PRODUCTIVITY COMMISSION

Trends in Australian Manufacturing

Commission Research Paper

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Foreword

The role of the manufacturing sector in the Australian economy has changed fundamentally over the past half century. The changes have been viewed with alarm by some and as a benign corollary to the expansion of the services sector by others.

This report examines key developments and trends in manufacturing in Australia. It probes the causes of the changes and their implications. The report was undertaken in response to the strong interest expressed by several participants at the Commission's annual research consultations, and notably by the Department of Industry, Tourism and Resources.

Given the complexity and breadth of issues affecting manufacturing, the Commission's research does not attempt to cover all issues, but concentrates on change, its causes and effects.

The Commission is grateful to those who provided assistance in the preparation of this study and welcomes further feedback on it.

Gary Banks

Chairman

August 2003

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Abbreviations

ABS	Australian Bureau of Statistics
AMC	Australian Manufacturing Council
ANZSIC	Australia and New Zealand Standard Industrial Classification
ASIC	Australian Standard Industrial Classification
AWE	Average Weekly Earnings
BIE	Bureau of Industry Economics
BTCE	Bureau of Transport and Communications Economics
CIF	Cost, Insurance, Freight
CIFA	Cost, Insurance, Freight and Exchange Adjustment
DFAT	Department of Foreign Affairs and Trade
DISR	Department of Industry, Science and Resources
DITR	Department of Industry, Tourism and Resources
ETM	Elaborately Transformed Manufactures
ERA	Effective Rate of Assistance
FDI	Foreign Direct Investment
FOB	Free-on-board
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GOS	Gross Operating Surplus
IC	Industry Commission
ICT	Information and Communications Technologies
JIT	Just-in-time Delivery
MFC	Manufacturing Census
MFP	Mutlifactor Productivity
NAC	National Accounts
NEC	Not Elsewhere Classified

OECD	Organisation for Economic Cooperation and Development
PC	Productivity Commission
PPP	Purchasing Power Parity
R&D	Research and Development
RBA	Reserve Bank of Australia
SEE	Survey of Employment and Earnings
SITC	Standard International Trade Classification
STM	Simply Transformed Manufactures
TAFE	Technical and Further Education
TCF	Textiles, Clothing and Footwear
TNC	Transnational Corporation
TQC	Total Quality Control
TREC	Trade Export Classification
UNCTAD	United Nations Conference of Trade and Development
VA	Value added
WTO	World Trade Organisation

OVERVIEW

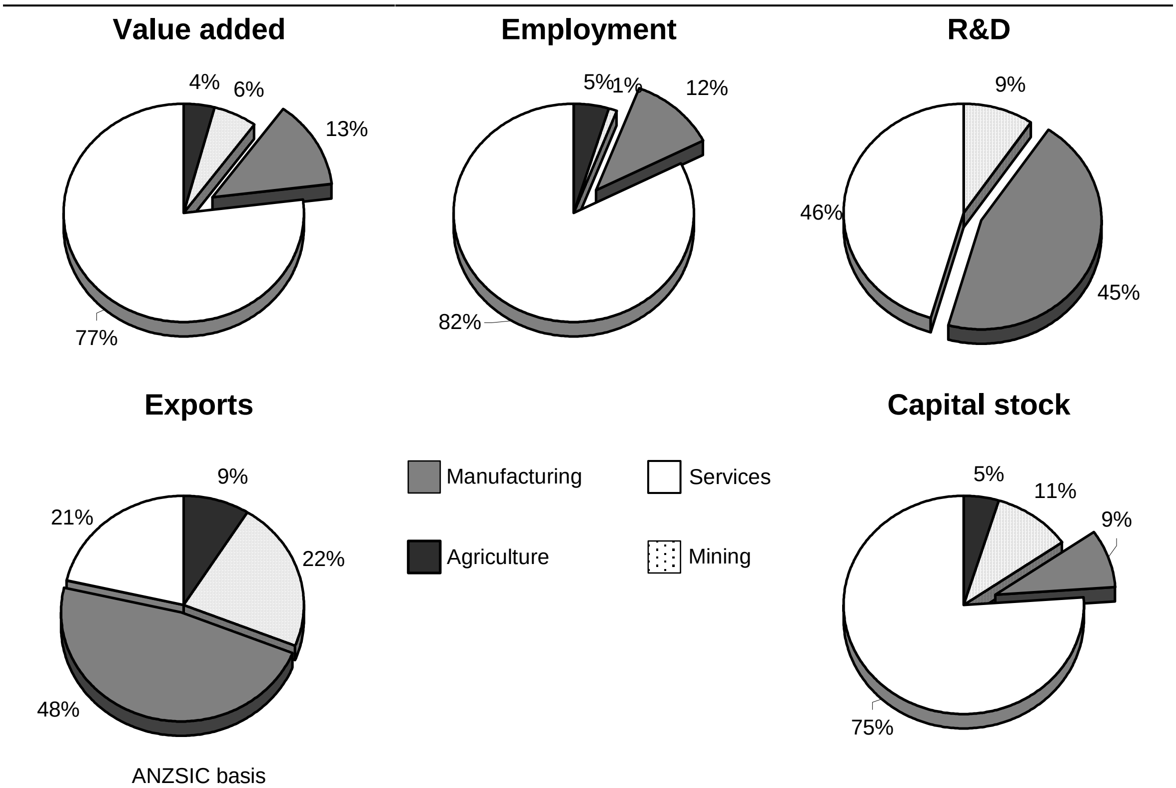
Key points

- Manufacturing output has quadrupled since the mid-1950s. The fastest growing activities have been those with links to Australia's natural endowments and products that are more differentiated, with higher skill levels and R&D intensities.
- Manufacturing growth, while strong, has not matched that of the services sector.
  - Manufacturing accounted for one in four dollars of national output in the 1960s, but only one in eight by the turn of the century.
  - The relative decline in manufacturing is a common feature of richer countries.
- In contrast to the output story, manufacturing employment has declined somewhat both in relative *and* absolute terms over the long term, although stabilising since the early 1990s.
- The *relative* decline in manufacturing has several causes and implications:
  - on the output side, the relative decline mainly reflects Australians' preference for more services as incomes rise. Import competition from lower-wage developing economies has only been a small contributor;
  - on the employment side, the decline is testimony to strong labour productivity growth, including from (high tech) capital investment;
  - some service activities once categorised as part of manufacturing have been outsourced, though this effect is relatively modest;
  - the impacts of structural change on unemployment have generally been moderate, though the effects have been bigger for some less competitive industries and regions; and
  - regional dependence on manufacturing has fallen.
- While productivity growth rates have been high compared with other sectors over the long term, manufacturing missed out on the (multifactor) productivity surge apparent for the market sector as a whole in the mid-1990s. However, productivity growth has been more vigorous in the last two years.
- Manufacturing is increasingly globally oriented:
  - exports increased from just over 15 per cent of manufacturing output in 1989-90 to around 24 per cent in 1999-2000, with import shares also rising.
- Continuing rises in 'intra-industry trade' — exports and imports of similar products — suggest that Australian manufacturing can develop capabilities within most areas, even those where competitiveness has generally declined.

Overview

Manufacturing plays a major role in the Australian economy, with levels of output and employment that considerably exceed mining and agriculture combined. It continues to be the dominant source of technological innovation in the business sector. Reflecting reduced barriers to trade, rising world incomes and increasing globalisation, trade in manufactures is growing faster than primary commodities. Indeed, opportunities for trade have never been greater for Australian manufacturing.

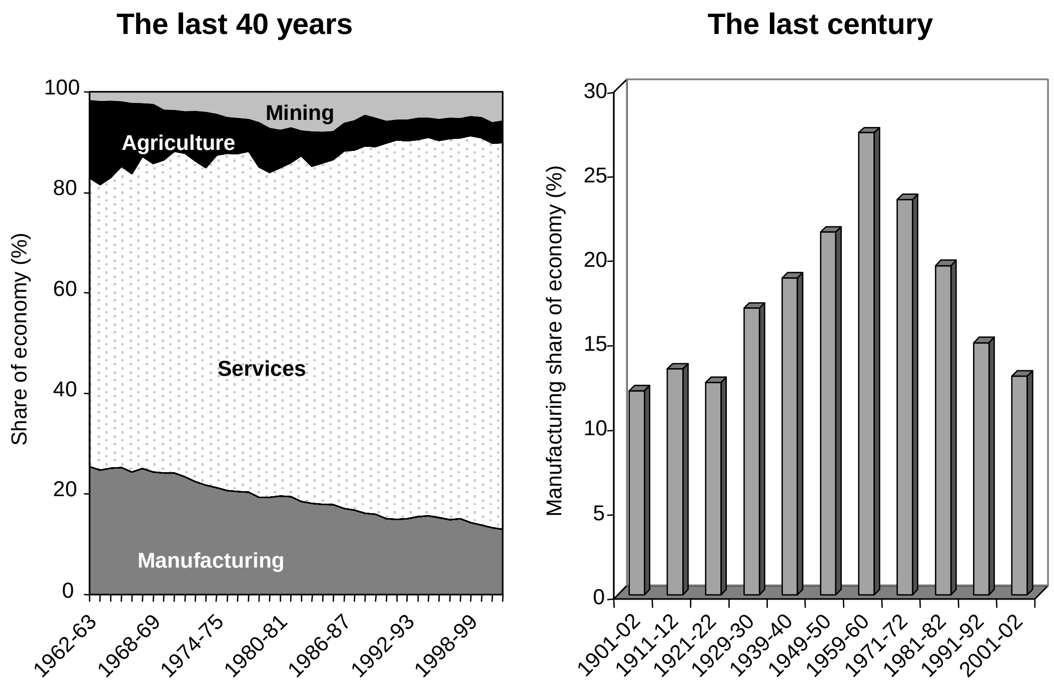
Figure 1 **Manufacturing's role in the economy**
2001-02



Yet, perhaps the most distinctive feature of manufacturing is its changing role in the Australian economy. At its zenith in the 1960s, manufacturing accounted for one in every four dollars of nominal gross domestic product. By the early twenty-first century, this had diminished to one in eight, and looks set to decline further as the services sector continues to expand. The direct contribution of manufacturing to today's economy is roughly on a par with its relative share in 1901.

A corollary of its declining share is that manufacturing's contribution to Australia's economic growth has also declined over the last forty years (figure 2). For example, from 1996-97 to 2001-02, average (nominal) economic growth was 6.8 per cent per year, of which manufacturing contributed 0.5 percentage points a year. In comparison, — and consistent with the pattern in several other OECD countries — services contributed 5.5 percentage points.

Figure 2 **Manufacturing has declined in *relative* terms**



About 30 per cent of the declining share of manufacturing in GDP can be attributed to slower growth in manufacturing prices relative to prices of other goods and services.

It is important to appreciate that the decline in manufacturing output is not an absolute one. On the contrary, real output in manufacturing has increased substantially — fourfold since 1954-55. This expansion is mainly the result of strong labour productivity growth — the large increase in output has been achieved without a commensurate increase in workers. In fact, manufacturing employment has fallen somewhat, from about 1.3 million in the mid-1960s to around 1.1 million by the early 1990s. However, it has subsequently remained at around that level.

Part of the relative decline of manufacturing reflects outsourcing. Manufacturing firms have increasingly outsourced service activities, such as information technology and accountancy, to other firms in the services sector. Although this reduces recorded activity in manufacturing, it merely reflects the reallocation of particular activities between sectors.

Even so, outsourcing does not account for most of the relative decline. Estimates based on changing input-output relationships in the economy suggest that, on one assumption, less than one percentage point of the 4.7 percentage points decline in the manufacturing share of the economy between 1980-81 and 1996-97 could be attributed to outsourcing.

While associated with some adjustment difficulties, the declining share of activity and employment accounted for by manufacturing can be seen as a corollary of positive overall outcomes for Australia. The relative decline is a consequence of strong labour productivity growth within the sector and the shift in consumer preferences to services as national income has risen:

- demand for manufactured goods as a share of total consumer expenditure has fallen significantly, from around 50 per cent in 1959-60 to 34 per cent in 2001-02 in constant price terms; and
- higher relative productivity growth has accounted for about half the drop in the manufacturing employment share in Australia.

The structural changes associated with these developments has meant that developed economies are becoming, in one commentator's terms, increasingly 'weightless', with economic power relying more on the exploitation of knowledge and services, rather than the capacity to manufacture things, dig them up or grow them. Manufacturing is undergoing the same transformation in role that saw agriculture's relative importance decline over the twentieth century. However, just as the diminution of agriculture's role can hardly attest to a systemic failure, the relative decline of manufacturing does not signify failings in that sector.

This view is reinforced by the fact that the declining share of manufacturing is not an Antipodean idiosyncrasy, but a common feature of economic development. Among 17 'rich' countries, only one (Singapore) experienced an increase in the share of manufacturing in nominal GDP over the two decades from 1978. In contrast, manufacturing increased in importance in eight of 18 poorer countries, consistent with the role of manufacturing in the development phase of countries.

There are other, more pessimistic views about the decline of manufacturing. These focus on the alleged effects of globalisation and trade liberalisation on factory closures and regional unemployment in industrial zones. They may also equate manufacturing and its relative performance with a capacity for future economic prosperity. However, these negative views of the sweeping structural changes affecting the economy are only partly borne out by the evidence:

- The growth of imports from poorer, lower-wage countries has had some impacts on employment in Australian manufacturing. However, the net effect has been reduced because, in response to trade pressures, manufacturing has re-oriented towards areas where it has greater comparative advantage, stimulating exports and employment in these activities.
  - Changes in the trade deficit in manufacturing explain only between one and three percentage points of the 13 percentage points decline in manufacturing's share of economy-wide employment from the late 1960s to 2001-02.
  - Over the period from 1977-78 to 1992-93, other estimates suggest that the employment losses resulting from import growth were almost entirely offset by employment gains associated with an expansion of exports.
- Over the long run, there does not appear to have been any relationship between unemployment rates and structural change in the economy. While there is evidence of short-term effects for some periods, in more recent times, structural adjustment within manufacturing appears to have had weaker short-run effects on unemployment.
- The contribution of the decline in manufacturing to regional unemployment has been generally small, except for industrial cities such as Newcastle, Geelong and Whyalla.

Manufacturing plays an important part in the national economy, but this should not be seen as pre-eminence, as some commentators have claimed. The notion that there is a sectoral contest in terms of economic significance ignores:

- the connected natures of sectors, each of which contributes to the outputs of others. For example, the pharmaceuticals industry is as much about service activities, such as managing clinical trials, generating new ideas, effective subcontracting and marketing, as it is about manufacturing drugs;
- that manufacturing is a heterogenous sector in terms of prospects for growth and competitiveness; and
- there is no demonstrated link between the size of the manufacturing sector and economic prosperity. Across developed countries, there is no relationship between income per capita and the manufacturing contribution to growth.

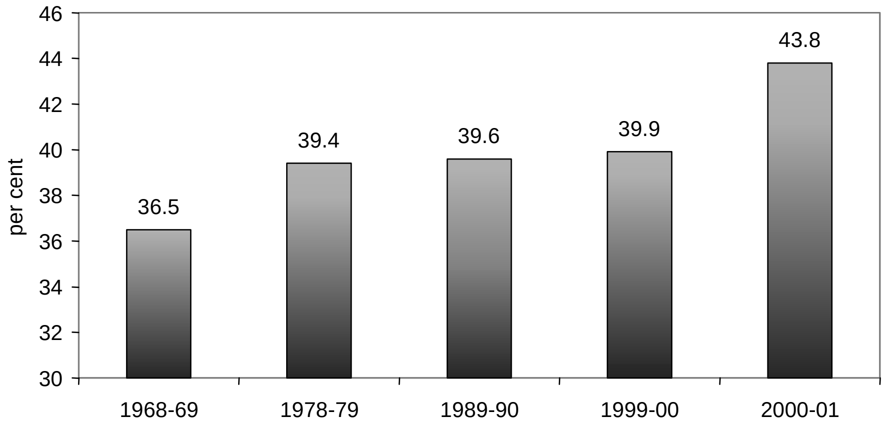
Changing trends within manufacturing

Manufacturing is a highly diverse sector that evades easy generalisations. This is not merely in relation to the high/low tech continuum, but across labour and skill intensities, trade orientation, growth rates and a host of other ways of characterising industries. While it is worthwhile examining trends and performance of the sector as a whole, it is also necessary to examine trends *within* the sector.

The long-term trajectory of manufacturing appears to have favoured two groups of industries.

- Manufacturing activities with strong links to Australia's natural endowments of food, forests and minerals account for a significant and growing share of manufacturing value added. In 1968-69, natural endowment-based manufacturing accounted for 36.5 per cent of manufacturing value added. By 2000-01, it accounted for just under 44 per cent (figure 3).
- A second category of goods — more differentiated products with higher skill and R&D intensities — also have tended to increase in relative significance. These include Medicinal and pharmaceutical goods, Photographic, scientific and medical equipment and, to a lesser extent, Electronic equipment. These three groupings increased in importance from a small base of 3.5 per cent of manufacturing value added in 1968-69 to 6.2 per cent by 2000-01.

Figure 3 **Natural endowment-based manufactures are contributing more to output**



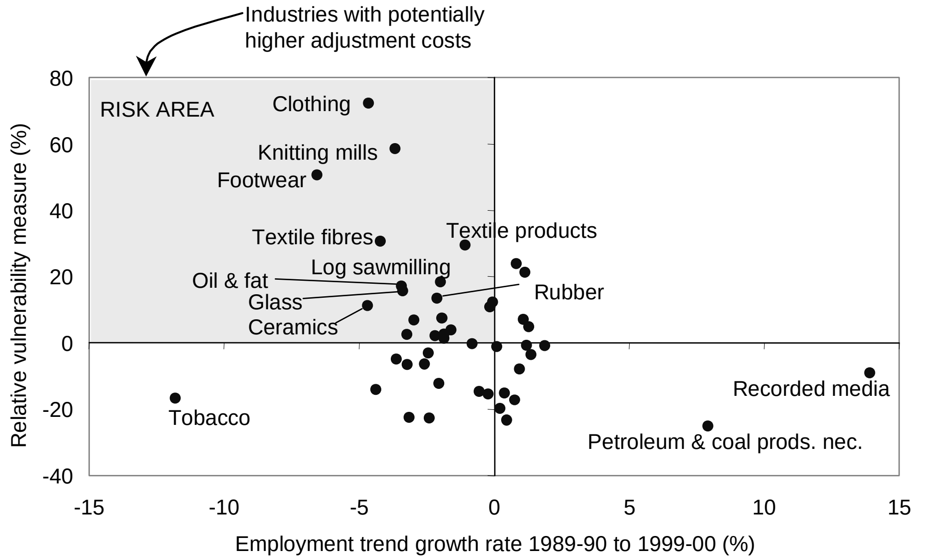
On the other hand, less complex goods produced by industries facing strong import competition and declining border protection have tended to decline over time — exemplified by the marked reduction in the significance of the textiles, clothing and footwear (TCF) industries over the last quarter century.

However, these generalisations conceal the enormous heterogeneity within manufacturing. For example, while six of the 15 slowest growing industries over the decade from 1989-90 to 1999-2000 were in the TCF group, several other industries within this group (such as cotton textile manufacturing) experienced growth rates well above the average for manufacturing.

Variations in output and productivity growth rates among industries lead to change in the structure of manufacturing, with output and employment shares shifting over time — in other words, 'structural change'. It is the process by which the economy shifts resources to more valuable uses. The evidence points to increasing structural change in manufacturing until the early 1990s, but it has since been steady, albeit remaining at a higher level than in the preceding 30 years. (The view that elaborately transformed manufactures are more likely to be protected from structural change pressures is not borne out by the facts.)

Abrupt structural change can also have adverse consequences because people displaced by change may not get new jobs quickly, depending on the vulnerability of the workforces exposed to change. Attributes such as poor English proficiency, older age and low educational attainment are major indicators of increased risk of unemployment. The workforces of the TCF industries (and, to a lesser extent, those in the Non-metallic products industries, such as glass and ceramics) are among the most vulnerable when measured in this way (figure 4). These industries have also faced the greatest declines in employment over the least decade.

Figure 4 **Where are the risks of labour adjustment highest?**



A feature of industrial adjustment in Australian manufacturing has been growing specialisation, with a greater degree of concentration of activity into particular niches. However, it is rarely the case that a whole field of manufacturing activity declines. Indeed, there appear to be islands of competitive advantage within almost all broad manufacturing categories.

On the other hand, while specialisation has increased across the roughly 150 manufacturing classes recognised by the Australian Bureau of Statistics, at the geographic level, specialisation has been decreasing. In 1981, a few major metropolitan areas accounted for most manufacturing activity in Australia. More specifically, the top eight areas accounted for just over 80 per cent of activity. Given that these areas are also the dominant population centres, this concentration is largely reflective of Australia's highly urbanised structure. However, over the ensuing years, manufacturing has become less geographically concentrated, with the top eight areas accounting for 74.2 per cent of total activity in 1996. This reflected the growth of manufacturing in Queensland and the reduction in importance of manufacturing in some regional industrial cities.

A related issue is whether there has been any tendency for such areas to specialise in manufacturing relative to other sectoral activities. Here, the evidence suggests less reliance on manufacturing as a source of regional activity and employment. For example, in 1981, there were eight areas in which manufacturing accounted for 24 per cent or more of area employment. By 1996, there was just one such area (Whyalla).

The manufacturing labour market

Over the past few decades, manufacturing has generally followed the labour market trends of other Australian sectors. Hours of work have increased for full time employees, but part time and casual work have increased in importance. On average, wages have risen at about the same rate as other sectors. Skilled employment has become more important, requiring greater educational requirements and changing the occupational mix of jobs. Despite impressions of increasing instability, the average duration of job tenure has increased. Unionisation has declined. Industrial stoppages have fallen. But behind these broad similarities, there remain some significant differences.

Manufacturing has generally lower levels of education than other sectors of the economy. A significantly lower share of its employees have university training and a considerably greater proportion of employees have no post-school qualifications.

On the other hand, manufacturing has education-intensive areas associated with research, design and development and the use of complex manufacturing processes (such as pharmaceuticals and biotechnology, scientific instruments and aerospace).

Manufacturing employs around 30 per cent of Australia's engineers — about three times the intensity of all sectors. And manufacturing accounts for about half of the total person years devoted to R&D for economic development purposes in the business sector.

Even in those parts of manufacturing dominated by more lowly educated workers, educational qualifications among the workforce have increased significantly in the past two decades. For example, in the TCF industries, over 80 per cent of the workforce had no post-school qualifications in 1984; this had fallen to 65 per cent by 2001.

Another way of charting the changing nature of the manufacturing workforce is by skill and occupational categories. A complex story emerges about changing patterns of skill. Overall, in the past 15 years, skilled occupations in manufacturing have increased at around half the rate of other sectors, reflecting the relative decline in high skill blue collar occupations, who play a more important role in manufacturing than elsewhere. And while high skill white collar employees have increased in manufacturing at around the same rate as in the rest of the economy, the main source of growth in white collar work in manufacturing has been in management and administration, rather than in professionals and associate professionals, as in other sectors. Unskilled blue collar workers have increased in relative importance in manufacturing (unlike other sectors). Nonetheless, there has been a reduction in the importance of unskilled work overall in manufacturing, reflecting a large decrease in unskilled white collar workers — indicative of the increased tendency for outsourcing service-type jobs in manufacturing.

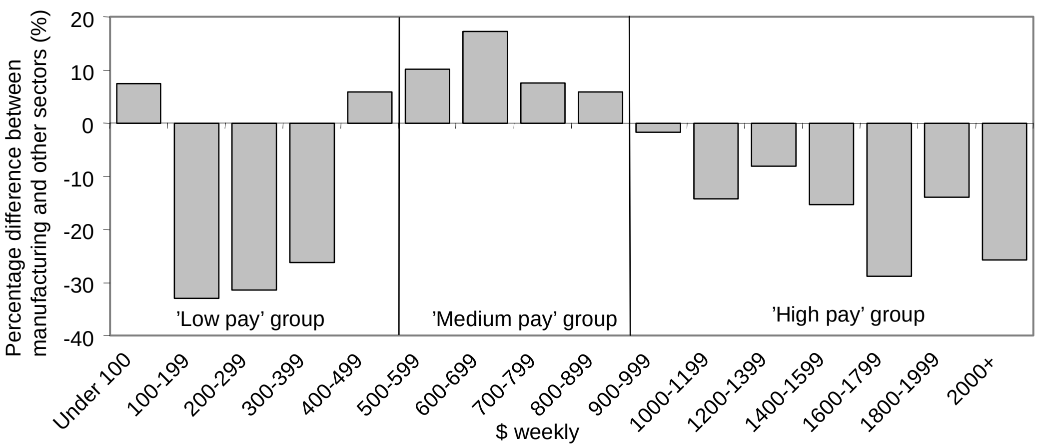
While manufacturing firms undertake less structured training and spend less on training as a share of wages than firms in other industries, they are more likely to have apprenticeships and to use unstructured training. The difference in training between manufacturing and other sectors is partly explained by its occupational and educational attainment structure, and by differences in employees' perceptions about the need for training. The training intensity in manufacturing increased relative to the average from 1990 to 2001-02, but, unlike the economy as a whole, showed no increase from 1996 to 2001-02.

Some see manufacturing as a high wage sector, and this sometimes forms a basis for industry development proposals.

It is true that real earnings per employee are high relative to other sectors — by about a 25 per cent margin in December 2002. However, this contrast mainly reflects differences in paid hours worked, rather than wage rates per se. (Manufacturing, with mining and major utilities, remains a sector in which full-time work is overwhelmingly dominant, especially for males. This no longer characterises some prominent service sectors, like Retail trade and Health and community services.) In fact, when the data are adjusted for hours worked, it is apparent that wage *rates* in manufacturing have been consistently *below* those in other sectors.

The wage distribution of manufacturing differs in some distinctive ways from other sectors (figure 5). Manufacturing is characterised by ‘thin tails’ at the ends of the wage distribution, having a smaller proportion of employees on very low wages and a smaller proportion earning very high wages.

Figure 5 **A ‘tale of two tails’: lower relative wages for the low and high paid**



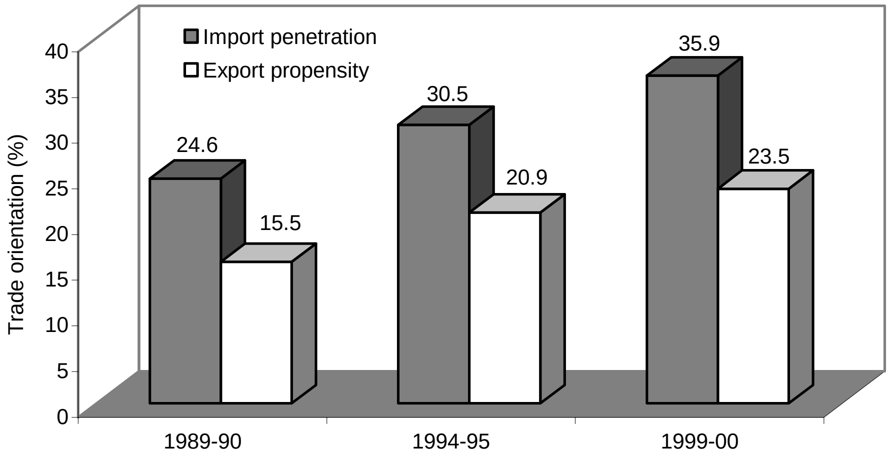
Trade orientation

There has been a large increase in export orientation as the Australian manufacturing sector has been opened to trade (figure 6). Manufacturing export propensities (the share of domestic manufacturing output that is exported) increased from 15.5 per cent to 23.5 per cent between 1989-90 and 1999-2000. While both simply and elaborately transformed manufactures (STMs and ETMs) showed substantial growth, export growth of ETMs was particularly strong (with the propensity growing by over 130 per cent).

Over the longer term, the increasing openness of manufacturing has meant that, whereas manufacturing exports were only about 14 per cent of total Australian exports in 1963-64, they stood at just under a third of exports in 1997-98.

Trade openness is a two-way street. The rise in export orientation has mirrored an increase in import penetration (the share of the domestic market supplied by imports) — from 25 per cent to 36 per cent (with growth rates in import penetration about the same for ETMs and STMs). Reducing tariffs on imports has effectively also reduced an implicit tax on exports.

Figure 6 **Manufacturing is becoming increasingly open to trade**



Manufacturing trade is increasingly characterised by intra-industry trade — that is, imports and exports of similar products (such as auto parts or wine). Consistent with this, industries with high import propensities tend to show increasing rates of export orientation, even at a highly disaggregated level. While clearly volatile at times, intra-industry trade has increased substantially in Australian manufacturing over the past 30 years, and particularly since the late 1980s:

- The index of intra-industry trade roughly doubled from 1988-89 to 2001-02.
- The strongest contributors to the expansion in intra-industry trade have been ETMs, such as motor vehicles and parts, and pharmaceuticals. This is partly driven by global integration of production, but also by the development of highly specialised niches within certain goods (such as medical and scientific equipment).

Growing intra-industry trade is suggestive of the capacity for Australian manufacturing to develop at least niche capabilities within almost all areas of manufacturing, even those for which competitiveness has generally been declining.

In addition to changes in government assistance policies (with rates of assistance to manufacturing falling from 35 to five per cent over the past three decades), the increasing openness of the Australian manufacturing sector has been influenced by an increase in the sophistication of the manufacturing bases of developing countries, a compositional change favouring growth of tradeable manufactured goods, and reduced transport and communication costs. For example, freight and insurance costs as a share of imports fell by over 40 per cent from 1988-89 to 2000-02.

A further dimension of greater openness has been greater integration of production facilities across national boundaries. Large, transnational corporations compete for customers around the world with components of the production chain strewn across nation states. This has been reflected in growing investment flows between countries.

However, while Australia's inward foreign direct investment (FDI) (across all sectors) posted high growth rates over the first half of the 1990s, it slowed considerably in the second half. This pattern is replicated within manufacturing. Indeed, FDI into Australian manufacturing fell from about $11 billion for the five years ending 1995-96 to about $9.5 billion for the following five years. However, this may simply reflect inherent volatility of investment, rather than a genuine trend.

Over the 1990s, *outward* investment by Australian-owned manufacturing companies have continued to grow strongly.

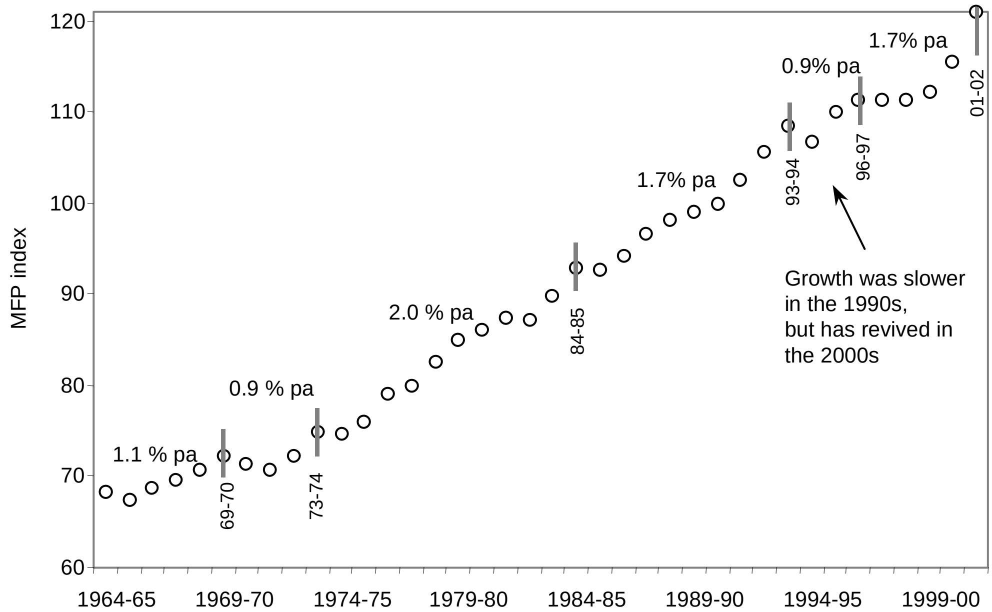
Productivity performance

Productivity growth has played a major role in shaping the performance of Australian manufacturing. In contrast to the services sector, where some of the growth of output has been driven by movements of labour to that sector, manufacturing output levels have grown despite significant falls in employment.

Labour productivity grew by 3.1 per cent per annum from 1964-65 to 2001-02. Much of this increase can be attributed to the increasing capital intensity of manufacturing. But the growth in capital service inputs has merely offset the impact of declining labour inputs. Over the period from 1974-75 to 2001-02, aggregate inputs into manufacturing did not change. Yet real output still increased by nearly 60 per cent. As a consequence, the increase in real output in manufacturing after accounting for the effects of changing labour and capital inputs — so-called *multifactor productivity* (MFP) — has been around 1.6 per cent per annum. This represents a manufacturing productivity dividend to Australians of nearly $400 billion over the relevant period.

An important feature of the market sector as a whole has been increasing MFP growth from the mid-1990s — reflecting a combination of microeconomic reforms (such as those in infrastructure) and the innovative use of information and communication technologies. But this acceleration of MFP in the mid-1990s is not apparent for manufacturing (figure 7). Indeed, the best description of MFP trends in manufacturing is that they have moved up and down around a fixed trend since the early 1960s (and down from a higher trend rate from the 1950s). This may have changed recently — the MFP figures for 2001-02 and 2000-01 are the first and second highest respectively in the last 17 years. Whether these high growth rates merely take MFP back to the level predicted by the long-run historical path, or represent a sustained shift in the underlying trend of MFP (as in the market sector), is not yet clear.

Figure 7 **Multifactor productivity growth in manufacturing**[a]



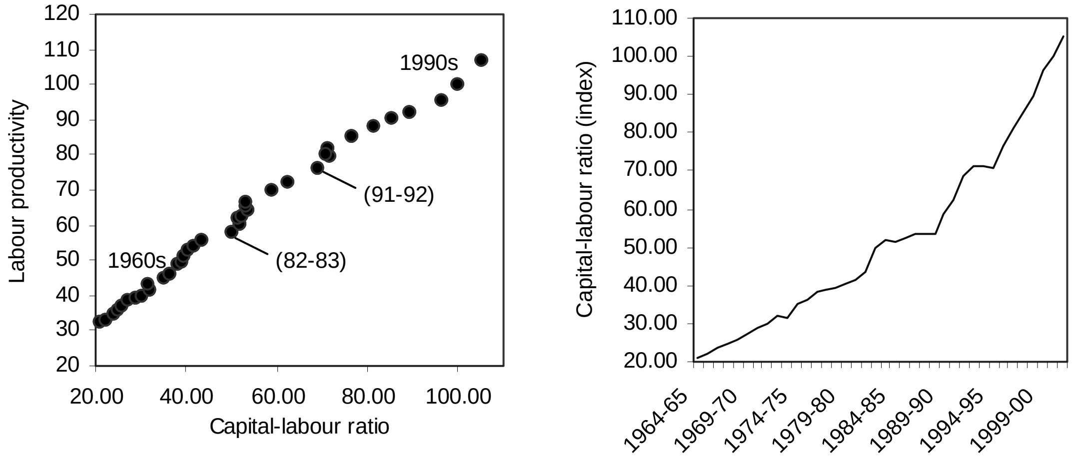
a This figure is amended from that shown in the paper version of the report, correcting a labelling error for 2001-02.

It is also worth stressing the importance of labour productivity, which has exhibited strong growth in manufacturing over the 1990s. A major reason for this has been increasing measured capital intensity (figure 8). This has been driven by several factors. In particular, technological advances in the global production of capital equipment:

- have made some capital items cheaper; or
- at given prices, increased the productive capacity of capital.

Computers and machines incorporating numerical controllers are examples.

Figure 8 **Capital intensity in manufacturing and labour productivity**



One reading of (at least a portion of) the labour productivity gains in manufacturing over the 1980s and 1990s is that these technological advances have meant that the Australian manufacturing sector has been able to acquire an effectively greater stock of capital at given market prices. The effect of technical change in capital is greater labour productivity and lower output prices in manufacturing.

