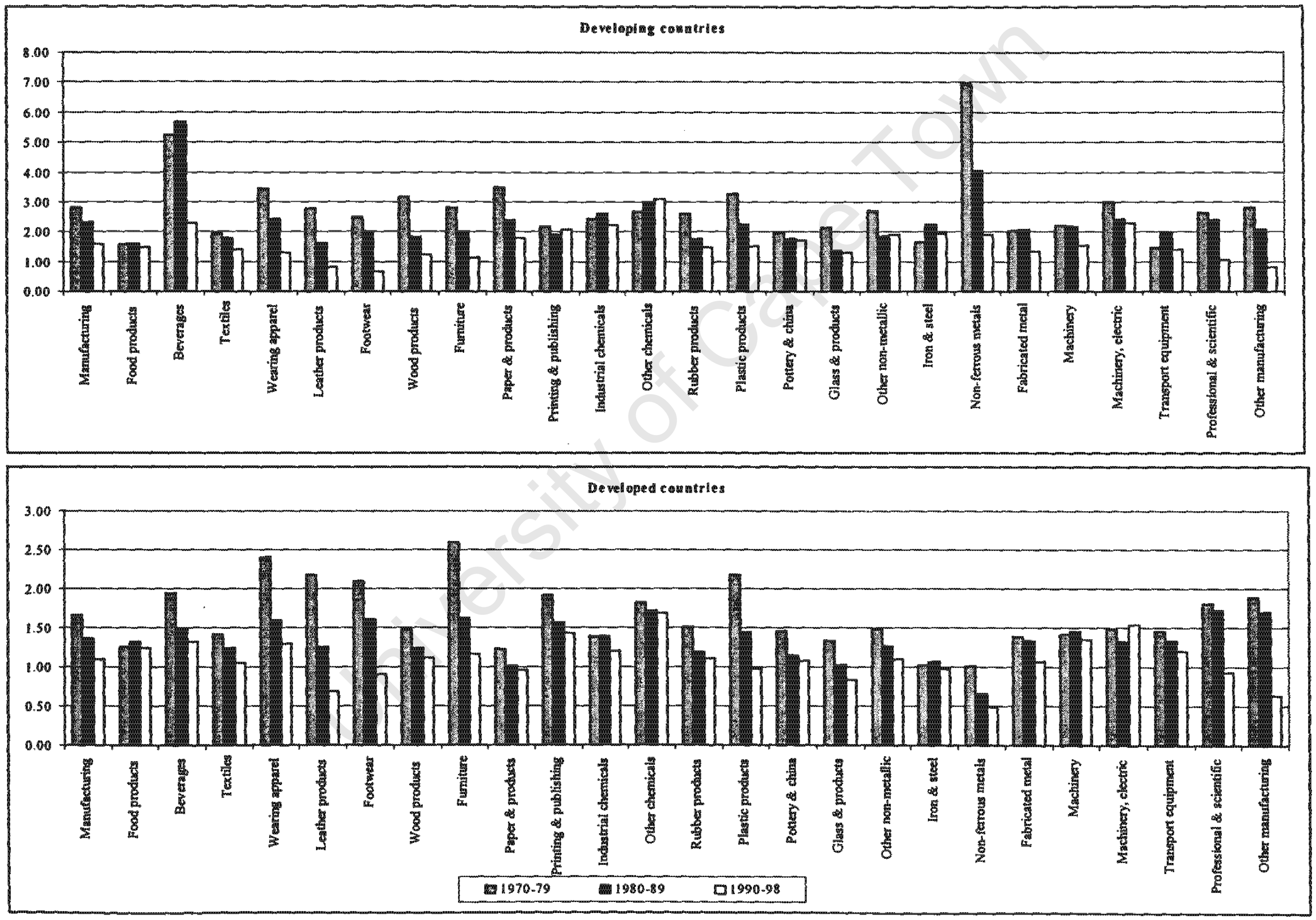
As shown by Golub (2000), South African labour cost competitiveness of aggregate manufacturing differs across developed and developing economies. To identify sectoral competitiveness across countries, a range of developed and developing countries were selected according to the availability of consistent data. The developed countries consist of: Canada, France, Hong Kong, Italy, Japan, Netherlands, Spain, United Kingdom and USA. The developing countries are: Chile, Hungary, India, Kenya, Korea, Mexico, Poland, Singapore, Turkey and Zimbabwe. Although these countries have been classified as developing, they show substantial differences in level of development.

Two panel data sets were constructed: a disaggregated panel and an aggregated panel. The disaggregated panel contains data for 28 sectors between 1970 and 1998 for all 19 countries. Three sectors – tobacco (314), petroleum refineries (353) and miscellaneous petroleum products (354) – were dropped as the data were either missing or highly irregular. The analysis is thus based on 25 industrial sectors (Table A5.1 in Appendix 5). In the aggregated panel, all country variables (except Mexico) were aggregated using the country share of total group trade (exports + imports) as weights. The panel thus consists of weighted average data for 24 sectors over the period 1970-98. The data used to construct the panel data sets were largely obtained from TIPS, United Nations, World Bank and OECD data sets. Further details of the data sources and the construction of the relevant variables are provided in the data Appendix 5.

5.2 Preliminary analysis of export performance and RULC

Table 7.1and Table 7.2 present average relative wages and relative productivity during the 1970s, 1980s and 1990s for developing and developed countries, respectively. RULC vis-à-vis these regions during these periods are presented in Figure 7.2. Sectors with RULC exceeding 1 reflect South African sectors with relatively high labour costs of production.

Figure 7.2: Average relative unit labour costs for each decade since the 1970s



The results are largely consistent with the aggregate manufacturing results of Golub (2000). RULC have improved substantially since the 1970s relative to both developed and developing economies. The improvement in competitiveness is widespread with RULC declining in most industrial sectors since the 1970s.

Table 7.1: Average relative wages and relative productivity by sector vis-à-vis developing countries

	1970-79	1980-89	1990-98	1970-79	1980-89	1990-98
	Relative wage			Relative productivity		
Total manufacturing[a]	3.58	3.00	3.32	2.15	1.98	2.31
Food products	3.34	3.97	6.02	2.93	3.09	3.82
Beverages	3.96	3.80	3.51	1.29	1.96	1.65
Textiles	2.40	1.95	2.04	1.51	1.55	1.43
Wearing apparel	2.33	1.66	1.72	1.00	0.85	1.03
Leather products	3.70	2.27	2.95	2.15	2.12	2.89
Footwear	2.86	1.47	1.04	1.40	0.84	1.35
Wood products	1.38	1.41	1.16	0.66	0.85	0.77
Furniture	3.29	2.57	1.94	1.45	1.53	1.67
Paper & products	3.59	3.26	3.00	1.89	2.56	2.14
Printing & publishing	4.05	4.63	6.98	6.32	3.94	3.99
Industrial chemicals	4.54	3.85	4.93	2.54	2.34	3.49
Other chemicals	3.23	4.47	4.86	1.53	2.59	2.23
Rubber products	3.91	2.47	2.11	1.67	1.36	1.21
Plastic products	3.40	2.55	2.32	1.40	1.13	1.16
Pottery & china	2.60	2.02	1.39	1.77	1.49	0.72
Glass & products	2.54	2.67	3.45	1.67	2.56	2.55
Other non-metallic	2.26	2.16	2.56	1.12	1.54	1.22
Iron & steel	3.85	3.47	5.67	2.58	2.57	3.54
Non-ferrous metals	1.88	1.67	2.72	0.99	1.78	2.98
Fabricated metal	3.71	3.44	3.47	2.56	2.01	2.01
Machinery	7.52	6.02	6.54	4.07	3.49	3.71
Machinery, electric	4.73	3.07	1.44	2.16	1.46	0.62
Transport equipment	4.52	3.98	4.32	4.64	2.58	4.92
Professional & scientific	3.60	3.07	2.57	1.77	1.57	2.52
Other manufacturing	5.33	2.22	2.25	2.25	1.21	2.43

Notes: (a) Unweighted average

Much of the improvement in competitiveness has been brought about by substantial depreciation in the currency during the mid-1980s and the late-1990s, although more so vis-à-vis developed economies during the latter period. The depreciating currency improved competitiveness by lowering the South African relative wage measured in a common currency. In all sectors average relative wages vis-à-vis developed countries were lower in the 1990s than in the 1970s. Compared to developing countries, average relative wages fell in 17 of the 25 sectors, with much of the decline occurring during the 1980s. Improvements in competitiveness vis-à-vis developing countries through depreciation of the currency slowed in the 1990s and relative wages of South African manufacturing workers rose in 15 of the 25 sectors.

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

Table 7.2: Average relative wages and relative productivity by sector vis-à-vis developed countries

	1970-79	1980-89	1990-98	1970-79	1980-89	1990-98
	Relative wage			Relative productivity		
Total manufacturing[a]	0.57	0.44	0.35	0.40	0.36	0.40
Food products	0.32	0.28	0.25	0.26	0.22	0.22
Beverages	0.55	0.42	0.35	0.29	0.29	0.31
Textiles	0.48	0.40	0.30	0.35	0.34	0.30
Wearing apparel	0.45	0.34	0.31	0.20	0.22	0.26
Leather products	0.55	0.35	0.26	0.30	0.33	0.43
Footwear	0.55	0.37	0.30	0.30	0.26	0.39
Wood products	0.25	0.23	0.19	0.17	0.19	0.17
Furniture	0.54	0.40	0.27	0.22	0.26	0.27
Paper & products	0.53	0.46	0.32	0.44	0.46	0.36
Printing & publishing	0.55	0.44	0.40	0.31	0.30	0.30
Industrial chemicals	0.69	0.48	0.40	0.52	0.38	0.42
Other chemicals	0.49	0.57	0.38	0.34	0.40	0.30
Rubber products	0.65	0.47	0.38	0.50	0.42	0.38
Plastic products	0.55	0.44	0.32	0.28	0.32	0.35
Pottery & china	0.46	0.39	0.25	0.41	0.37	0.30
Glass & products	0.41	0.37	0.36	0.34	0.39	0.48
Other non-metallic	0.36	0.29	0.25	0.24	0.22	0.24
Iron & steel	0.62	0.50	0.54	0.74	0.52	0.60
Non-ferrous metals	0.44	0.35	0.39	0.52	0.55	0.91
Fabricated metal	0.55	0.49	0.37	0.42	0.38	0.40
Machinery	1.21	0.91	0.61	0.87	0.62	0.61
Machinery, electric	0.91	0.69	0.30	0.59	0.51	0.23
Transport equipment	0.53	0.44	0.35	0.38	0.35	0.33
Professional & scientific	0.60	0.50	0.31	0.51	0.34	0.39
Other manufacturing	0.92	0.50	0.50	0.60	0.36	0.98

Notes: (a) Unweighted average

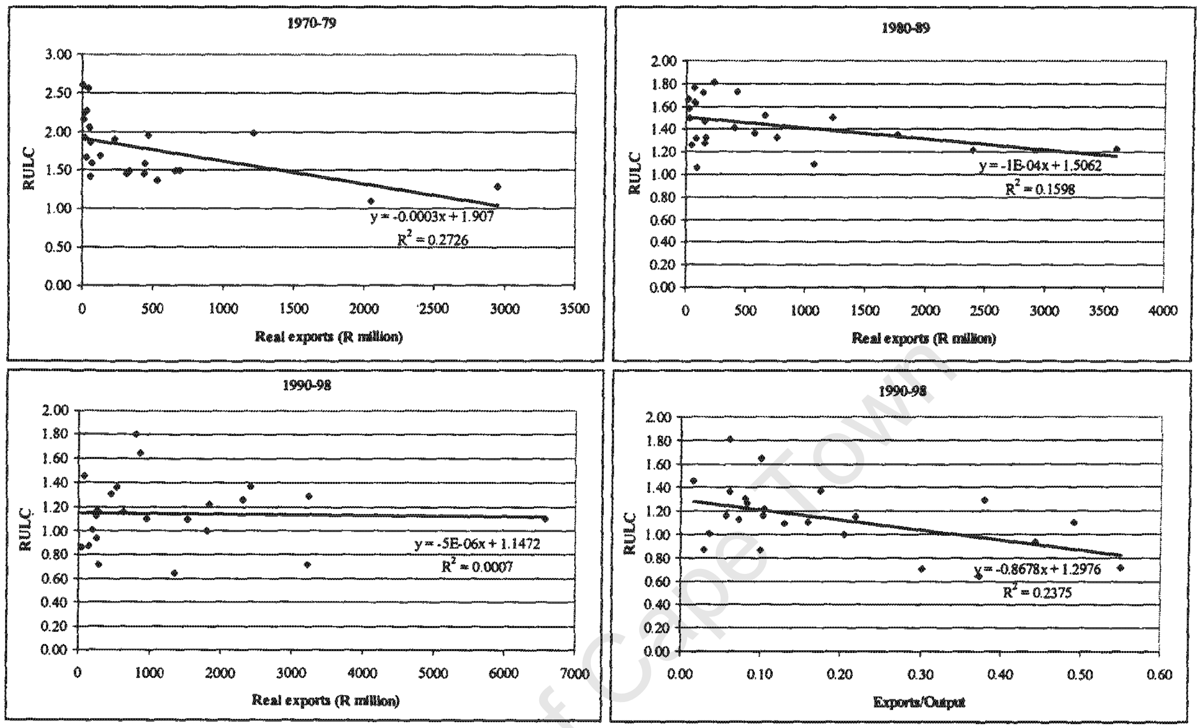
As found by Golub (2000), South Africa is relatively more competitive compared to developed countries than developing countries. South African labour is more productive than labour in developing countries, but wages are substantially higher resulting in a RULC value greater than 1 for most sectors. Average RULC vis-à-vis developing countries exceeded 1 for 22 of the 25 sectors during the 1990s. Compared to developed economies, South Africa was not competitive in 16 of the 25 sectors over the same period. Care must be taken in the interpretation of these level results as they are strongly influenced by the PPP deflator used (see Appendix 5). Nevertheless, the results suggest large differences in competitiveness across regions.

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

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

To explore the relationship between RULC and export performance, Figure 7.3 presents scatter plot diagrams between average RULC and average real exports for all decades since 1970. A clear negative is found for the 1970s and 1980s. Sectors with high RULC on average exported less than sectors with low RULC. During the 1990s, no relationship between RULC and real exports is evident. However, if one uses net exports or export orientation rather than average real exports the expected negative relationship is found in all periods. The negative relationship between exports as a share of share output (export orientation) and RULC for the 1990s is shown in the in the fourth quadrant diagram of Figure 7.3.

Figure 7.3: RULC and export performance



The data thus appears consistent with predictions made by the Ricardian model that countries export products with relatively low unit labour costs. In the following section these relationships are explored using econometric techniques.

6. Cross-section results

The cross-section estimations (Eq 7.6) that have traditionally been used to assess the Ricardian theory are first presented. Following Pesaran and Smith (1995), cross-section regressions on group means are estimated to obtain the average long-run coefficient. The cross-section equations are estimated using both the aggregated and disaggregated panel data sets. In the disaggregated case the equations are estimated for each country separately.

6.1 Aggregated panel data results

Because the aggregated data set covered the period 1970-98, it was possible to estimate the impact of RULC on export performance across sectors for a number of sub-periods. Eq 7.6 was estimated using log real exports, log net exports and log exports/output as dependant variables. For brevity only the estimated coefficients using log real exports are presented in Table 7.3. The other dependent variables yielded qualitatively similar results.

Looking first at the entire 1970-98 period, it is evident that RULC is significant in explaining the structure of South African real exports. 20 % of the variation in real exports between sectors is explained by RULC, and this rises to 51 % when RULC is broken up into relative productivity and relative wages. The RULC coefficient is negative and significant indicating that sectors with high RULC export less than sectors with low RULC.[93] The coefficient is, however, extremely large and suggests that on average a 1 % rise in RULC reduces real exports by –4.66 % in the long-run.

Table 7.3: Labour cost competitiveness and the structure of South African real exports, log real exports as dependent variable

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

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

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

The analysis of sub-periods suggests that the influence of relative unit labour costs on the structure of exports has diminished over time. During the periods 1970-79 and 1980-89, RULC, relative wages and relative labour productivity were significant in explaining the structure of exports. However, during the 1990s these variables are incorrectly signed and fail to explain the structure of trade, as shown by the low F-statistic. This is consistent with the cross-section diagrams of RULC and real exports shown in Figure 7.3. Cross sector regressions using the share of output exported as the dependent variable find a significant negative coefficient for RULC during 1990-94 and 1995-98, but no significant results for relative productivity and relative wage.[94] The weaker results during the 1990s suggest that factors unrelated to labour costs are becoming more important in influencing the sectoral composition of South African exports. Possible causes of the weaker relationship during the 1990s are discussed in Section 6.3.

6.2 Disaggregated data results

More detailed insight on the structure of trade vis-à-vis trading partners can be obtained by repeating the cross-section regressions for each country. Data limitations, however, constrained the number of possible export functions that could be estimated for developing countries. For example, bilateral trade data between South Africa and developing countries was extremely poor prior to 1990. Although bilateral Harmonised System (HS) trade data are available for developing countries after 1988, the results using this data were poor, as were the case for most estimates during the 1990s. For complete coverage of all countries the results using the log ratio of total

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[93] The coefficients are significantly higher than those found by Golub and Hsieh (2000).

[94] A coefficient of -1.66 is obtained for RULC during the 1990s. This is significant at the 5% level.

South African exports to trading partner exports as the dependent variable are presented in Table 7.4. This approach follows the original research by MacDougall (1951) and Stern (1962).

Two sets of cross-section regression results are presented in Table 7.4 for the periods 1980-89 and 1990-98. The first regressions (columns 1 & 3) have RULC as the explanatory variable. In the second regressions (columns 2 & 4), RULC is replaced with relative wage and relative productivity. For illustrative purposes only the significant coefficients of each country specific regression are presented in Table 7.4. Empty cells reflect coefficients insignificantly different from zero.

Table 7.4: Labour cost competitiveness and the structure of trade according to country, log total exports ratio as dependent variable.

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

Note: Dependent variable is log ($X_{South\ Africa}/X_{Foreign}$). Export data are obtained from the Canadian World Trade Analyzer.

When real bilateral exports were used as the dependent variable no significant results were found for the UK and Italy. Only relative productivity was significant for the US between 1980 and 1989. All remaining coefficients were of similar size and sign.

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

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

The results were weaker in developing countries than developed countries, although when significant (at or below the 10 % level) these were mostly of the correct sign.[95] The coefficient on relative wages in Zimbabwe and Poland were incorrectly signed, which may reflect the export of high wage-high productivity goods to these developing countries. Tsikata (1999) shows that the structure of South African exports is relatively capital and human capital intensive when compared to other middle-income countries.

6.3 Discussion

The cross-section results accord well with theoretical predictions, particularly during the 1970s and 1980s. A clear result from the disaggregated and the aggregated analysis is that the impact of RULC, relative wages and relative productivity on the level of real exports across sectors has diminished during the 1990s. Yet, as is shown in Figure 7.3, RULC are still important in determining export orientation of South African industries. Sectors with high RULC on average export relatively low shares of their output, even in the 1990s.

There are a number of possible reasons for the poor results during the 1990s. The 1990s were a period of significant structural breaks such as the ending of sanctions, the election of a new government, a new macroeconomic policy, new labour legislation and the initiation of tariff liberalisation. The significant structural changes during the 1990s have already been seen in the declining rank order correlation coefficients for RULC between the 1970s, 1980s and 1990s. The impact of these structural breaks may affect exports in a way that is not necessarily related to RULC. For example, the reintegration of South Africa into the world economy since

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

1994 led to rapid increases in exports to various regions. Some of this export growth is due to increased market access and not changes in labour cost competitiveness.

The cross-section estimator is also biased for low T (Pesaran and Smith, 1995). The 1990s may thus be too short a period for the cross-section estimator to give an unbiased estimate of the average long-run coefficient, particularly when there have been substantial changes in the policy environment.

The decline in importance of RULC may also reflect the rising importance of human capital and technology in determining export competitiveness. Figure 6.2 of Chapter 6 shows a bias in export growth towards skilled sectors. Using a factor classification system, Edwards and Schoer (2002) and Lewis (2001) also show a bias in South African exports of technology intensive and human capital intensive sectors that has continued into the late 1990s. The use of microelectronics and automation processes in production, the development of new products and production processes through innovation and R&D and the provision of after sales service are increasingly being seen as important determinants of competitiveness. This is the view that lies behind the recently proposed integrated industrial strategy framework of the Department of Trade and Industries (DTI) (DTI, 2001).