These productivity changes have been a significant contributor to the dwindling employment and output shares of manufacturing in the economy — and a major source of benefits for Australians. This underlines a theme of this report that structural change in, and the relative decline of, manufacturing should not be interpreted as a sign of failure in the sector or as a basis for remedial policy action.

1 Introduction

1.1 Views on the role of manufacturing

There are varying interpretations of the changing role of manufacturing in Australia and other developed economies. One view is that with the unabated expansion of the service sector, economic prosperity increasingly relies on the exploitation of knowledge and services, rather than the capacity to manufacture things, dig them up or grow them.

An associated, but typically more pessimistic, view about the trajectory of modern economies labels the dwindling employment and output share of manufacturing as ‘deindustrialisation’. This focuses on the alleged effects of globalisation and trade liberalisation on factory closures and regional unemployment in heavy industrial zones (the ‘steel belt’ in the United States, the North of England and Wollongong and Newcastle in Australia).

Against these perceptions of a dwindling role, there also remains a view that manufacturing — or at least high technology or high value added parts of manufacturing — continue to hold a special place in economies, providing a link between raw material endowments and sophisticated service inputs and knowledge.

Some commentators contend that manufacturing also holds a privileged position in trade. It is asserted that commodity exports are subject to widely fluctuating, but downward trending, terms of trade, and that there are limits to trade in services. In this context, exports of specialised manufactured goods are sometimes seen as an important driver of economic well-being.

In the light of these different views of the role of manufacturing, it is pertinent to examine developments in the sector in Australia over the last few decades and to explain some of the underlying drivers of change.

At the outset, it is important to recognise that generalisations about manufacturing activity tend to obscure what is happening at a less aggregated level. For example, while the textiles, clothing and footwear industry as a whole has recorded substantial absolute declines in its output over the last two decades, niches of comparative advantage have developed, evidenced by growing intra-industry trade.

A puzzle to be explored in this paper is how and why these pockets of competitiveness have developed.

1.2 Objectives of this study

The study reviews trends in Australian manufacturing, with the emphasis being on developments over the last two decades. It updates statistics and analysis presented in an earlier Industry Commission paper (Clark et al. 1996).[1] It is also a companion to a Productivity Commission report on Australia's service sector (McLachlan et al. 2002).

The report emphasises the following dimensions of change in Australian manufacturing:

- the nature and determinants of relative and absolute growth in manufacturing — at the aggregate level, for its constituent parts and by region;
- the impacts of globalisation and trade liberalisation on patterns of trade, domestic manufacturing activity and the Australian manufacturing labour market; and
- the extent of productivity change in manufacturing and its sources and implications.

In examining these issues, the report analyses trends in the economic performance of manufacturing — its output, employment, capital, wages, productivity, input-output linkages and foreign trade flows — and assesses the links between these measures.

In order to place the analysis in perspective, some comparisons are made with the performance of other sectors of the Australian economy and with manufacturing in selected OECD countries. The report also sometimes gives a longer term historical perspective on the development of manufacturing. However, it is important to recognise that the environment facing Australian manufacturing in the 21st century is very different from that it faced in the 1950s and 1960s when steep trade barriers gave the sector privileged access to the domestic market (Clark et al. 1996).

[1] Other recent publications that deal with trends in Australian manufacturing include: Genoff and Green (1998), Stilwell (2000), Argyrous (2000), Toner (2000), DISR (2001), RBA (2001a) and ABS (2002l).

1.3 What is meant by manufacturing?

The Australian Bureau of Statistics defines manufacturing to involve:

> … the physical or chemical transformation of materials or components into new products, whether the work is performed by power-driven machines or by hand (ABS 2002, *Manufacturing Industry, Australia, Preliminary*, Cat. No. 8201.0).

As noted in Clark et al. (1996), the key feature of manufacturing is transformation of raw and semi-processed materials. This can occur through a vast array of processes, such as stitching, weaving, cutting, joining, forging, mixing and fermenting.

Inevitably, the boundaries between manufacturing and other sectors are sometimes blurred, as they may also involve significant transformation of goods. For example:

- a mining plant may transform raw ore by crushing and sorting it; and
- the construction industry transforms raw materials — concrete, metal, wood and wire — into buildings. But since, for the most part, these are made at the site where the output will be used, they are not regarded as part of manufacturing. In contrast, pre-fabricated buildings that are factory-made and transported to a site are included as part of manufacturing.

Moreover, as part of their operations, many manufacturers employ cleaners, transport workers, accountants, computer software specialists and others to deliver services that, in some senses, are secondary to the transformation of goods. These people and the value they add within the firm are counted as part of manufacturing. But, were their services to be provided externally through a contracted service firm, their activities would be considered to be in the services sector. Thus, with the greater trend towards outsourcing (spurred, for example, by improved communication and information technologies and changing labour market and industrial relations arrangements), activities once counted as part of manufacturing have shifted to the service sector.

The point to emphasise is that 'manufacturing' is a convenient, but imperfect, way of categorising activities that share some common attributes. The current definition is, in part, an historical legacy — based on what were seen as the important industry classifications in the mid-20th century. However, this classification is increasingly under pressure as new industry groupings based on complementary service and manufacturing activities emerge. For example:

- the information technology industry spans traditional sectors, including hardware manufacture and assembly and a whole range of services (software and software services, systems design, and equipment and systems management);

- the pharmaceutical industry encompasses not only traditional manufacturing and packaging, but also quality assessment, regulatory approval, marketing and substantial, often outsourced, research and development activity. As noted by Pappas and Sheehan (1999), the traditional manufacturing component — manufacturing and packaging a drug — now comprises a relatively small share of total product costs.

In the UK, recent analysis of R&D and improving quality standards in services and manufacturing reveals that high-technology manufacturing has more in common with services than with low technology manufacturing (Greenhalgh and Gregory 1998).

Despite these new industry agglomerations, most statistical data in Australia and other advanced economies are still collected on the basis of traditional industry classes. Accordingly, much of the analysis of this report is based on Australian and New Zealand Standard Industrial Classification (ANZSIC) data at varying levels of aggregation (appendix A). Although there are some limitations, this framework remains useful for describing and analysing variations in the performance of different industries.

The report also distinguishes between the extent of transformation of goods, separating manufacturing into simply transformed manufactures (STMs) and elaborately transformed manufactures (ETMs) (appendix A). This classification has policy implications because it is often asserted that manufacturing performance is different across these two categories.

Finally, the report also differentiates industries by their relative intensity of technology generation (appendix A), categorising industries as low, medium or high technology.

1.4 Structure of the report

The report is structured as follows.

Chapter 2 examines the current role of manufacturing in the economy, exploring its main features and contribution to a range of common indicators — such as sales, value added, employment and R&D.

Chapter 3 considers the changing role of manufacturing over time compared with other sectors — and in particular assesses the extraordinary structural adjustment that has seen its role as an employer diminish over the last half century.

Chapter 4 identifies trends at the industry level within manufacturing and analyses the sources and impacts of structural change and turbulence.

Chapter 5 shifts the focus from an industry-by-industry analysis to the manufacturing labour market, identifying its commonalities and peculiarities relative to labour markets in other sectors.

A major trait of the modern manufacturing sector in Australia is its openness to trade and investment flows. Chapter 6 describes and analyses the main features of this greater global exposure.

Chapter 7 examines new productivity estimates for Australian manufacturing and seeks to understand why the experience for manufacturing in the 1990s has been quite different from that for the market sector as a whole.

This report does not cover some facets of manufacturing. In particular, there is no detailed examination of manufacturing R&D and innovation (beyond some consideration of their role in productivity achievement). This area has already been subject to considerable research. Its complexity and breadth would require a publication of its own.

2 A snapshot of the contribution of manufacturing

Key points

- Manufacturing remains a significant sector in Australia, with output and employment levels that are much greater than mining and agriculture combined.
- Manufacturing plays a much bigger role in R&D than would be supposed by its output share.
  - While its value added accounts for only 13 per cent of the economy’s value added, its R&D accounts for 3.5 times this (45 per cent).
- The economic contribution of manufacturing varies significantly across Australian States and Territories.
  - Its role is much smaller in Queensland, Western Australia and Northern Territory, where agriculture and mining continue to play a much larger role than in other States and Territories.
- Manufacturing is highly integrated with the economy, drawing on inputs from domestically supplied services, mining and agricultural inputs, as well as imported inputs.
  - These linkages underline the fact that competitiveness in manufacturing will often depend on efficient supply of inputs from other sectors, as well as imported inputs.

Before considering the trends in manufacturing over the last few decades, it is important to examine its present contribution to the economy.

2.1 Sectoral comparisons

Manufacturing remains a significant sector in Australia, with output and employment levels that are much greater than mining and agriculture combined (appendix K):

- In 2001-02, around one million people were employed in manufacturing, equivalent to around one in nine of those employed in Australia.

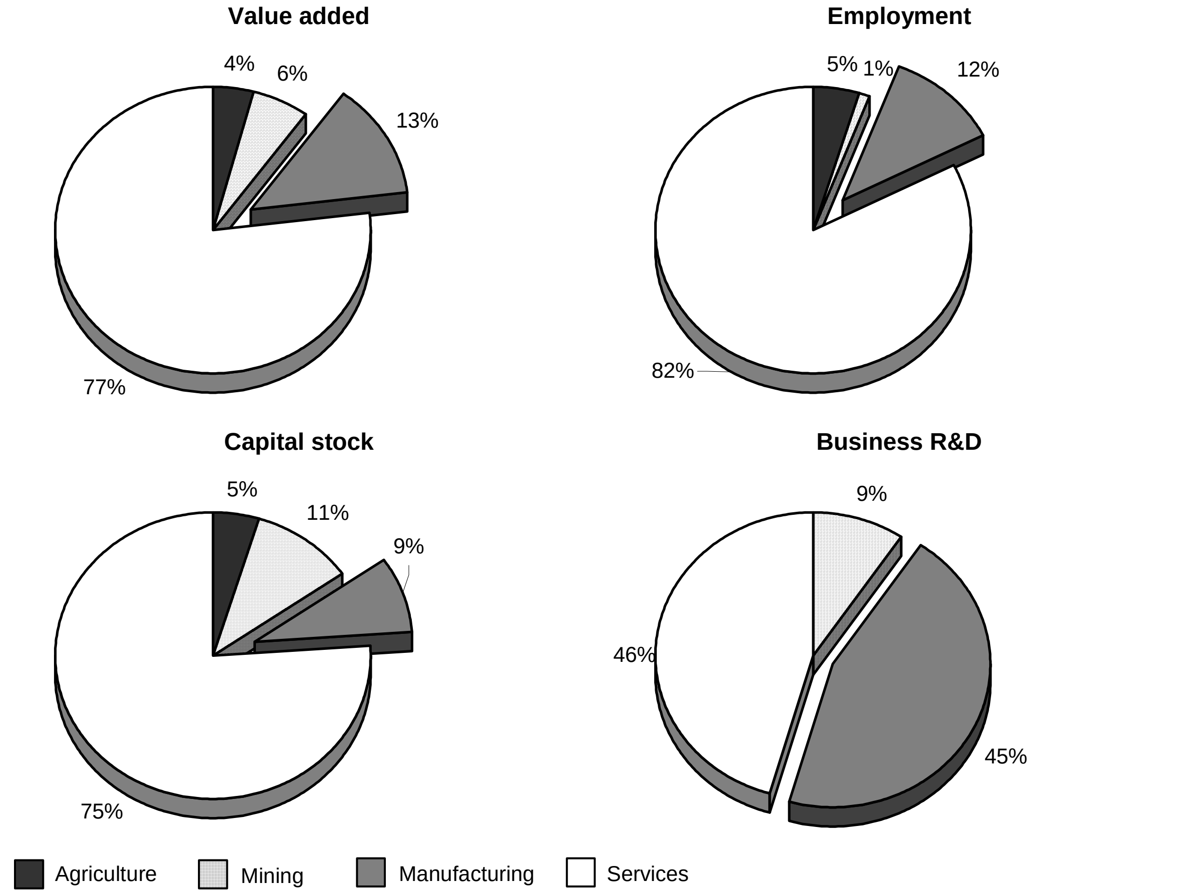
- The sector accounted for around $273 billion of sales, of which just under 30 per cent represented value added from the sector itself.

- It undertook 11 billion dollars of gross fixed capital investment and a further two billion dollars of investment in research and development (R&D).

Despite its significance, employment and activity in manufacturing is small by comparison with the services sector (appendix K and figure 2.1). For example, compared with manufacturing, the services sector employs seven times as many people and uses almost nine times the net capital stock.

Figure 2.1 **Sectoral contribution of manufacturing to Australian economic activity**

2001-02, current prices[a]



[a] R&D data relate to 2000-01 and exclude the agricultural sector, where business R&D is low.

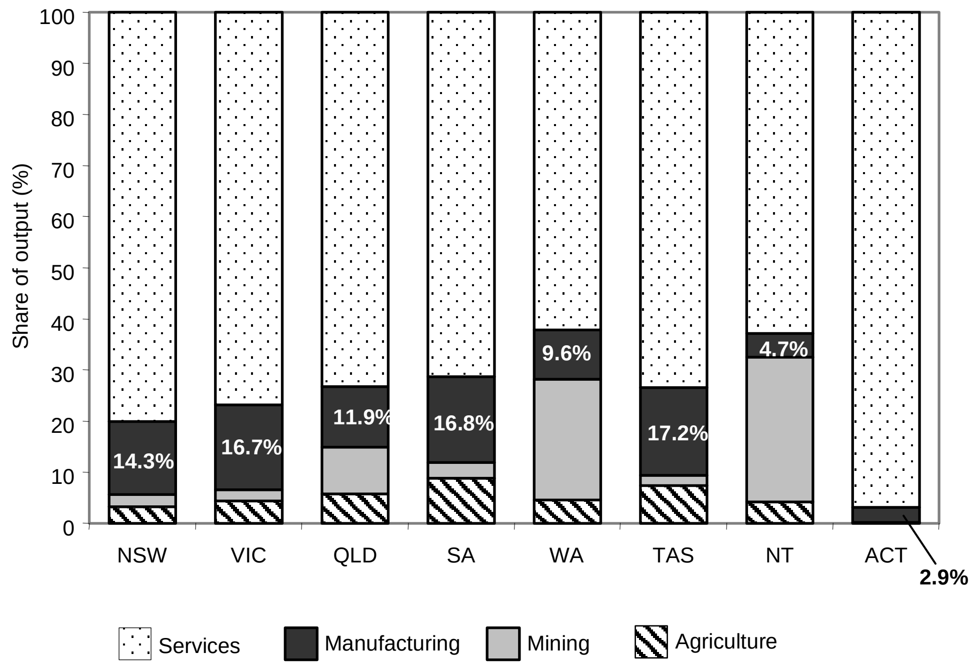
Data source: Appendix K.

However, manufacturing plays a much bigger role in R&D than would be supposed by its output share. Thus, while its value added accounts for only 13 per cent of the economy's value added, its R&D accounts for 3.5 times this (45 per cent). In contrast with the services sector, manufacturing is highly trade-exposed, both on global markets as it expands its export base, and in the domestic market in competition with imports. While there are conceptual and data complications associated with assessing the magnitude of exports, manufacturing accounts for between one-third and 60 per cent of Australia's merchandise exports and between 27 and 47 per cent of total exports of goods and services (chapter 6).

The economic contribution of manufacturing varies significantly across Australian States and Territories (figure 2.2). Its role is much more attenuated in Queensland, Western Australia and Northern Territory where agriculture and mining continue to play a much larger role than in other States and Territories. It plays a negligible role in the Australian Capital Territory, which is dominated by services (particularly government administration and defence). In general, the higher the per capita gross state product, the less important is manufacturing to a State or Territory — a link which is explored in greater detail in the following chapter.

Figure 2.2 **Sectoral contribution of manufacturing to State and Territory economic activity**

2001-02[a]



[a] The data are based on current price factor income measures of output derived from the State National Accounts. This is close, but not identical to, direct measures of value added. Total production excludes general government and ownership of dwellings, so the measures shown here are different from GDP shares.

Source: ABS (*Australian National Accounts: State Accounts 2001-02,* Cat. No. 5220.0).

2.2 Indirect contributions of manufacturing

The measures above give an incomplete picture of the role of manufacturing in the Australian economy because they fail to take into account the strong linkages between sectors.

Input-output tables (table 2.1) reveal these interdependencies. To produce $100 of output in 1996-97, manufacturers on average required $55 worth of inputs from other Australian industries ($6.40 from agriculture, $4.50 from mining, $23.10 from other manufacturers and $20.80 from the services sector).

Manufacturing is not only more integrated with the economy than other sectors, but is also more dependent on imported inputs. For example, to produce $100 of manufacturing output requires around $13 of imports, but the same output from other sectors requires only $5 or less of imported inputs. The greater linkages in manufacturing reflects the character of its operations. By definition, it is a sector based on the transformation of inputs (chapter 1). This has the implication that the value added share of output is less in manufacturing than in other sectors. However, high value added ratios are neither 'good' nor 'bad' — economic prosperity depends upon whether goods are produced efficiently.

Manufacturing also provides many inputs to other sectors (reading down table 2.1), with agriculture particularly drawing on its outputs. But manufacturing is not as important an input provider to other sectors as is the services sector.

Table 2.1 **Linkages between sectors**

1996-97[a]

		These sectors provide inputs . . .							
		Agric-ulture	Mining	Manuf-acturing	Services	Total interme-diate	Value-added	Imports	Total
		%	%	%	%	%	%	%	%
… to the output of these sectors	Agriculture	11.9	0.1	**12.8**	18.3	43.2	48.9	4.8	100.0
	Mining	0.0	9.2	**9.7**	20.3	39.2	54.3	4.8	100.0
	Manufacturing	**6.4**	**4.5**	**23.1**	**20.8**	**54.8**	**29.7**	**13.4**	**100.0**
	Services	0.3	0.6	**8.3**	29.5	38.6	53.9	3.6	100.0

[a] Based on direct allocation of competing imports. This means that all flows recorded in the first four columns of figures refer only to the use of domestic inputs and do not reflect the technological input structure of the sectors. The individual items do not add to 100 because the input-output column on indirect taxes is not shown.

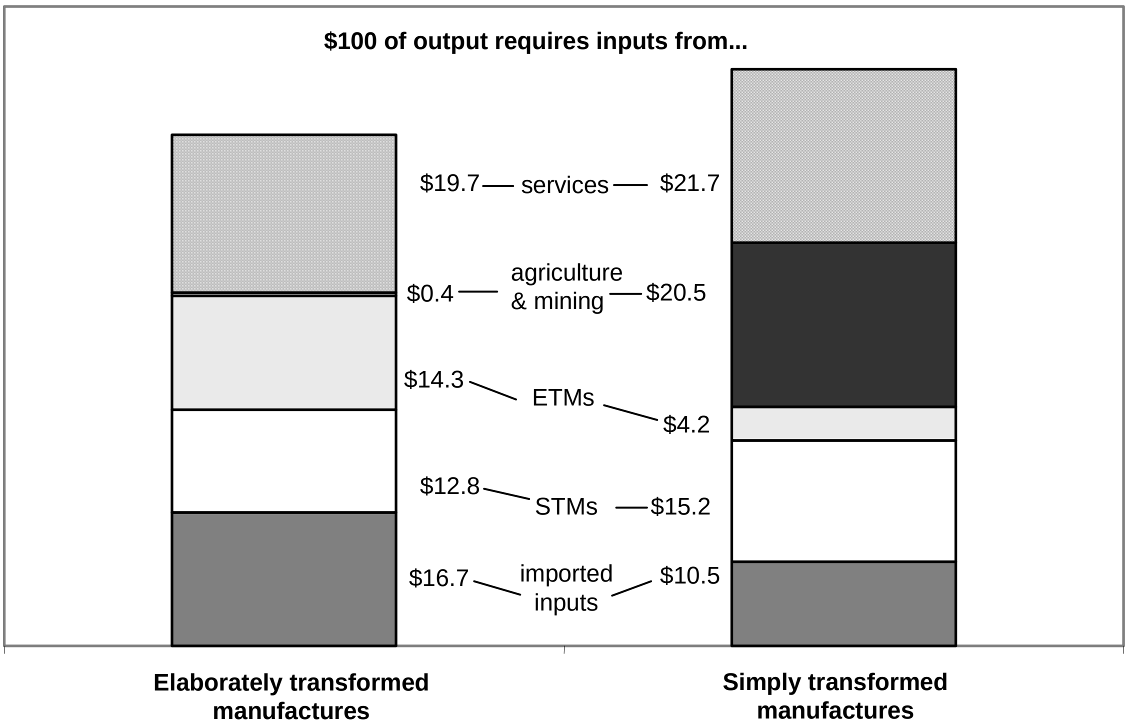
Source: ABS (*Australian National Accounts: Input-output Tables (Product Details) 1996-97,* Cat. No. 5215.0).

Table 2.1 disguises significant variations in intermediate input use between different manufacturing industries. At a more detailed level, there are marked differences between the input linkages of resource-processing manufacturing industries and industries that engage in greater transformation of products. The former show a strong dependence on inputs from agriculture and mining. This is most clearly exemplified by the meat and dairy industry, in which the bulk of inputs are provided by agriculture, with few inputs from other manufacturing (table L.1 in appendix L). The petroleum and coal products industry is a similar example, with a high dependence on mining.

Many other resource processing industries — such as other food, beverages and tobacco, textiles and leather, non-metallic minerals and basic metals — have strong links to the agricultural or mining sectors, but also strong linkages to other manufacturing industries.

In contrast to resource processing industries, more transformed manufactures have relatively weak linkages to the primary sectors and much stronger linkages with other manufacturing (particularly other elaborately transformed manufactures — ETMs) and with imported inputs (figure 2.3). For example, output of $100 of ETMs require only about 40 cents of inputs from agriculture and mining, compared with over $20 for simply transformed manufactures (STMs).

Figure 2.3 **Input and output linkages for ETMs and STMs**
1996-97



Data source: Table L.2 in appendix L2.

The importance of imported inputs is particularly apparent for some ETMs. Imported inputs account for more than $20 of every $100 of output for machinery and equipment, motor vehicles and clothing and footwear (table L.1 in appendix L). These linkages suggest that exchange rate changes are likely to have less marked impacts on the international competitiveness of ETMs than STMs, since price effects for final outputs are more significantly mitigated by input price changes.

The significant variations in the nature of the linkages between manufacturing industries and other sectors apparent in table 2.1, figure 2.3 and appendix L underscore the diversity that characterises manufacturing.

More broadly, these industry and sectoral linkages emphasise the fact that an economy is a system of complex productive relationships, in which output in any part is dependent on other parts. This has several implications:

- while some commentators consider the presence of significant imports of manufactured goods to be a sign of weakness in Australia's manufacturing capability, they are an essential input to domestic manufacturing output, especially for more sophisticated products;
- the size of a sector is a misleading indicator of importance since it ignores the role every sector plays in overall output in an economy. Thus, the fact that manufacturing is smaller than the services sector does not mean it is unimportant. (Similarly, the greater size of manufacturing relative to other goods sectors does not imply any pre-eminence on the part of manufacturing in goods production.)
- a corollary of the above point is that a reduction in the size of manufacturing may sometimes entail an increase in the competitiveness of manufacturing. For example, if efficiency improvements in the services sector substituted for services currently provided within manufacturing, this would depress the share of manufacturing in the economy. But it would also improve the overall competitiveness of manufacturing and be a source of a benefit, rather than a concern; and
- more generally, efficiency improvements in one sector can have benefits in others. For example, the important role played by infrastructure services — gas, electricity, water and telecommunications — in all other industries, including manufacturing, has reinforced the policy imperative for competition and other microeconomic reforms of infrastructure services. The understanding of connections between industries has also meant that 'industry policy' has, to some extent, shifted from support mechanisms aimed directly at stimulating particular sectors to measures that improve the efficiency of widely used inputs

and reduce ‘frictions’ in the economy that frustrate better linkages (such as transport and regulatory impediments).

Overall, this brief snapshot confirms that manufacturing accounts for a significant component of economic activity and that it has strong links to other Australian sectors and the global economy.

3 The changing role of Australian manufacturing

Key points

- Growth in real manufacturing output has increased substantially over the last half century, increasing fourfold from 1954-55 to 2001-02.
- But other parts of the economy have grown faster; so that the share of manufacturing in real and nominal GDP has fallen steeply. In real terms, it was just below one-quarter in the early 1960s, but only around one-eighth by the early 21st century.
- While its contribution to economic growth has waned over the long run, the contribution of manufacturing to real GDP growth has accelerated after a stagnant period in the early 1980s.
- Across countries, there is no relationship between income per capita and the manufacturing contribution to growth, dispelling the notion that a large manufacturing sector is required for economic prosperity.
- The relative decline of manufacturing in GDP is not unique to Australia, but a common feature of developed economies.
- The employment share of manufacturing has declined by an even greater amount than its output share, reflecting higher relative labour productivity growth in manufacturing and strong job creation in the services sector.
- In contrast, the share of economy-wide capital accounted for by manufacturing has declined by less than output or employment. Manufacturing remains one of the most intensive users of IT capital and is highly R&D intensive.
- The relative decline in manufacturing has principally been induced by improved labour productivity and, accompanying rising incomes, by greater consumer preferences for services.
- These are both features of an efficient, high-income economy.
  - In that sense, the diminishing share of manufacturing is largely a positive factor of our economy and not a sign of systemic weakness.
- Greater trade openness and more outsourcing by manufacturers of services are less important contributors to the relative decline of manufacturing.
- Impacts of the decline on unemployment and inequality have been modest, though looming larger for some vulnerable industries and regions.

Worldwide, the rapid growth of employment and output in the service sector in the last fifty years has eclipsed that in manufacturing. As noted by one commentator:

> The term ‘industrialised countries’ no longer carries any resonance: now, no advanced and growing country is dependent on production industries (Quah 1997, p. 55).

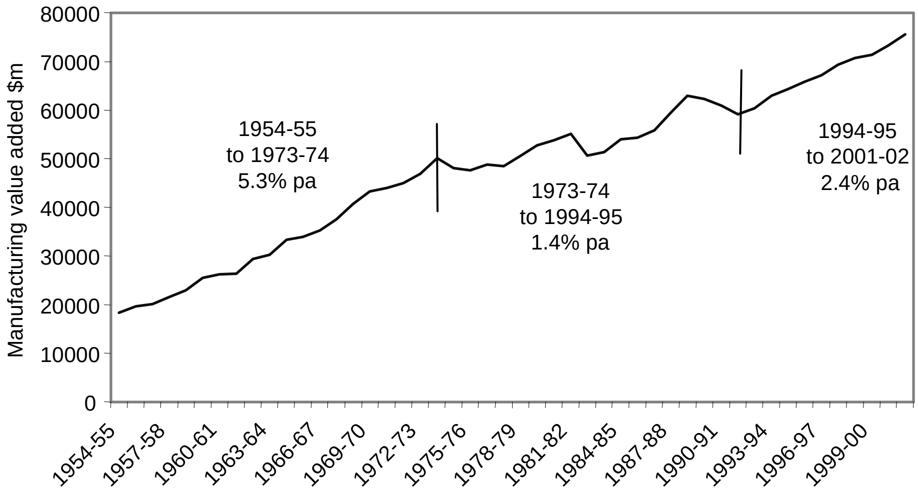
Quah coined the term ‘weightless’ economies as a description of the tendency for advanced countries to place greater emphasis on production of intangibles as they develop economically. A question arises as to how these structural changes have been manifested in Australia, especially given that some features of Australia’s economic performance have been distinctive, particularly its strong productivity performance and vibrant economic growth rates over the past decade. This chapter explores how the role of manufacturing in the Australian economy has changed over time.

3.1 Output growth in manufacturing and other sectors

Contrary to popular belief, output of the Australian manufacturing sector has grown considerably since the second world war. During the half century from 1954-55 to 2001-02, manufacturing output measured in constant prices increased more than four fold (a trend growth rate of 2.6 per cent per annum) (figure 3.1).

Figure 3.1 **Growth trends in manufacturing**

Value added 1954-55 to 2001-02, constant 2000-01 prices $m[a]



[a] Growth rates are trend annual growth rates, calculated by regressing log value added against a constant and a time trend.

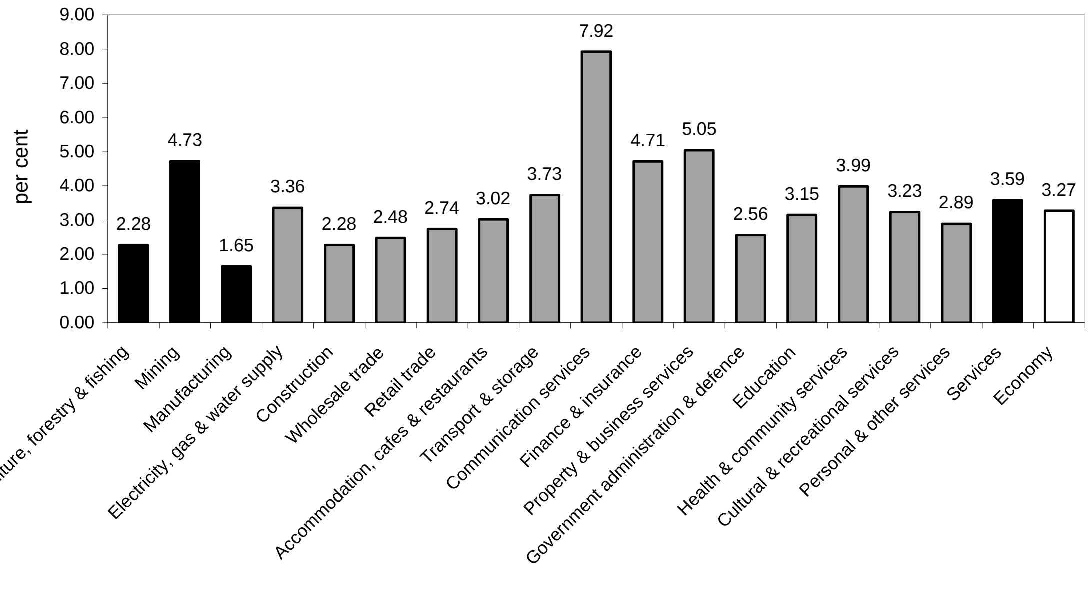
Data sources: Data for 1974-75 to 2001-02 are from the ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0), while data for the previous periods are spliced from manufacturing value added data from Foster and Stewart (1991) and BIE (1985).

Three distinct phases of growth can be identified over this period:

- very strong growth until the early 1970s;
- a stagnant period following the 1973 oil shock and the onset of high inflation, with frequent downturns, from the 1970s to the start of the 1990s; and
- a stronger and less volatile growth path from the early 1990s (after the recession) to the latest data year, 2001-02.

However, while manufacturing has continued to grow in absolute terms, other sectors have grown faster. Indeed, manufacturing had the slowest trend growth rate from 1974-75 to 2001-02 among 17 broad industry divisions (figure 3.2). And, while its output growth rate increased in the 1990s, its relative performance did not. Its output growth rate from 1991-92 to 2001-02 ranked fourteenth among the 17 industry divisions.

Figure 3.2 **Relative growth rates among Australian industries**
1974-75 to 2001-02[a]



[a] Annual trend rates of growth over the period were estimated by regressing log real value added against a constant and a time trend. Gross product was measured in constant 2000-01 prices.

Data source: ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0).

As a consequence, the share of manufacturing in GDP has declined significantly over the last four decades (table 3.1 and figure 3.3). From comprising roughly one-quarter of economic activity in the early 1960s, it fell to around one-eighth of activity by the early twenty-first century. This is roughly on a par with its contribution in 1901 — and testimony to the extraordinary structural change in the Australian economy over the last century (figure 3.4). At the current rate of decline, manufacturing would account for only around one-tenth of GDP some time between 2010-11 and 2015-16.[1]

Table 3.1 **Trends in the sectoral composition of GDP**

Current prices, 1962-63 to 2001-02

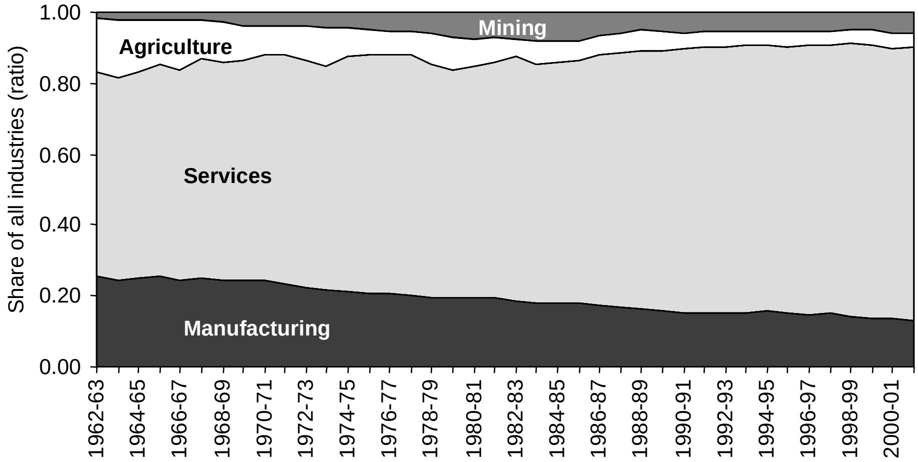
Year	*Agriculture*	*Mining*	*Manufacturing*	*Services*
	%	%	%	%
1962-63	15.2	1.9	25.5	57.4
1966-67	14.0	2.3	24.4	59.3
1971-72	8.1	4.0	23.4	64.4
1976-77	6.9	5.3	20.5	67.3
1981-82	6.9	7.2	19.5	66.5
1986-87	5.4	6.3	17.2	71.1
1991-92	3.9	5.7	15.0	75.5
1996-97	4.0	5.3	14.9	75.8
2001-02	4.2	5.8	13.0	77.0
1962-63 to 2001-02	-11.0	3.9	-12.5	19.6

a Services exclude gross operating surplus from dwellings. Shares are calculated using the aggregate of all industries, ignoring GOS from dwellings, taxes less subsidies and the statistical discrepancy.

Sources: ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0) and Reserve Bank of Australia, Australian Economic Statistics from Econdata, with older data spliced onto newer data to give a consistent series.

Figure 3.3 **Changes in the composition of the Australian economy**

1962-63 to 2001-02 (current prices)

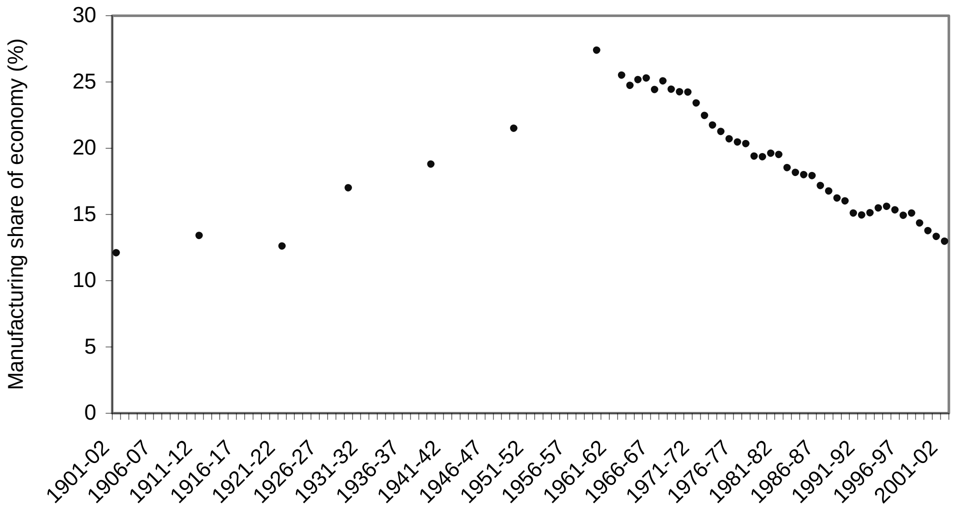


Data source: Table 3.1.

1 A range of simple models based on the manufacturing share were estimated (such as linear trends, exponential trends and logistic functions). The linear model — which presupposes that the percentage point decline is constant over time — is clearly not tenable over the very long run, but it fits the existing data well. It suggests that manufacturing will account for 10 per cent of GDP by 2010-11.

Figure 3.4 **The long-term contribution of Australian manufacturing to economic activity[a]**

1901-02 to 2001-02 (current prices)



[a] It should be emphasised that changes in definitions of sectors, collection accuracy and methods mean that the data are an indicator of the contribution of manufacturing, rather than an exact measure. Economic activity is measured as the sum of industries (other than GOS of dwellings) for 1962-63 to 2001-02. The shares for previous years are from Clark et al (1996) and are based on several measures of GDP.

Data sources: Clark et al. (1996) and table 3.1.

The contribution to growth

A corollary of the small (and declining) share of activity represented by manufacturing is that its contribution to Australia's economic growth has also been declining over the last forty years (box 3.1 and figure 3.5):

- Manufacturing accounted for around one-fifth of the average growth in the economy in the 1960s, or roughly in line with its sectoral share of aggregate output.
- But, by the close of the twentieth century, manufacturing accounted for only about one-fourteenth of economic growth, less than mining and not much in excess of agriculture.
- In contrast, the service sector is now by far the most important contributor to economic growth (accounting for 80 per cent of the growth).

Box 3.1 **The contribution of growth**

A simple growth accounting framework can be used to estimate the economic contributions of different sectors (Quah 1997).

At any time, total economic activity (y) is the sum of sectoral contributions (y_j):

$$y_t = \sum_j y_{j,t}$$

The proportional change in economic activity, g, is:

$$\frac{\Delta y_t}{y_{t-1}} = g_t = \sum_j \frac{\Delta y_{j,t}}{y_{j,t-1}} \times \frac{y_{j,t-1}}{y_{t-1}} = \sum_j g_{j,t}.s_{j,t-1} = \sum_j \gamma_{j,t}$$

where g_i is the proportional growth rate in sector j, s_i is its share of the economy and their multiple, γ_i, is the percentage points contribution of sector j to the economy. The values of g and γ is shown for various sub-periods below (with $\Sigma\gamma$=g).

Components of Australian GDP growth

Percentage points contribution to nominal growth

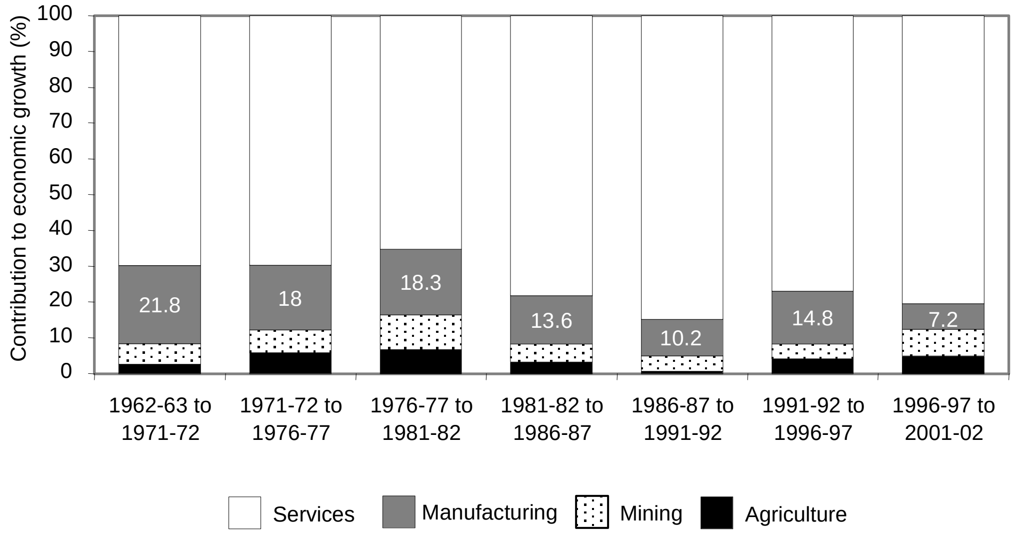
Time period	g[a]	γ			
	Total	Agriculture	Mining	Manufacturing	Services
	%	Average percentage points per year			
1962-63 to 1971-72	14.3	0.4	0.8	3.1	10.0
1971-72 to 1976-77	24.0	1.4	1.5	4.3	16.8
1976-77 to 1981-82	15.5	1.1	1.5	2.8	10.1
1981-82 to 1986-87	13.0	0.4	0.6	1.8	10.2
1986-87 to 1991-92	9.2	0.1	0.4	0.9	7.8
1991-92 to 1996-97	6.0	0.3	0.2	0.9	4.6
1996-97 to 2001-02	6.8	0.3	0.5	0.5	5.5

These findings relate to nominal economic growth rates, which are a combination of price and real output effects. These effects can be separated.

Relative prices of different sectors have changed significantly over time (figure 3.6), especially for agriculture and mining. These variations have large effects on sectoral incomes, particularly over the shorter-term:

- manufacturing has shown a slight negative trend in its prices relative to the economy as a whole; while
- in contrast, the service sector has shown an increasing trend relative to the economy as a whole.

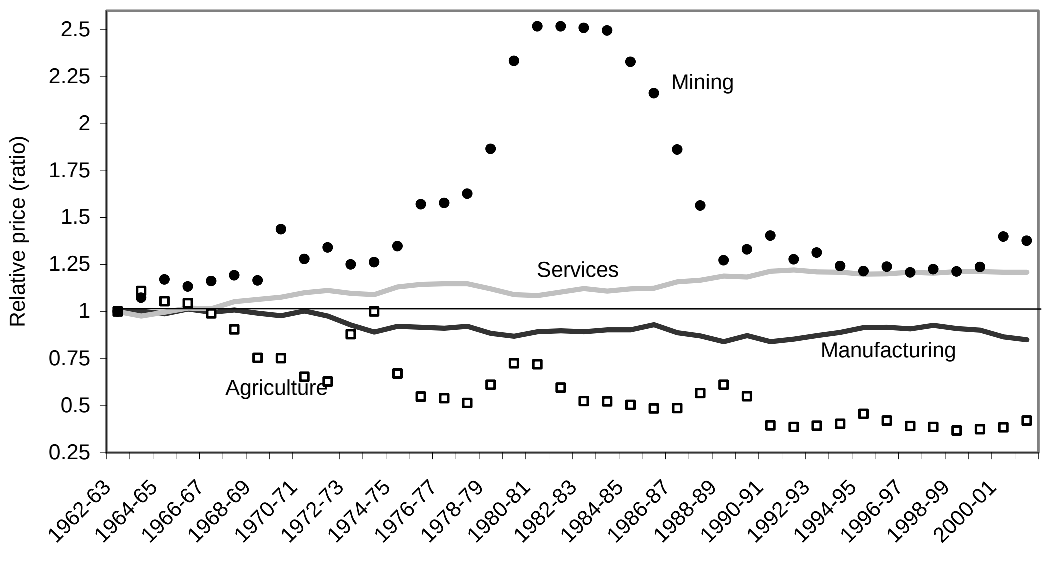
Figure 3.5 **The sectoral contributions to nominal economic growth**



a The shares are calculated as γ_j/g from the data shown in box 3.1.

Data source: As in table 3.1.

Figure 3.6 **Relative prices by sector**



a The figure shows the ratio of prices for each sector to the all industries price index. Prices were derived by dividing nominal output by real output. Prices are equal to one in 1962-63.

Data sources: Nominal data were obtained from the same sources as in table 3.1. Real data were obtained from the ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0) and Foster and Stewart (1991), with older data spliced onto newer data to give a consistent series.

This may be ascribed to higher productivity growth and greater trade exposure in manufacturing, which has lowered prices of manufactured goods relative to the mainly non-tradeable services sector.

Relative price changes have accentuated the decline in manufacturing and the rise of services. For instance, if only the *real* economy is considered:

- the manufacturing sector's share of the economy falls by 8.9 percentage points from 1962-63 to 2001-02 (compared with a fall of 12.5 percentage points when price effects are also taken into account) (table 3.2). The implication is that around 30 per cent of the long-run reduction in the nominal output share of manufacturing is due to changing relative prices;[2] and
- the service sector's share of the economy rises by 7.5 percentage points over the same period (relative to the nearly 20 percentage point increase in current price terms).

Table 3.2 **Sectoral composition of GDP**

1962-63 to 2001-02, constant 2000-01 prices[a]

Year	*Agriculture*	*Mining*	*Manufacturing*	*Services*
	%	%	%	%
1962-63	5.8	2.6	22.1	69.5
1966-67	5.4	2.7	21.2	70.6
1971-72	5.0	4.2	20.7	70.1
1976-77	4.9	4.7	19.4	71.0
1981-82	4.4	4.0	18.8	72.8
1986-87	4.3	4.7	16.7	74.3
1991-92	3.9	6.2	15.2	74.8
1996-97	3.9	6.1	14.2	75.7
2001-02	3.9	5.9	13.2	77.0
1962-63 to 2001-02	-1.9	3.3	-8.9	7.5

a Services exclude GOS from dwellings. Shares are calculated using the aggregate of all industries, ignoring GOS from dwellings, taxes less subsidies and the statistical discrepancy.

Sources: ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0) and Reserve Bank of Australia, Australian Economic Statistics from Econdata, with older data spliced onto newer data to give a consistent series.

Given this, the sectoral contribution to economic growth also shows some different patterns when constant price data are considered. Table 3.3 is the mirror of

2 The paradox that the service sector continues to grow strongly in real terms despite higher relative prices (Baumol 2001) *may* be traced to high income demand elasticities for services and complementarities between human capital formation and consumption of some services (Pugno 2002).

figure 3.5, but is based on real output only. It reveals the same ascendancy of the service sector, but shows a different pattern for manufacturing. While manufacturing's contribution to real economic growth over the long run has still declined significantly, its decline is less than when estimated using current price data.

Table 3.3 **The sectoral contributions to real economic growth**

Time period	*Agriculture*	*Mining*	*Manufacturing*	*Services*
	%	%	%	%
1962-63 to 1971-72	3.6	6.7	18.6	71.0
1971-72 to 1976-77	4.3	7.9	11.0	76.7
1976-77 to 1981-82	1.6	-0.4	15.2	83.6
1981-82 to 1986-87	3.1	10.2	1.7	85.0
1986-87 to 1991-92	1.5	14.9	5.8	77.8
1991-92 to 1996-97	4.1	5.8	9.8	80.4
1996-97 to 2001-02	3.6	5.0	8.4	83.0

Source: As in table 3.1.

In fact, using constant price data, the contribution of manufacturing to economic growth over the past twenty years has generally increased. While its contribution was close to zero in the early 1980s — a stagnant period for the sector — it had risen closer to its output share by the 21st century, reflecting more balanced growth in the real economy.[3]

Comparisons with other countries

The growing role of services and the weakening role of the goods-producing part of economies is ubiquitous among developed economies.[4] Among the 17 richest countries[5] for which data were available, only Singapore experienced an increase in the share of manufacturing in (nominal) GDP over the two decades from 1978 (figure 3.7 and table 3.4).

There was a strong inverse relationship between the decline of manufacturing and the growth of the service sector in these economies. More specifically, every one percentage point increase in the services sector was associated with a one

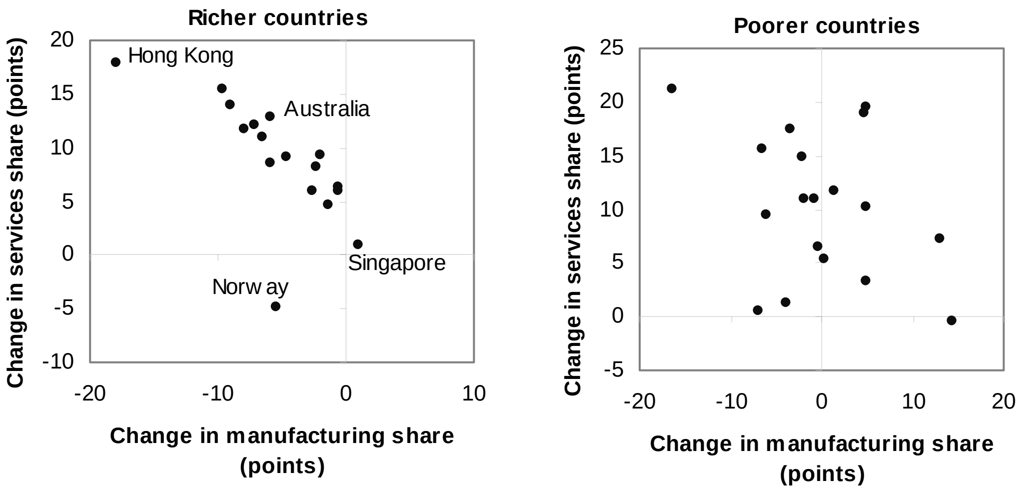
3 In the 'steady state', with balanced growth rates, the contributions of sectors to economic growth should be equal to their sectoral shares in output (Quah 1997, p. 51).

4 The data on which this comparative analysis is based includes construction and the electricity, gas and water sectors as parts of the goods producing sector, though they are included as services in the previous section.

5 Those with purchasing power parity income above $19 000 in international currency.

percentage point decline in manufacturing.[6] This general pattern reflects the fact that the remaining sectors of these economies (other than Norway) have experienced roughly balanced long run growth (so that their sectoral shares have not changed by much).

Figure 3.7 **Changes in service and manufacturing shares**[a]
1978-2000[b]



[a] Based on current price data. The service sector is defined using the World Bank approach. This definition excludes electricity, gas and water and construction, but includes gross operating surplus from dwellings and the statistical discrepancy. This is why the results for Australia differ from those in table 3.1. [b] Except that data for France, Japan, Netherlands, Sweden and the US are from 1978-1998, for Austria are from 1978 to 1999 and for Spain from 1980 to 1999.

Data sources: Data for the countries listed in note b above are from the OECD STAN database, Australia's data are from the ABS (*Australian System of National Accounts,* Cat. No. 5204.0), reconfigured to match the World Bank definition of services, while the remaining data are from the World Bank World Tables (Econdata 2003) The purchasing power parity income data used in the regressions are from the World Bank World Development Indicators database (http://www.worldbank.org/data/quickreference/quickref.html).

6 For rich countries, the change in manufacturing (ΔM) was found to follow the following relationship:

$$\Delta M = 4.3 - 0.99\, \Delta S; \quad R^2 = 0.84, N = 16$$

(3.5) (8.5)

where figures in parentheses are heteroscedasticity-corrected t statistics and ΔS is the change in services share. This excludes Norway, where growth of the mining sector associated with North sea oil drove the service sector share down, without as big an effect on manufacturing. For poorer countries, a more complex relationship was apparent:

$$\Delta M = -11.17 - 0.38\, \Delta S - 0.64\, M1978 + 0.00058\, PPP\_Income\_2001 + 2.15 \log(Population\_2001)$$

(1.0) (2.2) (6.0) (2.6) (2.0)

where M1978 is the manufacturing share of GDP in 1978. R^2=0.58, N=18.

In 8 of 18 poorer countries[7], manufacturing has actually risen in importance — often at the expense of agriculture and other sectors.[8] Reflecting the different phase of their development in these countries, there is a much weaker link between the rise of the service sector and changes in the manufacturing share of GDP (figure 3.7).

Table 3.4 **Changes in the current price share of manufacturing over 20 years**

Percentage of GDP – selected countries[a]

Richer countries	*Manufacturing share of GDP*			*Poorer countries*	*Manufacturing share of GDP*		
	1978	2000	Change		1978	2000	Change
	%	%	points		%	%	points
Hong Kong	23.7	5.7	-18.0	Argentina	34.1	17.6	-16.5
Italy	31.1	21.5	-9.6	Chile	22.9	15.9	-7.0
United Kingdom	27.0	18.0	-9.1	Brazil	30.7	24.0	-6.7
France	26.5	18.5	-8.0	China	40.7	34.5	-6.2
Spain	25.5	18.3	-7.2	Zimbabwe	19.8	15.8	-4.0
United States	23.1	16.5	-6.6	Philippines	26.0	22.6	-3.4
Japan	28.6	22.6	-6.0	South Africa	20.9	18.8	-2.1
Australia	**18.0**	**12.0**	**-5.9**	Mexico	22.6	20.7	-1.9
Norway	18.2	12.8	-5.5	India	16.6	15.8	-0.8
Austria	24.8	20.1	-4.7	Venezuela	14.9	14.4	-0.5
New Zealand	22.3	19.7	-2.6	Pakistan	15.0	15.1	0.1
Netherlands	19.3	17.0	-2.3	Turkey	13.7	15.0	1.3
Finland	26.9	24.9	-2.0	Saudi Arabia	5.1	9.8	4.7
Denmark	18.8	17.3	-1.5	Egypt	14.6	19.4	4.7
Canada	19.9	19.3	-0.6	South Korea	26.6	31.5	4.8
Sweden	22.1	21.5	-0.6	Bangladesh	9.9	14.7	4.8
Singapore	25.6	26.5	0.9	Malaysia	19.8	32.8	12.9
				Indonesia	11.7	26.0	14.3

[a] Data for France, Japan, Netherlands, Sweden and the US are from 1978-1998, for Austria are from 1978 to 1999 and for Spain from 1980 to 1999.

Source: See details in figure 3.7.

Although, in nominal terms, the changing shares of manufacturing and services in Australia is typical of other rich countries, the severity of the decline in the real share of manufacturing in the economy is unusual. For example, over the period from 1960 to 1994, the share of manufacturing in GDP for industrial countries as a group fell by around 8 percentage points in nominal terms, but *rose* by around

[7] Poorer countries were defined as those with less than 19 000 international dollars per capita (in purchasing power parity) terms for 2001.

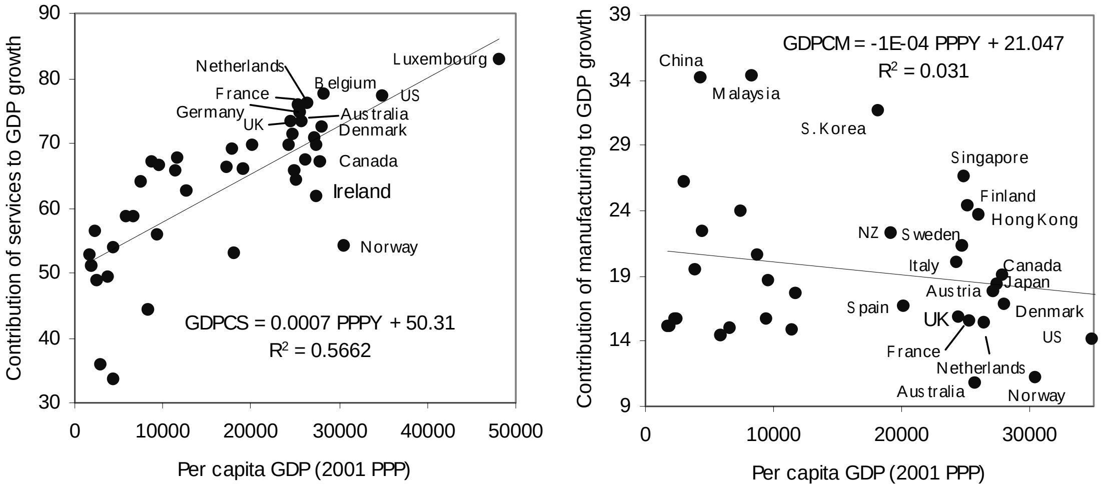
[8] In these countries, sectors outside manufacturing and services often remain very important, accounting for double the average share in 2000 of that in rich countries.

1 percentage point in real terms (Rowthorn and Ramaswamy 1997, pp. 8-10). In Australia, the manufacturing share fell significantly in both nominal and real terms.

Australia is also typical of other high income countries in that most economic growth is accounted for by growth in the services sector, rather than manufacturing.[9] Generally, the richer the country, the more that the service sector dominates economic growth (figure 3.8) — confirming the pattern found by Quah (1997) using earlier data.

Figure 3.8 **Links between per capita income and sectoral contributions to GDP growth**

1975-76 to 2000-01



a Data for manufacturing are available for fewer countries than for services, reflecting data inadequacies. The trend lines show the connection between purchasing power parity per capita gross national income in international dollars (PPPY) and the contribution of services (GDPCS) and manufacturing (GDPCM) to nominal GDP growth.

Data source: See figure 3.7.

For manufacturing, however, there appears to be no relationship between income per capita and the manufacturing contribution to growth. There are several rich countries (Sweden, Finland, Singapore) where manufacturing has remained a more significant source of economic growth. On the other hand, Australia is one of several high income countries (UK, France, Norway, Netherlands and the US) that have experienced small contributions by manufacturing to economic growth over the last few decades. This pattern dispels the notion that a large manufacturing sector is required for economic prosperity.

9 With an average contribution of 70 per cent among rich countries in the sample described in figure 3.7.

3.2 What has happened to employment and capital in manufacturing and other sectors?

Employment

The most evident symptom of so-called 'deindustrialisation' is the waning importance of manufacturing as an employer. It is often this feature of structural change that commentators emphasise, sometimes with the perspective that deindustrialisation is an adverse phenomenon closely linked to rising unemployment in the economy as a whole.

It is certainly the case that the share of total employment accounted for by manufacturing in Australia has fallen markedly over the last forty years — from over one-quarter of employment in 1966-67[10] to around 12 per cent in 2001-02 (table 3.5). Similar trends have been noted by Rowthorn and Ramaswamy (1997) for the European Union, the United States and industrial countries generally — with the timing of the decline apparent from around 1970. For example, the share of manufacturing employment in the US fell from a high of around 27 per cent in 1967 to around 16 per cent in 1994 — close to the experience of Australia.

Table 3.5 **Sectoral employment trends, Australia**
1966-67 to 2001-02

	Employment				*Employment share*			
	Agriculture	Mining	Manuf.	Services	Agriculture	Mining	Manuf.	Services
	'000	'000	'000	'000	%	%	%	%
1966-67	443.2	59.8	1270.9	3198.3	8.9	1.2	25.6	64.3
1971-72	424.7	91.7	1406.9	3762.1	7.5	1.6	24.7	66.2
1976-77	396.8	82.5	1321.4	4278.5	6.5	1.4	21.7	70.4
1981-82	427.0	101.6	1268.7	4765.7	6.5	1.5	19.3	72.6
1986-87	422.4	101.1	1125.8	5380.9	6.0	1.4	16.0	76.5
1991-92	408.9	89.7	1087.9	6057.9	5.3	1.2	14.2	79.2
1996-97	422.9	86.2	1131.8	6736.1	5.0	1.0	13.5	80.4
2001-02	438.3	80.9	1098.2	7589.9	4.8	0.9	11.9	82.4
Change 1966-67 to 2001-02	-4.9	21.1	-172.7	4391.6	-4.2	-0.3	-13.6	18.1

Sources: Employment data from 1985-86 are averaged quarterly data from ABS (*Labour Force Australia,* Cat. No. 6203.0). Past data were spliced from Foster and Stewart (1991).

10 Reflecting the war time manufacturing boom, it temporarily stood at even a higher proportion during the Second World War, with manufacturing accounting for 33 per cent of all employed persons by the mid-1940s (ABS, *2001 Year Book Australia*, Cat. 1301.0, p. 244).

However, in Australia (and most other industrial countries), this reduction in importance stems primarily from the fact that most new jobs have been created in the services sector, rather than as a symptom of massive net labour shedding in manufacturing. Overall, under 200 000 of net employment in Australia has been lost from manufacturing in this period, at a time when overall employment in the economy has increased by 4.2 million people. To put this in perspective, had all sectors of the economy, apart from manufacturing, recorded zero employment growth from 1966-67, then the share of manufacturing employment in 2001-02 would have been 23 per cent, compared with 26 per cent in 1966-67. Accordingly, all but a few percentage points of the declining manufacturing share of aggregate employment is associated with employment *growth* in services, rather than an absolute decline in manufacturing per se.

Another aspect of employment change in manufacturing is its link to productivity growth. The number of employees required to produce a given amount of value added has declined greatly over the last forty years. For example, in 2001-02, about 1.1 million employees (15 per cent fewer than in 1966-67) produced double the real output of 1966-67. Of course, the relevant issue for intersectoral employment shifts is productivity growth differences between sectors. Manufacturing labour productivity[11] grew at a trend rate of 2.5 per cent per annum from 1966-67 to 2001-02, compared with 1.2 per cent per annum for the services sector. This suggests that intersectoral productivity differences are likely to be a significant factor behind the declining employment share of manufacturing.[12]

As an illustration of the importance of this factor, the employment share of manufacturing was estimated under the assumption that manufacturing recorded the same output growth as measured, but only managed to achieve labour productivity growth equal to that of the services sector. It was assumed that overall employment in the economy stayed the same (since there is no long run relationship between productivity growth and unemployment — Layard, Nickell and Jackman 1991, p. 5).

Under this experiment, the employment share of manufacturing falls from 25.6 per cent in 1966-67 to 18.7 per cent, or a drop of 6.9 percentage points. This is much less than the actual drop in the manufacturing employment share of

[11] This refers to the most basic labour productivity measure — value added in constant price terms divided by employment. The measure is not adjusted for changes in hours worked or skill intensity.

[12] Measuring productivity gains in services is difficult. For the non-market segments of the sector, output is measured by labour inputs, necessarily leading to zero measured labour productivity growth. However, measurement error in services is unlikely to explain away the productivity differential between services and manufacturing (Griliches 1992).

13.6 percentage points, and is indicative of the significant role productivity growth differences have played in changing employment shares.[13] In similar experiments for developed economies generally, Rowthorn and Ramaswamy (1997) found that relative productivity growth was the most significant explanator for reduced employment shares — accounting for around two-thirds of the drop in manufacturing employment shares. The other third was accounted for by the higher growth rates in output in services relative to manufacturing.

Falling employment shares do not necessarily equate with falling absolute employment numbers. While both absolute and relative employment fell between 1966-67 and 1991-92, since then, manufacturing employment has risen (by around 10 000 people), despite continuing falling employment shares.

These sectoral shifts in employment are not a unique or adverse phenomenon. The large sectoral shifts in employment is a repeat — on a somewhat smaller scale — of the relative decline of agriculture in the 20th century, accompanying its rapid productivity growth and the development of other sectors. In the case of agriculture, its share of total employment has fallen from 26 per cent in 1910-11 to under 5 per cent currently.[14]

Capital stocks and R&D

The manufacturing sector has also accounted for a decreasing share of Australia's net capital stock since the mid-1960s (table 3.6). Manufacturing accounted for under 7 per cent of the around $800 billion increase in Australia's net capital stock over the period from 1966-67 to 2001-02, while the services sector accounted for just under 80 per cent of the national increase.

The relative decline in importance of manufacturing capital is not as marked as with employment, with only a modest 5 percentage point decline in the sector's share of total capital stocks (compared with over 13 percentage points in the case of employment). This reflects strong growth in net capital stocks in manufacturing (stocks more than doubled over the relevant period) relative to its declining employment trends. Overall, the manufacturing capital/labour ratio increased by around 150 per cent from 1966-67 to 2001-02, while it increased by a more modest

[13] Of course, this experiment makes some bold underlying assumptions, such as that productivity growth and manufacturing output are independent. In fact, productivity gains could be expected to lower prices of domestic manufacturing relative to other goods and services, including imports — having a stimulating effect on output that would partly offset the employment effects of productivity gains. Nevertheless, the experiment provides an indication of the magnitude of sectoral employment effects associated with productivity gains.

[14] ABS, *2001 Year Book Australia*, p. 244 (Cat. No. 1301.0).

51 per cent in services. The greater degree of capital deepening in manufacturing than services may provide a partial explanation for the stronger growth in labour productivity in manufacturing compared with services and, consequently, the size of the shift in employment shares apparent over the relevant period.

Table 3.6 **Sectoral net capital stock trends**

1966-67 to 2001-02

Year	*Net capital stock*				*Share of total capital stock*			
	Agriculture	Mining	Manuf.	Services	Agriculture	Mining	Manuf.	Services
	$m	$m	$m	$m	%	%	%	%
1966-67	41 355	11 845	45 133	243 663	12.1	3.5	13.2	71.2
1971-72	43 960	34 339	57 026	327 695	9.5	7.4	12.3	70.8
1976-77	46 855	39 874	60 419	415 704	8.3	7.1	10.7	73.9
1981-82	53 814	55 191	68 491	501 855	7.9	8.1	10.1	73.9
1986-87	56 880	71 178	73 581	598 503	7.1	8.9	9.2	74.8
1991-92	54 982	84 125	81 114	695 204	6.0	9.2	8.9	75.9
1996-97	52 498	101 585	89 102	764 085	5.2	10.1	8.8	75.9
2001-02	53 376	123 594	98 119	873 328	4.6	10.8	8.5	76.0
Change 1966-67 to 2001-02	12 021	111 749	52 986	629 665	-7.4	7.3	-4.7	4.8

Source: ABS (*Australian System of National Accounts, 2001-02*, Cat. No. 5204.0).

At more disaggregated levels of capital, the relative decline in manufacturing is more pronounced for buildings and structures than other types of capital — suggestive that investment in manufacturing has been directed more at improving plant output and productivity than building new plants per se.

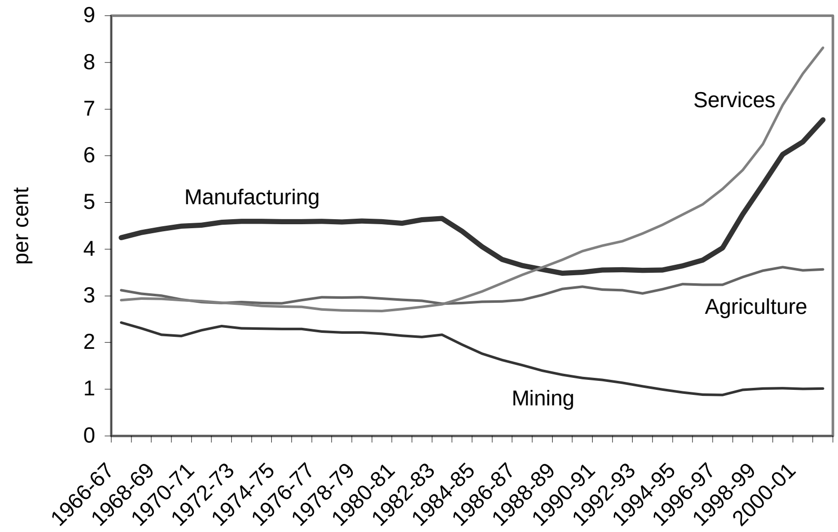
One of the key technological signatures of the last 30 years has been the growing importance of information technology (IT). Among the four general sectors examined here, manufacturing was the most intensive user of IT capital in its early days — the late 1960s — and remained so until the late 1980s when the services sector overtook it (figure 3.9). Currently, manufacturing and services are the most intensive users of IT — well above other sectors — especially following a rapid increase in IT intensities in these sectors from the mid-1990s.

Research and development

Growing R&D intensities reveal that technological knowledge accumulation has become increasingly important across all sectors of the Australian economy over the past 25 years (figure 3.10). Mining and manufacturing have exhibited the highest growth rates in R&D.

Figure 3.9 **The growth of information technology**

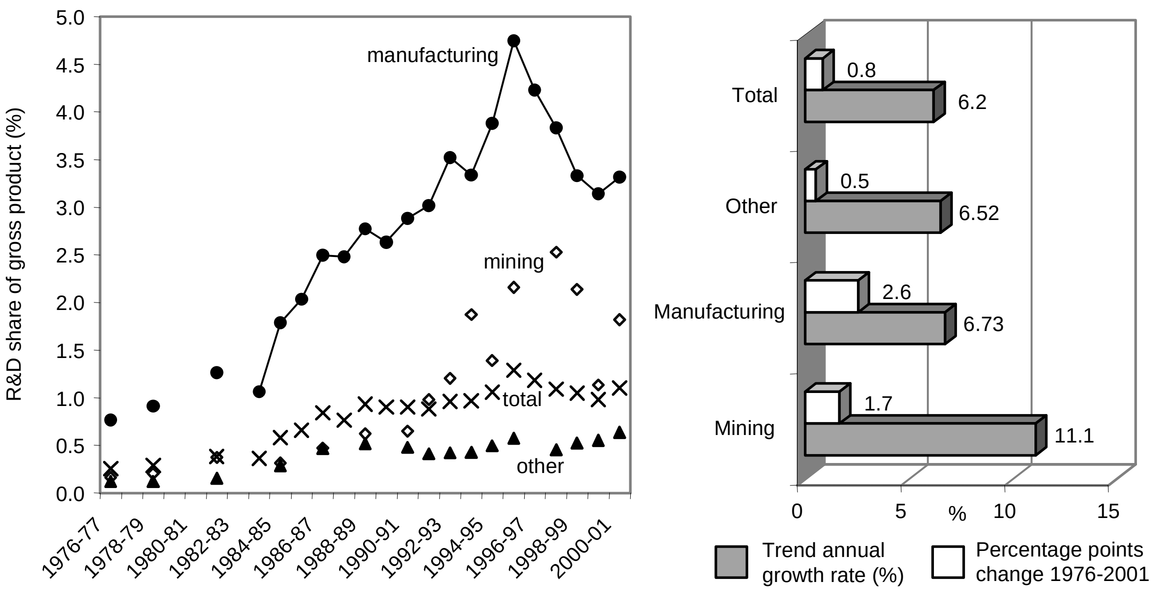
Share of IT in net capital stock, by sector, 1966-67 to 2001-02



Data source: ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0).

Figure 3.10 **R&D intensity**

1976-77 to 2000-01[a]

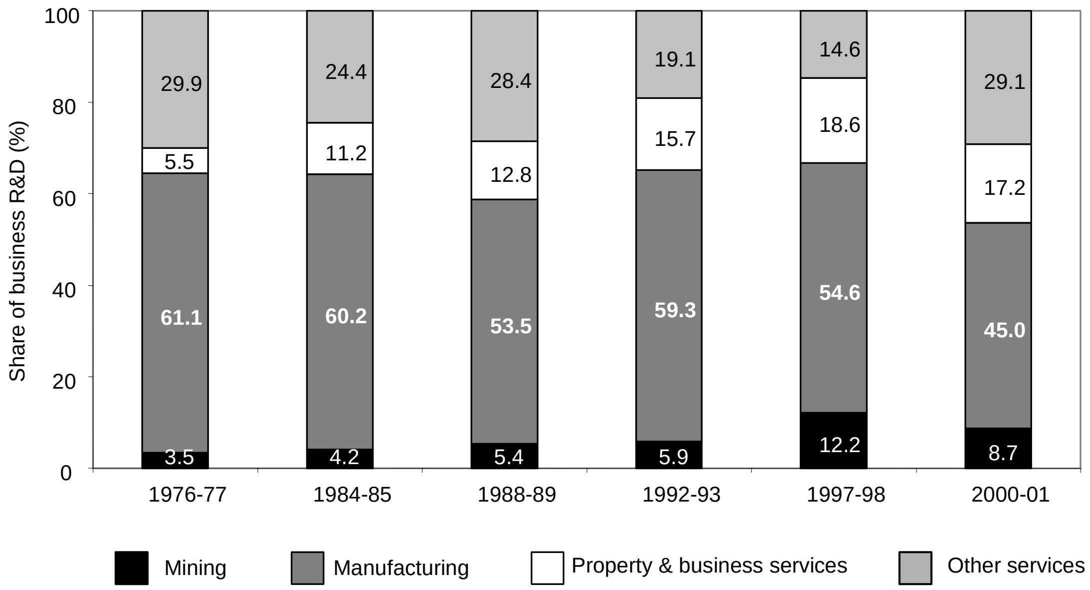


[a] Measured as R&D to gross product ratios. Data were not available for some years. Mining excludes services associated with mining. Other is all other non-farm sectors — and are mainly services. The total figure is based on total business R&D to total gross product in the economy excluding dwellings, taxes and the statistical discrepancy. The trend annual growth rate was estimated by regressing the logged value of the R&D intensities against a time trend.