7. Time series results

In this section the time series results are presented. The reduced form Eq 7.9 derived from the export demand and supply equations is estimated. An export demand function similar to Eq 7.7, but where P_x/P^* is proxied by RULC, is also estimated. This function implicitly assumes an infinite export supply elasticity. Both these equations were also estimated with RULC substituted by relative productivity, relative wages and exchange rates.

The estimations were completed in three stages. The export functions were first estimated using the aggregated panel data set using the Mean Group and the Dynamic Fixed Effects estimators. Secondly, to overcome possible slope

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hence the relatively poor results for developing countries.

heterogeneity across sectors the export functions were estimated for relatively homogenous sub-sector groupings: natural resource intensive, labour intensive, chemical intensive and machinery & metal products sectors. Thirdly, to account for possible heterogeneity across regions, the export functions were estimated for each country separately as well as for aggregated developed and developing country groupings.

7.1 Aggregated panel data results

Table 7.5 presents the DFE and MG estimates of the average long-run coefficients of the reduced form export function (Eq 7.9) and the adjusted export demand function (Eq 7.7) using the aggregated panel data set (1970-98). A first order ARDL model is used to represent the dynamic process in each case. In addition, a simple Partial Adjustment Model (PAM), where a single lagged dependent variable is included in the regressors, is estimated. The PAM has been the standard approach to modelling dynamics in export functions (see Goldstein and Khan, 1985). The short-run coefficients for the dynamic fixed effects regressions are presented in Table A5.4 in Appendix 5. The sector level results used to estimate the average long-run relationships using the MG estimator are presented in appendix Tables A5.5 and A5.6 of Appendix 5.

Table 7.5: Average long-run export coefficients using DFE and MG estimators, log real exports as dependent variable

	Dynamic fixed effects estimator				Mean group estimator		
	X Demand (1)	X demand with Rel Prod and Rel Wage (2)	Reduced form (3)	Reduced form with Rel Prod and Rel Wage (4)	Reduced form (5)	Reduced form PAM (6)	Reduced form with Rel Prod and Rel Wage (7)
RULC	-2.32		-2.19		-1.64	-1.71	
					0.54	*0.43*	
Rel Productivity		1.90		1.90			1.31
							0.44
Rel Wage		-3.04		-2.80			-1.52
							0.63
Capacity			-7.18	-4.94	-4.41	-3.63	-5.46
					2.45	*1.53*	*2.71*
World income	2.36	1.67	2.14	1.65	2.02	2.37	2.06
					0.61	*0.51*	*0.90*
ecm	-0.13	-0.15	-0.13	-0.15	-0.34	-0.34	-0.40
	0.02	*0.02*	*0.02*	*0.02*	*0.04*	*0.03*	*0.05*

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

Table 7.5 also presents the results with RULC decomposed into relative wages and relative productivity. Because country specific relative wages and nominal exchange rates are not measured in the same units, it is not possible to create weighted averages of each of these.[96] Relative wages for all countries were first converted to a common currency and weighted average indices for each sector were created from these (1987=100).[97] A one percent rise in relative wage can thus be brought about by a 1 % rise in nominal wages in South Africa or by a 1 % appreciation of the Rand with respect to all currencies. It is not possible to separate out which of these effects is more important.

As shown in Table 7.5, the average long-run coefficients are of the expected sign for all variables in all the regressions. RULC, relative wages and capacity utilisation negatively affect exports. In contrast relative productivity and world income positively affect exports. In calculating the MG estimates the iron & steel and rubber sectors were excluded. The individual regressions for these sectors gave extremely large long-run coefficients, which resulted in a substantial bias in the MG estimate of the average long-run coefficient (see Tables A5.5 and A5.6). The extreme impact of outliers on the MG estimator has also been found by Pesaran *et al.* (1999).

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

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

[97] The shares of world trade (exports + imports) in total sample trade were used as weights.

the demand for gasoline, Pesaran and Smith (1995) who estimate labour demand functions and Pesaran *et al.* (1999) who estimate a consumption function.

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

Relative wages and relative productivity are also shown to be important determinants of export competitiveness. The results of export demand and reduced form equations using relative wages and relative productivity as explanatory variables are shown in column (2), column (4) and column (7). A 1 % rise in relative productivity raises real exports by 1.31 % and 1.9 % in the long run. Relative wages, measured in a common currency, appear to have a stronger impact with a 1 % rise in relative wages reducing exports by between 1.52 % and 3.04 % in the long run. Either a rise in nominal wages or an appreciation of the domestic currency can raise the relative wage variable used in this regression. It is not possible to separate out the exchange rate and nominal wage effects.

World income has the correct sign with an average long-run income elasticity between 1.65 and 2.37. These values are similar to those found in the international survey by Goldstein and Khan (1985), but exceed those found by Fallon and Pereira de Silva (1993), Tsikata (1999), Golub (2000) and Golub and Ceglowski (2001) for South Africa. These studies find income elasticities for aggregate manufacturing exports ranging between 0.67 and 1.64.

Capacity utilisation has the expected negative sign, but the long-run coefficient appears exaggerated (-3.63 to -7.18). Tsikata (1999) for example finds that capacity utilisation has no effect on exports while Fallon and Pereira de Silva (1993) find that a 1 % rise in capacity utilisation reduces export orientation by up to –2.24 %. Finally, sanctions reduced real exports by between 0.2 % and 0.4 % between 1985 and 1993, a result also found by Tsikata (1999).

Other variables were also included in the analysis. Following Carlin *et al.* (2001) investment in machinery and equipment as a share of the total capital stock of machinery and equipment was included as an exogenous variable. This variable was used as a proxy for innovation, R&D and embodied technological change. No significant results were found. Effective rates of protection according to sector (between 1988 and 1997) were obtained from Fedderke and Vase (2001) and included as explanatory variables. Declines in effective protection are expected to capture reductions in the anti-export bias. Unlike Tsikata (1999), who found a negative relationship, no significant results were found. Insufficient data and the exclusion of non-tariff protection in calculating these effective rates of protection may explain the poor results.

7.2 Sector specific results

The export responsiveness of individual sectors to changes in labour cost competitiveness may differ from the average relationship. The DFE estimated coefficients exceed those of the MG estimator, which suggests heterogeneity across sectors (Pesaran and Smith, 1995). Further, Chow tests (see Baltagi, 2001) reject poolability of the slopes across sectors.[98] These tests, however, require stationarity of the error terms, which did not hold in some of the sector level regressions. The test in these cases is invalid.

In the aggregate analysis, heterogeneity across sectors was dealt with using the MG estimator. However, this estimator appears susceptible to outliers. Two further approaches are followed to explore possible heterogeneity across sectors. Firstly, the results of the individual sector regressions that formed part of the MG estimator are analysed. Secondly, the export functions are estimated for relatively homogeneous manufacturing sub-categories.

The long-run coefficients and the error correction term for individual sectors are presented in Tables A5.5 and A5.6. Care must be taken in interpreting these as the correct procedure outlined by Pesaran and Smith (1995) and Pesaran and Shin (1996)

[98] The Chow test statistic was 1.64 (F(184, 456)) for the regression using RULC and 1.51 (F(230, 408)) for the

for estimating long-run relationships using a correctly specified ARDL model has not been followed. However, as in Pesaran *et al.* (1999), the sector specific results are still presented. In the analysis that follows, the results of the estimations with RULC as the explanatory variable are emphasised. The results in Table A5.6 are qualitatively similar.

The results are mixed. For a long-run relationship to exist the error correction coefficient $\phi_i \neq 0$. This is less than zero for all but the iron & steel industry, although only significantly so for 14 of the 25 sectors. Sectors displaying rapid convergence to the long-run equilibrium ($\phi_i \leq -0.5$) were paper products, printing & publishing, transport and professional and scientific equipment.[99]

The long-run elasticity for RULC is correctly signed for 17 of the 24 sectors and significant in 8 of them. The largest significant coefficient is for furniture (-7.26) and the lowest is –1.57 for paper products. Labour intensive sectors appear most affected by RULC with 4 of the 6 labour-intensive sectors displaying negative coefficients. These are leather products, wearing apparel, wood products and furniture. These sectors also showed large negative long-run coefficients for the relative wage variable (Table A5.6). No coefficients for RULC were significant in chemical intensive sectors. Of the remaining sectors, significant and negative results were found for food, paper products, professional and scientific equipment and other manufacturing. As found by Goldstein and Khan (1985), the elasticities of sub-sectors generally exceed those for manufacturing as a whole.

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

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regression using relative wages and relative productivity. These are significant at the 5 % level.

[99] Evidence of serial correlation is found in 6 sectors (beverages, Leather, non-electrical machinery, transport and other manufactures). Heteroskedasticity is found in beverages, furniture, industrial chemicals, non-ferrous metal, glass products, electrical machinery, transport and professional and scientific equipment sectors. The functional form of 2 sectors are found to be mis-specified (transport and wood products). The individual estimates may be biased because of omitted variables and measurement errors that are correlated with the

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

Nevertheless, the wide variation in the individual sector estimates suggests that the aggregate manufacturing relationship between labour cost competitiveness and export performance does not necessarily reflect behaviour at the sector level. The export functions were thus estimated for a number of broadly defined manufacturing sub-sectors: natural resource intensive, labour intensive, chemicals and machinery & metal products (see Table A5.1 in Appendix 5 for a sectoral breakdown of these categories).[100] It is expected that the slope estimates for the sub-sectors will be more similar to each other, thus overcoming some of the problems associated the DFE estimator. The long-run estimates using the DFE estimator are presented in Table 7.6. The short-run estimates are presented in Appendix Table A5.7.

The export performance of labour intensive and chemical sectors is strongly influenced by labour costs of production. A 1 % rise in RULC reduces real exports in the long run by more than 2.5 % in each case. The decline in exports of natural resource intensive and machinery and metal products sectors is between 1.3 % and 1.5 %. Improvements in relative productivity and declining relative wages increase exports for all broadly defined sub-sectors. The impact of wages, however, appears stronger for all but the natural resource intensive sub-sector. Labour-intensive and chemical sector exports are particularly strongly affected by rising relative wages and have coefficients in excess of –3. Capacity utilisation and changes in world income

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regressors. The pooled estimates will be appropriate so long as the bias inducing correlations are not systematic.

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

affect exports of all broad sub-categories in the expected way, although the affect of these variables on machinery & metal product sectors is small. This sector also shows a much quicker convergence to the long-run equilibrium in response to shocks than the other sectors.

Table 7.6: Average long-run export coefficients for broadly defined manufacturing sectors, log real exports as dependent variable

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

7.3 Region specific results

As shown in the preliminary analysis, RULC, relative wages and relative productivity differ according to region. Trade flows also differ according to region with South Africa exporting relatively skill intensive products to developing countries and less skill intensive products to developed countries (IMF, 2000; Edwards and Schoer, 2002). In this section, the relationship between labour cost competitiveness and export performance is estimated according to region.

Unfortunately bilateral trade data between SA and its trading partners for a significant period of time are difficult to obtain. Consistent bilateral trade data were obtained from the Canadian World Trade Analyzer for developed countries between 1980 and 1998, but not for developing countries [101] This data was used to estimate real

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

export functions vis-à-vis each developed country in the sample as well as a weighted average for all developed countries. In addition, total South African exports between 1970 and 1998 were regressed on weighted averages of the exogenous variables for developed and developing countries. Although the coefficients are elasticities with respect to changes in total exports and not regional exports, the signs will indicate whether labour costs are important determinants of exports in each case. The long-run coefficients estimated using the DFE estimator and the aggregated data set are presented in Table 7.7. The short-run coefficients are presented in Table A5.8 in Appendix 5.

Table 7.7: Long-run coefficients for developed and developing countries, log total exports as dependent variable

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

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

The signs of the coefficients are as expected. The responsiveness of total South African exports to changes in relative productivity, relative wages, capacity utilisation and regional income appear similar for developed and developing countries. However, RULC vis-à-vis developed economies appears to have a more severe impact on exports in the long-run (-1.88) than RULC vis-à-vis developing countries (-1.16). This is consistent with the weak cross-section results for developing countries shown earlier. The signs of the long-run coefficients for developed countries

variables in log differences were estimated. The results were poor.

using bilateral SITC export data over the period 1980-98 are also consistent with expectations, but are generally lower than those estimated using total South African exports over the 1970-98 period. In all these regressions exports appear to respond more significantly to changes in relative wages than relative productivity.

Country specific export functions were also estimated using log real bilateral exports (for developed countries only) and the log total export ratio (for all countries) as the dependent variable. The results overall were weak, but the signs were generally consistent with theoretical predictions. The responsiveness of exports to labour cost competitiveness, however, was much lower than the estimates obtained in the aggregated analysis. These results are presented in Edwards and Golub (2002).

8. Conclusion

It has been argued that labour market institutions have reduced the flexibility of the South African labour market (Nattrass and Seekings, 2000) and that real wage increases in excess of those mandated by product prices and technology (Fedderke *et al.*, 1999) have negatively affected employment. Most studies analysing the impact of real wages on employment have focussed on the demand for labour by firms. No studies have adequately analysed the impact of real wages (and productivity) on employment through changes in export and import competitiveness. This chapter contributes towards this analysis by focussing on the impact of wages and productivity on South Africa's export performance. Although this chapter does not directly analyse the impact of trade on employment, the results are useful for the debate as they give insight into some of the constraints to export-led employment growth. This analysis also differs from earlier chapters in using the Ricardian continuum of goods model as the theoretical framework.

The evidence suggests that RULC for South Africa have improved since the 1970s. However, the improvement differs vis-à-vis developed and developing countries. During the 1970s and 1980s, the improvement in labour cost competitiveness vis-à-vis developed and developing countries was largely driven by the depreciation of the currency, which lowered relative wages measured in a common currency. During the 1990s, continued real depreciation of the currency lowered relative wages of South African workers, but largely relative to developed economies. Compared to developing economies, against which South Africa competes for developed country market share, relative wages rose during the 1990s. Improvements in RULC vis-à-vis developing (and developed) countries arose from superior labour productivity growth. Despite the improvement in RULC, South African manufacturing is still not competitive in most sectors against other developing countries.

This chapter also analyses the impact of labour cost competitiveness on export performance. RULC are found to have a strong impact on export competitiveness. This result is consistently found in the cross sector and time series regressions. A 1 % decline in competitiveness (rise in RULC) is estimated to reduce real exports by between 1.64 % and 2.32 % in the long run. Disaggregating RULC into its constituent parts, the chapter finds that a 1 % increase in relative productivity or decrease in relative wages boost exports by between 1.3 % and 3 % in the long run. The coefficients are larger for labour intensive sectors. Export performance is thus closely linked to labour cost competitiveness.

The improvements in RULC suggest that the depreciation of the currency and improvements in labour productivity more than offset real wage growth during the 1990s. However, the sources of improved competitiveness are not necessarily sustainable in their current form. Edwards and Golub (2002) argue that the improvements in labour productivity were largely achieved through capital-labour substitution (through the shedding of labour as shown in Chapter 6). As shown in Edwards and Golub (2002), South African TFP growth is poor compared to other economies. Poor TFP growth in South Africa has also been shown in Chapter 4.

Improvements in competitiveness through exchange rate depreciation are also not sustainable in the long run. This is already evident during the latter part of the 1990s when the rate of depreciation declined. For example, during the 1990s the depreciation of the currency was insufficient to reduce relative wages vis-à-vis a range of developing economies. These are South Africa's primary competitors for developed country imports. From an employment creation perspective, developing countries are major competitors in the production and export of labour-intensive products. During the 1990s relative wages rose in labour-intensive sectors such as food products, textiles, wearing apparel and leather products. These increases will have negatively affected export growth within these sectors, which may explain the low level of employment created through export growth shown in Chapter 6. Poor labour cost competitiveness vis-à-vis developing economies, particularly within labour-intensive sectors, is also consistent with the rising skill and capital-intensity of trade shown in Chapters 5 and 6.

The implications for the focus of this thesis are as follows. Firstly, export performance, and thus export-generated employment, is highly sensitive to wage increases. The strong real wage increases shown in Chapter 4 have thus substantially hindered employment generated through export growth. Secondly, during the 1990s, relative wages vis-à-vis developing countries rose in many labour-intensive sectors, although these increases were mostly offset by productivity gains. Nevertheless, the study shows that export performance within labour-intensive sectors are relatively strongly affected by labour cost competitiveness. The failure of these sectors to generate substantial employment growth through exports, as envisaged by GEAR, can partly be contributed to strong real wage increases. Further, the rising capital intensity of trade, in part driven by the poor performance of labour-intensive sectors, can also be related to excessive wage growth. These relationships are not tested directly, but are implied by the results of this chapter. Excessive wage growth thus appears to have curtailed employment generation through trade liberalisation. Policies that foster productivity growth and wage moderation will substantially enhance export-led employment growth.

Chapter 8

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

1. Introduction

There is increasing evidence that technological change has contributed significantly towards the rising skill intensity of production within South Africa. In Chapter 4, it was shown that within-sector shifts account for most of the aggregate increase in skill intensity of production within the manufacturing sector. In the decomposition analysis of Chapter 6, labour saving technical change resulted in substantial declines in employment of less-skilled labour between 1993 and 1997. Other empirical research (Bell and Cattaneo, 1997; Bowles, 1995; Bhorat and Hodge, 1999; Fedderke *et al.*, 1999) directly or indirectly also find large impacts of technological change on employment.

A major problem with all these studies is that they assume technological change 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). Feenstra and Hanson (1995a) argue that outsourcing by developed countries may also raise the relative demand for skilled labour in the country to which production is transferred. This occurs because the activities and technologies transferred to developing countries are more skill-intensive than those formally produced in these countries.

As discussed in Chapter 4, there is increasing evidence that trade and technological change are linked in South Africa (Belli *et al.,* 1993; Fallon and Pereira de Silva, 1994; Black, 1996; Hayter *et al.* 1999; Jonsson and Subramanian, 2000).

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* A more extensive version of this chapter was distributed as a discussion paper in the DFID CSSR research programme on 'Globalisation and Poverty' (see Edwards, 2002a). Rhys Jenkins from the Overseas

Further, as shown in the decomposition analysis of Chapter 6, the labour content of net trade is negatively correlated with employment losses due to direct labour saving. Export sectors in particular appear to be shedding labour as they gear up for the export market. Similar results were found by Hayter *et al.* (1999). These relationships suggest that trade-induced technological change and not exogenous skill-biased technological change have driven some of the within-sector shifts towards more capital and skill-intensive production techniques.

A further problem with these studies is that they use aggregated sector level data, which hides much of the firm level heterogeneity in the response to trade liberalisation. Coherent indicators of trade liberalisation at the sector level are also difficult to construct as the tariff structure is highly complex (see Chapter 2). As a result, a relationship between trade liberalisation and employment is frequently *inferred* from changing employment trends during the 1990s (as in Bhorat, 1999 and in Chapter 5 and 6). 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 new labour legislation. The relative role of each of these is in influencing employment patterns is unclear.

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 chapter extends the thesis by analysing the direct impact of trade liberalisation and technological change on employment at the firm level. In particular, the chapter focuses on the relative role played by trade-induced technological change. The chapter thus advances existing literature in South Africa by testing for the presence of 'defensive innovation' and assessing the impact on employment of rising export orientation and foreign direct investment.

Development Group at the University of East Anglia was the project coordinator under which this research fell.

The structure of the chapter is as follows. Section 2 presents background information on sample size, foreign ownership, export orientation and changes in employment. This is followed in Section 3 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-section econometric techniques are used in Section 4 to estimate labour demand functions. A conclusion ends the chapter.

2. Background analysis of the survey data

2.1 Sample information

The World Bank and Greater Johannesburg Metropolitan Council large manufacturing survey consists of 325 manufacturing firms with more than 50 full-time employees drawn from the Greater Johannesburg Metropolitan Area (GJMA).[102] 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 8.1) and three full employment size-classes (small: 50-99 employees, medium: 100-199 and large: 200-10000).[103] Within these multi-strata, simple random sampling was performed.

The National Enterprise (NE) survey is national in coverage and consists of 941 manufacturing firms, 39 % of which are large firms consisting of more than 50 employees. The survey was administered in late 1999 and early 2000 and covers the period from early 1998. The sample was selected from a database of over 40 000 firms that have credit or have applied for credit from financial institutions or suppliers during the three years prior to the purchase of the database (Gelb, 2001). Firms were

[102] 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, as a result, has not been analysed.

[103] The master database was constructed from the total number of registered firms from the following databases: Unemployment Insurance Fund, Matrix Marketing and Bureau of Market Research. See Annex 2 of the large firm survey report (Chandra *et al.*, 2001a) for more details on the sampling and weighting

stratified on the basis of 13 sectors,[104] two employment size classes (small: 0-50 employees and large: above 50 employees) and in the case of the small firms, also by location.[105] Within these multi-strata, simple random sampling was performed.