Data sources: ABS, *Research and Experimental Development,* Cat. 8104.0 (various issues). Sources for current price gross product series are described in table 3.1.

However, the manufacturing share of total R&D declined over the long run, reflecting the growing importance of R&D in services, particularly property and business services (figure 3.11). This is especially marked since 1992-93 — and can be traced to the increasing significance of software and telecommunications technologies in services.

Figure 3.11 **Sectoral shares of business R&D**
1976-77 to 2000-01



[a] Other services are all other non-farm sectors, including utilities, construction and other services. Mining excludes services to mining.

Data source: As in figure 3.10.

3.3 The reasons for the relative decline of manufacturing

There are several hypotheses that seek to explain the *relative* decline of manufacturing output in Australia and other developed economies. The major ones are:

- income-related preferences;
- measurement error given the relocation of service activities;
- shifting trade patterns; and
- relative price changes when considering nominal output shares (discussed above).

The other aspect of 'deindustrialisation' — the fall in the employment share — is explained by a combination of these output effects and the different sectoral productivity growth rates.

Consumer demand and income-related preferences

One likely source of the relative decline in manufacturing and the ascendancy of services is the notion that, with rising incomes, people spend a greater share of income on services (implying an income elasticity of demand above unity). As discussed by McLachlan et al. (2002, pp. 25-27), the international evidence on income elasticities is mixed, although most Australian studies confirm that elasticities exceed one. More recent evidence from abroad also suggests that income effects have been a significant force for structural change in developed economies. Evidence on the long-term shifts in consumer expenditures in Australia reveals that goods demand has fallen significantly as a share of total consumer expenditure,[15] from around 50 per cent in 1959-60 to 34 per cent in 2001-02 (in constant 2000-01 price terms) (figure 3.12).[16] These data exclude goods and services provided by government, which tend to emphasise services and which have also grown over the period concerned (McLachlan et al. 2002, p. 28).

The broad pattern indicated by the household expenditure data suggests that shifting consumer preferences are likely to be the most important determinant of the relative decline of manufacturing output and the growing ascendancy of services.[17] This is not an adverse phenomenon — meeting people's preferences makes Australia better off. This underlines why the diminishing share of manufacturing in the economy is largely a positive for Australia, rather than a problem.

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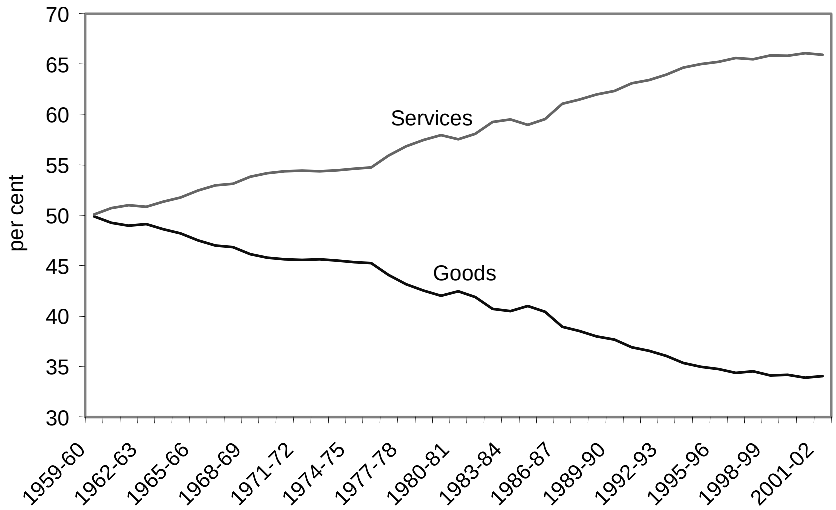
[15] This is not correct for all categories (for example, transport equipment shares of real expenditure had increased over the last forty years).

[16] The fall in shares in current price terms is greater — from 56 to 34 per cent.

[17] Unfortunately, it is not possible to directly relate changes in the shares of household expenditure accounted for by manufactured goods to changes in the share of manufacturing in real GDP. This is because household consumption includes imported goods (while production includes exports). It also reflects the fact that household expenditures are final goods, whereas, at the production level, sectors often provide inputs to other sectors.

Figure 3.12 **Share of consumer expenditure accounted for by goods and services**

2000-01 constant prices, 1959-60 to 2001-02[a]



a The definition of goods are food, alcohol and tobacco, clothing and footwear, furnishings and household equipment, purchase of vehicles, goods for recreation and culture, books, papers, stationary and artists' goods and personal effects. Constant price data for the last three categories are not available prior to 1985-86. The price index for these goods was imputed on the basis of movements in the aggregate price index for prior years, and a constant price series derived for the remaining years. Services are defined as residual consumption expenditure.

Data source: ABS (*Australian System of National Accounts, 2001-02,* Cat. No. 5204.0).

Statistical transfer of activities from manufacturing to services

The statistical allocation of outputs and employment into industries is based on the industry classification of the reporting unit.[18] Large manufacturing firms often undertake service activities (such as transport, warehousing, wholesale trade, accountancy, data processing, cleaning, maintenance and engineering design) that, under an alternative organisational structure, could be performed by outside contractors. Anecdotal and other evidence suggests that in the last two decades many large Australian manufacturing establishments have increased specialisation and have outsourced non-core activities to external contractors in order to improve efficiency (Revesz and Lattimore, 1997). Outsourcing often results in value-added and employment being reclassified from the manufacturing sector to services. The OECD (2000b) found that, in developed countries, manufacturers accounted for two-thirds of outsourcing.

[18] Typically either establishments (individual sites) or 'management units' (a line of business for which separate accounts are kept).

There is some statistical evidence to indicate that the outsourcing of service activities by manufacturers could also be significant in Australia:

- service inputs as a proportion of inputs into manufacturing increased by around 6 percentage points from 1980-81 to 1996-97 (table 3.7). 'Back-of-the-envelope' calculations suggest that if half of this change represented outsourcing, then the decline in the manufacturing value added share in the economy would have been 3.9 percentage points between 1980-81 and 1996-97, rather than the observed 4.7 percentage points. On that assumption, around 17 per cent of the decline in the manufacturing share over this period could be attributed to outsourcing; and
- the ratio of value-added to sales or turnover has generally declined over time. The ratio was 40.1 per cent in 1968-69 and 27.9 per cent in 2001-02.[19] Although several factors are at work, this may, in part, reflect a tendency for manufacturers to rely more on outside service suppliers.[20]

Accordingly, some of the observed decline in manufacturing may be illusory, reflecting changes in the boundaries of firms rather than real shifts in activities per se.[21]

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[19] The 1968-69 data are based on the value added to turnover ratio from the Industry Commission Manufacturing and Trade data series on Econdata (based on ABS manufacturing establishment data). The 2001-02 figure is value added to sales based on ABS National Accounts gross product data (Cat. 5204.0) and the estimate of sales and other income from the ABS Business Indicators (Cat. 5676.0). The two numbers are therefore calculated on a different basis and, for the few overlapping years of the series from which they are drawn, provide different perspectives on the ratio. For example, using the first data series for 1984-85 yields a value added ratio of 39.1 per cent, while using the second for the same year yields a ratio of 35.7 per cent. If a continuous spliced series is used, the ratio falls from 35.2 per cent to 27.9 per cent from 1968-69 to 2001-02.

[20] It could also reflect structural change within manufacturing over the later 1980s. Another possible explanator, changes in inventory management, is shown to be insufficient to account for the reduction (appendix D). Similar trends in value added ratios occurred in the UK. On the basis of a highly disaggregated model of British industry, Gregory and Greenhalgh (1996) found that contracting out was a significant explanator.

[21] Some firms that are defined as manufacturing also increasingly supply services to customers. For example, in a study of over 500 Australian manufacturing and other companies, it was found that around three-quarters of manufacturing firms incorporated and sold services in their product offering to customers (Kennedy 2002).

Table 3.7 **Changing input-output relationships, 1980-81 to 1996-97[a]**

		These sectors provide inputs . . .			
		Agriculture	Mining	Manufacturing	Services
		%	%	%	%
… to the output of these sectors	Agriculture	3.3	0.0	**-1.0**	8.9
	Mining	-0.2	-2.9	**-1.3**	-1.0
	Manufacturing	**-1.6**	**-0.2**	**-2.2**	**5.9**
	Services	0.2	-0.2	**-4.6**	9.3

a Data are based on the absorption matrix of the ABS input-output tables (with indirect allocation of competing imports, so that the table reflects the changing technological input structure of manufacturing and other sectors). The original 1996-97 and 1980-81 I/O tables were adjusted to increase their consistency with each other. This involved a concordance between ANZSIC and ASIC and the use of the earlier SNA68 conventions for the treatment of transport margins. The input-output coefficients for 1980-81 were subtracted from those for 1996-97 to give the above table.

Source: ABS (*Australian National Accounts, Input-Output tables 1979-80 and 1980-81*, Cat. No. 5209.0).

North-South trade

One of the pressures on manufacturing in developed countries (the ‘North’) has been the expansion of trade in manufactures, especially labour intensive manufactures exported by low wage developing economies (the ‘South’) (Wood 1994). This reduces output of such manufactures in developed economies. A typical industry example is clothing manufacture.

Of course, the import effect is partly offset by increases in aggregate manufacturing exports from the North to the South, but this need not abate labour displacement much since such exports tend to be more elaborately transformed, low-labour intensive products. So, even where in monetary terms there is no manufacturing trade deficit, the differential labour intensity of imports versus exports can have labour displacing effects. In theory, such trade-related shocks could raise inequality by creating a surplus of low skilled displaced workers (relative to high skilled workers), who are either pushed into other sectors and paid lower wages, or unemployed if there are wage and other rigidities.

However, the international evidence is largely not in favour of North-South trade as an explanation for the decline in the relative demand for unskilled labour in developed countries (Bhagwati 1995, Krugman 1996 and Berman et al. 1994). For example, the shift to higher skills is as much prevalent in non-trade exposed industries as trade exposed ones like manufacturing.

An alternative hypothesis is that skill-based technological change provides the best explanation for the changing demand for skilled versus unskilled workers and for their growing wage differentials. This is supported by recent studies by the

Productivity Commission (De Laine et al. 2000 and Laplagne et al. 2001) that point to technological change, rather than trade, as the major driver of increased demand in Australia for skilled over unskilled workers (although it is acknowledged that trade pressures can provide impetus for technological change).

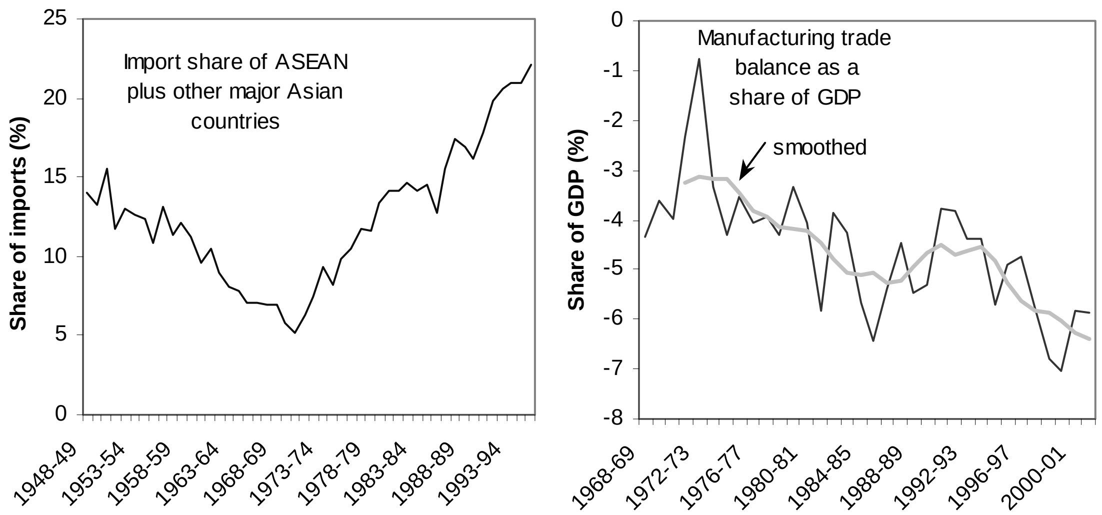
That said, this literature has mainly tested a particular form of the North-South trade hypothesis, which emphasises the skill composition of industries and relative movements in factor returns or unemployment. There remains a broader question of whether employment shares in industries and sectors exposed to stiff import competition might have declined due to output effects arising from import substitution.

Here the evidence on the significance of trade also suggests relatively modest impacts against the background of other influences. For instance, Rowthorn and Ramaswamy (1997) found that, for industrial economies, a reduction of one percentage point in the ratio of the manufacturing trade balance to GDP leads to a fall of 0.37 points in the manufacturing share of economy-wide employment. For industrial countries as a whole this was unimportant, since their overall manufacturing trade balance hardly deteriorated from the 1960s to the 1990s. However, the trade balance fell by around 3.5 percentage points in the US, so that trade effects could account for around a 1 percentage point reduction in the employment share of manufacturing for the US over this period.

In the Australian case, the trend manufacturing trade balance to GDP ratio has been similar to the US, falling by around 3 percentage points from 1968-69 to 2001-02 (figure 3.13). The share of total imports (primarily manufactured imports) sourced from lower-wage developing Asian economies has also risen significantly after 1970-71, suggesting that segments of low skill labour intensive manufacturing have particularly faced trade pressures.

Were the trade balance elasticity of 0.37 (discussed previously) to apply to Australia, this would imply that trade effects would have accounted for just over 1 percentage point of the observed 13 percentage point decline in the manufacturing share of economy-wide employment. This translates to a loss of around 102 000 workers from the sector, or a fall of around 8 per cent from the employment level of 1968-69. Looking at the manufacturing sector in isolation, as employment fell by 16 per cent from 1968-69, this would imply trade-related factors accounted for about half of the reduction. So North-South trade effects explain little of the relative employment changes in manufacturing, but a greater share of the absolute change.

Figure 3.13 **Possible trade effects associated with manufacturing**
Australia[a]



[a] The import share data relate to total imports. The data are from Reserve Bank of Australia, Economic Statistics on Econdata and relate to the period from 1948-49 to 1995-96. The manufacturing trade balance data were estimated as follows. A current price export and import series from 1988-89 to 2001-02 on an ANZSIC basis was obtained from the ABS. This was spliced with the ASIC series from the Industry Commission, Australian manufacturing and trade database on Econdata, which commenced in 1968-69. Exports include re-exports. The nominal trade balance was expressed as share of nominal GDP (from the ABS National Accounts).

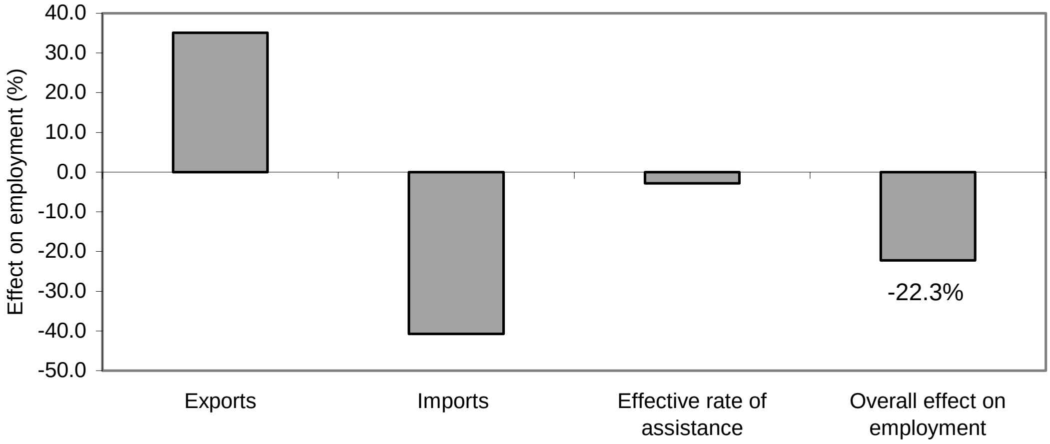
There are several other approaches that can be used to examine such effects.

Gaston (1998) has estimated an econometric model of the factors underpinning the employment changes in Australian manufacturing.[22] The model suggests strong negative effects on manufacturing employment associated with increased imports (and weaker positive effects associated with exports), consistent with the potential relevance of trade-related effects on employment. Smaller separate effects from lowered industry assistance are also apparent. Gaston's model (figure 3.14 and appendix M) implies that direct trade-related impacts accounted for around a 20 per cent fall in employment in manufacturing from 1969-70 to 2001-02.[23] This represents about 3 percentage points of the over 13 percentage points decline in the manufacturing share of economy-wide employment.

[22] Gaston examines trade-related pressures on employment through three variables: imports; exports; and the effective rate of assistance (with other variables to control for other pressures). The apparently curious inclusion of effective rates as well as trade measures is justified on the grounds that tariffs may have employment effects other than mediated directly through trade.

[23] The actual fall in employment was a little less than this over this period, suggesting that other factors partly offset trade-related pressures on employment.

Figure 3.14 **Trade effects on manufacturing employment**
1969-70 to 2001-02[a]



Data source: Appendix M.

However, other analysis suggests that this result overstates the trade pressures on manufacturing employment. De Laine et al. (1997) used input-output data to decompose changes in employment due to labour productivity, export demand, domestic demand changes, the structure of production, import replacement of final goods and import substitution of inputs (table 3.8). These estimates suggest a much bigger positive effect of exports on Australian manufacturing employment, sufficient to nearly offset the losses associated with increased import competition.

Table 3.8 **Decomposition of employment change in manufacturing[a]**
1977-78 to 1992-93

Time period	*Change in employment due to….*					
	All effects	Exports	Import substitution final demands	Import substitution intermediate demands	Total trade effect	Other effects
	No.	No.	No.	No.	No.	No.
1977-78 to 1983-84	-113 500	27 000	-37 400	-69 100	-79 500	-34 000
1983-84 to 1992-93	-52 900	187 600	-71 200	-37 400	79 000	-131 900
Total period	-166 400	214 600	-108 600	-106 500	-500	-165 900

[a] Based on input-output tables. The changes in total employment in manufacturing shown in this study do not match those used in the study by De Laine et al., but are qualitatively similar.

Source: De Laine et al. (1997).

Accordingly, while there is some question about the extent to which trade-related impacts might account for a share of the absolute decline in manufacturing employment, these impacts cannot explain the fact that overwhelmingly most net jobs have been created in the services sector. It is this restructuring of the economy that has been the dominant factor behind the drop in the employment share of manufacturing in the economy as a whole.

3.4 The implications of 'deindustrialisation'

The declining role of manufacturing in the economy is often miscast as an unfavourable outcome. However, as emphasised earlier, the actual output of manufacturing has not declined — and indeed has doubled from 1967-68 to 2001-02. Manufacturing remains a major source of economic prosperity for Australians and the most significant employer among individual industry divisions classified by the ABS (the service sector is cumulatively a much bigger employer, but it encompasses 14 divisions). Given its size, improvements in its performance can still produce significant gains for Australians.

Its *relative* decline has largely reflected rising incomes and changing preferences that have stimulated the relative demand for services. As a result, the economy-wide 'cake' has outgrown the 'slice' represented by manufacturing. High relative productivity growth rates in manufacturing have accentuated these effects for manufacturing employment. Since this structural shift is predominantly the realisation of consumers' choices, it is a process that has made Australians better off.

It is also apparent from the empirical evidence that a high share of manufacturing in GDP is not essential to sustain high living standards or strong economic growth, provided other sectors perform strongly.

Nevertheless, there are several potential concerns about the implications of 'deindustrialisation'.

Stagnant productivity growth?

One concern stems from the observation that productivity growth in the ascendant sector, services, is much lower than in manufacturing. If such trends persist, then, in the long run, average labour productivity will tend to mirror productivity growth achieved in the services sector — what Baumol et al. (1989) have referred to as 'asymptotic stagnancy'. The underlying premise is that the achievable productivity growth rate in many services is limited by the nature of the activity. For example, there do not appear to be significant labour saving technologies that could be employed in nursing homes and certain other labour intensive services. Where the national productivity growth rate converges on a low overall rate, the productivity growth rate in manufacturing by itself would make a minor contribution to overall productivity and prosperity in advanced countries.

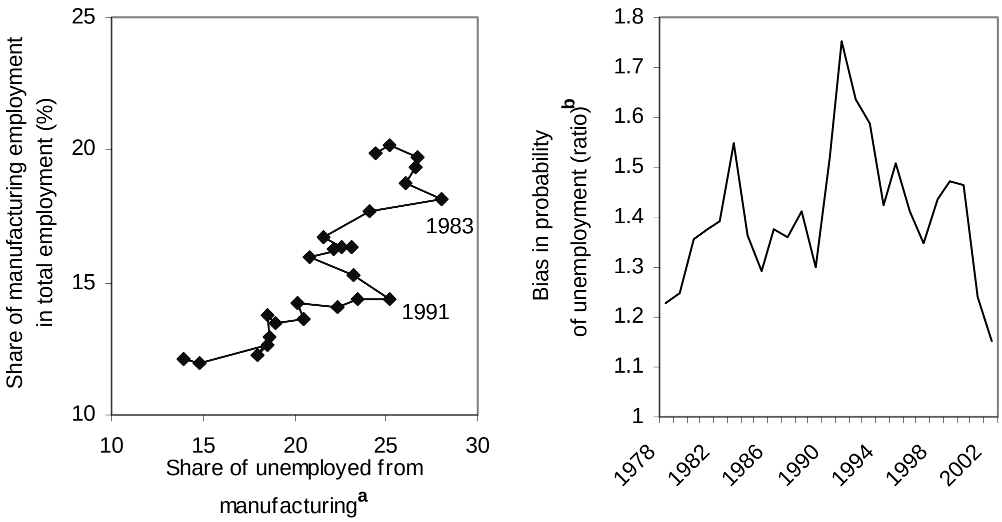
Whether, in fact, such economic stagnancy emerges, depends on assumptions about technological and efficiency gains in services. In the Australian case, labour productivity growth has been high in the 1990s for some service industries, such as wholesaling (Johnston et al. 2000). Moreover, from 1993-94 to 1999-2000, *multifactor* productivity growth rates in a range of service industries (such as Wholesale trade, Communication services, Transport and storage and Electricity, gas and water) were significantly higher than manufacturing (Parham 2002). The shift to services may not therefore have adverse implications for overall productivity performance. Greenhalgh and Gregory (1998) have reached similar conclusions about the UK — indicating that assumptions based on assuming uniformly poor productivity performance in services are not borne out by the evidence. They also point to the finding of important technological spillovers from manufacturing to services (Greenhalgh and Gregory 1998), which can raise productivity levels in these other sectors.

Unemployment and inequality?

Another major concern is that structural adjustment in the economy associated with ‘deindustrialisation’ has persistent adverse effects on unemployment (and inequality). This could occur if displaced workers do not always acquire a new job either (within the sector they have come from or in other sectors) due to scarce jobs, skill mismatch, job search time and constraints on geographical mobility.

As measured by the ratio of the manufacturing share of unemployed persons to the manufacturing share of employed persons, unemployment probabilities were consistently higher for employed persons in manufacturing from August 1978 to August 2002 (figure 3.15).

Figure 3.15 **Manufacturing as a 'source' of unemployment**
August 1978 to August 2002, Australia



a The ABS Labour Force Survey asks unemployed persons for the industry of their last full time job where they worked two weeks or more in the last two years. (After two years, the unemployed person is deemed 'unattached' to an industry, so the data do not record the original industry affiliation of the very long-term unemployed.) To derive the share of unemployed from manufacturing (U_{msh}), these numbers are expressed as a ratio of the total number of unemployed who have worked full time for at least two weeks in the last two years (that is, some unemployed — such as first time job seekers and the very long-term unemployed — are not included in the denominator). **b** The bias in probability of unemployment is the relative risk of unemployment in manufacturing relative to industries as a whole. It is expressed as U_{msh}/ E_{msh} where E_{msh} is the share of manufacturing employment in total employment.

Data source: ABS (*Labour Force, Australia,* Cat. No. 6203.0).

This measure includes people who voluntarily leave a job and then remain unemployed, so the data may exaggerate turbulence associated with supply and demand shocks to sectors. However, data on involuntary unemployment (measured by retrenchment and redundancy rates) suggest a similar picture. Involuntary unemployment rates are higher in manufacturing than in many other industries (and this appears to hold for manufacturing in other advanced countries). For example, from 1994-95 to 1996-97, manufacturing accounted for around 25 per cent of Australian layoffs, but only 14 per cent of employment (Murtough and Waite 2000). This trend has continued over the period from 1998-99 to 2000-01, with manufacturing accounting for 20.5 per cent of layoffs and around 13 per cent of employment. These two periods were not a time of net labour shedding in manufacturing (indeed employment grew modestly), so outflows were more than matched by inflows. Accordingly, high retrenchment rates do not necessarily lead to net employment losses in manufacturing.

It is not certain that manufacturing is contributing more to aggregate unemployment arising from high relative layoff rates, because changes in overall unemployment are determined by a whole set of interrelated flows (flows out of and into the labour force and between industries). That said, it is plausible that, given certain labour market rigidities, greater job turbulence in manufacturing may generate more unemployment than other sectors, once the relative sizes of sectors are taken into account. On the available evidence (table 3.9), people laid off from manufacturing have lower re-employment probabilities than mining and, by a small margin, services. They also tend to have higher rates of long-term unemployment than mining or agriculture (and about the same as services).

Table 3.9 **Outcomes following retrenchment or redundancy by sector of original employment**

Australia, 1994-1997 and 1998-2001

Labour market outcome	*Agriculture*	*Mining*	*Manufact-uring*	*Services*
	%	%	%	%
In July 1997, the share of people laid off[a] in the last 3 years who were …				
Employed	48.3	66.1	53.3	55.1
Unemployed	37.2	23.9	32.1	28.1
Not in labour force	13.9	11.0	14.5	16.8
In July 2001, the share of people laid off in the last 3 years who were …				
Employed	66.7	80.2	66.1	66.9
Unemployed	20.4	7.5	21.5	15.6
Not in labour force	12.0	12.3	12.3	17.6
Of those unemployed after being laid off from 1994-1997, share who were unemployed more than one year	12.3	19.0	23.6	24.2

a ‘Laid-off’ refers to either redundancy or retrenchment as the source of unemployment.

Source: ABS (*Retrenchment and Redundancy*, Cat. No. 6266.0).

However, in order to see the decline in manufacturing as a significant factor behind the economy-wide rising unemployment rates apparent from the 1970s to the 1990s, it would need to be shown that job turbulence had *grown* in manufacturing (rather than merely being high) or that re-employment probabilities were trending downwards for those laid off from that sector.

From the late 1970s, the relative likelihood of unemployment for a manufacturing worker generally rose until 1991. The data suggest that manufacturing was probably a major source of Australian unemployment in the two big economic downturns in the last two decades: the 1983 and 1991 recessions (figure 3.15). These two major recessions — reflecting major demand shocks — were instrumental in creating a large pool of unemployed from manufacturing.

Since 1991, the relative likelihood of unemployment in manufacturing has declined rapidly — suggesting a smaller role of the sector as a source of unemployment. This is despite the fact that, even over recent times, the steady pressure of import competition, changing consumer preferences and productivity growth have continued to induce a relative decline in manufacturing. This does not imply that these factors were not contributors to the big shifts in unemployment apparent at the time of the major 1983 and 1991 recessions. Rather, one conjecture is that the recessions were the triggers for releasing the pent up pressures of these longer term factors on manufacturing. Employment 'stickiness' stemming from the costs of scaling down operations and employment, and in the extreme, firm closure, suggests that many manufacturing firms may have held off adjustment, making them vulnerable to demand shocks when they occurred. The costs of scaling down operations are likely to be higher in manufacturing than some other sectors given the longer average tenure of workers (chapter 5) and the levels of redundancy provisions negotiated by unions (PC 2002b, 2003d).

One issue is whether the pressures of deindustrialisation since 1991 have created a similar vulnerability for manufacturing that has not yet been tested due to the absence of any major economic downturn. However, the state of manufacturing in 2002 is very different from its state in the 1970-1990 period. Trade barriers have come down since the 1970-1990 period and manufacturing has generally re-oriented itself to areas of comparative advantage (chapter 6). Industrial relations reforms and the growing use of more flexible employment arrangements are likely to have reduced employment stickiness. Manufacturing employment has stabilised, as has real manufacturing output as a share of GDP.

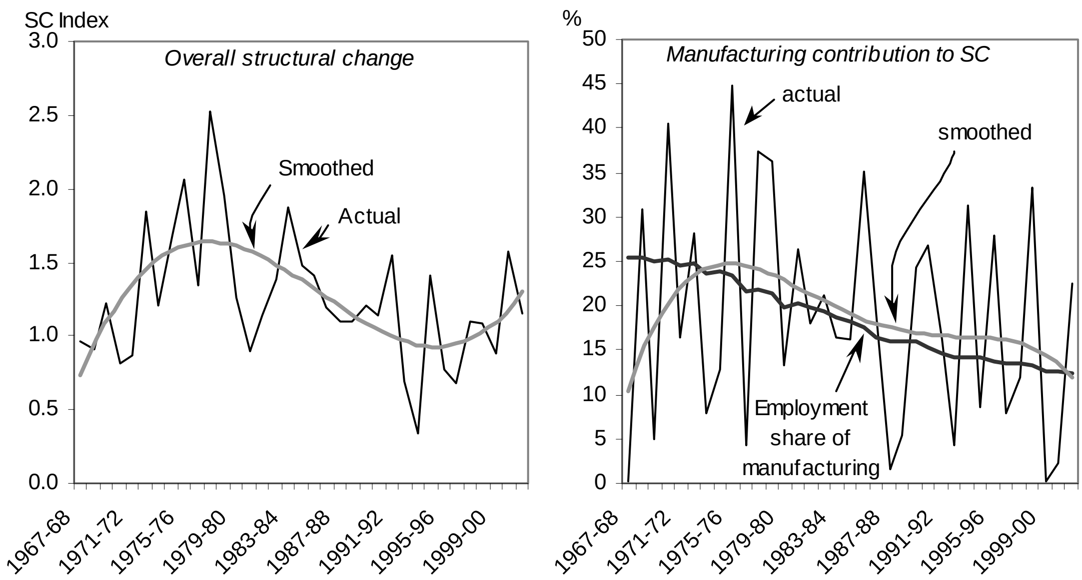
In these circumstances, it appears likely that, while the sectoral importance of manufacturing (in employment and nominal output terms) may continue to fall, the contribution of manufacturing to short-term unemployment may have abated.

Links between structural change and unemployment

Other data, based on measures of structural change, also provide clues on the role of manufacturing as a source of sectoral shocks to the economy. In this context, there is some evidence that, since the early 1970s, manufacturing has contributed more to structural change in the economy, measured as shifts in employment shares, than would be expected given its importance as an employer (figure 3.16). In 26 of the 35 years, the manufacturing employment share fell, raising the prospect of unemployment consequences given frictions associated with acquiring new jobs.

Figure 3.16 **Manufacturing and structural change in the Australian economy**

1967-68 to 2001-02[a]



[a] Structural change (SC) is defined as:

$SC_t = 100 \times \sum_{i=1}^{10} \frac{1}{2} \times |s_{it} - s_{it-1}|$ where s_{it} is the economy-wide employment share of industry i at time t.

The contribution of manufacturing to SC is half the absolute change in the manufacturing employment share as a fraction of the SC index. The SC index and the contributions of manufacturing to SC were smoothed by fitting polynomial functions to the data.

Data sources: Employment data are averaged quarterly data from ABS (*Labour Force, Australia,* Cat. No. 6203.0) from 1985-86. Past data are from Foster and Stewart (1991).

However, measuring the effects on unemployment of structural change is beset by difficult empirical and methodological difficulties. Different approaches have tended to identify quite different roles played by structural change in Australia. Trivedi and Baker (1985) found structural change was not an important source of Australian unemployment, while Hoque and Inder (1991) and (particularly) Groenweold and Hagger (1998) found that it was a significant source. More recently, using less restrictive assumptions than other models, Heaton and Oslington (2002) suggest that sectoral shocks play an important, but not overwhelming, role in determining the unemployment rate. Heaton and Oslington found that manufacturing accounted for a 10 per cent weighted contribution to the variance of the aggregate Australian unemployment rate from the late 1970s to the mid-1990s. However, sectoral changes were not found to contribute much to longer term variations in the unemployment rate.

Using decades rather than years or quarters, there is no apparent relationship between unemployment rate changes and changes in industrial turbulence. Indeed, average indices of industrial turbulence declined for a range of developed countries from the 1950s to the 1980s, despite rising unemployment rates. Over the very long run, there is no obvious relationship in the Australian or other OECD economies between the aggregate unemployment rate and structural change or productivity (Layard et al. 1991, pp. 294-301). As Layard et al. observe, structural change was not an invention of the 1970s, nor isolated to manufacturing decline and the emergence of services:

> People seem constantly to forget the massive restructurings of the past, such as the huge exodus from European agriculture in the 1950s and 1960s which was accompanied by so little unemployment (p. 295).

The effects of deindustrialisation on regional unemployment

Even if the long run effects of the declining role of manufacturing in the economy appear to play little role in determining unemployment levels in aggregate, there is a concern that persistent unemployment may be created in some regions associated with rapid structural adjustment. Such problems are likely to be more severe if there are obstacles to geographic mobility, so that displaced employees cannot readily gain access to more buoyant labour markets. These problems are exemplified by high regional unemployment rates in some advanced economies as industrial areas decline, such as the North of England generally and Newcastle and Wollongong in Australia.

Overall, in Australia there is only a weak association between changes in a region's manufacturing share and the change in regional unemployment rates between 1981 and 1996, although it is statistically significant (figure 3.17).[24] Regional industrial cities, such as Newcastle, Geelong and Whyalla, have exhibited particularly large reductions in the manufacturing share of employment and faced above average unemployment rates. But this pattern is not found generally.[25]

It is possible that the effects of manufacturing decline on regional unemployment are confounded by other factors. A regression model that took into account some of these factors suggests that for every 10 percentage points of decline in the share of manufacturing from 1981 to 1996 in a region, unemployment rates increased by 0.6 percentage points (which is relatively small relative to the mean unemployment rate). Other factors, such as average household income in 1981 (which picks up average levels of human capital, among other things) and the overall level of

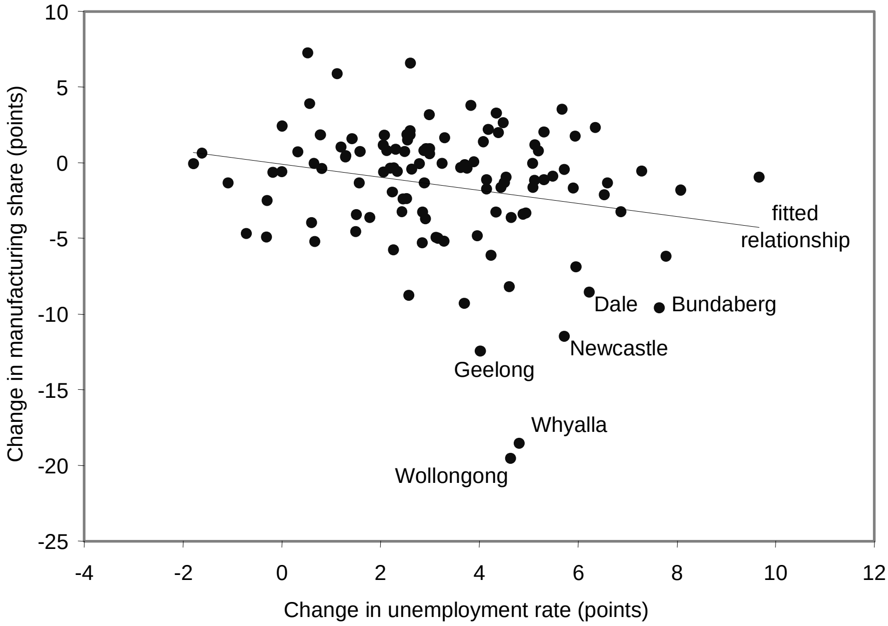
[24] But only using unweighted data.

[25] Lawson and Dwyer (2002) found that increased structural change at the regional level *increased* the likelihood of regional employment growth, thus questioning the notion that structural change necessarily stifles employment dynamism.

structural change were more important determinants of change in regional unemployment rates (box 3.2). It did not appear that unemployment persistence was higher (or lower) in areas where manufacturing previously predominated or where manufacturing decline was greatest (though it was higher where general sectoral turbulence was largest).

Figure 3.17 **Relationship between change in unemployment rates 1981-1996 and change in the manufacturing share of employment 1981-1996**

Australia



Data source: Derived from statistical subdivision data (see PC 1998a for sources and methods of compilation).

The overall effects of manufacturing decline on unemployment

In summary, it appears that the decline in manufacturing is likely to have had short-term effects on unemployment, though these do not seem to be apparent over the longer run. Moreover, at present, manufacturing appears to be playing a diminishing role as a source of unemployment in Australia, even though restructuring continues. The principal policy significance of the connection between sectoral turbulence and unemployment is the careful design of efficient labour market assistance and other labour market policies that reduce the structural impediments to re-employment. In the case of barriers to trade, this connection was one of the factors underlying the Commission's recommendation for phased reductions of tariff assistance in the automotive and TCF industries (PC 2002b, 2003c), rather than adoption of a potentially more disruptive 'cold turkey' approach.

Box 3.2 Determinants of regional unemployment changes

A model was built to explain changes in regional unemployment based on data on 113 regions (derived from aggregating up ABS statistical subdivisions). The data are described in Productivity Commission (1998a, p. 18). A variety of possible factors that could have been influential were considered, such as major city location, starting unemployment rates (based on the notion that unemployment rates tend to be mean reverting), starting household income levels (which will pick up average human capital and other factors described by Gregory and Hunter 1995), the change in the manufacturing share of employment (the main variable of interest here) and an index of structural change (to pick up overall sectoral turbulence). After eliminating non-significant variables, the preferred specification was:

$$(UR_{1996} - UR_{1981}) = \underset{(5.1)}{5.0} - \underset{(2.2)}{0.06}(M_{1996} - M_{1981}) - \underset{(6.1)}{0.33}Y_{1981} + \underset{(5.7)}{0.20}SCI$$

R^2=0.38, N=113.

where UR is the unemployment rate, M is the manufacturing share of employment in a region, SCI is an index of structural change and Y is average household income in a region (in $'000). T statistics are in parentheses. The results were weighted by the labour force in 1981 in each region. Unweighted results suggest a bigger and more statistically significant effect associated with manufacturing (with a coefficient of 0.95).

One associated question is whether unemployment tended to persist more in regions in which either the manufacturing share was initially higher or where the reduction in manufacturing employment share was greatest. With so few years of data available, a simple persistence measure was adopted:

$$\text{REVERT} = -(\text{UR}_{1996} - \text{UR}_{1991})/(\text{UR}_{1991} - \text{UR}_{1981})$$

In all regions, the unemployment rate increased from 1981 to 1991 and, in many, the rate fell from 1991 to 1996. If the rate fell significantly relative to the initial decline, then REVERT would be close to unity, while if it fell very little then it would be close to zero (and negative if unemployment continued to rise). So, where persistence is high, the measure REVERT will be low. There was no economically or statistically significant association between either the starting manufacturing share of employment (in 1981) or the change in manufacturing employment (though structural change more generally was associated with greater unemployment persistence, as was average initial household income). Accordingly, the statistical evidence does not indicate that unemployment persistence is higher (or lower) in areas where manufacturing has been important or where it has faced substantial declines.

4 Changing trends *within* manufacturing

Key points

- There is significant variation in performance between activities within manufacturing:
  - there are growing niches even within industries that are generally declining, like the TCF industries;
  - while overall manufacturing employment has declined, more than one-third of geographic areas in Australia have experienced an increase in the share of employment accounted for by manufacturing;
  - growth patterns of industries — even within the same manufacturing subdivision — tend to be quite different.
- Some parts of manufacturing have been growing strongly, especially activities with links to Australia's natural endowments of land, forests and minerals and those involving the production of more differentiated products entailing higher skills and R&D intensities.
- Some industries have experienced volatile growth from year to year. Simply transformed manufactures exhibit lower volatility than elaborately transformed manufactures, contrary to the common view that Australian manufacturing should move away from resource-linked production to stabilise incomes and supply.
- The 1990s was a stable era for manufacturing:
  - growth rates were less variable than in past decades; and
  - structural change — the degree to which activity and employment shifts between industries within manufacturing — generally increased until the early 1990s, but has since been steady.
- Differences in labour productivity growth rates and trends in demand between manufacturing industries have been important drivers of structural change.
- Domestic demand has been growing at a significantly stronger rate than real turnover in manufacturing, testimony to the increasing role played by imports in meeting domestic demand.
- Structural change does not usually have significant implications for unemployment.
  - However, there are several industries — such as TCF — where employees may be susceptible to prolonged unemployment if they lose their jobs.
- Manufacturing has continued to become more specialised. This is consistent with shifts towards activities in which Australia has a comparative advantage.
- At the geographic level :
  - regional dependence on specific manufacturing activities has generally declined; and
  - manufacturing has become less geographically concentrated.

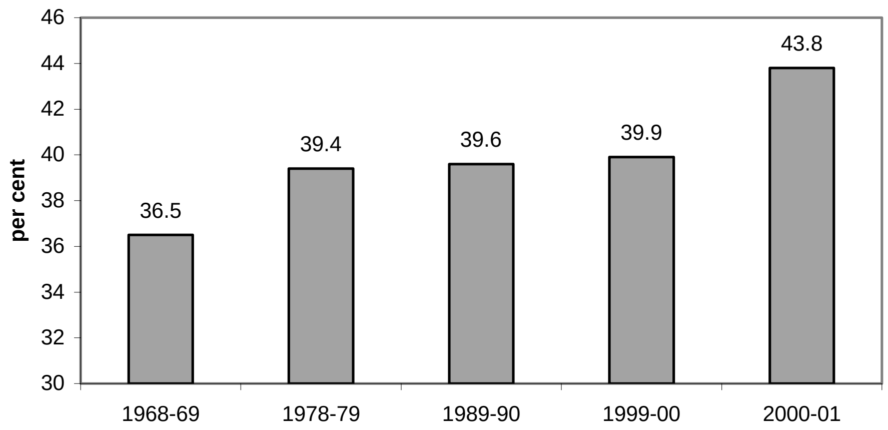
Whereas the previous chapter looked at the broader role of manufacturing and how this had changed relative to other sectors, this chapter briefly examines some features of the changing nature of manufacturing from within. That said, manufacturing is a highly diverse sector that evades easy generalisations. This is so not merely in terms of high or low tech, but also with respect to labour and skill intensities, trade orientation, growth rates and a host of other ways of characterising industries.[1]

4.1 The composition of manufacturing

The disposition of total manufacturing value added (in current prices) between activities gives a perspective on where resources in manufacturing have shifted over time. Nominal value added is preferable for this analysis because it takes account of both volume and price effects.

Manufacturing activities with strong links to Australia's natural endowments of land, forests and minerals account for a significant and growing share of manufacturing value added (figure 4.1 and table 4.1).

Figure 4.1 **Natural endowment-based manufacturing**
Share of total manufacturing value added, 1968-69 to 2000-01[a]



[a] Natural endowment-based manufacturing was defined as the sum of Food, beverages and tobacco, Wood and paper products, Simply transformed chemicals, Iron and steel and Non-ferrous metals. The data and sources are explained in table 4.1.

Data source: Table 4.1.

[1] Trade and productivity issues are examined in detail in the following chapters.

Table 4.1 **Output shares within manufacturing**

Value added, 1968-69 to 2000-01[a]

Industry description	*Share of value added (current prices)*				
	1968-69	1978-79	1989-90	1999-00	2000-01
	%	%	%	%	%
Food, beverages and tobacco	15.8	18.2	18.5	20.8	20.4
Textiles, clothing and footwear	9.8	8.0	6.1	4.4	3.6
Clothing & footwear	5.5	4.7	3.6	2.3	1.6
Textiles & leather	4.4	3.2	2.5	2.2	2.0
Wood and paper products	7.1	6.4	5.8	6.8	6.9
Printing and publishing	5.6	6.1	7.7	10.0	8.8
Petroleum, coal, chemicals	12.0	12.5	12.5	14.3	13.8
Simply transformed chemicals	4.2	4.2	3.5	4.4	5.0
Elaborately transformed chemicals	6.6	6.9	7.7	7.5	6.5
Medicinal and pharmaceutical products	1.1	1.4	1.3	2.4	2.3
Non-metallic mineral products	4.8	4.9	5.3	5.4	5.0
Metal products	17.7	18.8	19.6	15.7	19.2
Iron and steel	6.1	6.4	4.6	3.7	3.6
Non-ferrous metals	3.3	4.2	7.2	4.2	7.9
Simple metal fabrications	8.3	8.1	7.8	7.8	7.7
Machinery and equipment	24.9	22.5	21.7	19.6	19.1
Motor vehicles	7.5	6.5	7.8	5.7	6.5
Other transport equipment	3.7	3.4	3.0	2.9	2.0
Photographic, medical and scientific eq.[b]	0.4	0.7	0.7	1.3	1.4
Electronic equipment[b]	2.0	1.5	2.0	2.7	2.5
Electrical equipment[b]	5.1	4.8	4.1	2.9	2.5
Production equipment	6.2	5.5	4.1	4.1	4.2
Other manufacturing[b]	2.3	2.6	2.8	3.0	3.1
Simply transformed manufactures	45.7	47.6	47.4	47.5	50.8
Elaborately transformed manufactures	54.3	52.4	52.6	52.5	49.2
Total manufacturing	100.00	100.00	100.00	100.00	100.00

[a] The table is based on two series for each industry, matched to a common hybrid classification (appendix A) that is as close as possible to the existing ANZSIC. The data shown for 1968-69, 1978-79 and 1989-90 are based on ASIC data that are then matched to the new classification. The data shown for 1999-2000 and 2000-01 are based on ANZSIC data matched to the new classification. The ASIC data are value added, while the ANZSIC data are so-called ‘industry’ value added, to be distinguished from gross product. All data bar that for 2000-01 are based on establishment level data, while that for 2000-01 are based on management unit data. The differences between industry shares in 1999-2000 and 2000-01 largely reflect the changed basis of the ABS survey of manufacturing. [b] The concordance between ANZSIC and ASIC was imperfect. The results for these industries are less reliable than others.

Sources: ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and the Industry Commission (1995).

A second category of goods — more differentiated products with higher skill requirements and R&D intensities — also have tended to increase in relative significance. These include Medicinal and pharmaceutical goods, Photographic, scientific and medical equipment and, to a lesser extent, Electronic equipment.

These three groupings increased in importance from a small base of 3.5 per cent of manufacturing value added in 1968-69 to 6.2 per cent by 2000-01.

On the other hand, less complex goods produced by industries facing strong import competition and declining border protection have tended to decline over time — exemplified by the marked reduction in the significance of the textiles, clothing and footwear industries over the last quarter century. Other industries such as Simple metal fabrication, Other transport equipment and Electrical equipment have also faced strongly diminishing shares (table 4.1).

However, these are generalisations. Data at a more disaggregated level (the four-digit ANZSIC) reveal a large dispersion in output and employment growth among industries over the period from 1989-90 to 1999-2000.[2] For example, bread manufacturing has declined significantly in output terms (down 5.4 per cent per annum in real terms), while a range of other food and beverage products (Wine, Spirits, certain dairy product manufacturing and Poultry processing) have all experienced real growth rates in excess of six per cent per annum. Six[3] of the 15 slowest growing industries are in the textiles, clothing and footwear group, but several other industries in this group (Rope, cordage and twine manufacturing, Cotton textile manufacturing and Wool scouring) have experienced well above median real growth rates.

As discussed earlier, another way of delineating manufacturing is by the degree of transformation of inputs. Reflecting the strong association between resource endowments and manufacturing, simply transformed manufactures (STMs) account for about half the sales of manufactured goods in Australia, with the rest accounted for by moderately and elaborately transformed manufactures (table 4.2).

On the basis of a more crude taxonomy that classifies goods as either simply or elaborately transformed manufactures (ETMs) (chapter 1), the share of elaborately transformed goods has been remarkably stable over time (table 4.1).[4]

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[2] The available data for this period are in chain volume terms, not nominal value added.

[3] Wool textile manufacturing, Men's and boy's wear, Textile products not elsewhere classified, Hosiery, Textile finishing and Footwear.

[4] The ABS has only produced limited time series statistics using its five categories of the transformation of goods. The Commission developed a simple taxonomy of goods comprising simply transformed (largely the sum of STMs and MTMs) and elaborately transformed manufactures, which can be used for most historical manufacturing data because of its simplicity. The Commission's measure of ETMs is closely correlated with the ABS measure in table 4.2. The correlation between the ETM shares of industry using the Commission's approach (based on 1999-2000 data on turnover) and the ABS shares in table 4.2 was 0.984, suggesting that the estimates in table 4.1 of trends by degree of transformation will be reasonably accurate. While STMs appear to have increased their share of manufacturing value added over the long run in

Table 4.2 **How important are elaborate goods to Australian manufacturing?**

Sales of manufactures by degree of transformation, 2000-01[a]

Industry	*Simply transformed manufactures*		*Moderately transformed manufactures*		*Elaborately transformed manufactures*	
	Sales $b	% of STMs	Sales $b	% of MTMs	Sales $b	% of ETMs
Food, beverages and tobacco	53.2	50.7	0.0	0.0	0.0	0.0
Textiles, clothing, footwear and leather	1.5	1.4	2.4	10.2	3.8	4.2
Wood and paper products	6.0	5.7	4.9	20.9	3.1	3.4
Printing, publishing and recorded media	0.0	0.0	0.0	0.0	10.6	11.7
Petroleum, coal, chemical and associated product	21.8	20.8	6.2	26.4	14.5	16.0
Non-metallic mineral products	7.2	6.9	0.9	3.8	0.8	0.9
Metal products	15.1	14.4	9.1	38.7	12.2	13.4
Machinery and equipment	0.1	0.1	0.0	0.0	39.5	43.5
Other manufacturing	0.0	0.0	0.0	0.0	6.4	7.0
Total manufacturing	**104.9**	**100**	**23.5**	**100**	**90.9**	**100**

a The ABS examines the number and complexity of processes to determine the category of transformation into which to place sales activity. The classification has five categories, of which three (primary products, primary product manufactures and simply transformed manufactures) have been combined into the first category of 'simply transformed manufactures'.

Source: ABS (*Manufacturing, Australia 2002*, Cat. No. 8225.0).

Inadequacies in data suggest the importance of 'triangulation' — the verification of key results using other variables. For example, there is no long-run official series of value added for manufacturing at a highly disaggregated level. In 1989-90, a revised system for classifying manufacturing activities — ANZSIC — was introduced in place of ASIC. Value added data were not collected for several years.

Most recently, the ABS has drawn a distinction between gross product and industry value added and, in 2000-01, switched from an establishment basis for its surveys of manufacturing to a management unit basis. This cocktail of definitional and methodological changes, combined with missing data, means that, for the 1990s, it is only possible to derive reasonably accurate value added at the highly disaggregated level for a few snapshot years (adequate data are available at a more aggregated level). A concern with the 'snapshot' approach is that price changes can

table 4.1, the simple nature of the taxonomy and small change in the percentage share observed suggests that the change is not significant.

introduce large fluctuations in current price value added shares from year to year — especially for goods with commodity inputs (for example, petroleum). A particular snapshot might therefore be quite misleading.

Fortunately there are at least two other series available that can be used to verify the basic resource usage patterns implied by the value added snapshots. Data on turnover and employment are available from 1968-69 to 1999-2000 on a four-digit ANZSIC/ASIC basis — and it is possible to derive a reasonably consistent series by matching ASIC and ANZSIC categories (appendix A). The long time series allows trend growth estimates to be calculated (appendix O). This generally confirms the patterns noted above.

An international perspective

In order to identify any unique characteristics of the sectoral composition in Australia, it is useful to compare it with the composition in other industrialised countries (appendix J).[5]

As would be expected, there are marked variations in the composition of manufacturing in different OECD countries. The share of Processed food, Wood products and Metal products in Australia is considerably higher than in the other OECD countries examined, reflecting the continuing strong reliance of Australian manufacturing on agricultural and mineral products.

In contrast, production of engineering-intensive activities grouped under 'machinery and equipment' account for a much smaller share of manufacturing activity in Australia than in the OECD countries examined.

4.2 'Volatility' in Australian manufacturing

The volatility of industries is generally defined as the extent of variation in industry growth about a trend (table 4.3). For a *given* trend in output or employment, there would generally be more significant adjustment issues for those industries where employment or turnover changes are more volatile.

Industry turnover may also exhibit volatility because a specific industry has higher or lower price changes relative to manufacturing as a whole. Price volatility can

5 The industrial classification used for OECD countries is slightly different from that shown for Australian manufacturing. Table J.1 is based on the OECD-STAN classification, while the Australian data are based on ANZSIC. The main difference is the transfer of paper production from wood products to printing and publishing.

have important ramifications for other industries (as witnessed by the oil shock in the 1970s).

Generally, the degree of volatility suggested by employment and turnover-based measures are similar, suggesting that most volatility arises from changes in real supply, rather than from changes in the prices of goods relative to manufacturing prices as a whole.

Food, beverages and tobacco and Simply transformed chemicals[6] exhibit low volatility. The non-ferrous metals industry is also not volatile, but only when the employment-based measure is applied.

Industries with high degrees of volatility include Clothing and footwear, Motor vehicles, Photographic, scientific and medical equipment and Electronic equipment. As expected, smaller industries tend to exhibit greater volatility (there being less scope for random movements in the supply of one product to be offset by movements in others).[7] And STMs exhibit lower volatility than ETMs, which casts doubt on a common view that Australian manufacturing should move away from resource-linked production to stabilise incomes and supply.

It appears that the 1990s has been a relatively stable era for manufacturing, with levels of volatility generally lower than in previous decades (figure 4.2). For example, for manufacturing as a whole, volatility was less than half that prevailing in the previous two decades. This probably reflects the fact that, other than in 1990-91, there have been no general economic downturns in this period.

4.3 Structural change

A concept related to, but distinct from, volatility is that of structural change. This measures the extent to which factors and output shift *between* industries over time. While periods of volatility will often also be ones of significant structural change, this need not always be the case. For example, if all industries experience a rapid increase or decrease in activity of the same relative magnitude, volatility is high, but structural change is zero.

[6] Despite including petroleum, which is subject to large international movements in oil prices.

[7] Variations in the size of each industry group (measured as the log value of the employment) explained about one-quarter of the variations in volatility across industries.

Table 4.3 **Volatility of growth in manufacturing**

1968-69 to 1999-2000[a]

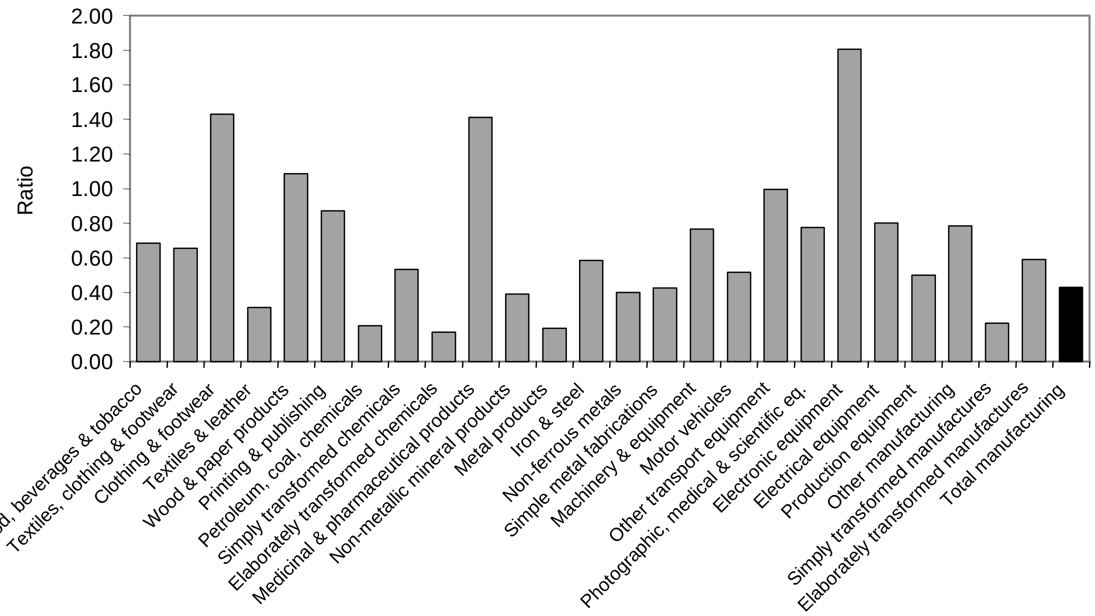
Industry	*Employment based*			*Turnover based*		
	All data	ASIC	ANZSIC	All data	ASIC	ANZSIC
Food, beverages and tobacco	0.04	0.04	0.03	0.05	0.06	0.03
Textiles, clothing and footwear	0.34	0.41	0.23	0.28	0.39	0.07
Clothing & footwear	0.46	0.47	0.44	0.29	0.26	0.15
Textiles & leather	0.33	0.43	0.15	0.47	0.68	0.05
Wood and paper products	0.21	0.20	0.23	0.29	0.31	0.24
Printing and publishing	0.11	0.11	0.10	0.13	0.13	0.10
Petroleum, coal, chemicals	0.10	0.13	0.03	0.13	0.18	0.03
Simply transformed chemicals	0.11	0.12	0.07	0.31	0.33	0.31
Elaborately transformed chemicals	0.17	0.22	0.04	0.18	0.19	0.18
Medicinal and pharmaceutical products	0.31	0.30	0.33	0.24	0.16	0.30
Non-metallic mineral products	0.20	0.25	0.10	0.37	0.37	0.22
Metal products	0.17	0.23	0.05	0.49	0.68	0.10
Iron and steel	0.27	0.30	0.19	0.57	0.80	0.15
Non-ferrous metals	0.12	0.13	0.06	1.86	2.51	0.60
Simple metal fabrications	0.26	0.32	0.14	0.36	0.44	0.19
Machinery and equipment	0.23	0.23	0.18	0.26	0.28	0.19
Motor vehicles	0.62	0.65	0.26	0.64	0.61	0.64
Other transport equipment	0.52	0.47	0.50	0.61	0.47	0.62
Photographic, medical and scientific eq.	0.62	0.63	0.50	0.69	0.40	0.86
Electronic equipment	0.99	0.78	1.45	0.84	0.69	1.25
Electrical equipment	0.25	0.25	0.22	0.34	0.36	0.27
Production equipment	0.36	0.42	0.24	0.54	0.61	0.34
Other manufacturing	0.33	0.37	0.28	0.38	0.43	0.16
Simply transformed manufactures	0.06	0.08	0.02	0.13	0.19	0.01
Elaborately transformed manufactures	0.17	0.19	0.11	0.17	0.21	0.08
Total manufacturing	0.11	0.13	0.06	0.13	0.17	0.03

[a] For the employment-based estimate of volatility using the combined ASIC/ANZSIC data, ∆log (employment) was regressed against a constant to give the mean growth rate, a time trend to pick up any general trend in growth rates over time, a dummy variable for ASIC to pick up any differences between growth rates between ASIC and ANZSIC observations and a dummy variable for the first ANZSIC observation (which was in 1989-90) in order to take account of the spike that occurs in growth rates in that year. The estimate of volatility is 100 times the standard error of the estimate (the standard deviation of the residuals, corrected for the degrees of freedom of the regression) of this equation for each industry. For the ASIC and ANZSIC-only data sets, the dummy variables were dropped from the regressions, but otherwise the same method was employed. For the turnover-based measure of volatility, a similar approach was adopted, except that ∆log P (where P is the general price index of articles produced by manufacturing) was added as an additional regressor to pick up general inflation.

Source: As in table 4.1.

Figure 4.2 **Relative volatility in growth rates[a]**

1989-90 to 1999-2000 relative to 1968-69 to 1989-90



[a] This compares the volatility (based on employment growth rates) of manufacturing in the post-1989 compared with the pre-1989 period. Volatility is as measured in table 4.3. Ratios less than one indicate that variation in the 1990s was less than that in the earlier period.

Data source: As in Table 4.1.

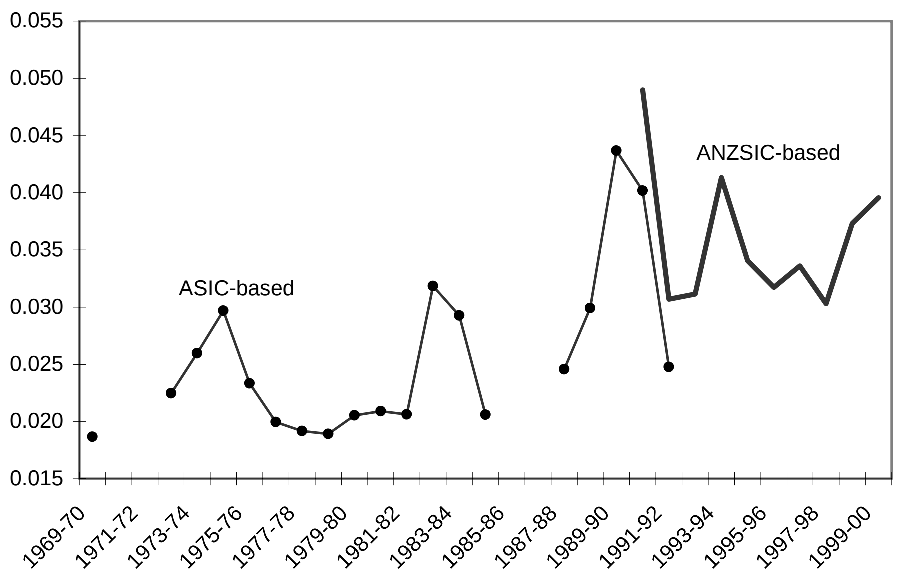
As noted in the previous chapter, structural change within manufacturing has been a perennial concern because of concerns that it leads to unemployment if displaced employees are not able to move easily into jobs in other industries. But structural change can also be seen as a desirable trait, since the benefits of trade liberalisation and other microeconomic reforms are often realised by resources being shifted to more efficient activities.

The largest spikes in structural change in manufacturing have occurred during recessions (figure 4.3). This reflects the fact that some manufacturing industries are more sensitive to downturns (appendix F), while others are only weakly sensitive. For example, investment-good producing manufacturing industries tend to be relatively sensitive to economic downturns, while food and beverage industries tend to be weakly sensitive.

When the breaks in the series are taken into account, as well as the influence of changing activity levels, it appears that the underlying rate of structural change in manufacturing increased until the early 1990s, but has since been stable. Nevertheless, even during a buoyant economic climate, there are considerable resource shifts between industries, reflecting the myriad of idiosyncratic influences that shape specific industry demands and supplies.

At a disaggregated level, industry groups have generally contributed to the level of structural change in manufacturing in proportion to their employment shares. For example, the food, beverages and tobacco industries accounted for around 16 per cent of the structural change apparent in manufacturing, and around 18 per cent of employment over the 1990s (columns 1 and 2 of table 4.4).

Figure 4.3 **Structural change within manufacturing**[a]
1969-70 to 1999-2000



a Structural change is measured as:

$$SC_t = 0.5 \times \sum_{j=1}^{n} \left| S_{jt} - S_{jt-1} \right|$$

The index is based on employment shares for 153 industry classes for the ANZSIC data from 1989-90 and 142 ASIC (or combined ASIC) classes for the early series from 1969-70. Gaps in the series reflect the fact that a manufacturing census was not conducted in some years.

Data sources: ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and the Industry Commission (1995).

However, some parts of manufacturing, most notably the electronic equipment industries and the declining textiles, clothing and footwear industries, have made much larger contributions to structural change than is suggested by their employment shares.

Table 4.4 **Structural change by industry**[a]

1989-90 to 1999-2000

Industry description	*Contrib. to struct. change* C_QAV	*Employ. share* C_EAV	$\frac{C_QAV}{C_EAV}$	*Average struct. change within each industry class QAV*	*Trend in QAV*
	%	%	ratio	ratio	%
Food, beverages and tobacco	15.7	17.5	0.9	0.031	1.8
Textiles, clothing and footwear	12.1	8.4	1.4	0.047	-0.8
Clothing & footwear	7.9	5.3	1.5	0.045	-0.7
Textiles & leather	4.2	3.1	1.3	0.045	-0.9
Wood and paper products	8.1	6.7	1.2	0.042	-0.1
Printing, publishing & recorded media	8.9	9.7	0.9	0.031	1.1
Petroleum, coal, chemicals etc.	11.0	9.8	1.1	0.031	-5.4
Simply transformed chemicals	2.2	1.9	1.1	0.036	-2.1
Elaborately transformed chemicals	7.8	6.6	1.2	0.041	-5.6
Medicinal and pharmaceutical product mfg	1.1	1.2	0.8	..	..
Non-metallic mineral products	3.6	4.0	0.9	0.030	5.3
Metal products	14.1	16.3	0.9	0.031	2.6
Iron and steel	2.9	3.4	0.8	0.017	6.9
Non-ferrous metals	2.6	2.6	1.0	0.032	1.2
Simple metal fabrications	8.6	10.3	0.8	0.030	3.4
Machinery and equipment	21.5	22.0	1.0	0.034	-4.9
Motor vehicles	5.5	6.1	0.9	0.022	8.3
Other transport equipment	2.9	3.0	1.0	0.037	-10.9
Photographic, optical, medical & scientific eq.	1.5	1.3	1.2	0.032	-11.7
Electronic equipment	3.1	2.2	1.4	0.038	-8.1
Electrical equipment	3.9	4.0	1.0	0.029	-5.4
Production equipment	4.5	5.4	0.8	0.028	-0.3
Other manufacturing	5.0	5.6	0.9	0.032	-2.5
Simply transformed manufactures	39.2	39.3	1.0	0.035	1.9
Elaborately transformed manufactures	60.8	60.7	1.0	0.036	-2.0

a The first column is the average contribution of each industry category to overall structural change in manufacturing. For the gth category at time t, it is calculated as:

$$C_{Q,t,g} = (0.5 \times \sum_{j=k}^{m} \left|S_{jt} - S_{jt-1}\right|) \Big/ (0.5 \times \sum_{j=1}^{n} \left|S_{jt} - S_{jt-1}\right|)$$

where the gth category is defined by industry classes from k to m (of the 1 to n total industry classes) and S_{jt} is the share of *total* manufacturing employment. C_QAV is then calculated by taking the average from 1990-91 to 1999-2000 for each category. The second column, C_EAV, is the average share of total manufacturing employment of each category over the relevant period. The third column — the ratio of the two — indicates whether the contribution to overall structural change by an industry category is more than could be expected given its employment contribution to manufacturing. QAV is the average level of structural change within each category over the relevant years. For any given year for the gth category Q is calculated as:

$$Q_{t,g} = 0.5 \times \sum_{j=m}^{k} \left|\tilde{S}_{jt} - \tilde{S}_{jt-1}\right| \text{ where } \tilde{S}_{jt} = E_{jt} / \sum_{j=m}^{k} E_{jt}.$$

The final column is the annual trend rate of growth of QAV from 1989-90 to 1999-2000.

Sources: ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0).

In theory, an industry category could make a large contribution to overall structural change in manufacturing if all of the industry classes making up that category grew or declined by the same large proportional amount. In that instance, there would be no structural change *within* that category. However, the evidence suggests that generally there is considerable structural change within industry categories (column 4 in table 4.4). For example, Textiles, clothing and footwear and Wood and paper products have exhibited significant structural change within, whereas Motor vehicles and Iron and steel have not (although structural change appears on the increase in the latter industry).

There is no apparent difference in the degree of structural change affecting STMs versus ETMs, although structural change has increased slightly in the former over the 1990s. This brings into question the common view that ETMs are more likely to be protected from structural change pressures.

The sources of structural change

The importance of productivity

It is possible to distinguish between changes in industry employment caused by shifts in labour productivity and those associated with changes in output levels:

- for given levels of output, increased labour productivity reduces employment in an industry; and
- for given levels of productivity, increased output raises employment in an industry.

The analysis (box 4.1) implies that both factors were influential in explaining structural change within manufacturing over the 1990s — inter-industry productivity and demand differences are roughly of equal importance as drivers of structural change within manufacturing.

Salter (1966) and a plethora of follow up studies (for example, Metcalfe and Hall 1983 and Harris 1988) have investigated another link between productivity change and structural change. Salter found that, in the US and UK, industries that had achieved high growth rates of labour productivity had faced lower cost increases, the relative prices of their outputs had fallen and their output had increased rapidly relative to others — this pathway to industry growth being dubbed the ‘Salter mechanism’. (The story for employment differed between the UK and the US, increasing for the fastest labour productivity industries in the former, but not the latter.)

For Australia, Harris found that, over the period from 1954-55 to 1981-82, relative price changes in manufacturing industry classes arising from differential growth rates in multifactor productivity (MFP) could explain a substantial part of the observed pattern of structural change in Australian manufacturing. Industries with more rapid productivity change had not distributed productivity gains as wage increases for employees, but had mainly lowered output prices and thus grown in relative size.[8]

Box 4.1 The effects of changing labour requirements and output growth on structural change

Employment (L) can be expressed as the multiple of real gross product (Y) and the reciprocal of labour productivity (ρ). Using this formulation, the degree to which structural change arises from shifting productivity rates and varying output levels between industries can be estimated.

Two sets of employment series were estimated for each of the 153 ANZSIC classes in 1999-2000:

- The first employment series ($\hat{L}_{i99}$) was derived by assuming that only labour productivity had changed since 1989-90 for each industry (i). Thus, $\hat{L}_{i99} = L_{i99|(Y_{i99}=Y_{i89})} = Y_{i89}/\rho_{i99}$.
- The second employment series ($\tilde{L}_{i99}$) was derived by assuming that only output had changed since 1989-90, so that: $\tilde{L}_{i99} = L_{i99|(\rho_{i99}=\rho_{i89})} = Y_{i99}/\rho_{i89}$.

A structural change index for the period between 1989-90 and 1999-2000 was derived using either $\hat{L}_{i99}$ or $\tilde{L}_{i99}$ as the last period values of employment. Structural change using the actual observed employment levels was 0.119, while it was 0.101 with $\hat{L}_{i99}$ and 0.132 with $\tilde{L}_{i99}$.

It should be noted that output changes and labour productivity changes may be linked themselves, which will tend to increase the importance of productivity differentials between industries when explaining structural change. The possible importance of the 'Salter mechanism' is discussed in the main text.