Table 8.1: Number and distribution of manufacturing firms, NE and GJMA surveys

	NE survey						GJMA survey	
	All firms		Large firms		Small firms		Large firms	
	No. of firms	Sectoral share (%)	No. of firms	Sectoral share (%)	No. of firms	Sectoral share (%)	No. of firms	Sectoral share (%)
Food & beverages	101	10.7	43	11.7	58	10.1	26	8.0
Wood, pulp & paper	119	12.6	40	10.9	79	13.8		
Chemicals, rubber & plastics[a]	121	12.9	41	11.2	80	13.9	48	14.8
Auto assembly & components	93	9.9	39	10.6	54	9.4	34	10.5
Textiles & clothing	116	12.3	45	12.3	71	12.4	14	4.3
Fabricated metal products	102	10.8	44	12.0	58	10.1	57	17.5
Furniture[b]	86	9.1	35	9.5	51	8.9	34	10.5
Electrical & other machinery	110	11.7	44	12.0	66	11.5	56	17.2
Printing & publishing	93	9.9	36	9.8	57	9.9		
Iron & steel							56	17.2
Total	941	100	367	100	574	100	325	100

Notes: Percentage shares may not sum to 100 % due to rounding up.
a. Does not include pharmaceuticals in the NE survey. Does not include rubber & plastics in the GJMA survey.
b. Includes paper in the GJMA survey.

Firms are distributed evenly across sectors in the NE survey with each of the nine sectors, accounting for roughly 11 % of the sample (Table 8.1). In the GJMA survey fabricated metal products, electrical products and iron & steel firms account for large shares (over 17 %) of the sample. Textiles & clothing firms are under sampled compared to the NE survey, which reflects the high proportion of these firms within the Western Cape and KwaZulu-Natal. For comparative purposes both surveys are weighted up to the national level in the cross-tabular analysis that follows.

2.2 *Employment*

As shown in Bhorat (2001) and Chapter 6, formal employment, particularly of less-skilled labour, has fallen significantly since 1994. Employment changes within

procedures.

104 In addition to the manufacturing sectors presented in Table 8.1, finance & business, information technology services, tourism & catering and retail services were included in the NE survey. These have been excluded as questions relating to trade liberalisation were not included in the services sector questionnaire.

105 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

the surveys are consistent with these trends. Using the GJMA survey, total full-time employment for a consistent set of firms declined between 1994 and 1998 for all but the food & beverages sectors. The median level of employment declined from 138 in 1994 to 118 in 1998.[106] The declines were notably strong in the textile and automotive sectors where employment declined by 28 % and 25 %, respectively, during this period.

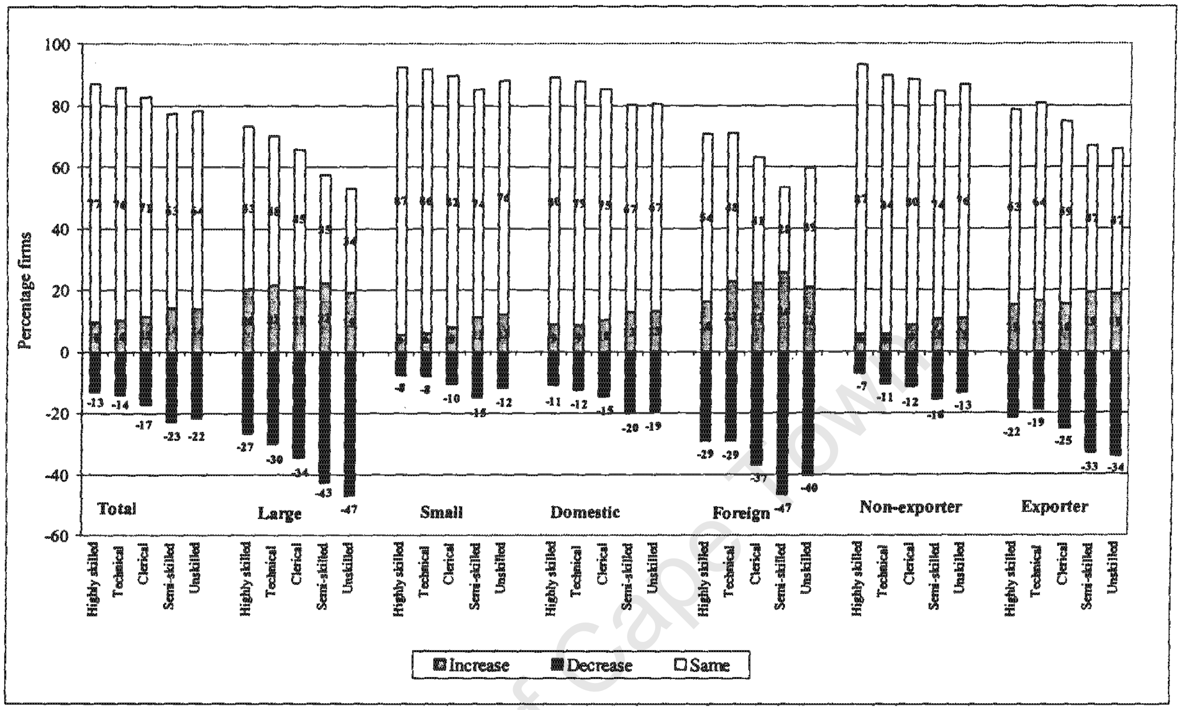
Because neither survey provides information on the level of occupational employment over a number of years, it is not possible to estimate the change in the occupational composition of employment since the early 1990s. However, the NE survey provides information on whether a firm increased, decreased or retained full-time employment for 5 occupational categories between the start of 1998 and the end of 1999; roughly a two year period. Figure 8.1 presents this data for each occupational category according to size, ownership and export 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 the shares in each column sum to 100%.

Figure 8.1 shows substantial heterogeneity in the employment decision of firms both between and within the size, ownership and trade orientation categories presented. 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, significant diversity is found amongst large firms, foreign firms and exporters with large shares of firms within these categories either increasing or decreasing employment.

(Gelb, 2001).

[106] Only firms for which full-time employment data were available for all periods were included. These firms made up 59 % of the total sample as many firms did not supply employment data for the earlier years. The downward trends, particularly since 1996, do not change if the sample of firms used to calculate total full-time employment is increased through excluding 1994 and 1995. Part-time employment is small and accounts for less than 6 % of total employment in the GJMA survey.

Figure 8.1: Changes in full-time employment between the beginning of 1998 and the end of 1999 according to occupation



Notes: Highly skilled consist of professional and managerial, technical consists of skilled artisans, 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 responses between large and small, foreign and domestic and exporter and non-exporter. According to this statistic the distribution of employment changes within each sub-category of the small-large, domestic-foreign, exporter-non-exporter classifications are significantly different from each other.

Overall, the number of firms that decreased employment in the NE survey exceeded those that increased employment for all skill categories (see the 'Total' columns). 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, for all skill categories the median level of employment in firms that reduced employment was significantly higher than in firms that raised or did not change employment.[107] This together with the relatively high share of firms that reduced employment suggests a net decline in total employment since 1998.

The decline in employment is also biased against less-skilled labour, particularly amongst large, foreign and export firms. For example, over 40 % of large and foreign firms reduced employment of semi-skilled and unskilled labour compared

[107] 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.

to approximately 28 % for highly skilled labour. The median level of employment in firms that reduced semi-skilled (60 employees) and unskilled labour (90 employees) was also significantly higher than in firms that raised or did not change employment (between 30 and 40 employees). The results thus *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.

2.3 Trade and foreign ownership

Table 8.2 presents the median values of a number of characteristic variables according to foreign ownership and export status using the NE survey.[108] Because large and small firms differ in many respects these comparisons are made for small and large firms separately. For each variable the difference in medians was tested for significance using the two-sample Wilcoxon rank-sum (Mann-Whitney) test. The results are also shown in Table 8.2.

Table 8.2: Key characteristics of foreign and export firms, NE survey

	Large		Small		Large		Small	
	Domestic	Foreign	Domestic	Foreign[a]	Non-exporter	Exporter	Non-exporter	Exporter
Distribution (%)	73.3	26.7	97.2	2.8	30.8	69.2	72.0	28.0
Medians								
Exports/output (%)	6.4	8.3**	7.1	25		7.4		7.5
Exports to Africa (% total)	68	75	100	100		70		100
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
Sales (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
Sales/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: Sales per labour and K/L are calculated using full time employees. High-skilled consists of professionals and managerial labour.

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

a. Foreign firms consist of all firms with at least a 10 % foreign ownership. There were at most 16 observations for small foreign firms. Comparisons with small domestic firms must be made with caution.

The distribution of large export and foreign firms are very similar across surveys. In both surveys, between 69 % and 71 % of large firms export, which is

[108] The medians and means do not coincide indicating a non-normal distribution of the variables. The mean results can be found in Edwards (2002a).

considerably higher than the share of small firms (28 %). The share of large firms partly or fully foreign owned is also similar in both surveys and ranges between 26 % and 27 %. The share foreign ownership for small firms in the NE survey (2 %) is, however, substantially lower than in the 5-20 % found by Chandra *et al.* (2001b: Table A13) using the GJMA small firm survey.

For both small and large firms the share of output that is exported is low. On average, large firms and small firms export 16.7 % and 12.8 % of their output, respectively. The median shares are substantially lower (around 7.4 %), reflecting high export orientation amongst a few firms. These values are low compared to other African and East Asian countries. Within Cameroon, Ghana, Kenya and Côte d'Ivoire similar shares of firms export, but these firms export between 28 % and 60 % of their output (Rankin, 2001). In Indonesia, South Korea, Malaysia, Philippines and Thailand exporters export between 36 % and 64 % of their output (Chandra *et al.*, 2001a). These firm level values are also low compared to the aggregated data where 25 % of manufacturing output is exported (see Chapter 5).

Differences in production structures are also evident. Compared to domestic and non-export firms, large foreign and large export firms, respectively, are more skill-intensive, produce more output, are more capital intensive and employ more labour which is also more productive (as shown in the Sales/L ratio). Large foreign firms also export greater shares of their output compared to large domestic firms. The regional destination of exports amongst large domestic and foreign firms appears similar, but small firms are more oriented towards the African market. Differences between exporter and non-exporter and between foreign and domestic owned firms are fewer amongst small firms, although small foreign and export firms produce more output and are more productive. There is no difference in the skill intensity of production amongst small firms.

3. A preliminary analysis of the impact of trade liberalisation on employment and technological change

The evidence presented in Section 2 shows substantial differences in employment decisions across different categories of firms. The bulk of small, domestic owned and non-export firms did not change employment between 1998 and the end of 1999. In contrast, a relatively high percentage of large, export and foreign owned firms reduced employment, particularly of semi-skilled and unskilled labour. These firms also tend to be more skill intensive.

In the following section cross-tabulations are used to analyse whether changes in the level and occupational structure of employment, as well as differences in productivity, are related to trade liberalisation directly or via trade-induced technological change.

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 are:

NE survey

What has been the impact of the cut in import tariffs since 1994 on the following aspects of *your* operation? (q54a and q81)

- Lower production price in South Africa[109]
- Loss of SA market share to foreign competitors
- Made your exports more competitive

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)

This chapter draws on these questions to analyse the potential impact of trade liberalisation on employment. Prior to this, the following section highlights a number of theoretical considerations regarding the impact of trade liberalisation on market share, employment, export performance and technological change at the firm level. Preliminary conclusions drawn from this section regarding the severity of the impact

[109] 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.

of trade liberalisation on employment are then formally tested in Section 4 using econometric techniques.

3.1 Theoretical and data considerations

As discussed in Chapter 3, trade liberalisation gives rise to general equilibrium effects on an economy. Because this chapter draws upon firm level surveys some of these general equilibrium effects cannot be captured. Nevertheless, a number of testable hypotheses regarding the impact of trade liberalisation on employment can be derived. Output and employment are expected to fall in import-competing firms experiencing a reduction in protection. 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 find 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. In a general equilibrium framework, sector-biased Hicks-neutral technological improvements raise the relative returns to the factors used intensively in that sector (see Chapter 3). At the firm level, the impact of Hicks-neutral technological change is a reduction in employment per unit output. However, as output expands so too will employment. Relative labour demand will only be affected via the general equilibrium related changes in relative factor payments.

In contrast, trade-induced technological change affects the relative demand for skilled labour directly. According to Wood (1994), firms raise productivity through unskilled-labour-saving technological progress in response to increased import competition. Relatively high investment in skill-intensive production technology coinciding with rising skill intensity of production in firms that are negatively affected by trade liberalisation is thus expected. 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). A higher share of firms restructuring production in the face of increased import competition relative to those that do not face such competition is thus expected.

Trade can also increase 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, the share of imports in intermediate goods should be positively correlated with a rising skill intensity of production.

A final form of technological change is skill-biased technological change, as discussed by Berman *et al.* (1994), Berman *et al.* (1998) and Machin and Van Reenen (1998).[110] The effect of skill-biased technological change is revealed in more intensive use of computers in the production process, which raises the demand for skilled labour relative to less-skilled labour in all sectors. Rising skill intensity across all sectors is expected, but these increases 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, no relationship between skill-intensive investment and trade liberalisation is expected. 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.

Limitations in the data affect the extent to which these relationships can be analysed. The firm surveys provide data for a particular period of time, although some recall data are provided in each survey. Because the surveys are not repeated, it is not possible to interrogate the relationship between trade liberalisation, technological change and employment by analysing the behaviour of the same set of firms over time. Most of the data in the NE and GJMA surveys relate to firm behaviour between 1997 and 1999. Trade liberalisation, however, accelerated from 1994. By the time the

[110] 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 (Leamer, 1996; Berman *et al.*, 1998). This is discussed in Chapter 3.

surveys were conducted, firms may have already exited or restructured production in response to increased international competition. This information is not captured in the firms' responses.

A further limitation is that the identified relationships often rely heavily on firm owners' perceptions rather than objectively sourced data. For example, firm owners or managers may erroneously attribute a loss in market share arising from changes in consumer preferences, the emergence of new firms and/or poor management practice to increased import competition. In an attempt to overcome this specific problem, scheduled nominal tariff data are assigned to each firm on the basis of commodities produced. Nevertheless, the possible shortcomings of the data need to be taken into account when interpreting the results.

3.2 Impact of trade liberalisation on market share and product price

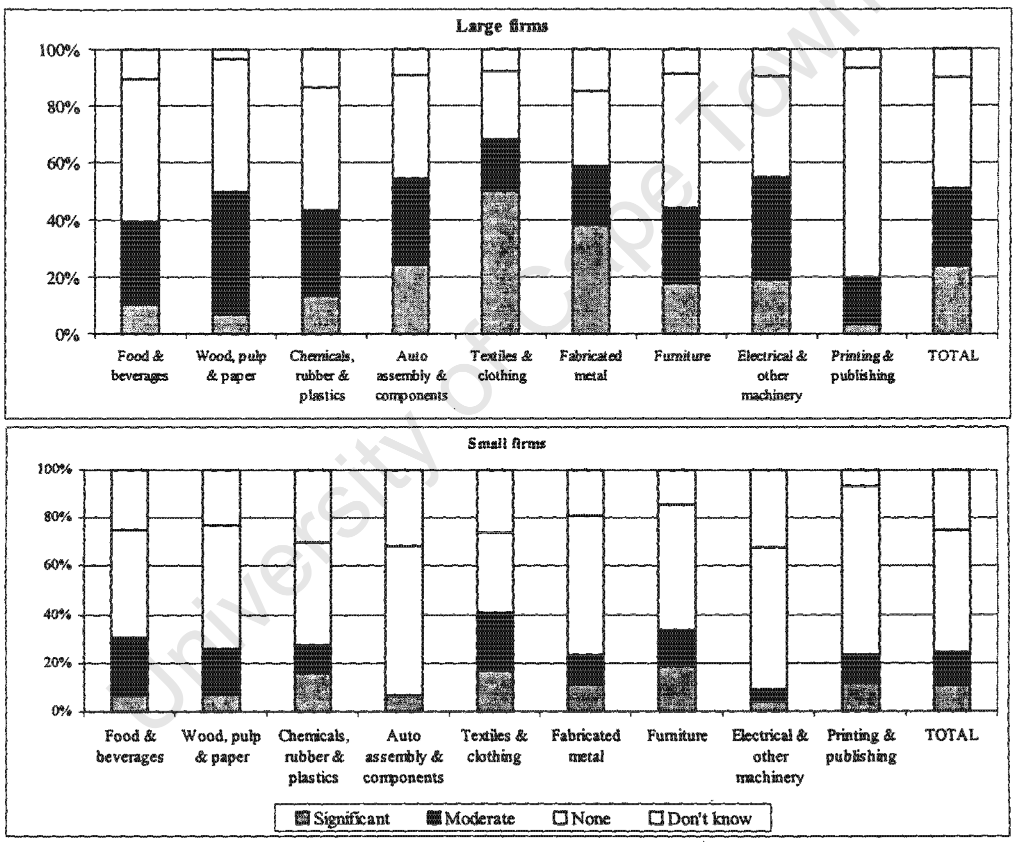
In the surveys, the negative impact of trade liberalisation is measured through its impact on a firm's product price or loss of market share to foreign competition. Figure 8.2 presents the distribution of NE survey firms according to the impact of trade liberalisation on market share. The impact of trade liberalisation on product prices is not presented in the figure, but is discussed in the text. Similarly, the results using the GJMA survey are discussed when differences between the surveys arise.

The impact of trade liberalisation 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 8.2 where 51 % of large firms were either significantly or moderately affected compared to 24 % of small firms.[111] If the relatively high share of small firms who did not know the impact of trade liberalisation on market share are excluded, the share rises to 32 %; a result similar to the 30 % in the GJMA small firm survey (Chandra *et al.*, 2001b). This is still less than the share of large firms.

[111] The share of large firms negatively affected in the GJMA survey is substantially lower than in the NE survey. Regional location and differences in the implementation (interview vs. post) may have affected the responses by firms. Care must thus be taken in interpreting the results.

High proportions of NE survey firms were also affected by declining product prices. 43 % of large firms experienced significant or moderate declines in product prices due to trade liberalisation, which is similar to the impact on market share. In contrast, the impact of price declines for small firms was more widespread with 35 % (or 40.5 % if those unaware are excluded) of small firms significantly or moderately affected.

Figure 8.2: Loss in market share from increased foreign competition since 1994 (% firms in each sector), NE survey



The impact of trade liberalisation on market share is not even across sectors, particularly for large firms. Less than 15 % of firms in printing & publishing, wood products, food & beverages and chemical sectors experienced a significant reduction in market share. Clothing & textile (50 %) and metal product (38 %) sectors were the most significantly affected amongst large firms, but largely through reductions in market share. Only 16 % of firms within these two sectors experienced significant reductions in prices due to trade liberalisation. 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. Further, declining market share in these sectors is less severe for small firms where only 17 % and 11 % of small textile and metal products firms, respectively, were significantly affected. Similar differences between large and small firms are also evident in the other sectors.

3.3 The impact of trade liberalisation on employment

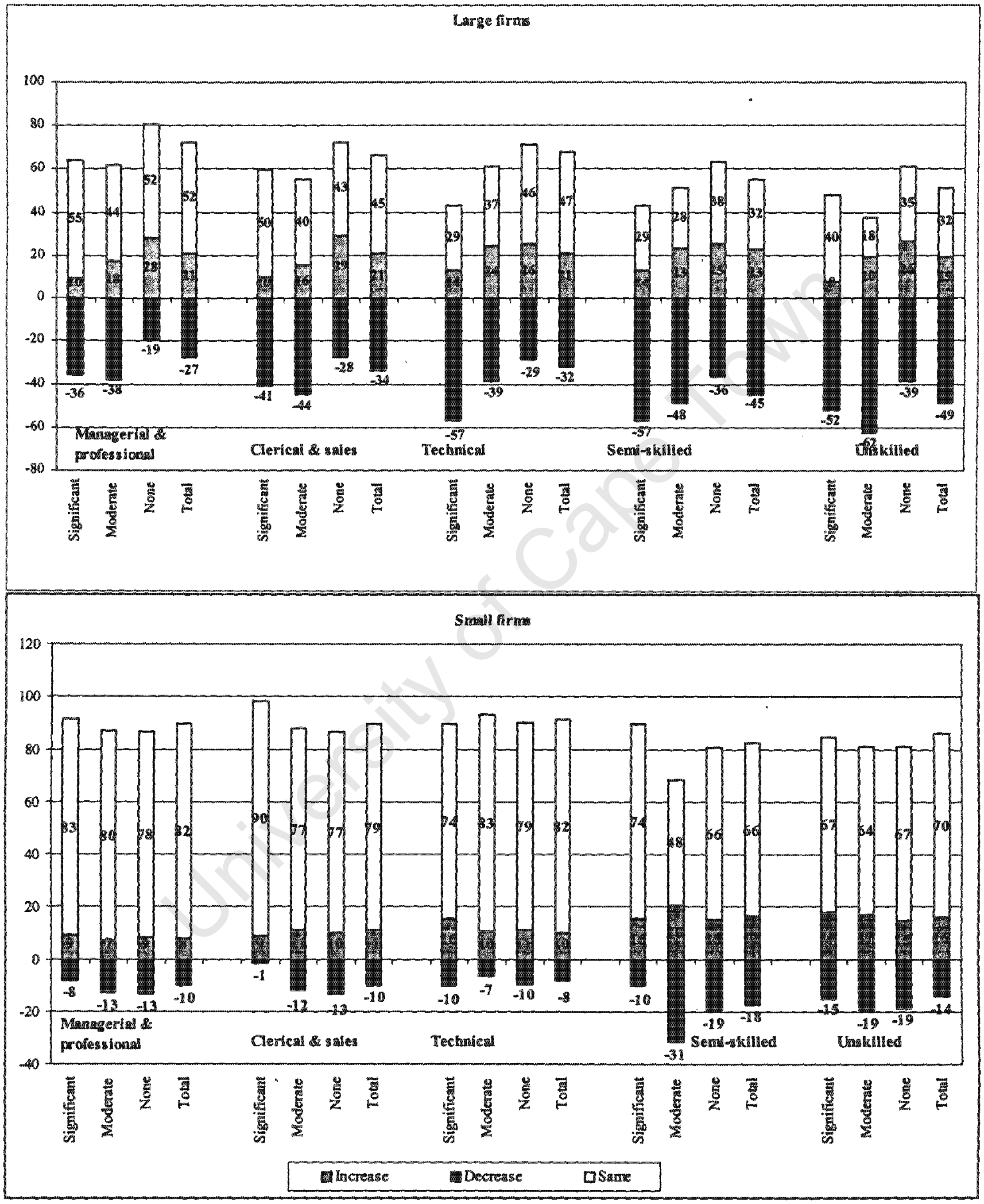
There are no questions within the surveys that ask firms for the direct and indirect (via new technology) impact of trade liberalisation on employment. Cross-tabulations are, therefore, used to analyse whether employment declines were relatively high in firms that were significantly or moderately affected 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 '*large*' negative effect on employment.

Figure 8.3 presents the share of NE survey firms that increased, decreased or did not change employment between early 1998 and late 1999 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 absolute value of the shares in each column sum to 100%. Separate diagrams for large and small firms have been constructed.

Using Figure 8.3, evidence in support of the view that trade liberalisation negatively affected employment can be shown by the following:

- 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.
- 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.

Figure 8.3: Employment changes between early 1998 and late 1999 according to the impact of tariff liberalisation on the loss of SA market share to foreign competition (% firms), NE survey



There is no evidence of either of these relationships for small firms.[112] For all skill categories the share of firms that reduced employment was equal to or higher

[112] The following Pearson chi-square probability statistics were obtained: managerial & professional (0.44), clerical & sales (0.55), skilled technical (0.97), semi-skilled (0.24) and unskilled (0.08).

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 test statistic, the distribution of employment changes differs significantly across trade liberalisation categories.[113] 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 consistent with our expectation regarding the impact of trade liberalisation on employment in import-competing firms. 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.

Similar relationships for total employment are found over the longer 1994-98 time period using the GJMA survey (Table 8.3). The median firm not affected by lower import duties/taxes since 1994 raised employment by 7.7 %, while the median firm that was negatively affected reduced employment by 8.9 %. The difference is significant only at the 10 % significance level. Similarly, the change in employment of the median firm was 7.7 % for firms not affected by declining product prices compared to –13.9 % for firms negatively affected. Again the relationship is statistically weak.

While a negative relationship between trade liberalisation and employment is found amongst large firms, but not small firms, the size of the impact is insufficient to account for the full decline in employment experienced since 1994. In the NE survey, large firms that both reduced employment of unskilled labour and were negatively

[113] The following Pearson chi-square probability statistics were obtained: managerial & professional (0.01), clerical & sales (0.01), skilled technical (0.07), semi-skilled (0.16) and unskilled (0.01). For all occupational categories the relationship is significant at the 1 % level when large and small firms combined.

affected by trade liberalisation account for 29 % of all large firms. If small firms are included the share declines to 15 %. The share of firms that reduced employment and were negatively affected by trade liberalisation is much smaller for the other occupational categories. Using the GJMA survey, firms significantly or moderately affected by tariff liberalisation account for 22 % of the decline in total employment, excluding the food & beverages sectors, between 1994 and 1998. If the food & beverages sector is included then these sectors actually positively affected employment. The possible impact of trade liberalisation on employment may be biased downwards by the closure of firms in response to increased import competition. Nevertheless, the data suggests that, while trade liberalisation may have exacerbated the decline in certain sectors, it is not the dominant cause of the decline. The vast majority of firms made employment decisions that were unrelated to trade liberalisation. A further implication of these numbers is that the impact of trade liberalisation on employment via technology choice will not be very large.

Table 8.3: Mean and median % change in employment between 1994 and 1998 according to the 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	*	

Notes: 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.

3.4 Impact of trade liberalisation on export performance

By lowering the relative price and reducing the cost of imported intermediate goods, trade liberalisation encourages export-led employment growth. Thus, according to international trade theory, employment losses occurring within import-competing firms are negated by employment gains within the export sectors.

A high percent (40 %) of large exporters in the NES survey felt that their export competitiveness improved as result of tariff liberalisation. If small exporters are included this percentage declines to 36 % of exporters, or 28 % of all firms. Using the GJMA survey, 18.8 % of all firms experienced significant or moderate reductions in raw material prices as result of tariff liberalisation. These shares are relatively low compared to the 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.

Using a similar cross-tabular approach to Figure 8.3, a positive relationship between improved competitiveness and employment would be revealed in a rising (declining) proportion of firms increasing (decreasing) employment as competitiveness improved. No such relationship is found for large firms between early 1998 and late 1999 (see Edwards, 2002a). Similarly, no significant relationship between employment changes and the impact of tariff liberalisation on raw material prices was found using the GJMA survey over the period 1994-98. Thus, even over the longer run, the relationship between improved competitiveness from trade liberalisation (in export and domestic firms) and employment growth appears weak amongst large firms.

The relationship between changes in employment and improved competitiveness was better amongst small firms. For all occupational categories the share of NE survey 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 from trade liberalisation led to greater employment growth.

Overall, however, the relationship is poor. This is partly due to the low level of export orientation amongst South African firms, but may also reflect the importance of other factors such as trade barriers, market access restrictions, transport facilities and the real exchange rate in determining export growth. For example, the real depreciation of the Rand since 1994 has raised the return to exporters, assuming a small price taking economy, but has also raised the cost of imported intermediate goods. Because price changes from exchange rate movements dominate price changes from trade liberalisation, the relationship between trade liberalisation and cheaper imported inputs may be obscured. A further reason for the poor relationship between improved competitiveness and employment growth is that firms were on average producing at 75 % of capacity, suggesting that export growth is likely to be achieved through increased capacity utilisation rather than an increase in production capacity, at least over the short term.

3.5 Trade liberalisation and technology choice

Trade liberalisation also affects employment through trade-induced technological change. In this section, Wood's (1994) hypothesis that firms adopt unskilled-labour-saving technology in response to increased import competition is analysed. The analysis of the impact of technological transfers (Pissarides, 1997) and pervasive skill-biased technological change is dealt with in the econometric analysis that follows this section.

In Table 8.4, the most important reason for the firm's last significant fixed capital expenditure is cross-tabulated on the severity of the impact of trade liberalisation on market share and product prices using the NE survey. The values in the table reflect the share of total firms within that row category, i.e. each row sums to 100 %. A relatively high percentage of negatively affected firms investing in labour-saving technology is consistent with 'defensive innovation'.

Looking at the 'Total' rows, expected sales growth and raising efficiency through new technology dominated firms' decisions to invest and together 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 each of these as the primary reason for investment.

Very few firms (less than 7 %) invested in order to reduce wage costs or labour conflict by cutting the workforce. The share of firms who invested in order to cut the workforce was also 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 and the decision whether to invest and the level of investment is unrelated to the severity of the impact of trade liberalisation. The investment behaviour of firms negatively affected by trade liberalisation appears to be no different from firms that were not affected.

Table 8.4: Most important reason for investment according to the impact of tariff liberalisation and firm characteristics (% firms), NE survey

	Most important reason for investment									
	Expected sales growth	Cut labour to reduce wage costs	Cut labour to reduce conflict	Technology to raise efficiency	Technology to improve product quality	Replace old machinery	Increase export competitiveness	Diversify products	Other	Total
Most important reason for investment according to impact of tariff cuts on product prices										
Significant	24.5	2.8	1.8	24.2	16.2	9.3	6.2	7.6	7.4	100
Moderate	26.5	6.6	2.0	25.3	15.5	9.9	4.1	4.1	6.1	100
None	27.4	5.2	1.5	25.0	7.6	11.2	6.2	9.6	6.5	100
Total	27.6	5.3	1.6	23.7	10.3	11.6	5.1	8.4	6.4	100
Obs	536									
Most important reason for investment according to loss of market share to foreign competitors										
Significant	15.7	7.6	4.1	29.8	13.2	8.5	7.1	8.0	5.9	100
Moderate	29.6	3.8	0.8	29.5	11.8	10.9	2.1	3.8	7.7	100
None	29.6	5.2	1.0	19.7	9.2	12.2	6.5	10.9	5.8	100
Total	27.2	5.4	1.6	23.5	10.5	11.5	5.3	8.7	6.5	100
Obs	543									

Notes: 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.

This is not a tight argument against Wood's (1994) hypothesis of 'defensive innovation'. While the major reason for investment may not be to reduce the labour force, investment in new efficiency improving technology may reduce employment, particularly of unskilled labour, if the technology is skill-biased. There may be an indirect relationship between a firm's 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 8.5 presents these cross-tabulations for unskilled labour. The row values sum to 100 %.

Table 8.5: 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 (87)
Employment rise & negative tariff effect	**36.7**	14.5	25.6	9.4	3.8	5.4	4.6	100 (33)
Employment fall & no tariff effect	16.5	12.3	30.5	15.4	3.2	11.4	10.8	100 (60)
Employment rise & no tariff effect	**47.7**	4.2	24.0	4.6	8.0	8.7	3.0	100 (56)
Total	24.6	10.1	36.2	9.2	4.0	8.4	7.6	100 (236)

Notes: Observations are in parenthesis in the Total column. 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 efficiency improving 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.

Supportive evidence is found when looking at changes in professional & managerial labour. Amongst firms that increased employment, those negatively affected by tariffs were more likely to invest in efficiency improving technology than those not affected by tariff liberalisation. Expected sales (41 % of firms) dominated reasons for firms that both experienced no effects from tariff liberalisation and increased employment. This is consistent with 'defensive innovation' where firms negatively affected by trade liberalisation invest in new technology that is skill-biased.

While a relationship consistent with 'defensive innovation' is found, the employment impact is likely to be small. Firms that reduced employment of unskilled labour, were negatively affected by trade liberalisation and invested in new technology account for only 19 % of all firms for which data were available. It is also possible that firms re-organised production rather than investing in new technology (as argued by Aguirregabiria and Alonso-Borrego (2001)), which would suggest that this is an underestimate of the full impact of 'defensive innovation'. However, when looking at the reasons for a decline in employment, no relationship between the severity of the impact of tariff liberalisation and changes in skilled and unskilled employment due to the re-organisation of production within firms is found.[114]

3.6 Discussion

In the cross-tabulation analysis substantial inter- and intra-sector heterogeneity in the impact of trade liberalisation on firms is found. A high percentage of large firms, particularly in clothing & textile, auto assembly & components and fabricated metal product sectors, experienced significant or moderate declines in market share as a result of greater import penetration. In contrast, the market share of small firms was largely unaffected by trade liberalisation. The impact of trade liberalisation on product prices differed suggesting different perceptions of how trade liberalisation affects each firm. Product level tariff data obtained from outside of the firm surveys may be a

[114] 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

more objective way in which to evaluate the impact of trade liberalisation on individual firms.

The impact of trade liberalisation on employment was also analysed and a negative relationship between employment changes and the severity of the impact of trade liberalisation on market share or the firm's operations was found in large firms. Overall, however, these firms account for a small percentage of all firms. No relationships were found amongst small firms. The impact of trade liberalisation on total employment thus appears to be small.

Some, albeit limited, evidence of defensive innovation is found. 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 or in expectation of future sales growth. However, of the firms that reduced employment of unskilled labour, those negatively affected by trade liberalisation were more likely to invest in new technology. A similar relationship was found amongst firms that raised skilled employment, despite the negative impact of trade liberalisation on their market share. These trends suggest that trade liberalisation may have increased the skill intensity of production, at least amongst large import-competing firms.

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. Multivariate regression analysis is a more appropriate method to determine the partial impacts of trade and technology on employment while controlling for the impact of other variables. In the following section, labour demand functions are estimated using regression techniques. Through these functions, the direct impact of trade liberalisation and technological change on employment at the firm level will be tested. Labour demand functions may thus give insight into whether employment has, on average, fallen within firms experiencing a reduction in tariffs. The use of labour demand functions for this purpose is widely followed in international empirical literature (Berman *et al.*, 1994; Harrison and

costs, etc.); and reason is different from all of the above.

Hanson, 1995; Currie and Harrison, 1997; Milner and Wright, 1998; Machin and Van Reenen, 1998; Harrison and Hanson, 1999; Teal, 2000; Görg and Strobl, 2001).

4. Labour demand functions

4.1 Deriving labour demand functions

Various approaches have been used to derive labour demand functions (see Hamermesh, 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). In these equations 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, 1995; Aguirregabiria and Alonso-Borrego, 2001) relative wages or relative employment are used as the dependent variable.

Labour demand functions are also derived from the Cobb-Douglas production function

Eq 8.1: $Q = A^{\gamma} U^{\alpha} S^{\beta}$

where Q is output, A is an index of Hicks-neutral technological progress, U is less-skilled labour and S is skilled labour (see Currie and Harrison, 1997; Milner and Wright, 1998; Greenaway *et al.*, 1999; Birdi *et al.*, 2001).

Solving for S in the system of first order profit maximising conditions (wage equals marginal revenue product) and then substituting into equation (Eq 8.1) yields

Eq 8.2: $$Q = A^{\gamma} U^{\alpha} \left[\frac{\beta U}{\alpha} \frac{w_u}{w_s} \right]^{\beta}$$

where w_u and w_s are the less-skilled and skilled wages, respectively (see Edwards, 2002a). By taking the log of this equation, the firm's derived demand for less-skilled labour can be expressed as

Eq 8.3: $$\ln U = \delta_0 + \delta_1 \ln A + \delta_2 \ln\left(\frac{w_u}{w_s}\right) + \delta_3 \ln Q,$$

where

Eq 8.4: $$\delta_0 = -\frac{(\beta \ln \beta + \beta \ln \alpha)}{\alpha + \beta}, \quad \delta_1 = -\frac{\gamma}{\alpha + \beta}, \quad \delta_2 = -\frac{\beta}{\alpha + \beta}, \quad \delta_3 = \frac{1}{\alpha + \beta}.$$

Similarly, the demand for skilled labour can be defined as

Eq 8.5: $$\ln S = \delta_0^* + \delta_1^* \ln A + \delta_2^* \ln\left(\frac{w_s}{w_u}\right) + \delta_3^* \ln Q,$$

where

Eq 8.6:

$$\delta_0^* = -\frac{(\alpha \ln \alpha + \alpha \ln \beta)}{\alpha + \beta}, \quad \delta_1^* = \delta_1 = -\frac{\gamma}{\alpha + \beta}, \quad \delta_2^* = -\frac{\alpha}{\alpha + \beta}, \quad \delta_3^* = \delta_3 = \frac{1}{\alpha + \beta}.$$

Demand for less-skilled labour is 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 relative wages (w_s/w_u) and technology and is positively related to output.

A limiting feature of the Cobb-Douglas production function is that it imposes a unitary elasticity of substitution between factors. A second problem, and of direct relevance to the question being addressed here, is that technology is exogenous and has a uniform impact on skilled and less-skilled employment within the sector (the coefficient on ln$A$ is the same in the S and U labour demand functions). Greenaway *et al.* (1999) deal with the exogeneity problem by modelling the technical efficiency parameter (A) as a function of import penetration and export orientation. Technological change, however, still has a uniform impact on skilled and less-skilled labour.

An alternative approach, and one that is followed in this chapter, whenever possible, is to use a constant elasticity of substitution (CES) production function similar to that used by Haskel and Slaughter (1998) and Acemoglu (2002). The CES production function is represented as:

Eq 8.7: $$Q = A[\alpha_1 U^{-p} + \alpha_2 S^{-p}]^{-1/p}, \quad p \geq -1$$

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

Eq 8.8: $$\frac{\alpha_1}{A^p}\left(\frac{Q}{U}\right)^{1+p} = \frac{w_u}{P} \text{ and}$$

Eq 8.9: $$\frac{\alpha_2}{A^p}\left(\frac{Q}{S}\right)^{1+p} = \frac{w_s}{P}.$$

Together Eq 8.7 to Eq 8.9 solve for the endogenous variables Q, S and U. Using the ratio of Eq 8.8 to Eq 8.9 relative labour demand can be expressed as:

Eq 8.10: $$\frac{S}{U} = \left(\frac{\alpha_2}{\alpha_1}\right)^{\sigma}\left(\frac{w_s}{w_u}\right)^{-\sigma}$$

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).

Like the Cobb-Douglas function, a shift in the technology parameter 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), a rise in (α_2/α_1) is interpreted as evidence of skill-biased technological change.[115] 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*.

Following the approach in Greenaway *et al.* (1999), (α_2/α_1) is modelled as a function of trade and technology variables

[115] The interpretation differs slightly from Haskel and Slaughter (1998). They include factor-augmenting technology terms in their CES function. This requires the additional assumption that the elasticity of substitution must exceed 1 for skill-biased technological change to raise the skill intensity of production (see Chapter 3). If ($\alpha_2 + \alpha_1 = 1$) is imposed, then a rise in α_2 strictly corresponds to technological change that results in some of the tasks previously performed by unskilled labour being taken over by skilled labour (see

Eq 8.11: $$\frac{\alpha_2}{\alpha_1} = f(M, X, \Phi)$$

where M is import penetration (or tariffs), X is export orientation and Φ reflects the effect of all other variables affecting technical efficiency. This is similar to Greenaway *et al.* (1999), but has the advantage that the skill bias of trade-induced technological change is modelled explicitly. Log linearising Eq 8.11 and substituting into the log of Eq 8.10, the following relative labour demand function can be estimated:[116] [117]

Eq 8.12: $$\ln\left(\frac{S}{U}\right)_i = \theta_{0i} + \theta_1\Phi_i + \theta_2 M_i + \theta_3 X_i - \sigma \ln\left(\frac{w_s}{w_u}\right)_i + \varepsilon_i.$$

This is, in effect, equivalent to the relative employment regressions of Hanson and Harrison (1995) and Harrison and Hanson (1999). The expected signs of θ_2 and θ_3 are positive. θ_1 is positive for all other technology variables that are skill-biased.

4.2 Data, variables and econometric methodology

The labour demand function specified in Eq 8.12 is estimated using both the NE and GJMA surveys. For comparative purposes the Cobb-Douglas labour demand functions Eq 8.3 and Eq 8.5 are estimated alongside the CES based relative labour demand function, although it has been shown that the latter is better suited to the analysis of trade and skill-biased technological change. The labour demand functions are estimated in levels using occupational employment data for high-skilled (professional & managerial) and unskilled (general labourers and related workers) labour provided in the surveys. It was not possible to standardise for work hours, which could bias some of the estimates (Hamermesh, 1993: 68).

Acemoglu, 2002).

[116] In this specification the trade and technology variables are not logged which implicitly assumes $\alpha_2/\alpha_1 = e^{\lambda_0}e^{\lambda_1\Phi}e^{\lambda_2 M}e^{\lambda_3 X}$. 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 variables while Hanson and Harrison (1995), Harrison and Hanson (1999) and Görg and Strobl (2000) do not.

[117] By solving for S in Eq 8.10 and substituting into the production function, it is possible to define U in terms of relative wages, (α_2/α_1) and output. However, because this function cannot be log linearised the marginal productivity equations (Eq 8.8 and Eq 8.9) or the relative labour demand Eq 8.10 are estimated.