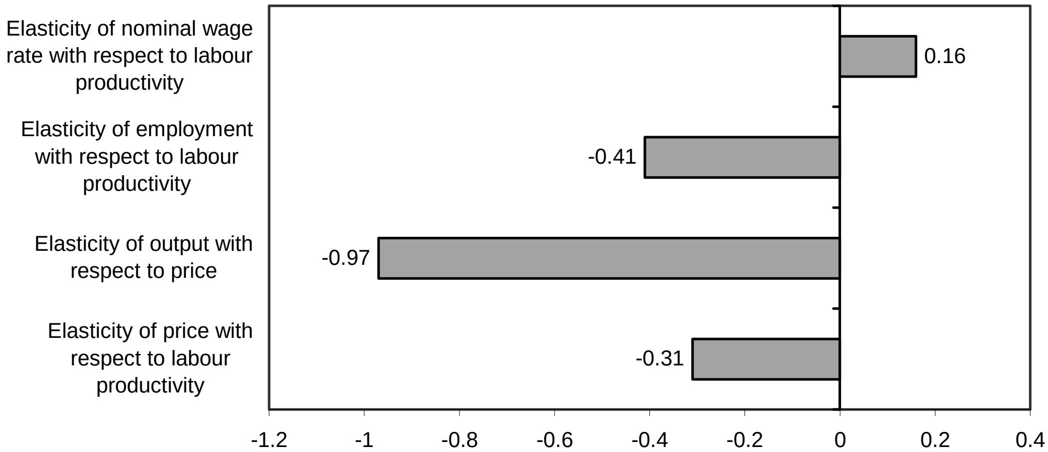
As contemporary data on capital stocks are not available on a highly disaggregated basis, it is not possible to examine the links between MFP change, prices, output and wages for the last decade. However, data on labour productivity, prices and

8 Even if labour productivity gains are distributed as wage increases in the short run, this is unlikely in the long run as labour is mobile between industries. Labour mobility limits inter-industry wage differentials. Accordingly, in the long run, differences in labour productivity growth rates between industries should be exhibited mainly as differences in relative output prices over time.

output provides some indication of the possible importance of the Salter mechanism as a driver of structural change in manufacturing. In particular:

- there is clear and statistically robust evidence that industries with above average labour productivity growth experienced below average increases in their gross output prices (figure 4.4). Differences in productivity growth rates explained between 30 and 40 per cent of the variation in output prices (appendix N). Since some of the observed labour productivity changes will reflect capital deepening rather than MFP growth, it is likely that the effect would have been stronger had MFP growth trends been available; and
- decreases in prices had significant effects on output, with a 10 per cent decrease in prices increasing output by between 7 and 10 per cent (figure 4.4 and appendix N).

Figure 4.4 **Links between productivity growth, prices and output**
Manufacturing, 1989-90 to 1999-2000



Data source: Appendix N.

However, despite the stimulatory effects of productivity-induced price cuts on output and thereby on labour requirements, the overall effects of increased labour productivity gains on employment are negative for Australian manufacturing over the last decade. This is in contrast to Salter’s findings for the UK, where productivity change and employment growth were positively correlated, but is in line with the findings of some later studies, such as Appelbaum and Shettkat (1995), for several other OECD countries. As found in past periods for Australia, the analysis reveals little relationship between nominal wage rate growth and productivity growth, which is consistent with long-term mobility of labour across manufacturing industries.

Overall, productivity change remains a powerful factor shaping structural change in manufacturing.

The impact of changing trade patterns

The Salter mechanism explains how demand effects arising from changes in relative price affect output in manufacturing. But it does not account for the effects on domestic production of shifts in tastes or, of more interest, the influence of changing patterns of international trade (box 4.2). Australia has become an increasingly open economy over the 1990s. This has reduced the importance of domestic demand on the growth of manufacturing and has been a significant source of structural change in manufacturing.

Box 4.2 **Trade effects on structural change**

A decomposition approach is a useful way of delineating which industries have been affected most by changing trading patterns and, accordingly, where trade has been an important contributor to structural change. The growth rate in real turnover in each manufacturing industry class can be expressed as:

$$\frac{\Delta Y_t}{Y_{t-1}} = \frac{S_t / P_t}{S_{t-1} / P_{t-1}} \times \frac{(1+e_t - m_t)}{(1+e_{t-1} - m_{t-1})} - 1$$

where S is total domestic demand (equal to turnover, plus imports, less exports), P is the price index for articles produced by manufacturing, e is the ratio of exports to total domestic demand (a measure of export orientation[9]) and m is the ratio of imports to total domestic demand (import penetration). The separate effects of changing domestic demand, import penetration and export orientation on ΔY/Y can then be broken down (approximately) by holding various elements of the above relationship constant. For example, the effect of changing export orientation on real turnover growth is:

$$\frac{\Delta Y_t}{Y_{t-1}} \Big|_{(S_t / P_t = S_{t-1} / P_{t-1}; m_t = m_{t-1})} = \frac{\Delta e_t}{(1+e_{t-1} - m_{t-1})}$$

Similar measures of the impacts on Australian manufacturing can be obtained for growth in real domestic demand and for import penetration. Results based on the decomposition are shown in table 4.5.

For manufacturing as a whole, domestic demand has been growing at a significantly stronger rate than real turnover in manufacturing, testimony to the increasing role played by imports in meeting demand (table 4.5).

9 This is different from export propensity, which is measured as exports to turnover of Australian manufacturing.

For some individual manufacturing industry classes, this effect has been accentuated.[10] For example, for the clothing and footwear industries, real turnover has declined significantly from 1989-90 to 1999-2000 (by 30 and 37 per cent, respectively), but domestic demand has increased modestly over this period (by 1 and 10 per cent, respectively). Thus, most of the contribution of these industries to structural change in manufacturing reflects their declining international competitiveness, rather than shifting demand patterns. Basic chemicals, Rubber products, Non-ferrous basic metal manufacturing and Transport equipment are in a similar vein.

In some cases, net trade impacts on manufacturing growth rates have been slight, either because:

- the goods are largely non-traded (such as for Tobacco products, Other wood products, Printing and publishing, Cement and non-metallic mineral products); or
- the pressures from increased imports have been offset by an increased export orientation, such as for Textile fibres and Photographic and scientific equipment. The underlying factors behind such increases in intra-industry trade are further explored in chapter 6.

Finally, in some cases, an increased export orientation has allowed some manufacturing industries to grow at rates appreciably above domestic demand. This has occurred only in areas linked to Australia's natural endowments of forests and food, such as dairy products, flour mills and log sawmilling.

Implications of structural change

The leading concern about structural change is its consequences for unemployment. The effects of economy-wide structural change — and the general shift away from output and employment in manufacturing to services — has already been explored in chapter 3. Structural change was found to be relevant, but not pivotal, to unemployment in the short run. Importantly, it had little bearing on long run unemployment.

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[10] Some caveats about the data should be noted. Trade data are less accurate below the subdivision level because of difficulties in matching commodities to industry groups and classes. Moreover, the ABS collect data on sales and trade data using different approaches, and time lags between the collections may vary. These data features suggest that the disaggregated measures of trade orientation in table 4.5 and in chapter 6 are indicative only.

Table 4.5 **Decomposition of real turnover growth in manufacturing**

1989-90 to 1999-2000[a]

3 digit ANZSIC industry	*Growth in real turnover*	*Growth in real domestic market*	*Change in export orientation*	*Change in import penetration*
	%	%	%	%
Meat and meat products	27.0	21.4	5.6	1.0
Dairy products	39.9	19.3	18.5	1.2
Fruit and vegetable processing	47.2	40.9	8.1	3.5
Oil and fats	-2.8	3.5	10.3	16.4
Flour mill and cereal foods	33.5	21.1	12.6	2.3
Bakery products	-11.8	-10.5	1.1	2.6
Other foods	35.6	55.3	-10.3	2.4
Beverages and malts	37.1	22.9	13.1	1.5
Tobacco products	-27.5	-27.0	1.7	2.4
Textile fibre, yarn and woven fabrics	2.8	-3.8	26.7	19.8
Textile products	-2.4	3.2	5.7	11.1
Knitting mills	-32.4	-17.9	5.7	23.3
Clothing	-30.4	0.7	3.3	34.1
Footwear	-37.4	9.8	2.7	45.7
Leather and leather products	3.7	-13.2	45.2	25.8
Log sawmilling and timber dressing	7.4	-2.6	9.1	-1.2
Other wood products	35.3	37.6	1.8	3.5
Paper and paper products	20.9	23.5	5.4	7.5
Printing and services to printing	50.5	50.5	0.9	0.9
Publishing	-9.6	-11.5	0.1	-2.0
Recorded media manufacturing and publishing	95.9	131.6	-0.8	14.6
Petroleum refining	-18.5	-29.3	19.4	4.1
Petroleum and coal products nec	235.8	676.5	-70.0	-13.2
Basic chemicals	19.1	41.8	6.9	22.9
Other chemical products	59.3	69.9	10.4	16.7
Rubber products	-9.9	10.1	6.2	24.3
Plastic products	25.6	32.0	2.4	7.2
Glass and glass products	-5.5	0.8	5.2	11.5
Ceramics	-1.1	1.3	4.6	6.9
Cement, lime, plaster and concrete products	15.4	15.3	0.2	0.1
Non-metallic mineral products nec	22.5	25.7	-0.2	2.4
Iron and steel	2.4	1.1	4.5	3.2
Non-ferrous basic metal products	-2.9	62.8	8.9	49.2
Structural metal products	23.6	25.4	-0.4	1.0
Sheet metal products	-5.4	-0.6	0.6	5.4
Fabricated metal products	6.3	18.1	2.5	12.5
Motor vehicles and parts	12.1	28.9	10.1	23.1
Other transport equipment	4.7	25.6	16.5	33.1
Photographic and scientific equipment	66.6	76.7	36.0	41.7
Electronic equipment	160.8	238.4	7.1	30.0
Electrical equipment and appliances	3.5	18.0	7.8	20.1
Industrial machinery and equipment	0.3	8.9	12.6	20.5
Prefabricated buildings	-34.2	-36.0	2.8	0.0
Furniture	4.5	13.8	1.0	9.1
Miscellaneous	-3.8	37.4	-12.3	17.7
Total manufacturing	**17.0**	**24.7**	**6.6**	**12.8**

[a] Data for non-ferrous basic metals are excluded because exports exceed turnover (reflecting under-enumeration of domestic activity due to commission work undertaken by other industries – see Industry Commission 1995, pp. 25-26). Exports and imports are on free-on-board basis.

Sources: ABS Censuses of Manufacturing (*Manufacturing Establishments,* Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and unpublished data on prices and trade from the ABS.

Nevertheless, there may be ‘hot spots’ of structural change *within* manufacturing that have significant implications for unemployment (and accordingly for adjustment policies). Structural change by itself need not have many implications for unemployment if employees move reasonably quickly to new jobs. Problems are more likely to arise if there are barriers to mobility, such as age, language, skill or locational specificity of a job. The characteristics of employees that lead to these barriers may also frustrate the capacity of managers to improve the efficiency of their businesses (for example, effective and affordable training may require a minimum standard of English proficiency or pre-existing skills). Consequently, the policy-relevant ‘hot spots’ are those where high rates of labour shedding coincide with obstacles to job mobility.

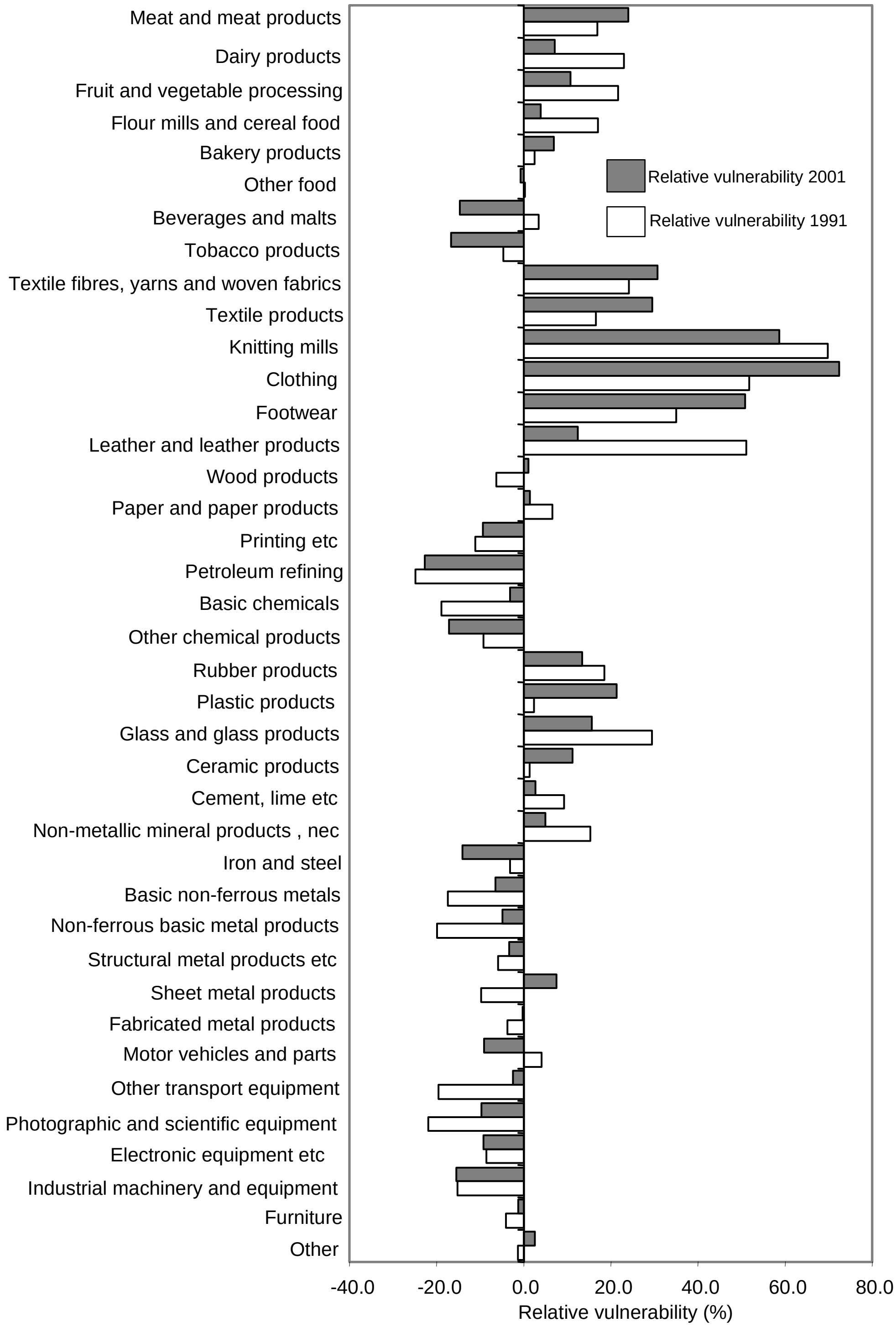
For example, in the Commission’s recent position paper (PC 2003c) on the textiles, clothing and footwear industries, it was found that some segments had characteristics likely to increase adjustment costs associated with job losses stemming from tariff reductions and increasing import competition. For instance, the majority of employees in the knitting mills and clothing manufacturing industries were born in countries where English is not the major language (compared with a minority in manufacturing as a whole). The Commission found that there was a much higher probability that an employee in the clothing industry was married, possibly decreasing the scope for geographic mobility.[11] The TCF sector, particularly the footwear and clothing industries, had a lower skill/education profile than manufacturing as a whole. Employees in this sector also tend to be older. Older workers, if displaced, tend to have greater difficulties in getting a new job and face greater constraints to geographic mobility than young people.

To identify possible areas where the potential for adjustment costs could be high, a measure of employer vulnerability was derived for all three digit manufacturing industries (appendix E and figure 4.5). The measure assesses the susceptibility of an employee in a given industry to continuing unemployment were they to lose their job. This susceptibility is based on an employee’s English proficiency, educational attainment and age — all of which are influential for labour market outcomes.

According to this index, workforces in the TCF industries stand out in terms of their relative vulnerability to change.

[11] Dockery (2000) finds lower mobility among female and married unemployed people.

Figure 4.5 **Relative vulnerability of employees to structural change**[a]



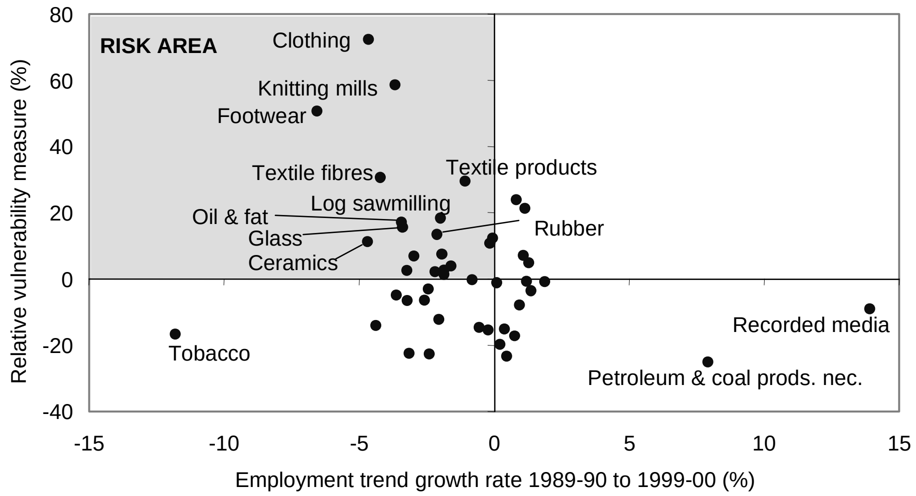
[a] Vulnerability measures susceptibility of employees to prolonged unemployment if they lose their jobs (appendix E). The indexes of vulnerability at the three digit ANZSIC level were then compared with the level for manufacturing as a whole to give a relative vulnerability measure for 1991 and 2001. Relative vulnerability is the difference between actual and average vulnerability.

Data source: Appendix E.

Adjustment costs are more likely to be experienced when an industry's workforce is vulnerable *and* the industry is declining. These conditions are found in several industries (figure 4.6), suggesting the potential for adjustment costs associated with change:

- the TCF industries — especially, Clothing, Footwear and knitting mills;
- oil and fat;
- log sawmilling;
- several non-metallic mineral products, such as glass and ceramics; and
- rubber products.

Figure 4.6 **Vulnerability and employment change**
Manufacturing



Data sources: Trends in employment data were obtained from the ABS Manufacturing Census, while the vulnerability measure is from appendix E.

Structural change and manufacturing performance

Quite apart from its dynamic effects on unemployment and other adjustment costs, it may be important to take into account structural change when interpreting the overall performance of manufacturing. One key area where this may be relevant is the productivity performance of manufacturing. As employment shifts between industry classes, it might move to classes with lower or higher productivity levels.[12] Aggregate productivity change in manufacturing will be a function of changes in productivity in each industry class and shifts between classes with different productivity levels.[13]

In fact, compositional changes in manufacturing explain very little of the change in aggregate labour productivity from 1989-90 to 1999-2000. Aggregate labour productivity gains in manufacturing largely represent the summed effects of labour productivity growth within the constituent manufacturing industry classes.[14]

Unfortunately, a long time series of real gross product is not available for manufacturing to assess whether the pattern for the 1990s held for preceding decades. However, there is some evidence that qualitatively it did so. Over the period from 1968-69 to 1991-92, *nominal* turnover per employee in manufacturing increased by around $86 000. Of this, about $82 000 (or 96 per cent) could be ascribed to the cumulative effects of increases in nominal turnover per employee at the industry class level and only $3 500 was due to shifts between industry classes.[15]

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[12] It should not be assumed that it is necessarily desirable to shift labour to activities that display higher labour productivity growth, since this ignores the important issue of whether there is sufficient market demand for additional output.

[13] That is, overall labour productivity change in manufacturing is a combination of changed productivity levels in each industry and shifts in industry shares:

$$\rho_t - \rho_{t-1} = \sum_{i=1}^{N} \left(\frac{S_{it} + S_{it-1}}{2}\right) \times \Delta\rho_{it} + \sum_{i=1}^{N} \left(\frac{\rho_{it} + \rho_{it-1}}{2}\right) \times \Delta S_{it}$$

where ρ is real gross product per employee and S is the employment share of each industry.

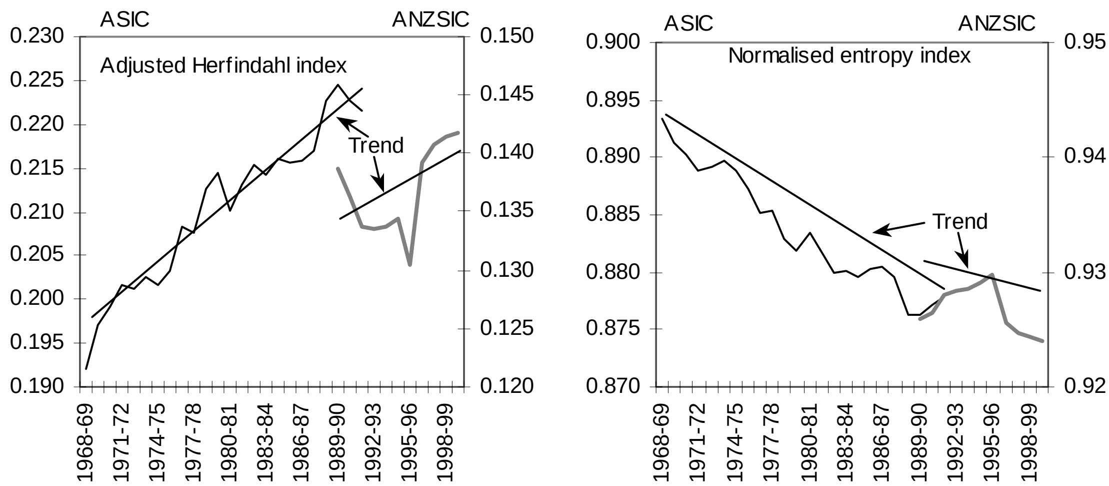
[14] These calculations are based on gross product and employment data from the ABS for the 153 ANZSIC classes. Of the improvement in labour productivity of around $17 000 per employee (in constant 1989-90 prices) from 1989-90 to 1999-2000, a little more than $17 000 reflected the effects of productivity change at the industry class level. The impact of shifts between industries at given productivity levels actually decreased productivity per employee by about $100 over the relevant period.

[15] Nominal turnover may be problematic because it incudes the effects of prices and changes in the value added to sales ratio. However, it is likely to give a rough indication of compositional impacts on aggregate manufacturing productivity. The results using nominal turnover for the period from 1989-90 to 1999-2000 were $50 723 due to changes in turnover per employee at the industry class level and -$2 788 due to shifts in employment across industry classes. These results give a qualitatively similar picture to that obtained using the real gross product data for the same period and reinforce the likely validity of using nominal turnover per employee for the period prior to 1992. The data on which these calculations are based are for 96 industry classes (that represent a concordance of the ANZSIC and ASIC data — appendix A).

4.4 Specialisation

Increased exposure to international trade increases the pressures on an economy to focus production on those activities in which it has a comparative advantage. Greater openness arising from reduced transport costs, falling barriers to trade and the general move to globalisation (chapter 6) suggest that specialisation might have increased over time in Australian manufacturing. To explore this, two measures of the extent to which activity in manufacturing has become concentrated in niches were estimated (figure 4.7) — one, the adjusted Herfindahl index, is a measure of concentration, and the other, the normalised entropy index, is a measure of diversification.

Figure 4.7 **Specialisation in Australian manufacturing**
1968-69 to 1999-2000[a]



a The measures were based on 142 industry classes for the ASIC-based data and 153 classes for the ANZSIC based data. The adjusted Herfindahl index (H) and entropy (ENTROPY) measures are defined as:

$H = 1 + \ln(\sum_{j=1}^{N} S_j^2 / \ln N$ and $ENTROPY = -\sum_{j=1}^{N} S_j \ln S_j / \ln N$ where N is the number of industry classes and S is the employment share of any class. Both measures are bound between zero and unity, except that the bounds are interpreted differently. In the case of H, it is bounded between zero (all equally sized industry classes) and unity (complete specialisation). In the case of the entropy index (which measures diversification), the bounds have the opposite meaning.

Data sources: ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and Industry Commission (1995).

Both measures, while differently constructed, point to an increasing tendency for specialisation. While potentially confounded by the shift to the ANZSIC system, it appears that the trend towards specialisation has been weaker in the 1990s than previous decades, though the difference is small and not statistically significant.

One possible explanation for the small difference is that the effective rate of assistance to manufacturing from border protection measures declined by more in the period from 1968-69 to 1989-90 than in the subsequent period.

4.5 Links between industries

While output growth rates of individual manufacturing industries have been highly variable, there may nevertheless be links between growth rates in one industry and those in others that reveal emerging patterns of advantage or disadvantage in manufacturing.

There appear to be many such links on the basis of annual growth rates in real value added from 1990-91 to 1999-2000 among the 153 four-digit ANZSIC industry classes. More specifically, there are 48 cases of positive correlations exceeding 0.8 and 34 cases of negative correlations below –0.8. For example, there is a high positive correlation in growth rates of Timber resawing and dressing and Pulp, paper and paperboard manufacturing. This may reflect forest harvesting practices whereby ‘prime’ logs are processed by sawmills, and secondary logs and sawmill residues are used to manufacture pulp for paper making.

On the other hand, there are 11 628 possible correlations between industries making up the four-digit ANZSIC classification.[16] Inevitably strong positive and negative correlations will emerge as a matter of mere chance. Thus, the fact that there is over a 90 per cent correlation in growth rates between printing and prefabricated building manufacturing not elsewhere classified seems likely to be a spurious correlation rather than an indicator of any real link.[17] In that context, it is hard to determine empirically which links are valid and which are numerical artefacts.

It might generally be expected that output growth would be more correlated among industries *within* an industry subdivision (which, by definition, have some common features) than between industries in *different* subdivisions. To measure such linkages:

[16] That is, 153 * 153 less the 153 correlations between the same industries, all divided by half because the correlation coefficient of industry j with i is the same as the correlation coefficient of industry i with j.

[17] Were growth rates to be purely random over time and between industries, it would be expected that there would be around 32 correlations above 0.8 and 32 below –0.8. The observed number of high positive correlations is consistent with some real associations (at the one per cent significance level), albeit even these could partly reflect the co-movement of some industries with general fluctuations in overall GDP, rather than genuine relationships between them.

- growth rates in real value added for 153 ANZSIC industry classes were correlated with each other; and then
- these were used to assess the relative strength of intra- and inter-subdivision links for nine industry subdivisions in manufacturing (table O.3 in appendix O).

On average, there are generally both low systematic (statistical) short run links between the performance of industry classes within the broader categories of manufacturing, and between classes in different subdivisions. For example, the average correlation between industry classes making up food, beverages and tobacco is only -2 per cent and it is close to zero against all other subdivisions too.[18] Only the industry classes making up the non-metallic mineral products subdivision have an average correlation with each other (and some other subdivisions) which is even modest.

One implication of this is that, over the short run, the economic forces that determine real growth rates of industries appear to be as different within an industry subdivision as they are between them. This suggests that measures of industry performance based on a subdivision's data should be seen as hiding a lot of unobserved variation within the subdivision — what applies to the whole certainly does not apply uniformly to the parts.

Similar results were obtained by assessing whether there were longer run links between industry classes (table O.4 in appendix O). While there were some apparent links, again there was no obvious tendency for these links to be stronger within an industry subdivision than between them.

4.6 Patterns in the regional distribution of manufacturing

The share of total Australian manufacturing activity accounted for by NSW and Victoria declined markedly over the last quarter century (table 4.6). The main

[18] One possibility is that there could be strong links between some subdivisions, but that high positive correlations between some classes are offset by high negative correlations between other classes in the same subdivisions (for example, this could arise if some industries within a group are substitutes and others are complements in demand). This could hide such associations. But when the absolute values of correlations are examined, the average correlation is around 25 per cent across all of the elements shown in table O.3. So the finding that there are no obvious special (short-term) links between industries *within* a subdivision compared with industries *between* subdivisions remains valid. Nevertheless, the average correlation is higher than would be expected if growth rates were purely random and independent. This would at least partly reflect the general tendency of industries to move with the business cycle.

reason for the fall in Victoria's share was the contraction in the TCF and machinery and equipment industries (appendix C). In NSW, the decline in clothing and footwear was also important, but was overshadowed by significant reductions in the metal products (mainly iron and steel) and machinery and equipment industries (principally other transport equipment and electrical appliances).

The shares of Queensland and Western Australia have increased, mainly because activity from all sectors has increased in these states — accompanying strong population growth. Metal products and petroleum, coal, chemical and associated products have been the strongest growing components.

Table 4.6 **Distribution of manufacturing value-added by State and Territory**

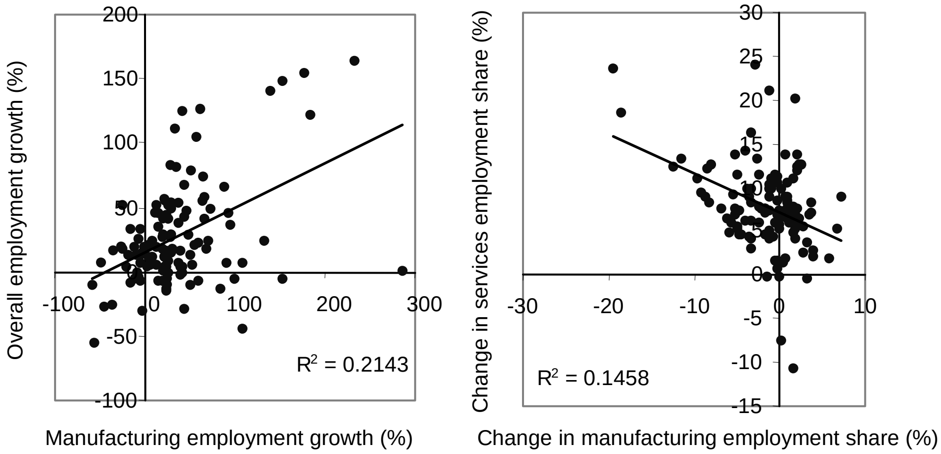
State/Territory	*Value added*			*Employment*		
	1977-78	2000-01	Change	1977-78	2000-01	Change
	%	%	points	%	%	points
NSW	38.1	32.1	-6.1	37.5	31.3	-6.2
Victoria	34.2	32.3	-1.9	34.6	31.9	-2.7
Queensland	10.4	14.3	4.0	9.8	16.1	6.4
South Australia	8.3	8.6	0.3	9.6	9.8	0.2
Western Australia	6.0	9.4	3.4	5.7	7.9	2.1
Tasmania	2.5	2.4	0.0	2.4	2.2	-0.2
Northern Territory	0.3	0.4	0.1	0.1	0.3	0.2
ACT	0.3	0.4	0.1	0.3	0.4	0.2

Sources: ABS (*Manufacturing Industry, Australia,* Cat No. 8221.0, 2003; *Manufacturing Establishments, Details of Operations by Industry Class Australia 1979-80*, Cat. No. 8203.0, 1981 (This has revised data for 1977-78).

Population Census data on 119 geographic areas of Australia from 1981 to 1996 reveal a complex story in the distribution of manufacturing within Australia. As noted in the previous chapter, some key regional manufacturing centres have experienced massive restructuring and contraction in manufacturing employment — such as Whyalla and Wollongong. But many areas (86 of 119 areas) have experienced growth in employment in manufacturing, though this is partly testimony to overall population and employment growth. (The association between employment growth in manufacturing and overall employment growth is apparent in figure 4.8.)

Figure 4.8 **Manufacturing employment growth patterns by geographic areas**

Australia, 1981 to 1996



Data source: Unpublished Population Census data for statistical divisions (SDs) and statistical subdivisions (SSDs).

Perhaps more surprising is that, despite the large reduction in the overall share of aggregate Australian employment accounted for by manufacturing, more than one-third of areas experienced an increase in the *share* of employment accounted for by manufacturing (46 of 119 areas). However, this was usually not associated with large employment gains:

- the aggregate increase in manufacturing employment from 1981 to 1996 in those areas where employment shares rose was just over 22 000 persons; while
- those areas experiencing a relative decline accounted for an overall decrease in manufacturing employment of just over 170 000 persons.

The geographic disparities are witness to the highly specific forces that determine employment and activity within industries. This facet of manufacturing emphasises a recurring theme in this report — an overall decline in manufacturing employment and shares does not mean that all the parts of manufacturing mirror the whole.

At the regional level, the strong negative association between (declining) growth in the employment share of manufacturing and the ascendancy of services found in aggregate time series data or at the international level is still apparent (figure 4.8), but is much less strong. Again, this reflects the fact that, in particular areas, other industries — such as mining and agriculture — show large variations in employment growth.

In 1981, a few major metropolitan areas accounted for most manufacturing activity in Australia. The top eight areas accounted for 80.5 per cent of activity.[19] Given that these areas are also the dominant population centres, this result is largely reflective of Australia's highly concentrated urbanised structure. However, over the ensuing years, manufacturing has become less geographically concentrated., with the top eight areas accounting for 74.2 per cent of total manufacturing employment in 1996.[20] This largely reflects the growth of manufacturing in Queensland and the reduction in importance of some regional industrial cities.

A related issue is whether there has been any changing tendency for areas to specialise in manufacturing relative to other sectoral activities.[21] The evidence suggests reduced specialisation in manufacturing across areas.[22] For example, in 1981 there were eight areas where manufacturing accounted for 24 per cent or more of area employment. By 1996, there was just one such area (Whyalla).

There is also evidence that, at the two-digit level, regional specialisation *within* manufacturing has also fallen over time.[23] This could have important implications for any impacts of future demand or supply shocks in manufacturing. This is because regional dependence on particular manufacturing activities, especially for non-capital cities, can increase labour market vulnerability. A particular question highlighted in the Productivity Commission's inquiry into textiles, clothing and footwear has been trends in regional dependence on this rapidly declining and already vulnerable sector (PC 2003c, pp. 46-51). The evidence suggests declining regional dependence on the TCF industries. For example, in 1981, there were 27 areas (of 119) in Australia where the most vulnerable segment — clothing and

[19] In order of importance, the Melbourne, Sydney, Adelaide, Brisbane, Perth, Newcastle, Wollongong and Greater Geelong SSD or SDs.

[20] These are the same areas in 1981, except that Geelong has been replaced by the Gold Coast and Brisbane and Adelaide have swapped places in the rankings. Using the adjusted Herfindahl measure of concentration of manufacturing across areas in Australia (AH), AH was 0.153 in 1981 and 0.122 in 1996.

[21] This is separate from the issue of concentration of manufacturing across areas. It would be possible to have less concentration of manufacturing across a few areas if some areas grew much more than others, even if the degree of specialisation were to increase.

[22] Based on a measure of dispersion of the shares of area employment in manufacturing. Across the 119 areas, the coefficient of variation of these shares was 0.66 in 1981 and 0.49 in 1996.

[23] Adjusted Herfindahl indexes of concentration (AH) were calculated for activities within manufacturing for each of the 119 areas for 1981 and 1996. In a regression it was found that AH(1996) = 0.04 + 0.53 AH(1981), suggesting weaker specialisation. This does not contradict the findings elsewhere in this chapter that specialisation within industries has tended to increase in manufacturing over time. First, that finding was based on four-digit data, which allows more scope for specialisation to be revealed. Second, regional economies may diversify their activities, even if particular activities are accentuated when all regional activity is aggregated.

footwear — accounted for more than five per cent of manufacturing employment in an area. By 1996, there were only 18 such areas. On average, outside the major capital cities, dependence on clothing and footwear as an employment source more than halved from 1981 to 1996. A weaker, but still significant decline in regional dependence on basic metal products — another industry subject to significant pressures — was also apparent.

5 The manufacturing labour market

Key points

- Manufacturing has generally lower average levels of education among its workforce than other sectors.
- The sector has exhibited strong growth in educational attainment over the last 15 years, reflecting skill-based technological change and shifts in employees' educational preferences and practices.
  - but skilled occupations have grown more slowly than in other sectors, mainly as a result of the relative decline in high skill blue collar occupations.
- Manufacturing firms typically undertake less structured training and spend less on training as a share of wages and salaries than other industries. But they are more likely than the average to have apprenticeships and trainees, and to use unstructured training.
- Real earnings per employee in manufacturing are high relative to other sectors, but this reflects longer hours rather than higher wage rates.
  - on average, real wage rates are actually lower in manufacturing than elsewhere.
- The average duration of jobs — a measure of job stability — is higher in manufacturing than other sectors and has been growing over time.
- Casual jobs, fixed term contracts and self-employment have a relatively low incidence in manufacturing compared with the average.
  - but such employment forms have been increasing rapidly in manufacturing, as in the economy generally.
- Days lost from industrial stoppages have fallen dramatically in manufacturing from peak levels in the mid 1970s.
- Union membership rates have also declined, with the rate of decline accelerating in the 1990s.
- Manufacturing workplaces are now much safer than in the past. Over the period from 1992-93 to 2000-01, new compensation cases per million hours of work fell by 39 per cent.
  - To put accidents into perspective, time lost from work-related health problems in manufacturing exceeded that due to industrial stoppages by a factor of seven.
- The share of employment accounted for by small businesses have increased over the long term.