Only the estimates for large NE survey firms are presented as the GJMA results were very weak and the product data used to assign outside tariff levels to each firm are not available for the small NE survey firms.[118] Much of the relationship between trade liberalisation and employment shown in the cross-tabular analysis is found within large firms so this is a primary area of interest. All the level regressions were estimated using OLS with the estimates adjusted to account for the stratification procedure followed in the survey designs (Stata, 1999). Observations were not weighted. A more extensive analysis including other occupational categories and small firms is presented in Edwards (2002a).[119]

Regressions for the change in labour demand were also estimated. The GJMA survey was used to estimate changes in labour demand over the periods 1994-98 and 1997-98. It was not possible to estimate the CES based change in relative labour demand, as the required occupational employment data were not available.

Finally, changes in occupational employment using the Cobb-Douglas based labour demand functions were estimated using the NE survey data on whether a firm increased or decreased full-time employment between the beginning of 1998 and the end of 1999. Because of the binary dependent variable (employment increase = 1 and employment decrease = 0) a maximum likelihood probit model was used.[120] Estimates were also adjusted to account for the stratification procedure followed in the survey design.

Names and descriptions for the independent variables are presented in Table 8.6. Hourly wages (excluding overtime and non-wage costs) for 1998 were only available from the GJMA survey, but were missing for many firms. The relative wage variable has thus been excluded from all regressions. Sector dummies included in the regressions capture sector specific average wages, but do not account for wage variation amongst firms within each sector. The omission of the relative wage

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[118] A lot of data was also missing for small firms. In most of the regressions only 30 % of all small firms were included compared to 60 % of large firms.

[119] The results in Edwards (2002a) are largely consistent with the results if this analysis and are excluded as they provide no additional insights.

[120] Note that firms that did not change employment are excluded from the sample in the probit analysis. This reduces the sample size substantially.

variable may induce omitted variable bias into the estimates. This proved problematic in two cases (see later).

Table 8.6: List of variable names and descriptions

Variable name	Description
Dependent variables	
High-skilled	Natural logarithm of Professional and managerial labour
Unskilled	Natural logarithm of Unskilled labourers and related workers (general labourers, security, etc.)
Technology related variables	
Foreign	Dummy variable for firms with more than 10 % foreign ownership
I/Assets	Log investment in last financial year/value capital stock
Techno	Dummy variable for firms whose primary and secondary major reason for investment was to improve efficiency or product quality through new technology (=1)
M&E share of I	Share of total investment spent on machinery & equipment during last financial year (NE)
Imported M&E/M&E I	New imported machinery & equipment as share of total investment in machinery & equipment during 1998 (GJMA)
Computer share of I	Share of total investment spent on computers during last financial year
% M in raw materials	Percentage of total raw material costs comprised of imported raw materials
Training share of I	Training expenditure during previous and current financial year divided by total investment during last financial year (NE)
% workforce trained	Number of workers trained as share of total workforce in 1998
Trade related variables	
Exporter	Dummy variable for firms that export (=1)
Tariff97	Tariff rates for 1997 obtained from WTO (1998)
Dtariff9300 Dtariff9700	Change in tariff between 1993-2000. Calculated as ((1+tariff00)/(1+tariff93)-1). Similarly, Dtariff9700 reflects tariff liberalisation between 1997-2000.
Tariff-market share	Dummy variable for firms experiencing significant and moderate impact (=1) of trade liberalisation since 1994 on market share (NE)
Tariff-operations	Dummy variable for firms experiencing significant and moderate impact (=1) of trade liberalisation since 1994 on business (GJMA)
Tariff-price effect	Dummy variable for firms experiencing significant and moderate impact (=1) of trade liberalisation since 1994 on product price (GJMA and NE)
Other variables	
Expected sales up Expected sales down Expected sales same	Dummy variables 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) and in 1998 (GJMA)
employ ≤ 50	Dummy variable for firms with 50 employees or less (=1)
50 < employ ≤100	Dummy variable for firms with between 51 and 100 employees (=1)
100<employ≤200	Dummy variable for firms with between 101 and 200 employees (=1)
200 <employ	Dummy variable for firms with greater than 200 employees (=1)

A variety of technology related variables were included. As in Krueger (1993), Feenstra and Hanson (1995a), 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. 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 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'. All technology variables were also regressed on tariff related variables. A negative relationship between investment in skill-biased technology and tariff liberalisation is further evidence of trade-induced technical change.

Following Hanson and Harrison (1995), the imported share of raw material purchases and the domestic share in machinery and equipment investment are included to account for trade-induced technological change.[121] The domestic share in machinery and equipment investment was subsequently dropped as the coefficient was insignificant and its inclusion reduced the sample size considerably. A positive correlation between the imported share of raw material purchases and skilled labour demand is consistent with trade-induced technological change that is skill-biased.

The ratio of training expenditure to investment and the percentage of employees receiving in-house or outside training were also used in both the NE and GJMA regressions. 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, a negative impact on the relative demand for skilled labour is expected.

The transfer of technology through foreign ownership is expected to raise the relative demand for skilled labour, as is found by Feenstra and Hanson (1995a,b), Hanson and Harrison (1994) and Harrison and Hanson (1999) for Mexico. A dummy variable for firms with greater than 10 % foreign ownership was included to capture this effect. A dummy variable for exporters was also included to capture any skill-biased efficiency gains or technology transfers through exporting.[122]

[121] Feenstra and Hanson (1995a) and Feenstra and Hanson (2001) interpret these variables as evidence of 'outsourcing'.

[122] 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, access to blueprints for the manufacture of the good and direct transfers of technology from a foreign partner.

To capture the direct impact of trade liberalisation on employment, dummy variables indicating whether a firm's product price (tariff-price effect) or domestic market share (tariff-market share) was significantly or moderately affected were included. The dummy variable for firms "not affected" or with an "unknown" impact of trade liberalisation was used as the omitted variable in each case. For an independent assessment of the impact of trade liberalisation on firm behaviour, scheduled tariff rates and changes in product prices due to trade liberalisation during the 1990s were calculated from data in Kuhn and Jansen (1997), WTO (1998) and Van Seventer (2001). These were assigned to each firm on the basis of products manufactured. The results using this tariff data are presented separately.

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

4.3 Estimation results

The labour demand regressions exploit variations in firm characteristics to determine the extent to which the level, change and skill intensity of employment reflect trade policies as well as other factors such as foreign ownership, export orientation, size, and technology. These relationships are not necessarily causal and reflect a partial correlation holding all other variables constant.[123]

The results for the estimated demand functions for high-skilled and unskilled labour using the NE survey are presented in Table 8.7. Both the level and change results are given. The change in labour demand results include a specific regression in which insignificant variables are systematically eliminated. The estimated coefficients of the change (average annual growth) in total labour demand functions using the GJMA survey are presented in Table 8.8. In both the NE and GJMA change in labour demand regressions, separate regressions using exogenously assigned changes in product prices due to tariff liberalisation are estimated. It must also be noted that the required data for many variables are missing for a large share of the firms. The

[123] For example it is possible that the skill intensity of production drives computer investment rather than the other way round. Further, SA firms are known to lobby for tariff protection on the basis of expected employment declines (Casale and Holden, 2000). Tariff levels in this case are endogenous.

estimated relationships between trade liberalisation, technology, export performance and employment are briefly discussed.

4.3.1 Trade liberalisation, export orientation and employment

As shown in Table 8.7, no association is found between the level of tariffs in 1997 and the skill intensity of employment or the employment of high-skilled and unskilled labour at the firm level using the NE survey. However, as in the cross-tabular exposition, a relationship is found between the change in employment and the severity of the impact of trade liberalisation on market share. According to the probit model (Table 8.7), large firms whose market shares were significantly or moderately affected by trade liberalisation (tariff-market share) had a 22.6 % to 25.5 % greater probability of decreasing employment of unskilled labour, between early 1998 and late 1999, compared to firms that were not affected. For high-skilled labour, firms that experienced significant or moderate declines in product prices (tariff-price effect) were 32.8 % to 34.4 % more likely to reduce employment than firms that were not affected. Similar results were found for semi-skilled and skilled-technical workers, although these are not shown (see Edwards, 2002a). Within the GJMA survey, the coefficients on the dummy variables representing firms whose output and prices were significantly or moderately negatively affected by tariff liberalisation are individually significant, but of contradictory signs (Table 8.8). However, the joint restriction that the coefficients equal zero can not be rejected suggesting no relationship between firms' perceptions of the impact of tariff liberalisation and their employment decisions when using the GJMA survey.

The regressions using exogenous tariff data present more of a problem. In all results the coefficient on the variable measuring the impact of tariff liberalisation is negative, suggesting that relatively large declines in employment occurred within firms experiencing relatively small tariff reductions. These results are inconsistent with initial expectations. However, two of the coefficients are only significant at the 10 % level suggesting that the relationship, if any, is poor. Further, the tariff reductions calculated using the scheduled tariff rates are largest in highly protected sectors. As shown by van Seventer (2001), the efficiency of tariff collection in highly protected sectors is extremely low. This implies that the scheduled tariff reductions for highly protected sectors used in the regressions exaggerate the true impact of trade liberalisation on prices. Sectors experiencing relatively low reductions in tariffs may nevertheless experience relatively large price reductions and hence declines in employment. This could explain the negative coefficient on the tariff variable. These results highlight that even at the firm level, it is difficult to find a consistent relationship between trade liberalisation and changes in employment.

Trade liberalisation also boosts competitiveness, and hence output, of firms through lowering the cost of imported intermediate goods. A positive relationship between employment creation and improved competitiveness (domestic and export) is expected. Over 40 % of large NE exporters experienced significant or moderate increases in competitiveness due to trade liberalisation. However, no relationship between improved competitiveness and employment is found in the cross-tabulations or regression results using either the NE or GJMA surveys. Instead, exporters reduced total employment compared to firms solely supplying the domestic market. As shown in the NE survey probit results, exporters were 30 % and above more likely to reduce employment of unskilled and high-skilled labour compared to domestic-oriented firms. Similar results are found in the GJMA survey where average annual employment growth between 1994 and 1998 was approximately 10 percentage points lower amongst exporters than amongst domestic-oriented firms.

These results are qualitatively similar to the industry level results of Greenaway *et al.* (1999) in the UK and Hayter *et al.* (1999) in South Africa. Both studies interpret the relationship as evidence of trade-induced efficiency gains, suggesting that there has been substantial restructuring of production and employment in export-orientated firms in order to raise export competitiveness. Similar results were also found in Chapter 6. Further, Chapter 7 has shown the importance of productivity growth for improved export performance.

4.3.2 Skill-biased and trade-induced technological change

The NE survey level regression results show that the indicator of skill-biased technological change, the share of investment in computers, is significant in explaining the skill intensity of employment at the firm level. This relationship appears to be driven by the negative association between investments in computers and employment of unskilled labour found in the NE survey level regressions (Table 8.7). Similar relationships are found in international studies (not firm level) by Berman *et al.* (1994), Berman *et al.* (1998) and Machin and Van Reenen (1998). In a firm level study of the US, Krueger (1993) finds that workers who use computers on their job earn 10 % to 15 % higher wages. The substantial investments in information and communication technology in the South African economy since the 1980s (see Hodge and Miller, 1996) are thus a possible cause of the rising skill intensity of employment over this period.

There is also evidence of trade-induced technological change that is skill-biased. As in Harrison and Hanson (1999) and Görg and Strobl (2001), the skill intensity of employment within NE survey firms is positively correlated with the imported share of raw materials. This relationship is not found when using the GJMA survey. Further evidence of skill-biased technology transfers is shown in the negative relationship between unskilled employment and foreign ownership. As shown in the correlation analysis earlier, foreign owned firms are more skill-intensive compared to domestic firms. Hanson and Harrison (1994), Feenstra and Hanson (1995b) and Harrison and Hanson (1999) found similar results in firm level studies of Mexico. Feenstra and Hanson (1995b, 2001) attribute this to technology transfers arising from the outsourcing of production by developed countries. These technology transfers also appear to be labour saving. Relative to domestic firms, foreign owned firms reduced employment during the 1990s (see GJMA results).

To test for the presence of *defensive innovation*, all technology related variables were regressed on tariff liberalisation related variables. The results were mostly poor, although firms negatively affected by trade liberalisation were more likely to invest in new efficiency-improving technology. This relationship is consistent with the results found in the cross-tabular analysis. Although causation cannot be inferred from this result, the relationship is consistent with Wood's (1994) view that firms respond to increased import competition by adopting skill-biased technology. Overall, however, the evidence for defensive innovation is weak.

Table 8.7: Labour demand in large manufacturing firms, NE survey

	Demand for labour using OLS			Change in labour demand using probit model					
				Δ Unskilled			Δ High-skilled		
	High-skilled/unskilled	Unskilled	High-skilled	General	Specific	Incl. tariff	General	Specific	Incl. tariff
	Coef.	Coef.	Coef.	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx
Expected sales down				-0.273 ***	-0.241 ***	-0.305 ***	-0.636 ***	-0.579 ***	-0.659 ***
Expected sales same				-0.189 ***	-0.210 ***	-0.135 *	-0.174	-0.318	-0.395 **
Log sales		0.654 ***	0.742 ***						
Foreign	0.241	-0.347 **	-0.101	-0.055		-0.122	-0.065		-0.280 *
Exporter	0.441 *	-0.273	0.091	-0.486 ***	-0.529 ***	-0.482 ***	-0.431 **	-0.314 **	-0.380
I/assets				0.124 ***	0.111 **	0.092 **	0.049		-0.050
Techno				0.037		-0.133	0.040		0.033
M&E share of I	0.079	0.016	-0.078	-0.165		0.108	0.119		0.209
Computer share of I	1.994 ***	-1.538 ***	0.268	-0.100		-0.109	-0.102		-0.335
% M in raw materials	0.010 **	-0.008 **	0.001	-0.001		0.000	-0.007 **		-0.004
Training share of I	-0.048	0.044	-0.007 ***	0.094 ***	0.093 ***	0.063 ***	-0.193	-0.285 **	-0.293
Age	-0.003	0.005	-0.001	-0.003 *		0.000	-0.009 *	-0.008 **	-0.006
	-0.005	0.000	-0.003						
Δ tariff 93-2000						-2.435 **			-1.774 *
Tariff-market share				-0.226 *	-0.255 **		-0.069		
Tariff-price effect				-0.154			-0.344 **	-0.328 **	
100<employ<=200	-0.207			-0.106	-0.166		0.052	0.019	
200 <employ	-0.371			-0.089	-0.228		-0.116	-0.186	
obs	202	197	211	124	133	136	84	95	92
F-stat	5.89 ***	13.63 ***	42.85 ***	66.9 ***	67.25 ***	73.61 ***	48.47 ***	43.41 ***	48.3 ***
R2	0.30	0.52	0.77	0.43	0.40	0.43	0.42	0.33	0.38

Notes: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively. Observations were not weighted in the regressions and all specifications include industry dummies.

The following dummy variables have been omitted: Food & beverages sector, 50<employ≤100 and Expected sales up.

The coefficients of the probit regression 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. These regressions exclude firms that did not change employment.

The null hypothesis of no omitted variables was rejected (using the Ramsey RESET test) in the high-skilled level regression.

*, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.

Table 8.8: Change in labour demand using total employment, GJMA

	1997-98		1994-98	
	General	Incl. tariff	General	Incl. tariff
	Coef.	Coef.	Coef.	Coef.
Δ Log sales	0.252 *	0.299 ***		
Foreign	-0.050	-0.062	-0.092 ***	-0.085 ***
Exporter	-0.046	-0.094 **	-0.107 **	-0.094 **
Log I/assets	-0.017	-0.014		
M&E share of I	-0.013	-0.034	-0.018	-0.069 *
Imported M&E/M&E I	-0.048	-0.048	-0.024	-0.009
% workforce trained	0.033	0.018	0.019	0.016
Age	-0.002 *	-0.002 *	-0.002 **	-0.002 **
Δ tariff		-1.209 **		-0.318 *
Tariff-operations	-0.154		-0.136 **	
Tariff-price effect	0.147		0.138 **	
100<employ<=200	0.039	0.024	0.082 *	0.082 **
200 <employ	0.069	0.080 *	0.031	0.032
obs	121	149	102	124
F-stat	2.620 ***	4.150 ***	2.930 ***	3.730 ***
R2	0.248	0.236	0.325	0.273

Notes: *, ** and *** reflect significance at the 10%, 5% and 1% significance level, respectively.
The dependent variable is the annual average growth in employment. All specifications include industry dummies.
The null hypothesis of no omitted variables is rejected in the 1994-98 regression.
In the 1994-98 regression price changes due to tariff liberalisation are calculated using 1993 and 2000 tariff data. In the 1997-98 regressions, tariff data for 1997 and 2000 are used.

4.3.3 Other results

A number of other interesting relationships emerge from the results. Declines in employment are strongest in large and old firms. As expected, changes in sales or expected sales are important determinants of employment growth. Training is found to be negatively associated with the skill intensity of production, particularly the employment of high-skilled labour. Further, firms that invested relatively heavily in training reduced employment of high-skilled labour, but raised employment of unskilled workers between early 1998 and late 1999. These results suggest that training is a substitute for skilled labour.

5. Conclusion

This chapter 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.

The study finds a negative relationship between trade liberalisation and employment amongst large firms, but not small firms. The size of the impact, however, is insufficient to account for the full decline in employment experienced in South Africa since 1994. In the NE survey, large and small firms that both reduced unskilled employment and were negatively affected by trade liberalisation account for 15 % of all firms. Using the GJMA survey, firms significantly or moderately affected by tariff liberalisation 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 possible impact of trade liberalisation on employment may be biased downwards by the closure of firms in response to increased import competition. Further, the inclusion of exogenous tariff data also resulted in contradictory relationships between trade liberalisation and employment. This highlights a problem associated with the use of firm level surveys to evaluate the impact of trade liberalisation. Nevertheless, the data suggests that, while trade liberalisation may have exacerbated the decline in certain sectors, it is not the dominant cause of the decline. The vast majority of firms made employment decisions that were unrelated to trade liberalisation.

Trade liberalisation has improved export competitiveness for many firms, but this has not led to increased employment. Domestic firms are still characterised by low levels of export orientation compared to other African and Asian economies. The regression results show that large export oriented firms shed labour during the 1990s compared to firms solely supplying the domestic market. Export firms are restructuring in the face of increased exposure to the international market and are in the process raising productivity through the shedding of labour. Chapter 7 has shown the positive impact of increased labour productivity on export performance. Exporters are also relatively skill-intensive compared to other firms suggesting that the restructuring of production and adoption of new technology within these firms is biased towards skilled labour. This shift may also reflect structural changes in export production as South Africa adjusts to increased competition from low wage economies such as China and India. Wood (1997) has highlighted this process within Latin American economies during the 1980s.

Other evidence of technological change is also found. Imported raw materials complement skilled labour. Foreign firms have raised productivity through shedding of labour, possibly facilitated by skill-biased technological transfers. At the same time, rapid advances in microelectronics, as revealed in the adoption of computers, have raised the skill intensity of production. Some evidence, albeit weak, is found for defensive innovation. The cross-tabulation results also show that of the firms that reduced unskilled employment, those that were significantly affected by trade liberalisation invested predominantly in new technology. Those not affected by trade liberalisation reduced employment primarily in response to a decline in expected sales growth. Together these results suggest that technological change, whether trade-induced or not, has been a major influence in the changing patterns of employment within South Africa.

Chapter 9
Conclusion

The South African economy has undergone substantial structural reform during the 1990s. The election of a new government in 1994 initiated a range of new policy reforms that were designed to encourage economic growth as well as uplift the standard of living of the previously disenfranchised majority. These reforms were far reaching including the writing of a new constitution, a macroeconomic strategy, new labour legislation and an overhaul of all social and welfare policies. Substantial progress was also made in opening South Africa's trade regime. Sanctions were dropped, which opened new markets for domestic exporters, but also exposed the economy to increased international competition. The government also embarked on an ambitious program of tariff liberalisation, as agreed in the Uruguay round of the GATT/WTO negotiations.

The impact on the economy of these reforms has been mixed. Output has grown, but slowly. Manufacturing exports also grew strongly, but largely during the mid-1990s. During the latter half of the 1990s, export growth was mediocre compared to other middle-income countries (Golub, 2000; Edwards and Schoer, 2002). Exports have also become more capital intensive, which runs contrary to the stipulated aim of encouraging export-led employment growth. Import penetration has also risen strongly in labour-intensive sectors.

At the same time, formal employment growth declined, particularly amongst less-skilled labour. Data, provided by the South African Standardised Industrial Database (2003), indicates that over 700 000 semi and unskilled workers lost formal employment in manufacturing, mining and services between 1990 and 1998. Debates on the causes of the decline in employment are extensive and include fiscal restraint, restrictive labour legislation, poor education policies, poor productivity growth, skill-biased technological change and increased international competition.