Over the last few decades, manufacturing has generally followed similar labour market trends as other Australian sectors. Hours of work have increased for full time employees, but part time and casual work have increased in importance. Unionisation has declined. Wages have risen by about the same as in other sectors. Skilled employment has become more important, requiring greater educational requirements and changing the occupational mix of jobs. Despite popular impressions of increasing job instability, the average duration of jobs has increased. Industrial stoppages have fallen.

It is not surprising that, in broad terms, these features are common across sectors. They reflect forces that operate throughout the economy and, in some cases, globally. Labour mobility, while not perfect, reduces variations in wages or conditions across sectors in the Australian economy (after controlling for skills or other firm, worker or industry-specific factors that affect labour market outcomes). Technological change has shifted the relative demands to skilled rather than unskilled labour and, with other factors, has affected educational attainment and occupational mixes in all industries. And institutions and laws governing industrial relations have changed for all employees.

Nevertheless, while there are many common elements to labour market developments in manufacturing and other sectors, it is important to recognise that there are also differences, both between manufacturing and other sectors and, more strikingly, within manufacturing. It is also important to examine the nature of jobs in manufacturing — such as their pay levels compared with the service and other sectors and their relative precariousness — because perspectives on these features are often based on myths rather than facts.

As employment levels have been examined in the previous chapter, this chapter concentrates on other aspects of the labour market, such as skill and educational attainment, training, wages, job intensity, job stability, non-traditional employment, industrial disputes and occupational health and safety (OH&S) issues. These features of jobs and labour markets provide insights into job 'quality' in manufacturing compared with other sectors — and help dispel opposing myths about manufacturing as either 'old economy', 'dark satanic mills'[1] or, through the tangibility of its outputs, one of the few repositories of 'real' or 'good' jobs.[2]

[1] For example, in 2002, the UK Manufacturing Foundation expressed concerns that adverse attitudes to manufacturing were affecting recruitment, originating from false impressions about it being an 'old economy' 'smokestack' sector (http://www.manufacturingfoundation.co.uk/pdf/inv-tender-attitudes-to-manufacturing.pdf). Similarly, Weersing (2002) considers negative and inaccurate impressions of manufacturing present barriers to employment in the sector.

[2] McLachlan et al. (2002, p. 40) cite and criticise this perspective when looking at service jobs.

5.1 Skill and education

Manufacturing has generally lower average levels of education among its workforce than other sectors (table 5.1). The proportion of the manufacturing workforce with:

- university training is around half that for the workforce generally; and
- no post-school qualifications is somewhat higher than for employees generally (by around 5 percentage points).

Table 5.1 **Educational attainment in the Australian workforce**

1984, 1994 and 2001[a]

Industry/sector	*University degree*			*Other post-school qualifications*			*Without post-school qualifications*		
	1984	1994	2001	1984	1994	2001	1984	1994	2001
	%	%	%	%	%	%	%	%	%
Agriculture	2.3	4.5	6.3	24.6	25.6	30.1	73.1	70.0	63.6
Mining	8.1	14.4	21.0	91.9	35.8	40.3	..	49.8	38.7
Manufacturing total	4.5	7.2	11.2	35.3	37.4	39.1	60.2	55.5	49.7
Food, beverages and tobacco	4.5	5.8	11.4	28.5	26.9	29.7	67.0	67.3	59.0
Textile, clothing, footwear & leather	1.9	4.7	7.7	17.3	20.6	26.8	80.8	74.7	65.5
Wood and paper products	2.2	3.0	8.5	36.4	39.9	35.7	61.4	57.1	55.8
Printing publishing & recorded media	6.5	8.1	16.4	43.2	41.3	40.1	50.3	50.7	43.5
Petroleum, coal, chemical etc	10.8	15.3	21.3	30.9	35.2	32.3	58.3	49.5	46.4
Non-metallic mineral products	4.6	6.8	10.2	30.5	28.7	34.1	64.9	64.4	55.7
Metal products	3.0	4.4	7.3	39.9	47.1	47.0	57.1	48.5	45.7
Machinery and equipment	4.7	9.9	10.9	44.0	44.5	48.9	51.3	45.6	40.2
Other manufacturing	4.6	5.4	6.8	40.2	33.8	42.6	55.1	60.8	50.5
Electricity, gas & water supply	8.4	13.6	24.5	45.3	50.5	45.1	46.3	35.9	30.4
Construction	2.4	3.2	6.2	51.8	54.0	52.8	45.8	42.9	41.0
Wholesale and retail trade	3.6	5.2	7.4	34.2	34.9	37.9	62.2	59.9	54.7
Transport & storage	4.4	5.7	7.9	36.6	31.3	32.8	59.0	63.0	59.3
Communication services	..	11.6	15.4	..	31.9	33.3	..	56.5	51.3
Finance, insur., property & business	15.5	22.1	31.7	29.4	30.1	28.6	55.1	47.8	39.7
Government admin & defence	27.1	25.3	33.9	41.2	27.8	29.4	31.7	46.9	36.7
Health, education and community	4.3	35.3	46.4	34.2	33.8	30.3	61.4	30.9	23.4
Cultural, recreational, personal & accommodation, cafes etc	14.4	7.1	13.4	33.4	35.1	36.4	52.2	57.8	50.2
Total	9.6	14.6	20.3	35.9	35.0	35.3	54.5	50.4	44.3

[a] Other post-school qualifications include vocational training and all other non-university diplomas and certificates. It also includes (the small populations of) people who are still at school. These estimates relate to the highest educational attainment, regardless of whether the worker is using this education on the job or otherwise. Data are based on survey information, and so information for manufacturing subdivisions is less reliable than for divisions. The 1994 and 1984 data were based on ASIC categories. A concordance between ASIC and ANZSIC based on three digit data for manufacturing was used to match the data sets. The concordance is generally satisfactory, except for other manufacturing.

Source: Unpublished data from the ABS.

On the other hand, manufacturing has a relatively high intensity of engineers and, to a lesser extent, scientists. For example, manufacturing employs around 30 per cent of Australia's engineers, about three times the intensity of all industries (Borthwick and Murphy 1998). Manufacturing is also the major location for business R&D

activity, with associated expert personnel. Of the total person years of R&D undertaken for economic development purposes by business in 2000-01, just under 50 per cent were undertaken in manufacturing.[3]

So manufacturing presents a picture of contrasts — it has education-intensive areas associated with research, design, and development and the use of complex manufacturing processes or products, while it also has low skill activities, such as repetitive assembly work. High education intensities are concentrated in particular segments of manufacturing, such as Pharmaceuticals and Scientific and medical instruments. Other sectors, particularly Textiles, clothing and footwear and Food, beverages and tobacco, make more intensive use of less educated workers.

In the economy generally, the importance of educated employees appears to be increasing. Between 1984 and 2001, the educational standard of the entire workforce increased considerably, with the proportion of university graduates more than doubling and the proportion of employees without any post-school qualifications falling by around 10 percentage points (table 5.1).[4]

Manufacturing has exhibited a similar, but somewhat stronger, growth in educational attainment in its workforce. In general, those manufacturing industries with low average levels of educational attainment amongst their workforces in 1984 have experienced the greatest percentage increases in the share of highly educated employees. For example, the share of university trained employees increased by about four-fold between 1984 and 2001 in textiles, clothing, footwear and leather and wood and wood products, two industries with very small initial bases of such employees. This is double the economy-wide rate of increase.[5]

There are several competing hypotheses about the origins of this broad shift in higher educational attainment in the workforce:

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3 12 113 person years of a total 24 912 person years (ABS *Research and Experimental Development, All Sector Summary 2000-01*, Cat. No. 8112.0).

4 It should be noted that many workers without post-school qualifications have finished high school, whereas others with vocational qualifications did not complete high school. But what matters here is not length of schooling, but the fact that vocational staff received more technical training than those who did not pursue further training after high school.

5 This general pattern of convergence in educational attainment rates was confirmed using some simple regression analysis. For 19 industries/sectors (excluding communications where initial data were missing and health and education which was an outlier), a regression was estimated showing that the higher the initial base, the lower the subsequent growth rate: $(\log S_{2001} - \log S_{1984}) = 1.35 - 0.33 \log S_{1984}$ where S is the share of university trained employees (with an R^2 of 0.46 and a t statistic on the initial share of 3.8).

- some of the shift may reflect changes in people's education and training practices and preferences, rather than industry-demand driven requirements for more educated workers;

- structural adjustment might explain some of the shift, so that industries and sectors with higher (lower) levels of education intensity may have grown faster (slower). This is called the 'between' industry effect (De Laine et al. 2000). For instance, this might arise if increased trade pressures reduced relative employment in low skill, labour intensive manufacturing; and

- skill-based technological change may have generally increased the requirements for higher skilled employees across all industries — the 'within' industry effect.

Using a measure of high skill, De Laine et al. find that the 'within' effect accounted for about 40 per cent of the increase in high skill employment rates in the Australian economy from 1978-85, and 80 per cent of the increase from 1986-98. This is an indicator of the increasing pervasiveness of requirements for more skilled employees. For manufacturing, they find evidence that skill-based technological change is even more pervasive, with 'within' effects accounting for 79 per cent and 98 per cent of the increase in high skill rates between 1978-85 and 1986-98, respectively.

These trends also apply to university education rates. For the economy as a whole, 92 per cent of the increase in university education rates from 1984 to 2001 is explained by within industry effects. For manufacturing, the comparable estimate is 95 per cent.[6] Thus, different measures of skill and educational attainment are suggestive of the wide-ranging impacts of skill-based technological change in all industries, not just those that are often perceived to be 'high technology'.

A more complex story about skills emerges when occupational data are examined (table 5.2). High skill white collar employees have increased in manufacturing at around the same rate as in the rest of the economy. However, whereas the driving force behind this change in other sectors has been the growth in the occupational share of professionals and associate professionals, the main source of growth in white collar workers in manufacturing has been in management and administration.[7] Overall, skilled occupations in manufacturing have increased at

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[6] The decomposition into within and between industry effects is described in De Laine et al. (2000, p. B.1). Unpublished ABS Labour Force data were used for employment estimates to calculate employment shares.

[7] In manufacturing, the share of management and administration has increased by over 55 per cent (from 5.6 to 8.7 per cent of the manufacturing workforce), whereas the share has decreased by about 10 per cent for other sectors. In contrast, professionals and associate professionals have

around half the rate of other sectors. This reflects the relative decline in high skill blue collar occupations (for example, tradespersons), which play a more important role in manufacturing than elsewhere.

Table 5.2 **Occupational skill mix in Australia[a]**

Skill classification	*1986-87*		*2000-01*		*Change[b]*	
	Manuf-acturing	All other sectors	Manuf-acturing	All other sectors	Manuf-acturing	All other sectors
	%	%	%	%	%	%
Total high skill	49.2	53.9	51.9	59.6	5.5	10.5
High skill white collar	18.9	38.3	23.0	45.8	21.3	19.5
High skill blue collar	30.2	15.6	28.9	13.8	-4.4	-11.6
Total medium skill	23.4	13.9	21.8	11.9	-6.8	-13.7
Medium skill white collar	2.7	5.0	2.3	3.8	-15.7	-23.6
Medium skill blue collar	20.7	8.8	19.5	8.1	-5.7	-8.1
Total low skill	27.4	32.2	26.3	28.4	-4.0	-11.7
Low skill white collar	12.2	23.7	9.9	22.1	-19.1	-6.7
Low skill blue collar	15.2	8.5	16.5	6.3	8.1	-25.6

[a] Data refer to the number of employees only and therefore exclude employers and own-account workers. Data for 1986 are estimates based on the first Australian Standard Classification of Occupations (ASCO1) data. These have been concorded to their closest ASCO2 category. High skill white collar jobs are defined as management, professionals and associate professionals. Medium skill white collar jobs are defined as advanced clerical, sales and service jobs. Low skill white collar jobs are defined as intermediate and elementary clerical, sales and service jobs. High skill blue collar jobs are defined as trades persons and related jobs, Medium skill blue collar jobs are intermediate production and transport jobs, while low skill blue collar jobs are labourers and related workers. [b]The change is the percentage change (not percentage points) in the ratio of various occupational groups.

Source: Unpublished Labour Force data from the ABS.

At the other end of the occupational skill spectrum, there has been a reduction in the importance of low skill workers in manufacturing, albeit not as marked as that occurring in other sectors. But, unlike other sectors where the share of unskilled blue collar workers has fallen dramatically, unskilled blue collar workers have actually increased in relative importance in the manufacturing labour force. The overall reduction in importance of low skilled workers in manufacturing stems from the large decrease in unskilled white collar workers (for example, clerical workers).

It is possible that some of these changing occupational patterns reflect outsourcing, with manufacturing firms increasingly outsourcing both routine low skill white collar work (such as records management) and professional services (such as marketing and design). To that extent, it suggests that the apparently slower growth in skills in manufacturing may be partly illusory, simply reflecting the changing boundaries of firms in the sector (chapter 3).

increased by only around seven per cent in manufacturing, compared with 30 per cent for other sectors.

Training

A major component of intangible investment by firms is in the formal and informal training of their workforces. Increases in human capital achieved through training can facilitate productivity improvement and technological diffusion in firms and the economy at large (Blandy et al. 2001).

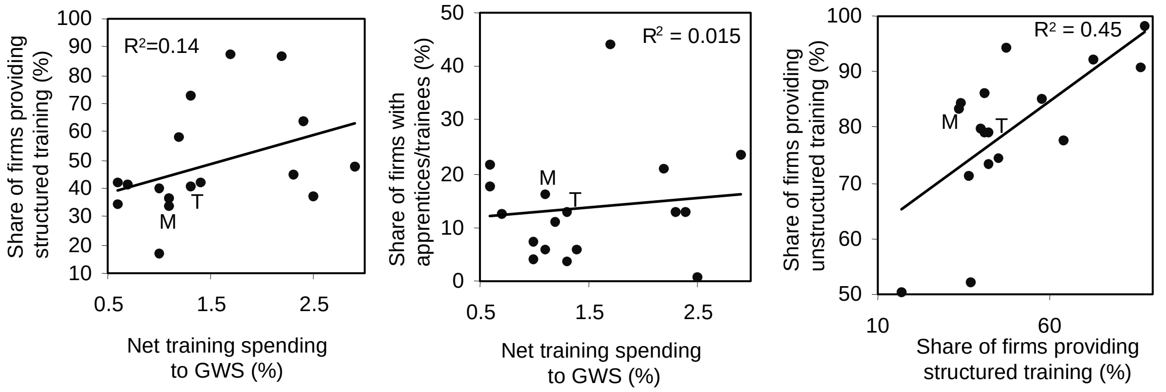
Training intensities are also an indicator of the changing nature of industries, providing insights on their uptake of technology, the sophistication of their workplace activities and the degree to which decision making is devolved to employees. For example, using the Business Longitudinal Study, Dockery (2001) found that innovative firms and those introducing new technologies or other new business practices were more likely to train workers than other firms (with training as the result, not the trigger, for change).

Training also reflects the nature of labour markets in which firms are placed. Training intensities are usually lower for firms employing transitory employees (reflecting difficulties for the firm appropriating the returns from training) and in low skill jobs (where on-the-job learning is often achieved quickly, so that further training has relatively modest payoffs).

Existing evidence on training intensity suggests that firms in manufacturing typically undertake less structured training and spend less on training as a share of wages and salaries than other industries (figure 5.1 and table 5.3).

Figure 5.1 **Links between different training measures in Australian industry**

2001-02[a]



a See table 5.3 for definitions. R^2 refers to the degree of variation in either of the variables in a plot explained by variation in the other. M denotes manufacturing and T total for all sectors.

Data source: See table 5.3.

Table 5.3 Key training indicators, Australian industry, 2001-02[a]

Industry	Gross spend	Net spend[a]	Net spend per worker	Net spend to GWS[b]	A/T share[c]	Share of employers providing training[d]		
						Any	Structured	Unstructured
	$m	$m	$	%	%	%	%	%
Mining	121	119	1643	2.3	12.7	76.2	45.2	74.3
Manufacturing	429	395	434	1.1	16.3	83.3	33.6	83.2
Electricity, Gas and Water Supply	80	74	1279	2.2	21.1	90.9	86.7	90.7
Construction	120	93	208	0.6	21.6	75.7	42.0	73.4
Wholesale Trade	248	235	422	1.1	6.0	71.8	36.5	71.1
Retail Trade	194	151	127	0.6	17.6	86.4	34.1	84.5
Accommodation, Cafes & Restaurants	71	57	147	0.7	12.6	91.5	41.3	86.3
Transport and Storage	132	120	426	1.0	4.1	52.3	17.0	50.4
Communication Services	146	144	1279	2.5	0.7	52.3	37.1	52.3
Finance and Insurance	408	401	1323	2.4	12.9	81.5	64.0	77.5
Property and Business Services	652	614	537	1.4	5.8	82.4	42.2	79.0
Government Administration & Defence	289	265	719	1.7	44.0	98.2	87.5	98.2
Education	356	317	479	1.3	3.7	93.3	72.9	92.1
Health and Community Services	437	355	383	1.2	10.9	85.2	57.9	85.2
Cultural and Recreational Services	63	56	225	1.0	7.3	80.0	39.7	79.7
Personal and Other Services	271	256	859	2.9	23.5	94.5	47.5	94.5
Total	**4018**	**3653**	**458**	**1.3**	**12.9**	**81.1**	**41.0**	**79.2**

[a] Net spending is gross spending less subsidies or payments made by employees of other organisations to attend in-house training courses. [b] GWS are gross wages and salaries. [c] The A/T share is the share of employers with apprentices or trainees. [d] Structured training has a specified content or a pre-determined plan designed to increase competencies, while unstructured training is all other kinds.

Source: ABS (*Employer Training Expenditure and Practices, Australia, 2001-02,* Cat. No. 6362, April).

On the other hand, manufacturing firms are more likely than the average to have apprenticeships and trainees, and to use unstructured training. Spending intensity, the incidence of structured and unstructured training and apprenticeships reflect generally different dimensions of training within firms. As a consequence, these different facets of training are generally weakly correlated (figure 5.1).

It appears that the choice of training mode depends on the occupational and educational mixes of sectors (table 5.4). Accordingly, on the basis of simple bivariate correlations:

- sectors with fewer labourers and more diploma-educated employees tend to have higher spending on training as a share of wages;
- sectors with relatively more labourers, tradespeople and those with skilled vocational qualifications are more likely to have a higher incidence of apprenticeships; and

- structured training is strongly positively associated with a higher relative incidence of university trained employees and professionals, and strongly negatively associated with a higher incidence of employees with no post-school qualifications and intermediate production workers.

Table 5.4 **Links between training and employee characteristics**

Correlations between training mode and occupational and educational mixes of sectoral workforces, 2001-02[a]

Occupational or educational attainment category	*Net training spending share of GWS*[b]	*Employers with apprentices or trainees*	*Provided training to employees*	*Provided structured training to employees*
	ρ	ρ	ρ	ρ
Occupational category				
Professionals	0.08	-0.22	0.31	0.48
Associate professionals	0.08	0.14	0.37	0.04
Trades	-0.13	0.27	-0.04	-0.18
Advanced clerical	-0.03	0.07	-0.19	0.04
Intermediate clerical	0.09	0.15	0.12	0.29
Intermediate production	0.01	-0.21	-0.71	-0.53
Elementary clerical	-0.08	-0.17	-0.28	-0.36
Labourers	-0.42	0.29	0.21	-0.28
Educational attainment				
University degree	0.20	-0.05	0.41	0.67
Skilled vocational qualification	0.00	0.26	-0.14	-0.13
Basic vocational qualification	-0.13	0.09	0.06	-0.08
Diploma	0.37	-0.21	0.15	0.39
No post school qualification	-0.21	-0.14	-0.49	-0.72

[a] The table shows correlation coefficients (ρ) of training measures by sector with the shares of various occupations and education attainment categories by sector. For example, the ratio of net training expenditure to gross wages and salaries among different sectors has a negative 42 per cent correlation with the share of labourers in the sectoral workforces. The data for training, occupational and educational attainment relate to slightly different periods (namely 2001-02, 2000-01 and 2001, respectively). [b] GWS is gross wages and salaries.

Source: See tables 5.1 - 5.3.

These findings suggest that it is not appropriate to regard a simple metric — such as the ratio of training expenditure to wages or the incidence of structured training — as a basis for judgments about the relative performance of manufacturing in training their employees. Unstructured training and learning on the job are important sources of learning (as demonstrated by evidence about the general benefits of experience, after controlling for training), but are difficult to measure in expenditure terms. The capacity for productive unstructured training is likely to vary by industry. Thus, comparisons between industries of training based only on structured training favours those industries where structured training is the preferred mechanism for learning.

The occupational and educational mix of the manufacturing workforce suggests that structured training and expenditure to wages are likely to be less than the average for the workforce as a whole. To test this more thoroughly, a multiple regression model was constructed for each of the four training measures in table 5.4, with explanators based on selected occupational and educational share variables. This then enabled an assessment of whether, *given its occupational and educational attainment structure*, manufacturing had a higher or lower level of training than expected. The results suggested that, after controlling for these variables, manufacturing had:

- a statistically significant higher training spending to wage ratio than the average; and
- a statistically significant higher incidence of all training (whether structured or unstructured) than the average.[8]

Although the available data are limited, the findings do not support the notion that, based on simple comparisons of training measures between sectors, training is excessively low in manufacturing.

Quite apart from the comparison between manufacturing and other sectors, an area of emerging concern has been training expenditure over time. For example, Buchanan and Watson (2000) consider that falling employer-funded training intensities are a serious issue for skill formation. However, their analysis predates more recent information on training expenditure, which might be useful for painting a longer term picture of training.

Unfortunately, while ABS surveys on training undertaken by business are available for several years[9], the evidence on training intensity over time is dogged by several data comparability problems. For example:

- unlike past surveys, the 2001-02 ABS survey used net expenditure over a financial year as the measure of spending[10] and did not include wages and salaries paid to employees while undertaking training;

[8] It was also found that, after controlling for occupational and educational attainment, manufacturing had a higher incidence of structured training and a lower incidence of apprenticeships than the average, but neither result was statistically significant.

[9] 1989, 1990, 1993, 1996 and 2001-02.

[10] Not gross spending over a reference quarter as in past surveys.

- the 2001-02 survey did not include data on hours of training received, so no longer term comparison of training based on hours of training over time is possible; and
- surveys prior to 1996 were based on the ASIC, not ANZSIC, classification.

Nevertheless, after taking account of major changes to the basis for survey collections, it appears that the economy-wide ratio of training expenditure to gross wages and salaries has remained roughly stable over time (table 5.5). The rise in 1993 and the decline in 1996 are likely to partly reflect the impacts of the introduction and suspension of the Training Guarantee Levy. The training intensity in manufacturing increased relative to the average from 1990 to 2001-02, but unlike the economy as a whole, shows no increase from 1996 to 2001-02.

Table 5.5 **How much do employers spend on training?**

Gross training expenditure by employers as a share of gross wages and salaries[a]

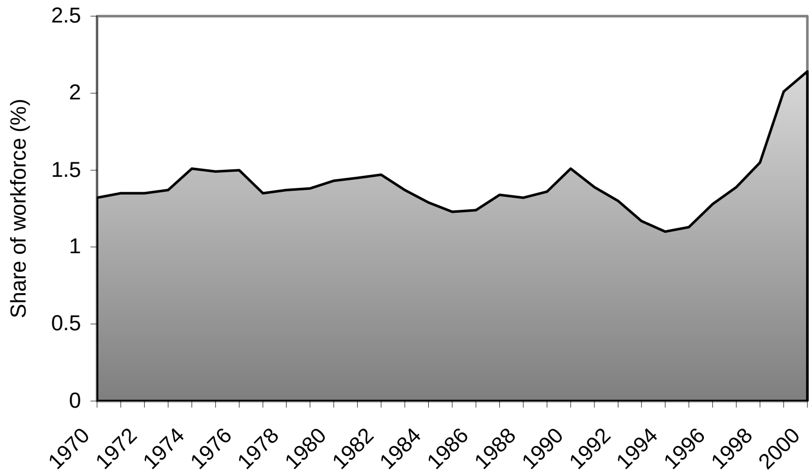
Industry	*1990*	*1993*	*1996*	*2001-02*
	%	%	%	%
Mining	2.2	2.7	2.9	2.3
Manufacturing	1.0	1.4	1.2	1.2
Electricity, Gas and Water Supply	2.1	2.4	2.6	2.4
Construction	0.6	0.9	0.5	0.8
Wholesale Trade	1.6	2.0	1.5	1.2
Retail Trade	0.5	0.6	0.9	0.8
Accommodation, Cafes and Restaurants	0.5	0.8	0.6	0.9
Transport and Storage	1.5	1.4	2.2	1.1
Communication Services	2.2	3.3	1.9	2.5
Finance and Insurance	2.9	1.8	1.7	2.4
Property and Business Services	1.4	2.0	1.5	1.5
Government Administration and Defence	1.8	1.9	1.9	1.9
Education	..	1.2	1.4	1.5
Health and Community Services	1.0	1.3	1.2	1.5
Cultural and Recreational Services	1.1	1.8	1.4	1.1
Personal and Other Services	0.7	1.1	2.3	3.1
Total	**1.3**	**1.5**	**1.2**	**1.4**

[a] A number of adjustments to survey data were made to produce a reasonably consistent series over time. The major ones were as follows. First, 2001-02 data were converted to gross expenditure on training (by multiplying the net spending to gross wages and salaries (GWS) by the ratio of gross to net spending for each sector). Second, wages and salaries paid to employees while undertaking training were subtracted from survey estimates of spending for 1990, 1993 and 1996 to give consistency with the 2001-02 survey. While survey data were available on these values for 1990 and 1993, such wage and salary expenditure was estimated for the 1996 survey by multiplying the average hours of training by an average wage for each industry. Third, data for 1990 required minor interpolation for some sectoral divisions to match the ANZSIC basis on which information was available for later years. Fourth, the 1993 data use information from the original 1993 data and the re-estimated 1993 data supplied by the ABS in its 1996 survey to derive overall 1993 estimates.

Sources: ABS (various issues) *Employer Training Expenditure, Australia*, Cat. No. 6353.0 and ABS *Employer Training Expenditure and Practices, Australia, 2001-02*, Cat. No. 6362.0.

Apprenticeships and traineeships play a particularly important role in skill formation in production and trades activities in manufacturing and other trades-intensive sectors.[11] Numbers in the workforce were declining rapidly in the early 1990s, but have since experienced a (principally trainee-led) boom (figure 5.2).

Figure 5.2 **Apprentices and trainees in Australia**
Share of the population aged 15-64 years, 1970-2000



Data source: National Centre for Vocational Education Research (NCVER) 2001 from http://www.ncver.edu.au/research/proj2/mk0008/growth.htm#fig1.

Summing up

The evidence on skill formation — undertaken privately by employees, sponsored or undertaken by employers, and through subsidised arrangements — suggests relatively strong economy-wide investment in human capital. But, such investment has been generally weaker in manufacturing.

Interpreting this lower investment is difficult. It may be symptomatic of under-investment in training in manufacturing — reflecting the possible effects of imperfect information about the benefits of training and difficulties for employers in appropriating the benefits of general training. On the other hand, a judgment that there is a training problem in manufacturing that requires intervention would be premature. Lower investment could reflect efficient differences in skill formation between manufacturing and other sectors (box 5.1).

[11] 16.3 per cent of manufacturing employers had apprentices or trainees compared with 12.9 per cent for all sectors (ABS, *Employer Training Expenditure and Practices, Australia, 2001-02,* Cat. No. 6362).

Box 5.1 **Differences in training intensities between industries can be efficient**

In making comparisons over time or between industries, it is important to emphasise that, while training expenditure may produce significant benefits for business and the economy, more may not always be better. A high rate of training in one industry or at one time, even standardised for occupational and educational employee characteristics, may not be superior to a lower rate in another industry:

- Differential training intensities can reflect differences in subsidies provided for training or differences in the mechanisms by which training is supported. As noted by Dumbrell (2002), subsidy rates appear to differ sectorally, while subsidies or regulations encouraging training vary through time.
- Regulation or business licensing requirements may compel structured training in some sectors, but not others.[12] To the extent that differential regulations are optimal, then they will create optimal differences in the incidence in training between sectors. If the regulations are not optimal, then they lead to underinvestment in some sectors or overinvestment in others, depending on the nature of the deficiency in their design.
- Increasing investments in human capital are likely to be associated with diminishing marginal productivity at some point, with that point varying with the nature of the firm, employee and industry. To demonstrate that a lower training rate was inefficient compared with a higher training rate it would need to be shown that a greater investment in training would produce a sufficient economic payoff. It is revealing that there is a strong negative correlation between sectoral training intensity and the share of employees that identify a low need for training.[13] These results suggest that, at least some, intersectoral differences in training intensity are likely to be an efficient outcome.

[12] For example, weaker legislative, regulatory or licensing requirements for structured training may partly explain the lower relative level of such training in manufacturing. On average, 30.9 per cent of manufacturing employers saw such requirements as a reason for structured training (compared with 38.1 per cent for all sectors — ABS Cat. 6362.0, 2003).

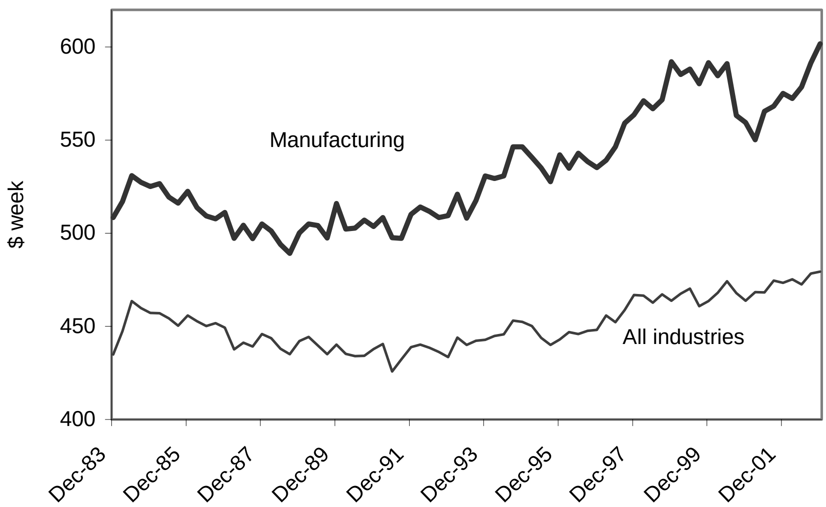
[13] Data from two surveys (ABS *Employer Training Expenditure, Australia*, July-September 1993 Cat. No. 6353.0 and *Education and Training Experience, Australia 1993*, Cat. No. 6278) on employee perceptions of the adequacy and need for training and actual training supplied can be examined to determine any associations. The proportion of employees citing there was no need for training explained just under 80 per cent of the variation in training to GWS among different sectors. When the share of employees citing inadequate training was included, these variables explained just under 90 per cent of the intersectoral variation in expenditure per GWS and around 75 per cent of the variation in training hours supplied. Employees in manufacturing were slightly more likely to cite their training as inadequate (but the effect was small and statistically insignificant). The incidence of employees citing no need for training was around 30 per cent higher in manufacturing than other sectors (the difference being statistically significant at the 10 per cent level).

5.2 Earnings and work intensity

Real earnings per employee in manufacturing are high relative to other sectors (figure 5.3). In the December quarter 2002, average earnings per employee in manufacturing were over 25 per cent higher than the average for the private sector. The margin has been growing over the last two decades, with average earnings in manufacturing increasing at roughly double the growth rate of the private sector.[14]

However, higher average wages are not the result of high wage *rates* for employees in manufacturing compared with like employees in other sectors, but primarily reflect differences in average weekly paid *hours worked* per employee.

Figure 5.3 **Average real earnings per employee[a]**
Manufacturing and all industries, December quarter 1983 to December quarter 2002



[a] Earnings include wage and salary payments of all kinds (ordinary time and overtime) to all employees (junior, adult, full time, part time and casual). Constant price estimates were produced by deflating nominal weekly earnings by the weighted average capital city CPI.

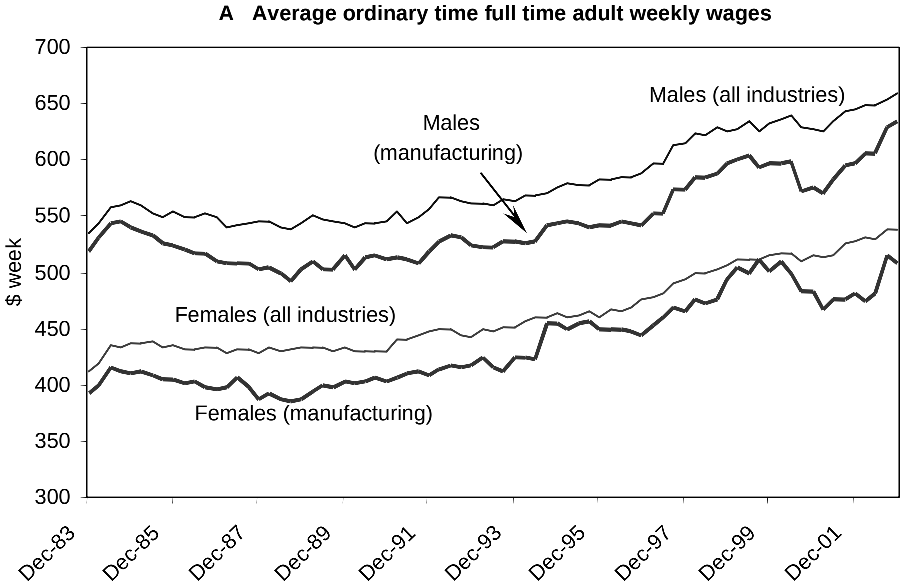
Data sources: ABS (*Average Weekly Earnings*, Australia Cat. No. 6302.0; and *Consumer Price Index, Australia,* Cat. No. 6401.0).

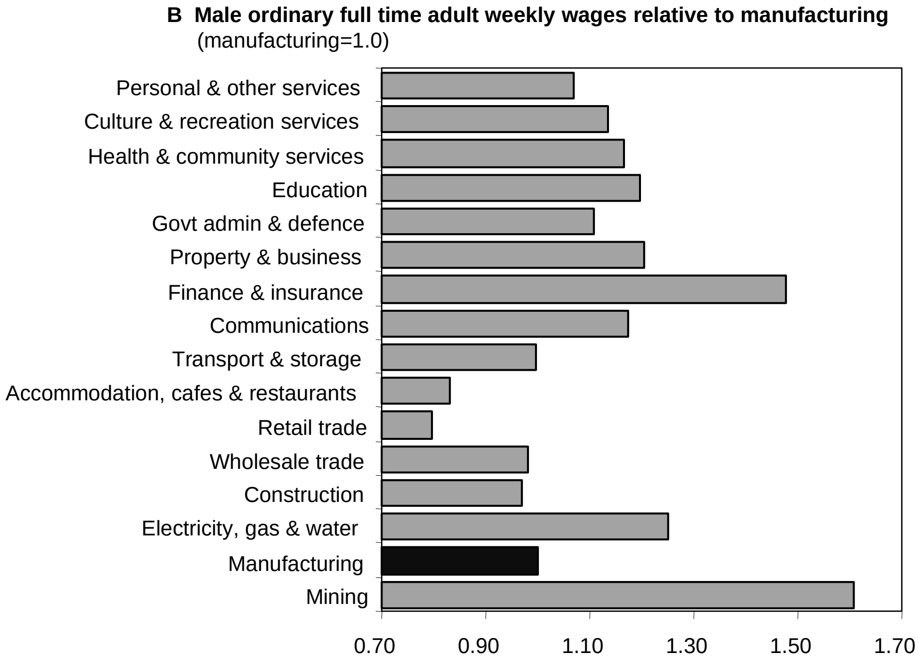
In fact, the average ordinary time full time adult wage rate in manufacturing has been consistently slightly below that of the private sector generally (figure 5.4).