This thesis contributes to empirical research on the determinants of employment change in South Africa during the 1990s. The primary objective is to assess the impact of trade liberalisation on the level and occupational structure of employment since the early 1980s. In the process, the contributory role played by technological change and labour market institutions are revealed as key underlying micro issues and are explored in individual chapters.

In international empirical literature, skill-biased technological change and trade liberalisation vie for centre stage as the dominant factor driving rising wage inequality and/or the rising skill intensity of production. In developed economies, the evidence points towards skill-biased technological change as the most important factor, but disagreement on the appropriate empirical methodology and theoretical framework remains. This thesis thus uses a variety of theoretical and empirical methodologies to interrogate the different ways in which trade liberalisation and technological change have affected labour in South Africa.

Most analysis and testable hypotheses are grounded in the general equilibrium Heckscher-Ohlin-Samuelson (HOS) model and, in particular, the Stolper-Samuelson (SS) theorem. However, the primary application of this model is in developed countries where the stark predictions, namely that trade liberalisation raises wage inequality, accord well with the simple two-country two-sector two-product model framework. In middle-income countries, such as South Africa, the theoretical predictions are more ambiguous. Through both factor-content and price-effect analyses, this thesis makes an important contribution to the analysis of trade liberalisation on labour in middle-income countries.

The thesis also focuses on the impact of technological change on labour in South Africa. A particular contribution of the thesis is that it attempts to account for the impact of trade-induced technological change on labour. This focus is of considerable importance to the trade-labour debate, as the impact of technological change on labour is not necessarily independent of the liberalisation process. For example, in the face of increased international competition arising from a reduction in tariffs, firms may adopt labour-saving technology in order to compete effectively with international suppliers. By solely focusing on the direct impact of liberalisation on labour, the potentially important indirect effects via technological change are ignored.

Finally, the thesis uses an alternative theoretical framework to the HOS model, namely the Ricardian model, to assess the impact of labour cost competitiveness on export performance. This analysis differs from other chapters in that the link between trade liberalisation and employment is not analysed directly. However, the Ricardian model provides insight into how real wage increases in South Africa have affected export-generated employment as well as the rising capital and skill-intensity of trade. Further, the focus on labour productivity within the Ricardian framework links in with the analysis of technological change.

The broad conclusions regarding the impact of trade liberalisation and technological change on employment are now discussed.

1. Trade liberalisation, employment and the structure of production

South Africa has made substantial progress in liberalising trade during the 1990s. As Chapter 2 shows, average nominal and effective rates of protection fell by 50 % during the 1990s. Protection declined in all sectors, although more in some sectors than others. Tariff liberalisation also reduced the implicit tax on exports, which has raised export competitiveness. Although protection has fallen, substantial progress can be made in reducing the number of tariff lines, tariff bands and non-*ad valorem* tariff rates. Very high tariffs are still found in processed foods, motor vehicles, clothing and textiles sectors.

Isolating the employment impact of trade liberalisation in South Africa from the numerous policy reforms is extremely difficult. Two approaches are followed in this study. Firstly, changes in employment and factor earnings are directly related to changes in tariff protection. Chapter 4 draws on the Stolper-Samuelson theorem to estimate factor earnings mandated by product price changes arising from changes in tariff levels. Chapter 8 draws upon firm survey data where firms are asked to assess the severity of trade liberalisation on their market share and product price. These responses, as well as exogenous data on changing tariff levels, are related to changes in employment patterns at the firm level.

Secondly, changing trade patterns during the 1990s are assumed to be related to trade liberalisation or changes in the international trade environment. This is a tenuous link, but one that is followed in most domestic and international literature. Chapters 5 and 6, for example, analyse the changing structure of trade and the consequent impact on occupational employment between 1984 and 1997.

Despite the different methodologies used, drawing a conclusive link between trade liberalisation and factor returns and/or employment remains difficult. Adequate measures of protection that include tariff equivalents of non-tariff barriers are difficult to obtain. Further, the conclusions drawn from the results often reflect the assumptions (e.g. full employment) inherent within the theoretical framework. Nevertheless, some broad conclusions can be derived.

The thesis finds that the impact of tariff liberalisation on labour varied during the different phases of the liberalisation process. As shown in Chapter 4, tariff liberalisation raised wage inequality between 1988 and 1992, but also raised the return to labour relative to capital. Not too much confidence is placed on these results, as the impact of the reduction in quotas and surcharges during this period is not accounted for. The results for the rest of the 1990s are less problematic, as quotas and surcharges had largely been removed.

During the rest of the 1990s, tariff liberalisation negatively affected labour. As shown in Chapter 4, tariff liberalisation placed downward pressure on wages relative to capital during the 1990s. Under rigid wages, this will have led to a reduction in employment, which is consistent with employment trends during this period. The positive relative return to capital is also consistent with the structural shifts in trade and production towards more capital-intensive sectors shown in Chapter 5. Consistent results are also found in the firm survey analysis of Chapter 8. Firms whose market share was negatively affected by trade liberalisation were more likely to reduce employment relative to firms whose market share was not affected.

However, evidence presented in the thesis suggests that the negative impact on employment of trade liberalisation during the 1990s is small relative to other factors. As shown in Chapter 6, net trade positively affected employment between 1993-97, despite the increase in import penetration. Changes in final demand and skill-biased technology are shown to be the dominant forces influencing employment patterns. Trade liberalisation during the 1990s also cannot account for the significant decline in less-skilled employment relative to skilled employment during this period. Tariff liberalisation during the 1990s raised the return to less-skilled-labour relative to skilled labour (although the return to both was negative). Mandated wage changes arising from trade liberalisation thus shed no light on the shedding of less-skilled labour relative to skilled labour during the 1990s.

Trade liberalisation also only affected employment negatively in large firms (Chapter 8). Small firms were largely unaffected by trade liberalisation, and even when they were, they did not change employment in response to the increase in import competition. Firms that were negatively affected by trade liberalisation and reduced unskilled employment account for at most 15 % of all firms using the National Enterprise Survey. According to the Greater Johannesburg Metropolitan Survey, firms whose operations were significantly or moderately affected by trade liberalisation account for 22 % of the decline in total employment, excluding the food & beverages sector. If the food & beverages sector is included, then these sectors actually raised employment. Substantial heterogeneity in the response of firms to trade liberalisation makes it difficult to robustly estimate the direct contribution of trade liberalisation to the decline in employment. Nevertheless, these results suggest that other factors are the primary causes of the employment problem in South Africa.

The evidence presented in this thesis suggests that real wage growth, particularly of less-skilled labour, is an important source of the employment problem in South Africa. The effect of real wage increases on employment is not a central tenet of this thesis, so this conclusion is made tentatively. Nevertheless, the evidence presented shows that, despite mandated declines in real wages (by trade liberalisation and import prices) during the 1990s, real wages grew on average by 2.7 % per annum. The relative wage of less-skilled labour also grew at a rate faster than was mandated by tariff liberalisation. Excessive wage increases are thus consistent with the decline in employment during the 1990s, which fell particularly hard on less-skilled labour.

Real wage growth can also account for the low net impact of trade on employment shown in Chapter 6, as well as the rising capital and skill intensity of trade shown in Chapters 5 and 6. Using a Ricardian model, Chapter 7 shows that relative unit labour costs (RULC) have a strong impact on export competitiveness and thus export performance. A 1 % decline in competitiveness (rise in RULC) is estimated to reduce real exports by between 1.64 % and 2.32 % in the long run. Disaggregating RULC into its constituent parts, the chapter finds that a 1 % increase in relative productivity or decrease in relative wages boost exports by between 1.3 % and 3 % in the long run. The coefficients are larger for labour intensive sectors.

Although labour cost competitiveness improved during the 1990s, much of the improvement was through real depreciation of the currency, not improvements in productivity. In fact, during the 1990s, wages in many labour-intensive sectors increased relative to a range of developing countries. These results thus suggest that strong real wage growth during the 1990s had a significant negative impact on export-generated employment growth. Further, because export performance of labour-intensive sectors is more susceptible to labour cost competitiveness, strong real wage growth will have contributed towards the rising capital and skill intensity of production and trade.

The results of the thesis also suggest that international price movements have shifted against labour. Import prices mandated significant increases in the return to capital relative to labour during the 1990s. Further, import price increases were strongly biased towards skill-intensive sectors, which will have raised wage inequality. These trends are consistent with the changing employment patterns (assuming rigid wages) during the 1990s. The trends in import prices are also consistent with the decomposition analyses of Chapter 5 and 6, which show a rising capital and skill intensity of net trade. International price movements may reflect the entry of China and India into the world economy, and thus signal a change in the comparative advantage of middle-income countries towards more skill-intensive products.

In conclusion, the thesis finds that trade liberalisation negatively affected employment during the 1990s. However, the impact of trade liberalisation is small relative to other changes such as real wage growth, international price movements, technological change and growth in final demand.

2. Trade, technology and employment

The thesis also presents an in-depth analysis of the impact of technological change on labour in South Africa. Skill-biased technological change is frequently cited as the primary factor raising wage inequality and the skill intensity of production within developed and developing economies. However, much of the literature fails to account for the sector-bias of skill-biased technological change. As shown in Chapter 3, the sector bias, and not the factor bias, of technological change determines relative wage shifts in a general equilibrium framework. Further, many studies do not account for unskilled labour saving technological change brought on by increased international competition. Thus, the impact of trade liberalisation on labour may be larger than the direct effect traditionally estimated in empirical literature.

This thesis interrogates these various relationships using a variety of empirical methodologies. Chapter 4 uses two approaches. Firstly, the changing skill intensity of employment is decomposed into within-sector and between-sector shifts, with the former reflecting skill-biased technological change. Secondly, the general equilibrium approach of Leamer (1996) is used to estimate the impact of sector-biased technological change on factor returns. Chapter 6 uses an input-output decomposition methodology to isolate the impact of technological change on employment relative to final demand and trade flows. Chapter 8 uses firm level data to identify correlations between indicators of technological change (use of computers, training) and the skill composition of employment. In all these analyses, the possible effect of trade liberalisation and international trade on technological change is also explored.

Substantial evidence of skill-biased technological change is found within sectors. The decomposition analysis of Chapter 6 shows that skill-biased technological change is the dominant factor influencing employment within South

Africa since the mid-1980s. Similarly, the decomposition in Chapter 4 of the rising skill intensity of employment in manufacturing into within-sector (technology) and between-sector shifts show that the former overwhelmingly dominates. Chapter 8 also finds a strong positive correlation between investments in computer technology, an indictor of skill-biased technological change, and the employment of skilled labour within firms. The rapid adoption of information technology during the 1990s will thus have contributed towards the decline in employment of less-skilled labour experienced during this period. These results point to skill-biased technological change as the driving force behind the rising skill intensity of employment in South Africa.

However, these analyses do not take the sector-bias of technological change into account and thus fail to adequately account for the general equilibrium effects of technological change. Chapter 4, therefore, estimates the impact of sector-biased technological change, as measured by TFP growth, on relative factor payments. No unambiguous results are found. TFP growth was very low during the 1990s, which does not reflect the onset of significant productivity improving technological change. Further, sector-biased TFP growth mandated no significant changes in the return to labour or capital between 1988 and 2000.

TFP growth is found to be concentrated in less-skill intensive sectors from the early 1980s, which will have reduced wage inequality (or increased employment of less-skilled labour) according to the general equilibrium framework. This result thus suggests that technological change is not the cause of the employment problem in South Africa during the 1990s. However, the measure of technological change, TFP growth, used in this chapter is inadequate to conclusively isolate this relationship. Methodological limitations lead to potentially large biases in the estimates of productivity growth and the aggregated level of the data prevents the identification of compositional shifts, possibly due to trade liberalisation, occurring within sectors.

The thesis thus fails to isolate the impact of sector-biased technological change on relative factor payment and/or employment during the 1990s. Further analysis using alternative measures of technological change and more disaggregated level data is required to firmly establish the impact.

The thesis also investigates the impact of trade-induced technological change on labour in South Africa. The thesis finds that trade-induced technological change is concentrated within export-oriented firms and sectors. The effect is lower employment growth generated through export expansion. For example, the firm survey analysis in Chapter 8 finds that large export-oriented firms shed labour during the 1990s compared to firms solely supplying the domestic market. This occurred despite improvements in competitiveness arising from a reduction in tariffs on their inputs. The decomposition analysis of Chapter 6 also shows that employment losses due to direct labour saving technological change are concentrated within sectors experiencing high export growth. These results suggest that export-oriented firms are shedding labour, particularly less-skilled labour, in order to raise labour productivity. As shown in Chapter 7, labour productivity is an important determinant of export performance amongst South African firms.

Some evidence of defensive innovation in response to trade liberalisation is found in the firm survey, but the impact on employment appears small. Of the firms that reduced unskilled employment, those that were significantly affected by trade liberalisation invested predominantly in new technology. Amongst firms that increased employment of professional & managerial labour, those negatively affected by tariffs were more likely to invest in efficiency improving technology than those not affected by tariff liberalisation. Those not affected by trade liberalisation reduced employment primarily in response to a decline in expected sales growth. However, these firms accounted for a small percentage of overall firms implying that defensive innovation accounts for, at most, a small share of the decline in employment during the 1990s.

The analysis of technological change thus suggests that skill-biased technological change has contributed towards the rising skill intensity of production in South Africa. Trade-induced technological change has also had an impact, although the effect appears to be small. More detailed analyses, using better indicators of technological change, are required for more precise estimates of the impact of technology on labour.

In conclusion, the employment problem in South Africa is multi-faceted. Because of the numerous changes that have occurred during the 1990s, it becomes very difficult to ascertain the relative impact of trade liberalisation, technological change and factor market changes on employment patterns. The results of this thesis suggest that trade liberalisation has placed increasing pressure on the returns to labour during the 1990s. Increased export orientation also led to the shedding of labour to raise productivity and some induced technological innovation. Technological innovations appear to have been biased against less-skilled labour. However, real wage rigidities have exacerbated these pressures leading to substantial reductions in employment levels.

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Appendices

Appendix 1

Table A1.1: Effective protection rates and anti-export bias using a 71 sector Supply-Use table

	Effective protection rates				Anti-export bias			
	1988	1993	1997	2000	1988	1993	1997	2000
Agricultural products	16.7	8.2	7.0	5.8	1.5	1.3	1.1	1.1
Mining and Quarrying	1.8	1.3	0.6	0.1	1.1	1.0	1.0	1.0
Meat products	1789.4	1867.3	2900.6	2352.0	-0.3	-1.1	12.0	6.6
Fish products	40.0	10.5	39.3	10.4	1.6	1.2	1.5	1.2
Fruit and vegetables products	25.1	28.7	41.8	36.7	1.6	1.6	1.6	1.6
Oils and fats products	52.2	65.3	7.4	17.8	4.1	3.2	1.4	1.5
Dairy products	14.7	14.5	43.9	72.6	1.5	1.4	1.6	1.9
Grain mill products	30.2	3.6	17.7	24.0	2.0	1.3	1.3	1.4
Animal feeds	-28.5	-12.5	-9.6	-4.1	1.3	1.2	1.1	1.2
Bakery products	67.6	71.8	77.3	73.0	2.6	2.1	2.2	2.2
Sugar products	11.8	9.3	-7.0	63.0	1.3	1.2	1.0	1.7
Confectionary products	35.5	37.8	38.3	16.4	1.6	1.6	1.5	1.4
Other food products	33.2	61.5	24.5	25.2	1.7	2.0	1.4	1.4
Beverages and tobacco products	36.9	28.4	37.4	23.2	1.7	1.6	1.6	1.4
Textile products	231.2	200.3	156.1	92.2	-28.5	21.9	6.9	3.2
Made-up textile products	138.2	121.7	87.6	70.9	12.6	7.5	4.5	2.8
Carpets	67.5	131.3	174.1	181.5	-5.7	52.3	15.1	6.0
Other textile products	12.3	19.4	18.2	28.0	1.8	1.7	1.6	1.5
Knitting mill products	193.1	361.9	340.0	176.5	-3.8	-9.0	-25.5	10.1
Wearing apparel	260.4	346.1	308.5	191.9	-5.1	-8.0	-16.7	12.6
Leather products	55.8	69.2	36.8	43.6	7.2	4.5	3.9	3.1
Footwear	120.9	127.1	77.5	68.1	5.5	5.2	3.1	2.7
Wood products	30.7	23.4	22.7	19.5	1.7	1.4	1.4	1.3
Paper products	-0.6	7.4	13.0	10.8	1.2	1.2	1.2	1.2
Containers of paper	19.0	52.0	26.5	31.9	1.6	2.0	1.6	1.6
Other paper products	21.0	25.7	20.4	32.9	1.4	1.5	1.4	1.5
Printing & publishing	16.1	18.9	14.3	5.6	1.2	1.3	1.2	1.1
Petroleum products	38.2	23.5	19.5	12.9	1.5	1.3	1.2	1.1
Basic chemical products	4.6	8.0	2.9	0.9	1.1	1.1	1.1	1.0
Fertilizers & pesticides	6.8	8.5	8.7	5.8	1.3	1.3	1.2	1.1
Primary plastic products	38.6	14.6	26.9	16.7	1.7	1.3	1.4	1.3
Paints	49.6	40.9	22.3	10.1	2.3	2.0	1.5	1.3
Pharmaceutical products	27.3	15.7	1.2	-2.5	1.5	1.3	1.1	1.0
Soap products	92.3	84.9	77.4	71.6	3.7	3.1	2.4	2.2
Other chemical products	26.8	18.5	11.4	5.6	1.6	1.4	1.2	1.1
Rubber tyres	46.7	45.2	48.4	45.7	1.9	1.7	1.7	1.6
Other rubber products	66.3	69.5	48.5	30.9	2.4	2.1	1.8	1.5
Plastic products	77.1	48.3	28.5	24.1	2.4	1.8	1.5	1.4
Glass products	25.3	21.5	15.9	15.3	1.4	1.3	1.2	1.2
Ceramicware	34.6	28.1	25.2	22.4	1.4	1.3	1.3	1.2
Ceramic products	-5.7	20.3	9.5	7.5	1.0	1.3	1.1	1.1
Cement	-0.3	-0.3	-0.4	-1.3	1.0	1.0	1.0	1.0
Other non-metallic products	46.0	32.2	12.4	14.4	1.6	1.4	1.2	1.2
Iron and steel products	20.2	15.8	10.1	10.5	1.4	1.3	1.2	1.2
Non-ferrous metals	30.7	14.2	4.9	4.6	1.6	1.3	1.1	1.1
Structural metal products	18.9	28.8	6.7	6.5	1.4	1.5	1.2	1.1
General hardware products	52.4	32.0	28.0	25.2	1.7	1.5	1.4	1.3
Other fabricated metal products	28.9	40.3	19.1	17.1	1.7	1.7	1.3	1.3

Non-electrical machinery	4.6	4.2	1.2	2.1	1.2	1.2	1.1	1.1
Electrical industrial machinery	23.6	19.8	6.8	11.1	1.6	1.5	1.2	1.2
Other electrical products	28.8	31.8	22.7	18.6	1.8	1.6	1.4	1.3
Radio and television products	56.0	27.3	-1.9	-0.2	2.7	1.8	1.1	1.1
Motor vehicles	217.8	171.3	81.8	70.6	-3.0	-4.2	16.3	7.4
Other transport products	11.2	18.3	5.3	0.0	1.2	1.3	1.1	1.0
Furniture	41.7	54.9	53.4	46.8	1.9	1.9	1.8	1.7
Jewellery	252.7	156.5	208.4	97.1	63.9	8.1	5.2	2.7
Other manufacturing	17.3	20.9	8.9	5.6	1.2	1.3	1.1	1.1
Electricity	-1.4	-1.2	-0.7	-0.6	1.0	1.0	1.0	1.0
Water	-1.8	-1.6	-1.0	-0.8	1.0	1.0	1.0	1.0
Buildings	-12.7	-12.3	-7.8	-6.6	1.0	1.0	1.0	1.0
Other constructions	-13.1	-11.6	-6.8	-5.8	1.0	1.0	1.0	1.0
Trade services	-2.1	-2.2	-1.6	-1.3	1.0	1.0	1.0	1.0
Accommodation	-6.1	-4.7	-5.3	-4.7	1.0	1.0	1.0	1.0
Transport services	-6.1	-4.8	-3.4	-2.6	1.0	1.0	1.0	1.0
Communications	-3.0	-2.2	-1.2	-0.9	1.0	1.0	1.0	1.0
Business services	0	0	0	0	1.0	1.0	1.0	1.0
Real estate services	-1.0	-0.9	-0.7	-0.5	1.0	1.0	1.0	1.0
Other business services	-2.6	-2.4	-1.8	-1.5	1.0	1.0	1.0	1.0
General Government services	-3.0	-2.6	-1.5	-1.2	1.0	1.0	1.0	1.0
Health and social work	-5.8	-4.6	-2.8	-2.0	1.0	1.0	1.0	1.0
Other services / activities	-2.7	-2.5	-1.8	-1.5	1.0	1.0	1.0	1.0

Note: The anti-export bias is calculated as (1-ERP)/(1+XRP). If trade policies are neutral then the anti-export bias equals one. If they raise value-added in the domestic market compared to the export market the anti-export bias exceeds one. Negative values arise when the additional protection associated costs exceed world value added. Exports should not occur in this case.

Appendix 2

Within- versus between-industry effects

Aggregate changes in the share of skilled labour in total employment, ΔS, can be expressed as:

Eq.A2.1 $$\Delta S = \sum_i \Delta S_i \overline{P}_i + \sum_i \Delta P_i \overline{S}_i$$

where S_i is the share of skilled labour in total employment for sector i and P_i is that share of sector i's employment in total employment. The bar over a variable denotes a time mean. The first term on the right hand side captures the impact of skill upgrading within industries. The second term captures the impact on the share of skilled labour in total employment arising from changes in the sectoral composition of employment, i.e. the *between* component.

In South African much of the rise in skill intensity within firms, ΔS_i, has been driven by reductions in less-skilled labour rather than increases in skilled labour. To account for the effect of the decline in less-skilled employment within sector i, ΔS_i can be expressed as:

Eq A2.2: $$\Delta S_i = \Delta\left[\frac{Ls_i}{Ls_i + Lu_i}\right]$$

where Lu_i and Ls_i are less-skilled and skilled employment, respectively. Through manipulations this can be re-written as:

Eq A2.3: $$\Delta S_i = \frac{1}{(Ls_i + Lu_i)^2}(\overline{Lu}_i \Delta Ls_i - \overline{Ls}_i \Delta Lu_i).$$

The first term within the bracket reflects the change in skill intensity of employment within sector i driven by changes in skilled employment. The second term reflects the negative impact of a rise in less-skilled employment on the skill intensity of employment.

If equation Eq A2.3 is substituted into EqA2.1 the following function is obtained:

Eq A2.4

$$\Delta S = \sum_i \frac{(\overline{Lu_i}\Delta Ls_i)}{(Ls_i + Lu_i)^2}\overline{P_i} + \sum_i \frac{(\overline{Ls_i}\Delta Lu_i)}{(Ls_i + Lu_i)^2}\overline{P_i} + \sum_i \Delta P_i \overline{S_i}\ .$$

The first term captures the within-sector shifts arising from changes in employment of skilled labour, the second captures the within-sector shifts arising from changes in less-skilled employment and the final term captures the between-sector shifts.

Appendix 3

(a) Deflation of the Input-Output tables

Different approaches exist with respect to deflation (double deflation or deflation along the rows) as well as the choice of deflators. Limitations of available data in South Africa imply that most deflation procedures are rather crude. For example, Van Seventer (1988) deflates input-output tables using GDP deflators in his analysis of employment and trade regimes. This implicitly assumes a common deflator for domestic production, exports and imports. Bhorat (1999) who uses the ratio of trade to gross domestic product measured in nominal values makes a similar assumption. This paper attempts to deflate the input-output tables using a variety price deflators. Inadequate data implies that the procedure is still crude and substantial scope for improvement exists.

Deflating input-output tables to a common year is a complex and data intensive task. One requires sector specific domestic output deflators, export deflators where the f.o.b (free on board) price differs from the producer price, and import prices. The latter are extremely difficult to obtain as frequently the data are not collected, and when they are available they are generally expressed at their c.i.f (cost, insurance and freight) value. These then have to be adjusted for tariff and/or other barriers. Finally, even if the data are available the estimated deflators are sensitive to levels of aggregation.

Using a similar method to most studies in the Chenery *et al.* (1986) volume, the input-output tables were deflated along the rows. Given available data, these tables were aggregated into 29 industrial sectors defined using the 4th edition SIC system (Table A3.1). Domestic production and exports were deflated to 1990 prices using implicit gross output deflators derived from the National Productivity Institute (NPI, 1997). These are based on the Central Statistical Services (now Statistics South Africa) indices of the physical volume of manufacturing production (P3041.3) (SSA, various years). The base year for this data is 1990. When sectors were grouped (motor vehicles and other transport equipment) a gross output weighted deflator was used. Community, social and personal services were deflated using the implicit deflator derived from the Reserve Bank Quarterly Bulletin, the base year of which was also 1990 (Reserve Bank, various years).

Table A3.1: Sector classification and aggregation

Economic sectors	SIC 4	Disaggregated sectors
Primary sector	1	Agriculture, Forestry and Fishing
	2	Mining and Quarrying
Manufacturing		
Capital-intensive	351, 352	Chemicals and chemical products
	351, 353, 354	Other basic chemicals
	371	Iron and Steel basic industries
	313	Beverages
	372	Non-ferrous metal basic industries
	341, 342	Paper products and printing & publishing
Intermediate-K-intensive	314	Tobacco products
	384, 385	Vehicles and transport equipment
	311, 312	Food manufacturing
	361, 362, 369	Non-metallic minerals
Labour-intensive	383	Electrical machinery
	355, 356	Rubber and plastic products
	382	Non-electrical machinery
	321	Textiles
	381	Metal products
Ultra-labour-intensive	331	Wood and wood products
	39	Other manufactures
	323	Leather products
	332	Furniture
	324	Footwear
	322	Wearing apparel
Social Overhead	41, 42	Electricity, gas and water
	51, 52	Construction (contractors)
Services	61, 62	Wholesale and retail trade, catering and accommodation
	71, 72	Transport, storage and communication
	81, 82, 83	Finance, insurance, real estate and business services
	9	Community, social and personal services

Notes: The manufacturing factor-content sectors were derived using relative K/L ratios, a method also used by Bell and Cattaneo (1997). South African manufacturing statistics K/L ratios (in R millions) for 1988 were used to discriminate between sectors according to the following: Capital-intensive ≥ 70, $40 \leq$ Intermediate-K-intensive < 70, $20 \leq$ Labour-intensive < 40, Ultra-labour-intensive < 20.

Import price deflators are difficult to obtain. Statistics SA provided import price deflators (1980 base) prior to 1988 for 7 broad sectors defined according the SITC system. In 1988 Statistics SA (formerly Central Statistical Services) changed the base year to 1988 and began using the SIC system. These however are not directly comparable. Statistics SA also provides detailed sectoral producer price indices for 'output of SA industries for SA consumption' and 'commodities for SA consumption' (P0142.1). The latter is a composite index of both 'output of SA industries for SA consumption' as well as an imported component. Through some manipulation of the domestic and imported weights for some of the broad economic sectors as well as the detailed sectoral weighting for the domestic indices it is possible to derive a rough sectoral import price index. Three other sources exist, namely: implicit import price deflators from the Reserve Bank Quarterly Bulletin; SA manufacturing statistics, which provides sectoral import price deflators for manufacturing between 1980 and 1993; and Industrial Development Corporation (IDC) data for 1988 to 1997 using 1995 as a base year (see Jansen and Joubert, 1998). The latter method utilises 8 digit HS trade data provided by Customs and Excise to construct the import price indices and reflects the most advanced method used so far.

Limitations in the availability of data necessitated the choice of two distinct time periods: 1984-93 and 1993-97. 1993 served as the base year for the 1984-93 period and the import deflators from SA manufacturing Statistics were used. When sectors were grouped (motor vehicles and other transport equipment) an import weighted index was used. For agriculture and mining sectors the Central Statistical Services SIC import price deflators were used (P0142.1). Although the base year for these sectors was 1988, the composition of these products is unlikely to have changed significantly between 1988 and 1993. Implicit import price deflators from the Reserve Bank Quarterly for imports of goods and non-factor services were used to deflate the service sector. This implicitly assumes common import price changes for all the service sectors. Given that these are generally non-traded products this is unlikely to have significant effects on the results.

For the 1993-95 period, the IDC import price deflators from Jansen and Joubert (1998) were used, implying a base year of 1995. Once again implicit import price deflators from the Reserve Bank Quarterly for imports of goods and non-factor services were used to deflate the service sector.

(b) Occupation by industry matrices

Detailed occupation by industry (29 industrial sectors) matrices were derived from the 1980 Census and 1997 OHS. The manufacturing sub-sectors were then aggregated into four broad factor-content categories (See Table A3.1). Then, using a 9 by 10 occupation by industry matrix (with manufacturing as a single sector) derived from the 1994 OHS, matrices for 1984, 1988 and 1993 were extrapolated using average annual growth rates. Occupation by industry matrices derived from the 1995 OHS and 1996 Census were used to check the consistency of the 1994 and 1997 matrices and changes were made where necessary. For example, the 1996 Census occupational breakdown was used for the mining and quarrying sector in 1997 as it was not available in the 1997 OHS.

Because compatible manufacturing sub-sectors could not be generated from the 1994 OHS, manufacturing was treated as a single sector in deriving the above matrices. The occupation by manufacturing factor-content sub-sector matrices for 1984, 1988 and 1993 were then extrapolated from the relevant 1984 and 1997 matrices using average annual compound growth rates. The occupational shares were subsequently adjusted to ensure consistency with those of total manufacturing derived earlier.

These were subsequently adjusted to ensure consistency with the Standardised Employment Series provided by Statistics South Africa. Manufacturing employment data was obtained from WEFA. A converging iterative process, whereby first the rows and then the columns were adjusted to ensure consistency with the total employment values, was used. In constructing the matrices, the government sector including teachers has been excluded as the high numbers of teachers employed by the government bias the share of skilled employment within the 'community, social and personal services' sector upwards. In addition, much of the distortion in the 1980 Census in which the TBVC states were excluded is avoided as the bulk of the employees from these states fell within the government sector.

The aggregation process followed implies that some of the sector level variation in employment changes is lost.

(c) Sensitivity of employment responses to choice of deflators

A number of problems exist with the deflation procedure used, particularly differences in base years for the import and production deflators. To test the rigor of the results, two further sets of import price deflators were used. These were the import price indices derived from the sectoral producer price indices and the gross output deflators (assumes common deflator for imports, exports and domestic production). The results prior to 1993 were similar, but marginal differences existed between 1993 and 1997. In particular, net trade showed a negative impact when using the PPI derived import price deflators, although in no case was the effect greater than –1 % total employment. This series appears to underestimate the significant currency depreciation in 1996 and thus overestimates real imports. When using the gross output deflators the net trade effect between 1993 and 1997 is again small but positive. The results of this chapter therefore appear robust to the choice of deflator.

Appendix 4

Table A4.1: Disaggregated occupational impact of economic growth (% initial year total employment)

1984-88	Final Demand	Exports	Imports in demand	Imports in intermediates	Total import penetration	Net trade	IO coefficient	Total gross output	Labour coefficient (n)	Total technology	Employment change
	(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)=(2)+(5)	(7)	(8)	(9)	(10)=(7)+(9)	(11)
Professionals	0.30	0.18	-0.02	-0.06	-0.07	0.11	0.03	0.44	0.74	0.77	1.18
Managerial	-0.01	0.15	-0.02	-0.03	-0.05	0.11	-0.08	0.01	0.68	0.60	0.69
Clerical	0.31	0.31	-0.04	-0.08	-0.12	0.19	-0.17	0.33	0.71	0.55	1.05
Sales	0.20	0.27	-0.03	-0.06	-0.09	0.18	-0.10	0.28	0.26	0.16	0.54
Skill agriculture	0.35	0.02	0.03	0.05	0.08	0.10	0.06	0.51	-1.08	-1.02	-0.57
Artisans	-0.74	0.42	-0.07	-0.32	-0.39	0.03	-0.06	-0.77	-0.11	-0.17	-0.89
Machine operator	0.14	0.55	-0.07	-0.19	-0.26	0.30	-0.27	0.16	0.24	-0.03	0.40
Elementary	3.78	0.62	0.19	0.17	0.36	0.98	0.66	5.42	-6.71	-6.06	-1.30
Other	-0.03	0.07	-0.01	-0.02	-0.02	0.05	-0.01	0.00	-0.88	-0.89	-0.88
Total	4.29	2.60	-0.02	-0.55	-0.57	2.03	0.06	6.38	-6.16	-6.10	0.22
Empl change	288437	174986	-1595	-36742	-38337	136649	4191	429277	-414605	-410414	14673
1988-93											
Professionals	-0.25	-0.05	-0.09	-0.04	-0.12	-0.17	0.50	0.08	0.99	1.49	1.07
Managerial	-0.24	-0.04	-0.07	-0.04	-0.10	-0.14	0.26	-0.13	0.63	0.89	0.51
Clerical	-0.31	-0.11	-0.12	-0.04	-0.16	-0.27	0.53	-0.05	0.56	1.09	0.51
Sales	-0.27	-0.12	-0.08	-0.02	-0.10	-0.22	0.47	-0.01	-0.14	0.33	-0.15
Skill agriculture	-0.09	0.02	0.00	0.01	0.00	0.02	0.09	0.03	-0.65	-0.56	-0.63
Artisans	-0.93	-0.37	-0.18	0.09	-0.10	-0.47	0.65	-0.75	-1.59	-0.94	-2.34
Machine operator	-0.69	-0.13	-0.25	-0.05	-0.30	-0.43	0.59	-0.53	-0.14	0.45	-0.67
Elementary	-1.78	-0.08	-0.20	0.08	-0.13	-0.21	2.38	0.39	-4.81	-2.43	-4.42
Other	-0.07	0.00	-0.02	-0.01	-0.03	-0.03	0.05	-0.05	-0.69	-0.64	-0.74
Total	-4.63	-0.87	-1.02	-0.02	-1.04	-1.91	5.53	-1.02	-5.84	-0.32	-6.86
Empl change	-312271	-58950	-68509	-1544	-70054	-129004	372727	-68548	-394030	-21303	-462579
1993-97											
Professionals	1.00	0.42	-0.23	-0.22	-0.45	-0.03	0.01	0.98	1.76	1.76	2.74
Managerial	0.38	0.32	-0.16	-0.13	-0.29	0.03	0.32	0.73	-0.38	-0.07	0.35
Clerical	0.59	0.52	-0.25	-0.25	-0.50	0.01	0.55	1.16	-3.20	-2.65	-2.04
Sales	0.55	0.41	-0.21	-0.17	-0.37	0.04	0.50	1.09	-2.61	-2.11	-1.52
Skill agriculture	0.26	0.19	-0.01	-0.02	-0.03	0.16	-0.15	0.27	0.55	0.40	0.82
Artisans	1.05	0.49	-0.34	-0.45	-0.78	-0.29	0.22	0.98	-1.60	-1.38	-0.62
Machine operator	1.22	0.82	-0.36	-0.40	-0.76	0.06	0.07	1.35	-3.14	-3.07	-1.79
Elementary	4.97	2.01	-0.49	-0.54	-1.03	0.98	-2.33	3.62	-7.34	-9.66	-3.72
Other	0.19	0.11	-0.06	-0.04	-0.10	0.01	0.02	0.22	1.93	1.95	2.15
Total	10.23	5.28	-2.12	-2.20	-4.32	0.96	-0.78	10.41	-14.04	-14.82	-3.63
Empl change	642176	331899	-133114	-138348	-271463	60436	-48933	653679	-881920	-930853	-228241

Appendix 5

(a) The impact of wages and productivity on exports and employment

In this section the model presented in Chapter 7 is extended to include the demand equilibrium condition. The impact of changes in relative wages and productivity on exports, output and employment are discussed in more detail.

The *A(z)* curve shown Figure 7.1 of Chapter 7 only represents the technological features of the two economies. To determine the equilibrium relative wage in the standard DFS model, it is necessary to introduce the demand side. Assuming uniform homothetic Cobb-Douglas utility functions a constant share of expenditure will be spent on each good z, $b(z) = P(z)C(z)/Y$, where Y is total income and $C(z)$ is consumption of good z.. Because of identical tastes the share of income spent on home country produced goods is equal in both countries, i.e. $b(z) = b^*(z)$.

In the continuum of goods model the fraction of total income within each country spent on home country produced goods can then be represented as

Eq A5.1 $$G(\bar{z}) \equiv \int_0^{\bar{z}} b(z)dz$$

where $(0, \bar{z})$ denotes the range of products for which home has a comparative advantage. As the range of products produced by the home country $(0, \bar{z})$ rises, so the share of income, $G(\bar{z})$, spent on home country products rises. $G(\bar{z})$ is thus an increasing function of z. The total income spent on home production will equal $G(\bar{z})(wL + w^* L^*)$ where $(wL + w^*L^*)$ is world income.

In equilibrium, total expenditure must equal total income for each country. This implies that the total income spent on home production by both home and foreign consumers will equal total labour income in the home country:

Eq A5.2 $$wL = G(\bar{z})(wL + w^* L^*) .$$

Through simple arithmetic manipulation this relationship can be expressed in terms of a balance of trade condition:

Eq A5.3: $[1-G(\bar{z})]wL = G(\bar{z})w^*L^*.$

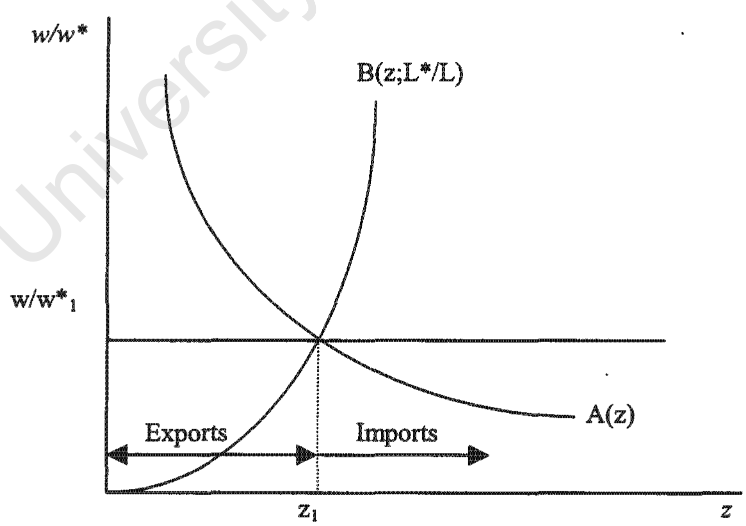
The left-hand side denotes expenditure by the home country on imports, while the right hand side denotes expenditure by foreigners on home country exports. The balanced budget condition requires these two to be equal.

Manipulating this function such that relative wage is on the left-hand side yields

Eq A5.4: $$\frac{w}{w^*} = \frac{G(\bar{z})}{1-G(\bar{z})}\left(\frac{L^*}{L}\right)$$

which is depicted in Figure A5.1 as curve *B(z;L*/L)*. The curve is positively sloped as an increase in the range of goods produced domestically raises demand for labour, which increases wages. Alternatively, using the balance of trade condition, if *z* increases, the value of exports rises and the value of imports falls. To correct the trade balance relative wages will have to increase such that import demand rises and exports decline.

Figure A5.1: The continuum of goods model



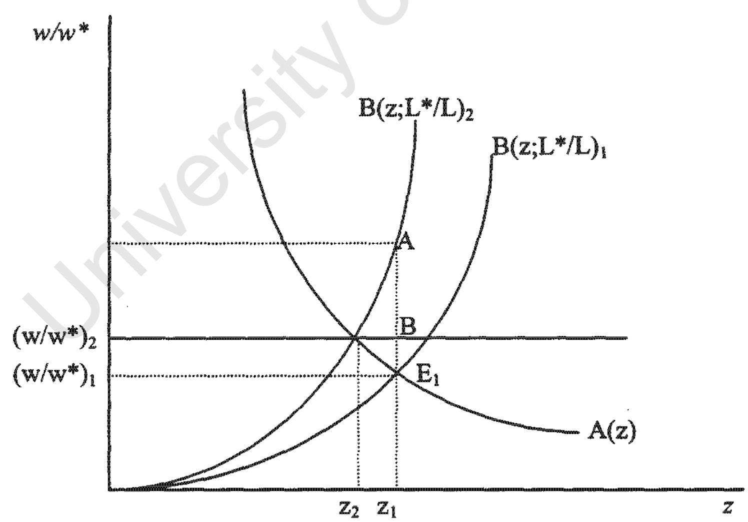
Together the production technology relationship (*A(z)*) and the demand relationship determine the equilibrium relative wage (*w/w**) and the geographic pattern of specialisation (z_1).

Traditionally, the model has been used to analyse the impact of exogenous changes in labour endowments and technology on relative wages and production specialisation. However, by assuming exogenous relative wages then relative employment is endogenised. It is then possible to analyse the impact of shifts in relative wages and technology on production specialisation and employment.

Impact of a rise in relative wages

Assume home wages rise (through union activity or labour regulation) such that the relative wage rises from $(w/w^*)_1$ to $(w/w^*)_2$ in Figure A5.2. At existing levels of employment and production specialisation (z_1) a trade deficit emerges as the additional income ($w_2L_1 - w_1L_1$) raises import demand. Further, the cost of production increases for all home country firms, which under perfect competition in the product market raises prices, $\Delta P(z) = a(z)\Delta w$. The increase in domestic prices reduces the competitiveness of all home country firms, but it is only those firms around the original equilibrium level, E_1, that are no longer able compete with foreign producers. The range of output produced and exported declines as result.

Figure A5.2: Relative wage changes



Because wages cannot adjust, the balance of trade equilibrium is restored through a reduction in employment (L). Note that this implicitly assumes that the adjustment process occurs via changes in domestic, not foreign, employment and that foreign wages also do not adjust. The adjustment process is reflected in a shift upwards of the demand equilibrium curve from $B(z;L^*/L)_1$ to $B(z;L^*/L)_2$.

Some interesting features emerge. Firstly, specialisation of production at the new equilibrium occurs at z_2 reflecting a smaller range and total value of products exported.[124] Secondly, the percentage decline in employment (represented as AE_1) is greater than the percentage rise in wages (BE_1). This arises because the decline in cost competitiveness of many sectors negatively affects the range of products produced and exported. The negative employment impact required to restore the original trade balance if the range of products exported remained $(0,z_1)$ is thus amplified by the decline in production from $(0,z_1)$ to $(0,z_2)$. Net welfare for the home country has declined, as is shown by the decline in national income ($w_1L_1 < w_2L_2$). Because prices of the range of products previously produced by home $(0,z_1)$ rise, real national income declines by a greater proportion than nominal income. However, the real income of those workers who retain employment in the home country rises. For these workers the price of home produced goods rises in proportion to the increase in the wage, but the cost of foreign goods remain constant.[125] Foreign country real income per worker declines as the price of home country exports rise.

Productivity improvements

In the standard Ricardian model with flexible wages, a uniform rise in productivity across all sectors in the home country increases the relative wage of the home country as well as the range of products produced and exported (Dornbusch *et al.*, 1977). The impact of productivity improvements when wages are rigid is now analysed.

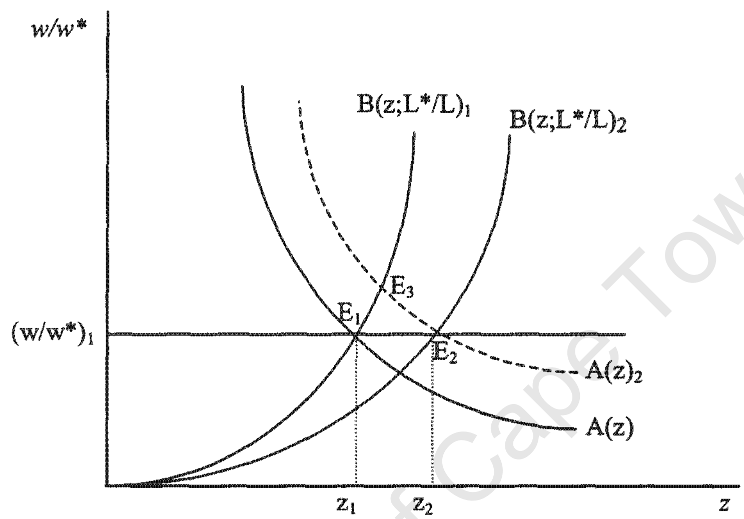
A uniform rise in productivity across all sectors ($a(z)$ declines for all z) causes the relative productivity curve $A(z)$ to shift upwards by the same proportion. This is represented in Figure A5.3 by a shift of $A(z)$ to $A(z)_2$. At relative wage level $(w/w^*)_1$ home country labour cost competitiveness rises reflecting a decline in the labour cost of production, $\Delta P(z) = \Delta a(z)w$. The improved competitiveness of home producers boosts the number of home goods produced and exported, which in turn causes a trade surplus. If wages were flexible, the increased demand for labour would place upward

[124] Value of exports = $G(z)w^*L^*$. Because $G(z)$ declines as z declines and w^*L^* are assumed fixed, the value of exports decline. As shown later, national income also declines.

[125] The price of goods previously produced by home country, but now produced by foreign country will rise, but by proportionately less than the rise in wage.

pressure on wages. However, as wages are sticky upwards, the increased demand for labour increases employment. This is shown by a shift in the $B(z;L^*/L)_1$ curve to $B(z;L^*/L)_2$. A new equilibrium E_2 is attained with more employment and an increased range of output produced $(0,z_2)$.

Figure A5.3: Productivity improvements



A rise in productivity has a number of positive impacts on the home and foreign country. Employment, the total value of exports and the range of products produced and exported by the home country increase. Although the rise in value of exports initially causes a trade surplus, the increase in employment and thus domestic income raises the value of imports such that the balance of trade equilibrium is restored. This implies that the export performance of the foreign country improves as well. Although the range of products produced by the foreign countries declines, output and employment in these remaining industries increase in order to satisfy the import demand by home country consumers.

Total income of the home country improves ($w_1L_2 > w_1L_1$) reflecting an increase in employment at constant relative wages. Because of initial assumptions, total income of the foreign country remains constant. However, productivity improvements reduce prices of all home country products, which raises the real income of labour in both the home and foreign country.

If wages are not sticky upwards, the increased demand for labour arising from the improvement in productivity raises relative wages.[126] Equilibrium will settle at E_3 and exports increase by less than the case of sticky upward wages. As outlined in Dornbusch *et al.* (1977) domestic and foreign real income also rise in this case.

(b) Data sources and the construction of variables

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

Industrial sectors

Table A5.1 presents the industrial sectors used in the analysis.

Table A5.1: Industrial sectors

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

Note: Tobacco (314), Petroleum refineries (353) and Miscellaneous petroleum and coal products (354) have been excluded.

[126] This could arise if existing labour were able to capture some of the productivity increases.

NR, L, CH and MM stand for natural resource intensive, labour intensive, chemical intensive and machinery & metal products. Other manufactured products sector has been excluded in the broad sub-sector analysis.

Relative unit labour cost (RULC)

Unit labour costs for sector *i* in country *j* can be written as:

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

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

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

Eq A5.5: $$RULC_{ijk} = \frac{a_{ij}w_{ij}}{a_{ik}w_{ik}e_{jk}}$$

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

While this approach provides a useful indication of movements in relative unit labour costs over time, is does not adequately reflect relative *levels* of unit labour costs at any particular point in time (Hooper and Larin, 1989). To make comparisons between levels of unit labour costs it is necessary to convert a_{ij} into a common currency, i.e. convert real output in the unit labour requirements into comparable currencies. Traditionally purchasing power parity (PPP) exchange rates are used. Incorporating these changes into Eq A5.5, $RULC_{ijk}$ becomes

Eq A5.6: $$RULC_{ijk} = a_{ij}.\frac{PPP_{jk}}{a_{ik}}.\frac{w_{ij}}{w_{ik}e_{jk}}$$

where PPP_{jk} is the purchasing power parity between country *j* and *k*. In this format relative productivity is not affected by short term nominal changes in exchange rate, but relative wages are. When $RULC_{ijk}$ > (<) 1 the labour cost in producing a unit output (*j*) in country *i* exceeds (is less than) that of country *k*.[127]

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

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

Manufacturing data by sector and country are generally available from two sources: the United Nations Industrial Development Organisation (UNIDO) Industrial Statistics database (INSTAT) and the OECD STAN data set. These data sets contain, amongst other variables, values for employment, real and nominal output, value added and wages and salaries. As the OECD STAN data set does not have data on many developing countries (other than Mexico and Korea) and data were at times not available during the 1970s, it was decided to focus on the UNIDO data set. A comparison of RULC using the UNIDO and STAN data sets indicates that the UNIDO based values over–estimate RULC compared to the STAN based values by between 50 and 100 % (Table A5.2).

Table A5.2: Comparison of differences in RULC between STAN and UNIDO databases ($RULC_{UNIDO}$ /$RULC_{STAN}$)

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

Note: Comparison based on common Value added deflator used to deflate sectoral value added.
Unweighted is the simple average across sectors. Weighted values are calculated using total value added, employment and wages and salary for manufacturing. For Japan and the UK the STAN values for total manufacturing were available, but were not available for sectors.
Data are only available for developed countries.

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

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

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

The relative productivity variable was constructed by dividing real value added by employment. This was then converted to a common currency using PPP exchange rates for 1987. Unfortunately, PPP exchange rates are not available for South Africa necessitating the construction thereof.[128] PPP_t is represented as:

Eq A5.7: $$PPP_t = \left(e_0^* \frac{P_0^\$}{P_0^d} \right) \frac{P_t^d}{P_t^\$}$$

where $\left(e_0^* \frac{P_0^\$}{P_0^d} \right)$ is the equilibrium real exchange rate and P_t^d and $P_t^\$$ are domestic and foreign prices at time t. Given the equilibrium real exchange rate it is possible to calculate PPP_t for all t using the correct domestic and foreign prices. However in SA case we do not have this information. Golub (2000) overcomes this problem by using the average real exchange rate $\sum_{t=1}^{n} \frac{1}{n} \left(e_t \frac{P_t^\$}{P_t^d} \right)$ as a proxy for the equilibrium real exchange rate. This is the process followed here. Manufacturing value added deflators calculated from nominal and real manufacturing value added obtained from the World Development Indicators (WDI) were used as the price indices. Ideally, sector specific PPPs should be used, but as these were not available a common PPP for

[128] Recently Van Dijk (2003) has calculated PPPs for South Africa.

manufacturing as a whole was assumed.[129] While this may distort level comparisons at the sector level, the trends in RULC are not affected. In the econometric analysis, level differences are captured by the inclusion of sector specific intercepts leaving the estimates of the slope coefficients unaffected.

Table A5.3: RULC using common value added deflator divided by RULC using sector specific deflator, unweighted average for manufacturing.

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

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

Two approaches to deflating value added were pursued. In the first case, sector value added was deflated to base year 1987 using a common value added deflator for each country derived from the WDI. In the second case, sector value added was deflated using sector specific deflators calculated from the nominal and real output values and indices in the UNIDO data set. This approach assumes that the output and value added deflators are the same. The sector specific deflators were highly variable at times, and various procedures were used to correct the data (see later). The correlation coefficient between the common value added deflator and the sector specific deflator exceeded 0.8 in most cases. The exception was Italy where the correlation coefficient was below 0.3 for almost all sectors.[130]

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[129] As Golub and Hsieh (2000) show the use of different PPPs give rise to different results. The signs however were not reversed.

[130] Other exceptions were Electrical machinery (-0.03) and Professional goods (-0.66) for Japan, Rubber products (-0.86) for Netherlands and Miscellaneous petroleum products (-0.01) for the UK.

RULC values calculated using the value added deflator were lower than those calculated using the sector specific deflator prior to 1980, but higher during the 1990s (Table A5.3). The sector specific deflator based values show a greater decline in RULC and thus improvement in competitiveness over the period. Nevertheless, the ranking of sectors according to RULC are similar for the different deflators. The Spearman's correlation coefficient exceeded 0.78 for the 1980s and 1990s. The rank correlation coefficient was lower at 0.41 in the 1970s.

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

Trade data

International trade data were required for the export functions and as weights for the aggregation process. Trade data were obtained from a number of sources. Customs and Excise bilateral trade data classified according to the 8 digit Harmonised System was downloaded from the TIPS Online data site (www.tips.org.za). This was converted into the ISIC classification system consistent with the UNIDO data set using a concordance file obtainable from the same site. Unfortunately, this data are only available from 1988 and are for the Southern Africa Customs Union (SACU) and not South Africa alone.

Total country exports and bilateral trade data between South Africa (essentially SACU) and each country were then obtained from Canada World Trade Analyzer. This data are available from 1980-98. The Canadian World Trade Analyzer data are classified according to SITC and were converted to the UNIDO ISIC classification using a concordance file constructed from one available on the Jon Haveman site (http://www.eiit.org/) (as used by Edwards and Schoer, 2002).

Unfortunately the bilateral trade data were only complete for the developed countries. A further problem is that South Africa did not report any data between 1974 and 1991 (Tsikata, 1999). The data for this period are then obtained from partner countries.

Total South African imports and exports according to sector between 1970 and 1998 were obtained from TIPS and were used in the aggregate panel data set. The countries within the sample account for 55 % of total SA exports and 55 % of total SA imports. Although the countries in the sample do not account for all South African trade, much of the missing trade can be located within Europe where it is expected that RULC will move concurrently with those of other developed countries.

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

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

<u>Other variables</u>

Other variables such as real investment in machinery and equipment, real capital stock of machinery and equipment, real and nominal output, employment and capacity utilisation have been used in the study. This data were obtained from SASID (2003).

<u>Issues relating to the updating of data</u>

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

Firstly, the classification of industrial sectors changed over the years. This resulted in large once off changes in the level of output or value added measured between years. This was a problem if the real index and employment had not been similarly adjusted. In most cases employment, value added and output (real and nominal) were adjusted to be consistent with the reclassification of industrial sectors. At times the value added variable had not been adjusted correctly. Changes in gross output were then used to adjust the *level* of value added for that sector. The remainder of the series was adjusted using value added growth rates derived from the original data.

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

Thirdly, sometimes data were aggregated across sectors for some of the years, usually when the industrial sectors were reclassified (e.g. iron & steel (371) with non-ferrous metal (372)). The aggregated sectors were disaggregated using the average share in the 3 to 5 years prior to the reclassification of sectors. Where possible alternative data sources were used (STAN data for OECD countries). Employment levels were adjusted using relative average wages prior to the reclassification.

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

In order to further check the data for outliers and level changes the following assessment procedure was used:

- Sector level deflators for each country were analysed for sudden shifts or outliers. When nominal output and the real index clearly diverged as the result of once off shifts, the initial level of the real index was adjusted and the original growth rates were used to adjust the trend in the real index. Compound growth rates were used to replace outlying deflators.

- Figures of RULC for each country were then analysed for outliers and sudden shifts in levels. The raw data was re-analysed in problematic cases. This process was useful in identifying errors in the value added data.

(c) Additional tables

Table A5.4: Short-run export coefficients using DFE, log real exports as dependent variable

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

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

Table A5.5: Sector specific estimation and diagnostic results based on ARDL(1,1,1,1) specification.

		ECM	RULC	Capacity	Sanctions	Income	se	SC	FF	HE	R2
Food	coeff	-0.19	-4.36	-25.48	0.07	-2.73	0.12	0.57	4.88	2.65	0.85
	Prob	[.146]	[.050]	[.216]	[.846]	[.167]		[.459]	[.040]	[.115]	
Beverages	coeff	-0.20	0.82	-22.16	0.08	0.91	0.22	3.10	0.14	7.62	0.96
	Prob	[.088]	[.749]	[.082]	[.926]	[.836]		[.095]	[.708]	[.010]	
Textiles	coeff	-0.09	-4.37	6.78	-1.77	8.43	0.11	0.38	2.19	0.14	0.95
	Prob	[.415]	[.164]	[.455]	[.477]	[.453]		[.544]	[.157]	[.710]	
Apparel	coeff	-0.24	-3.17	-4.44	-0.32	4.93	0.24	0.09	0.28	0.14	0.95
	Prob	[.238]	[.001]	[.672]	[.602]	[.309]		[.773]	[.604]	[.713]	
Leather	coeff	-0.45	-2.11	14.81	-0.92	-0.51	0.18	9.97	1.40	0.08	0.96
	Prob	[.001]	[.003]	[.005]	[.013]	[.747]		[.005]	[.252]	[.785]	
Footwear	coeff	-0.34	0.06	-28.26	-0.20	0.30	0.40	1.00	0.13	1.56	0.75
	Prob	[.070]	[.980]	[.113]	[.789]	[.948]		[.331]	[.720]	[.222]	
Wood products	coeff	-0.43	-3.41	-6.48	0.11	-0.15	0.30	1.47	5.64	2.50	0.84
	Prob	[.020]	[.003]	[.091]	[.771]	[.946]		[.241]	[.029]	[.126]	
Furniture	coeff	-0.29	-7.26	-0.26	-1.24	0.88	0.44	0.01	0.18	9.92	0.96
	Prob	[.025]	[.005]	[.979]	[.139]	[.909]		[.919]	[.679]	[.004]	
Paper products	coeff	-0.50	-1.57	-0.73	-0.06	1.62	0.14	1.05	2.01	0.36	0.95
	Prob	[.025]	[.070]	[.826]	[.732]	[.017]		[.318]	[.174]	[.555]	
Printing	coeff	-0.52	-0.69	-15.91	-0.61	2.05	0.33	0.00	0.16	0.02	0.79
	Prob	[.011]	[.638]	[.099]	[.111]	[.124]		[.989]	[.694]	[.885]	
Industrial chemicals	coeff	-0.23	-1.15	-6.50	-0.53	2.16	0.13	0.02	1.91	3.23	0.97
	Prob	[.108]	[.344]	[.251]	[.198]	[.014]		[.904]	[.184]	[.084]	
Other chemicals	coeff	-0.20	-6.07	3.17	-1.12	2.59	0.21	6.71	0.43	0.15	0.91
	Prob	[.143]	[.211]	[.810]	[.192]	[.020]		[.018]	[.523]	[.700]	
Rubber	coeff	-0.12	2.91	-14.59	0.48	8.84	0.21	0.02	1.09	1.92	0.96
	Prob	[.498]	[.585]	[.648]	[.735]	[.091]		[.883]	[.310]	[.178]	
Plastic	coeff	-0.12	0.32	-11.09	0.22	4.19	0.16	0.28	0.03	1.28	0.98
	Prob	[.060]	[.931]	[.390]	[.768]	[.213]		[.606]	[.857]	[.268]	
Glass products	coeff	-0.35	-0.81	-3.23	0.18	3.59	0.21	0.12	0.41	3.01	0.85
	Prob	[.165]	[.550]	[.453]	[.649]	[.113]		[.728]	[.532]	[.095]	
Other non-metallic minerals	coeff	-0.49	3.13	-2.29	-0.76	6.15	0.32	2.99	0.10	0.12	0.63
	Prob	[.007]	[.109]	[.508]	[.046]	[.029]		[.101]	[.750]	[.727]	
Iron and Steel	coeff	0.02	32.22	18.86	4.76	16.90	0.14	2.02	0.79	1.10	0.94
	Prob	[.778]	[.778]	[.833]	[.771]	[.729]		[.172]	[.387]	[.304]	
Non-ferrous metal	coeff	-0.10	-0.15	20.50	-1.65	-3.69	0.26	0.42	0.95	4.92	0.82
	Prob	[.543]	[.955]	[.651]	[.668]	[.724]		[.523]	[.343]	[.036]	
Fabricated metal products	coeff	-0.25	-1.20	-1.37	0.35	5.40	0.18	1.09	0.65	0.06	0.95
	Prob	[.047]	[.327]	[.789]	[.410]	[.018]		[.310]	[.430]	[.809]	
Non electrical machinery	coeff	-0.44	-2.49	-2.89	-0.27	1.35	0.28	6.04	0.11	1.85	0.84
	Prob	[.022]	[.113]	[.491]	[.491]	[.006]		[.024]	[.741]	[.185]	
Electrical machinery	coeff	-0.14	3.15	-6.13	0.85	2.06	0.23	2.33	2.77	4.18	0.94
	Prob	[.286]	[.524]	[.610]	[.533]	[.062]		[.144]	[.113]	[.051]	
Transport	coeff	-0.69	-1.23	-1.75	-0.48	4.44	0.34	3.26	3.66	7.46	0.78
	Prob	[.001]	[.384]	[.430]	[.128]	[.003]		[.088]	[.072]	[.011]	
Professional & scientific	coeff	-0.90	-1.80	1.37	-0.30	0.73	0.17	0.26	0.00	2.95	0.95
	Prob	[.000]	[.000]	[.372]	[.033]	[.003]		[.616]	[.969]	[.098]	
Other manufacturing	coeff	-0.24	-1.62	-4.77	-0.31	-0.28	0.11	9.88	1.66	1.58	0.97
	Prob	[.069]	[.006]	[.216]	[.191]	[.845]		[.006]	[.213]	[.220]	

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

Table A5.6: Sector specific estimation and diagnostic results based on ARDL(1,1,1,1,1) specification.

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

Table A5.7: Short-run export coefficients for broadly defined manufacturing sectors using DFE estimator, log real exports as dependent variable

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

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

Table A5.8: Short-run coefficients estimated using the DFE for developed and developing countries, log total exports as dependent variable

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

Note: Standard error are in italics below the coefficients
***, **, * indicate statistical significance at the 1 %, 5 % and 10 % levels, respectively.