[14] From the December quarter 1983 to the December quarter 2002, real earnings per employee in manufacturing grew by over 18 per cent compared with 10 per cent for the private sector as a whole.

Figure 5.4 **Average real weekly wage rates and earnings**[a]

1989-90 prices[b]





[a] Ordinary time full time adult wages exclude overtime payments and relate only to full time work (or work over 35 hours per week) for adults or those receiving full adult pay rates. ‘All industries’ refers to all private sector industries. [b] Constant price estimates were produced by deflating nominal weekly earnings by the weighted average capital city CPI.

Data source: See figure 5.3.

The data show that:

- in 2001-02, the real wage rate was around seven per cent below the all industries (private sector) average for males and 10 per cent below the corresponding average for females;
- while wage rates grew relatively rapidly in manufacturing over the ensuing six months (to December 2002), a wage margin still remains, albeit reduced (to 3.8 and 5.5 per cent for males and females, respectively); and
- average wage rates in many other sectors, such as mining and finance and insurance, are considerably higher than manufacturing.

As noted by Clark et al. (1996), fostering the development of manufacturing is not necessarily the best way to create high wage jobs in the economy.

Consistent with labour mobility, long run trends in real (ordinary time full time) wage rates have been similar between manufacturing and the private sector as a whole (though growth rates are quite sensitive to the time periods selected[15]). Over the period 1984-85 to 2001-02, ordinary time full time adult earnings in manufacturing increased by around 12 per cent in real terms for males and 16 per cent for females. The corresponding growth rates for all employees were 15.7 and 21.2 per cent for males and females, respectively.

Given its lower average wage rates, the major basis for higher average manufacturing earnings is the greater share of employees who are employed on a full-time basis. Manufacturing, with mining and major utilities, remains a sector in which full-time work is overwhelmingly dominant, especially for males — a pattern that has remained stable over time.

This no longer characterises some prominent service industries, like Retail trade and Health and community services. For example, the share of male employees in manufacturing working full time was over 95 per cent in 2001-02 — a decline of less than 3 percentage points since 1984-85. The corresponding share for all industries was under 86 per cent — a decline of more than 8 percentage points over the past two decades (table 5.6).

Notwithstanding generally similar changes in hours worked *within* part-time and full-time categories across sectors, the effect of this compositional change is that,

[15] For example, growth rates in private sector ordinary time wage rates were around five percentage points higher than manufacturing from 1984-85 to 2001-02, but the growth margin disappeared in the six months to December 2002.

for a given number of employees, more hours are being worked in manufacturing than the average. This is reflected in earnings.[16]

Table 5.6 **Work intensity in manufacturing and all industries**

1984-85 and 2001-02[a]

Intensity measure	*Manufacturing*			*All industries*		
	1984-85	2001-02	Change	1984-85	2001-02	Change
	'000	'000	%	'000	'000	%
Full time employees	1057	980	-7.3	5431	6630	22.1
male	824	772	-6.3	3833	4408	15.0
female	233	208	-10.9	1598	2222	39.0
Part time employees	76	110	44.4	1179	2577	118.6
male	21	40	92.2	252	735	191.2
female	55	70	26.5	927	1842	98.8
Average full time weekly hours	38.5	41.1	6.9	40.2	42.3	5.3
male	39.1	41.9	7.2	41.3	43.7	6.0
female	36.4	38.4	5.4	37.5	39.4	5.1
Average part time weekly hours	17.2	17.2	0.1	15.4	16.4	6.3
male	18.3	17.7	-3.5	15.7	16.2	3.2
female	16.8	17.0	1.0	15.4	16.5	7.4
Average weekly hours worked	37.0	38.7	4.5	35.7	35.0	-2.0
males	38.6	40.7	5.5	39.7	39.8	0.3
females	32.6	33.0	1.0	29.4	29.0	-1.2
Full time employee share	93.3	89.9	-3.4 pts	82.2	72.0	-10.0 pts
males	97.5	95.1	-2.5 pts	93.8	85.7	-8.1 pts
females	80.8	74.7	-6.0 pts	63.3	54.7	-8.6 pts

[a] 1984-85 data are based on the average of the November 1984 to May 1985 quarters, while data for 2001-02 are based on the average of the August 2001 to May 2002 quarters.

Source: Unpublished data from the ABS *Labour Force Survey*.

There is considerable variation in average wage rates within manufacturing. This reflects factors such as varying skill intensities, the importance of large versus small firms, capital intensity[17], unionisation and wage pressures from import competition (table 5.7). For example, the capital intensive Iron and steel, Non-ferrous metals and Simple chemicals (oil refineries, gas plants and fertiliser plants) groups and the

16 The gender composition of the manufacturing workforce compared with other sectors may also be influential because males tend to work longer and at higher wage rates than females (though the underlying factor at work may be the changing occupational structure of jobs, rather than gender per se). Relative to other industries, manufacturing is a much greater employer of males. The male share has not changed over the last two decades. In contrast, across all industries, the male share is both lower and significantly declining.

17 Quite apart from a greater tendency for higher average skills in high capital intensive sectors, full utilisation of capital is more likely to lead to overtime and additional rates associated with shift work.

skill-intensive pharmaceuticals industry have wage rates that are well above the average for manufacturing.

Table 5.7 **Relative hourly wage rates in manufacturing**

Total manufacturing = 100, 1984-85 to 1999-2000[a]

Industry subdivision/group	*1984-85*	*1990-91*	*1994-95*	*1999-00*
	Index	Index	Index	Index
21 Food, beverages and tobacco	99.0	95.5	100.2	100.2
22 Textiles, clothing and footwear	80.4	81.6	80.7	79.2
223-225 Clothing & footwear	75.0	76.4	74.0	73.0
Rest of 22 Textiles & leather	90.3	90.4	89.8	87.4
23 Wood and paper products	96.1	98.2	96.3	93.2
24 Printing, publishing and recorded media	108.3	109.1	110.1	108.9
25 Petroleum, coal, chemicals & assoc. prods.	112.0	113.2	117.7	116.6
251-253 Simply transformed chemicals	143.5	149.6	153.5	150.3
254-256 Elaborately transformed chemicals	102.2	102.2	105.9	104.1
2543 Medicinal and pharmaceutical product mfg.	110.0	109.7	125.9	134.8
26 Non-metallic mineral products	113.4	103.6	105.0	106.1
27 Metal products	106.2	104.6	104.9	103.2
271 Iron and steel	122.3	119.0	139.5	127.9
272-273 Non-ferrous metals	133.8	130.1	141.1	138.7
274-276 Simple metal fabrications	89.7	91.1	85.5	88.3
28 Machinery and equipment	100.1	103.8	99.4	102.5
281 Motor vehicles	98.5	108.6	100.1	101.5
282 Other transport equipment	113.0	116.2	113.5	122.4
283 Photographic, medical and scientific eq.	100.3	95.0	102.9	97.5
284 Electronic equipment	101.9	113.3	106.3	108.9
285 Electrical equipment	92.6	93.9	93.7	97.4
286 Production equipment	97.3	98.2	91.8	94.1
29 Other manufacturing	78.5	75.3	70.0	66.7
Total manufacturing	100.0	100.0	100.0	100.0
Simply transformed manufactures	106.5	104.0	107.4	105.3
Elaborately transformed manufactures	95.6	97.3	95.2	96.7

[a] The data measure the wage rate of each industry subdivision or group relative to manufacturing. They do not show how absolute wage rates have changed over time. Wage rates were estimated using wages and salaries and employment from the ABS Manufacturing Census and adjusting by average hours worked (on the basis of unpublished ABS data derived from the Labour Force Survey).

In contrast, Clothing and footwear and Other manufacturing have considerably lower wage rates — these industries tend to have lower skills, a greater share of small, less capital intensive firms,[18] lower profitability[19] and face greater import competition.

[18] For example, in 2000-01, firms employing less than 20 people accounted for 54 per cent of total employment in other manufacturing and 34.2 per cent of total employment in the TCF industry (these were the two subdivisions where small firm shares were greatest in manufacturing).

Interestingly, average wages in elaborately transformed manufactures are slightly lower than simply transformed manufactures — and this relativity has been maintained over time. This suggests that the degree of transformation of goods, often seen as a proxy for the sophistication of manufacturing, is a poor guide to earnings.

The variation over time in relative wage rates in particular manufacturing industries is much smaller (around one-fifth[20]) than the variation across industries at a given time. This is likely to reflect the fact that variations in wage rates between industries are accounted for by differences in their skill or job attributes, which do not tend to change rapidly over time.

Despite some pockets of lower pay in manufacturing, the likelihood of low paid employees (full time wages below $600 a week[21]) in manufacturing is about the same as in the economy as a whole.

However, at the more extreme tails of the wage distribution, there are some significant differences. This is revealed by the lower relative incidence of very low paid workers (below $400 a week) in manufacturing than other sectors (figure 5.5). In August 2002, the rate of very low paid employment was about 4.2 per cent in manufacturing and 5.8 per cent in all other industries. Consequently, in a given population of full time employees, there would be 28 per cent fewer employees in the very low paid category in manufacturing than non-manufacturing. This may well reflect the dominance of male employment in manufacturing (with males generally receiving higher wages than females).

On the other hand, the likelihood of being higher paid is also lower in manufacturing than in the workforce generally, with 31.3 per cent of full time employees in manufacturing being highly paid ($900 or more weekly), compared with 35.7 per cent of full time employees in other industries. So manufacturing is characterised by 'thin tails' at the ends of the wage distribution.

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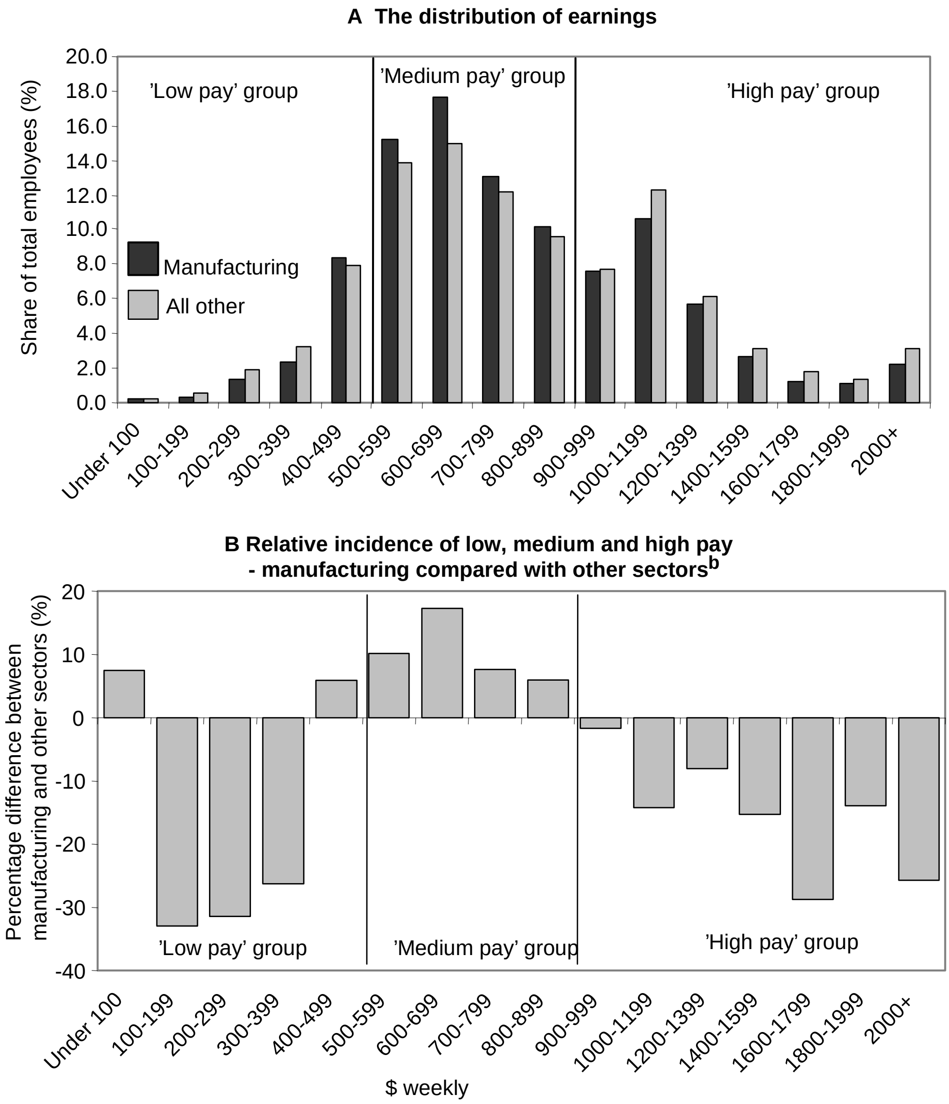
[19] For example, in 2000-01 the average profit margin for large firms was -0.1 per cent in the TCF industry and 2.6 per cent in other manufacturing (the two lowest rates in manufacturing at the subdivision level). This compared with the manufacturing average of 6.5 per cent (ABS, *Manufacturing, Australia* Cat. 8225.0, April 2003, p. 21).

[20] The average coefficient of variation *across* the manufacturing subdivisions/groups for the four years was 18.6 per cent. In comparison, the average coefficient of variation *across* years for the 19 manufacturing groups was 3.6 per cent — or around one-fifth of the across-manufacturing variation.

[21] The categories low, medium and high are from McLachlan et al. (2002, p. 43).

Figure 5.5 **Distribution of employees by weekly full time earnings**[a]

Manufacturing and all other sectors, August 2002



[a] Data refer to weekly earnings in the main job for full time employees. Following McLachlan et al. (2002), the three groups were structured so that each accounted for close to a third of total employment. [b] The relative incidence (Ω) of an earnings category (w) is

$$\Omega_w = (s_{wM} \ / \ s_{wO} - 1) \times 100$$

where s is the proportion of employees in manufacturing (M) or other sectors (O) in the wth wage range.

Data source: ABS (*Employee Earnings, Benefits and Trade Union Membership, Australia, August 2002*, Cat. No. 6310, March 2003).

This ‘tale of two tails’ is an enduring feature of the wage distribution for manufacturing (table 5.8) and probably reflects some persistent differences between the occupational compositions of various sectors. The pattern in the wage distribution over time is also interesting because it throws light on whether the substantial restructuring of jobs and industries within manufacturing has significantly altered the wage distribution in a distinctive way. It is apparent that real wage growth from 1977 to 2002 for the bottom decile has been significantly less than those in the top deciles. However, as noted in other research (Borland 1996 and Keating 2003), the experience in manufacturing is not distinctive, with generally increasing wage inequality occurring across all sectors.

Table 5.8 **Changes in the wage distribution in manufacturing[a]**

Year and industry	*p10/p50*[b]	*p10 real wage*	*p50 real wage*	*p75 real wage*	*Decile associated with $388*[c]
	ratio	$ 2002 prices	$ 2002 prices	$ 2002 prices	%
1977					
Manufacturing	0.69	403	587	719	8.4
All industries	0.64	388	606	772	10.0
1984					
Manufacturing	0.66	414	630	787	8.0
All industries	0.59	383	644	843	10.3
1990					
Manufacturing	0.66	393	597	768	9.6
All industries	0.59	369	622	806	11.6
1997					
Manufacturing	0.68	454	668	919	5.2
All industries	0.61	429	709	955	7.5
2002					
Manufacturing	0.67	477	715	978	3.8
All industries	0.61	458	750	1053	5.6
1977 to 2002	Points	% change	% change	% change	Points
Manufacturing	-0.02	18.4	21.8	36.1	-4.6
All industries	-0.03	18.1	23.8	36.5	-4.4

a Based on weekly earnings in main job by full time employees between 1977 and 2002. The weighted average CPI for capital cities was used to convert wages to constant prices. Full-time earnings were used to avoid conflating shifts to part time and casual work with shifts in wage rates paid to different employees. The published ABS data on earnings distributions by sector are available for earnings intervals, rather than at the decile level. Earnings at different deciles were estimated by fitting a natural cubic spline to the cumulative earnings distribution. **b** P10, P50 and P75 refer to the 10th, 50th and 75th percentile of the earnings distribution. **c** $388 is a benchmark wage level equal to the 10th percentile in 1977 for all industries.

Source: ABS (various issues), *Weekly Earnings of Employees (Distribution)*, subsequently re-named *Employee Earnings, Benefits and Trade Union Membership, Australia*, Cat. No. 6310.0.

The pattern of increasing inequality has to be interpreted carefully and should not be seen as a symptom of structural change in manufacturing:

- First, since the pattern is similar across sectors, it is picking up economy-wide changes, rather than something specific to manufacturing.
- Second, the pattern seems to have altered in the 1990s. From 1990 to 2002, growth in real wages in the bottom decile grew at higher rates than the median

for both manufacturing and other sectors (though growth in wages at higher deciles have continued to outstrip that at the bottom end).

- Third, wage inequality is measured by changes in *relative* rather than absolute wages over time. Increases in skill or other employee attributes are likely to stretch the income distribution at the higher end of the wage scale, increasing measured inequality. However, this does not imply that there has been any adverse impact on earnings at the bottom end. In this context, it should also be noted that, if low wages are defined using a fixed dollar benchmark (the weekly wage in August 1977 for the bottom decile), the proportion of employees in the lowest pay category (the bottom decile) had more than halved in manufacturing by 2002 (and decreased by 44 per cent in all sectors) (table 5.8).

Overall, the effect of employment changes and the shifts in real earnings meant that the number of very low paid[22]employees declined by 65 per cent in manufacturing between 1977 and 2002 and by 32 per cent in all sectors. In contrast, the number of highly paid[23] employees increased by 68 per cent in manufacturing and by 132 per cent in all sectors, the difference between the two mainly reflecting relatively greater employment growth in other sectors.

5.3 Stability of employment

One indication of job stability is the average duration of an employee's current job. Despite apparently increasing structural change in manufacturing (chapter 4), the estimated average duration of employment has risen over time (table 5.9).

The proportion of the manufacturing workforce employed in the same job for five years or more now accounts for around half the employment in the sector, compared with less than 40 per cent in 1971-72 (figure 5.6). The average duration of jobs in manufacturing, 7.6 years, is greater than for a range of service industries — such as Wholesale and retail trade and Recreation, personal and other services — and, as a consequence, higher than the all sector average.

One reason for longer job tenure in manufacturing may be slow employment growth relative to faster growing service industries. More specifically, where job creation rates are high, there are strong inflows of new workers that reduce average job duration levels. Such new workers may remain in their current job for a long duration, but this cannot be observed until many years later. This factor is

22 Those earning at or below the earnings level in the first decile for all sectors in 1977 ($388 in 2002 prices).

23 Those earning at or above the earning level in the 75th percentile in 1977.

particularly noticeable for female employees. Across all sectors, average employment duration for female workers has increased following the steep rise in female participation in the 1970s (Borland 2000a, p. 6).

Table 5.9 **Estimated average duration of current job[a]**

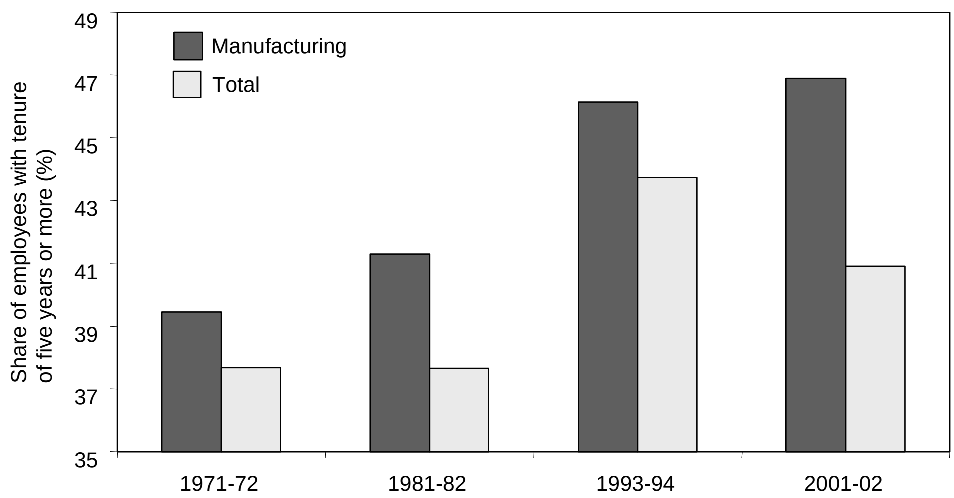
Industry/sector	*1980-81*	*1987-88*	*1993-94*	*2001-02*
	years	years	years	years
Agriculture forestry & fishing	10.7	12.0	12.3	12.2
Manufacturing	7.4	6.9	7.2	7.6
Construction	5.8	7.2	7.6	8.2
Wholesale and retail trade	5.6	5.0	5.3	5.3
Transport & storage	8.2	8.1	8.0	7.8
Finance property and business services	5.6	5.1	6.2	5.6
Public administration and defence	8.3	7.7	8.6	8.7
Community services	6.1	6.7	7.6	7.7
Recreation personal and other services	4.7	4.4	4.4	5.2
Total	7.0	6.7	7.0	6.9

a The ABS publication on job mobility (Cat. No. 6209.0) divides the work force into a number of time brackets, according to duration of employment in the current job. Mid-points corresponding to these time brackets were used to estimate the average duration of current job, with an average duration of 26 years assumed for the over 20 years time bracket. Mining, Communications services and Electricity, gas and water supply have been excluded either because data were not available for some years or only as part of an 'other' category.

Source: ABS (various issues), *Labour Mobility, Australia*, Cat. 6209.0.

Figure 5.6 **Changing patterns of job tenure in Australia**

Share of employees in same job for 5 years or more, 1971-72 to 2001-02



Data source: ABS (various issues), *Labour Mobility, Australia*, Cat. 6209.0.

However, different employment growth rates do not seem to explain persistent differences in average tenure between sectors.[24] For example, average tenure has changed very little in manufacturing (where it was high in both 1980-81 and 2001-02) and finance, property and business services (where it was relatively low in both years), despite very different employment growth profiles. The absence of strong systematic links between past employment growth and tenure reflects the importance of gross job reallocation — the net gain or loss in jobs is small relative to gross inflows and outflows. A panel of workplace data for Australia provides some evidence that gross job reallocation rates are less in manufacturing than other sectors (Mumford and Smith 1996). In that sense, the higher apparent job stability in manufacturing probably does not reflect its history of slow job growth over the past few decades, but an inherent higher probability of long-term job retention. The dominant role played in manufacturing by male employees — who tend to have longer job tenure than females employees — is likely to be a contributor to this. Another possible explanation may be that job skills in some service industries, such as retailing, are more portable than in manufacturing, facilitating greater job mobility.

While average job duration appears relatively high in manufacturing, involuntary job loss rates are also relatively high. For example, Borland (2000a) and Borland and McDonald (2000) found that, from 1984 to 1996, the average retrenchment rate in manufacturing was 4.8 per cent for males (the second highest among the sectors analysed) and 4.6 per cent for females (the highest among the sectors analysed). Other data on the contribution of manufacturing to unemployment changes paint a similar picture (chapter 3). Were job losses to be drawn uniformly from all employees, regardless of tenure, then it would be expected that a higher job loss rate would result in a *lower* average job duration in manufacturing than other sectors (simply because, for a given level of employment, there would have to be higher annual inflow rates). However, where downsizing occurs, job losses are disproportionately incurred by those with short job tenures, in part reflecting last-in, first-off layoff practices.[25] Accordingly, the job loss and tenure pattern for manufacturing suggests that new jobs are more insecure, but established jobs are more stable than other sectors.

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[24] Changes in average job tenure between two snapshot years (1980-81 and 2001-02) were regressed against changes in long-term job growth preceding these snapshot years (for 9 sectors). No obvious relationship was apparent.

[25] The ABS Labour Mobility Survey shows that, across all sectors, job losses (voluntary or involuntary) represent around five per cent of the stock of employees with over 20 years tenure (in 2001-02), whereas such job losses are around 44 per cent of the stock of employees with one year or less tenure.

5.4 Casual jobs and other non-traditional employment in manufacturing

Another dimension of job security and quality is the extent to which employees can be readily laid off, regardless of whether that eventuality arises, and the degree to which they can access entitlements, such as leave or sick pay. Some forms of employment have generally lower security and/or entitlements than others. These employment categories make up ‘non-traditional’ employment, which refers to any job which is not a full-time position in somebody else’s business, with regular hours and an effective contract for ongoing employment.

There are several forms of non-traditional employment, each with different characteristics:

- fixed term employees — employees receiving entitlements, but employed for a fixed term;[26]
- own account workers — self-employed workers without staff;
- employers; and
- casual workers — employees who are not entitled to paid holiday or sick leave.

As noted by Murtough and Waite (2000), there are considerable difficulties in enumerating the various categories. For example, there is an important distinction between ‘permanent’ casuals (whose jobs are of limited real precariousness) and those whose employment is genuinely informal, irregular and uncertain. In the ABS Labour Force Survey, owner managers are also missclassified as casuals. Nevertheless, in recent new surveys[27] designed to better classify workers by the degree of their attachment to their jobs, the ABS has more reliably identified the extent of non-traditional employment by type and sector. While there is no perfect taxonomy for non-traditional employment, table 5.10 shows one perspective (excluding employees and self-employed in their own enterprises who are on contract).

Overall, the manufacturing labour force is dominated by arrangements in which there is a strong attachment of the employee to the job. Casual jobs, the self-employed and fixed term contract employment all have a relatively low incidence in manufacturing compared with the average and particularly with a range of service

26 Discussed by Waite and Will (2002).

27 The *Forms of Employment Survey* (run in August 1998 and November 2001) and the Survey of *Employment Arrangements and Superannuation, Australia* (2000).

sectors, such as Retail trade, Accommodation, cafes and restaurants and Cultural and recreational services.

Table 5.10 **Non-traditional employment in manufacturing versus other sectors**

April to June 2000, share of sector employment

Sectors	*Fixed term contract*	*Self-identified casuals*	*No leave but not self-identified casual*	*Employee in own incorp. enterprise not on contract*	*Self-employed in own unincorp. enterprise not on contract*	*Non-traditional employment*
	%	%	%	%	%	%
Agriculture, forestry & fishing	0.6	17.4	1.8	11.5	47.5	78.8
Mining	8.2	1.8	3.6	2.7	1.4	17.7
Manufacturing	1.4	10.6	0.8	5.9	6.1	24.8
Electricity, gas & water supply	7.6	5.9	0	0.3	0	13.8
Construction	0.9	11.5	3.3	8.4	12.1	36.2
Wholesale trade	1	9.8	0.9	12	7.3	31.0
Retail trade	0.7	35.2	1.4	5.8	11.5	54.6
Accommodation, cafes & restrnts.	1.3	49.9	1.9	3.3	8	64.4
Transport & storage	1.7	14	0.9	4.3	8.6	29.5
Communication services	1	6.4	1.9	0.7	6	16.0
Finance & insurance	2.5	3.6	1.3	7.6	2.5	17.5
Property & business services	2.8	17.8	3	8.2	9.3	41.1
Government administration & def.	10.4	5.7	2.2	0	0	18.3
Education	13.3	17.2	1.1	0.3	2.6	34.5
Health & community services	4.7	17.2	2.1	3.9	5	32.9
Cultural & recreational services	6.8	31.2	3.8	3.6	9.9	55.3
Personal & other services	2.7	14.6	1.8	2	18.3	39.4
Total	**3.3**	**18.3**	**1.8**	**5.6**	**9.6**	**38.6**

Source: ABS (*Employment Arrangements and Superannuation, Australia*, Cat. No. 6361.0, 2001).

Available statistics point to increased economy-wide ‘casualisation’ of employment over time (DEWRSB 2000 and Barnes et al. 1999, pp. 85ff). Consistent with this, total casual employment in manufacturing (as defined by the ABS) increased by over 90 per cent from 1985 to 1997 (Barnes et al. 1999). This is just a little less than the average increase apparent for all sectors (102 per cent). Unfortunately, these trend data confuse different types of casual employment (Murtough and Waite 2000).

There is, however, reasonable information about the relative importance over time of one class of non-traditional employment — employers and own account workers — within manufacturing and other sectors (table 5.11). This shows that the share of non-wage earners in manufacturing is smaller than in many other sectors, particularly agriculture and construction. This partly reflects larger average enterprise size in manufacturing.

The share of own-account workers in the manufacturing work force increased markedly between 1984-85 and 2000-01, but still remained small relative to other sectors. While an increase was evident for most segments of manufacturing, it was most striking in the TCF industry, possibly as a result of an increase in outsourced self-employed workers ('outworkers').

Table 5.11 **The share of non-wage earners in the workforce**

1984-85 and 2001-02[a]

Sector/industry	*Employers*		*Own-account workers*	
	1984-85	2001-02	1984-85	2001-02
	%	%	%	%
Agriculture, Forestry and Fishing	16.0	11.9	48.1	36.0
Mining	0.7	0.2	2.0	2.5
Manufacturing	2.2	1.9	2.9	4.9
Food, beverages and tobacco	1.0	1.1	0.7	1.4
Textile, clothing, footwear & leather	3.2	3.7	3.6	11.7
Wood & paper products	4.6	4.1	3.7	4.2
Printing, publishing & recorded media	2.1	1.1	2.5	4.7
Petroleum, coal, chemicals etc.	1.0	0.6	1.3	1.8
Non-metallic mineral products	2.7	3.1	4.6	9.3
Metal products	2.5	2.4	2.4	3.3
Machinery & equipment	1.2	1.1	1.8	4.0
Other manufacturing	5.0	4.1	12.7	15.3
Electricity, Gas and Water Supply	0.0	1.1	0.2	0.5
Construction	8.7	6.5	26.2	27.6
Wholesale Trade	3.9	2.6	5.7	5.4
Retail Trade	9.5	4.9	12.2	7.0
Accommodation, Cafes and Restaurants	10.1	5.7	4.6	3.5
Transport and Storage	3.4	2.2	11.5	13.1
Communication Services	0.4	1.4	2.4	10.4
Finance and Insurance	0.8	0.9	3.1	4.1
Property and Business Services	8.6	3.7	10.8	11.7
Government Administration and Defence	0.0	0.0	0.0	0.4
Education	0.2	0.4	2.3	2.8
Health and Community Services	3.2	1.8	1.6	4.0
Cultural and Recreational Services	6.1	2.1	12.8	13.8
Personal and Other Services	5.9	4.7	13.4	14.4
Total	**5.2**	**3.6**	**9.9**	**9.7**

[a] Data for 1984-85 are based on the average over the November 1984, February 1984 and May 1985 quarters, while data for 2001-02 are the average over the August 2001, November 2001, February 2001 and May 2002 quarters.

Source: ABS (*Labour Force Australia,* Cat. No. 6203.0, 2002; time series form ABS SuperTable).

There are commonly expressed concerns about non-traditional employment (ACIRRT 1999). It is claimed that such forms of employment often do not meet employees' needs, may reduce incentives for training of workers, decrease job security and lower overall conditions. While some of these claims have substance, it should not *necessarily* be assumed that the greater prevalence of non-traditional employment is a 'bad' feature of service sector employment, and that its relative absence in manufacturing is a 'good' facet of this sector:

- some non-traditional jobs may have reasonably high security — with regular hours and the expectation of ongoing work, so that precariousness and non-traditional employment are not necessarily linked;
- the preferences of employees differ, so that some prefer non-traditional employment (Wooden and Warren 2003);
- the different technologies and markets in which diverse sectors operate condition the types of employment that are appropriate. For example, the need to meet demand outside standard working hours differs between sectors (Wooden 2000), as do the payoffs to firms from maintaining tenure and capturing training or learning by doing; and
- there may be a tradeoff between jobs with less desirable characteristics (lower training, wage rates, stability, or power) and unemployment.

5.5 Industrial disputes

Industrial disputes have fallen significantly in Australia across all sectors since the peak disputation period in the 1970s. Economy-wide, there was around a twenty-fold reduction in working days lost per employee due to industrial disputes from the mid-1970s to the early 21st century. This mainly reflected the falling incidence of disputes, but was accentuated by reduced average strike duration and the shrinking scope of disputes (table 5.12).[28]

Manufacturing has roughly followed the national trends, with working days lost per employee due to industrial disputes falling by around 90 per cent from 1973-1975 to 2000-2002. Nevertheless, days lost per employee in manufacturing are about three times higher than the national average — though well below that for construction and coal mining.

28 Incidence is the number of disputes per employee, duration is the number of working days lost per *involved* employee and scope is the number of employees involved per dispute. Multiplied they give the working days lost per employee. All three factors were significant contributors to reduced working days lost per employee from 1973-1975 to 2000-2002.

Table 5.12 **Industrial disputes in Australia**

Working days lost per employee[a]

Period	*Mining*		*Manufacturing*		*Construction*	*Transport, storage etc*[b]	*Education, health etc*[c]	*Other*[d]	*Total*
	Coal	Other	Metal prods. etc.[e]	Other					
	Days	Days	Days	Days	Days	Days	Days	Days	Days
1973-1975	8.99	2.35	2.89	0.86	1.79	0.89	..	0.19	0.85
1985-1987	8.85	2.11	0.39	0.32	0.62	0.26	0.12	0.05	0.23
1990-1992	4.17	0.91	1.02	0.24	0.21	0.23	0.16	0.05	0.20
1995-1997	5.35	0.48	0.16	0.11	0.43	0.08	0.11	0.01	0.10
2000-2002	1.08	0.04	0.17	0.12	0.24	0.04	0.03	0.01	0.05
Change 1973-75 to 2000-2002 (%)									
	-88.0	-98.4	-94.0	-86.4	-86.5	-95.7	-75.3	-95.5	-94.4
Relative days lost									
1973-1975	10.6	2.8	3.4	1.0	2.1	1.1	..	0.2	1.0
2000-2002	22.7	0.8	3.6	2.5	5.1	0.8	0.6	0.2	1.0

[a] The data are based on average days lost over calendar years. The basis for the calculation of working days lost per thousand employees was changed in January 1995. Data were backcast to December 1990. Prior to December 1990, this calculation used estimates of employees from the ABS Survey of Employment and Earnings. From December 1990, employees data have been obtained from the ABS Labour Force Survey. [b] Comprises transport, storage and communication services. Data for 1973-1975 were estimated by weighting data for stevedoring and other transport, storage and communication services. [c] Comprises Health, education and community services. Data were not available for the 1973-75 period. [d] Comprises Agriculture, forestry and fishing, Electricity, gas and water supply, Wholesale trade, Retail trade, Accommodation, cafes and restaurants, Finance and insurance, Property and business services, Government administration and Defence, Cultural and Recreational Services and Personal and Other Services. [e] Comprises Metal products, machinery and equipment.

Source: ABS, *Industrial Disputes, Australia*, Cat. No. 6321.0.

Within manufacturing, the typical pattern over time has also been a reduction in working days lost per employee due to industrial disputes (table 5.13). However:

- some manufacturing subdivisions have recorded much greater falls than the average. Parts of manufacturing that were strongly associated with industrial action from 1980 to 1990 — Meat and meat products and Basic metals — now report days lost per employee that are small fractions of their peaks; and
- a few industry subdivsions — TCF and Wood and wood products — have experienced increasing numbers of working days lost per employee over the long run, but these still remain at or below the average for manufacturing.

Table 5.13 **Number of working days lost due to industrial disputes per employee[a]**

Industries	*1985-1987*	*1990-1992*	*1995-1997*	*1999-2001*	*Trend 1985 to 2001*
	Days	Days	Days	Days	%
21 Food, beverages & tobacco	0.39	0.36	0.24	0.20	-9.5
211 Meat & meat products	0.99	1.15	0.56	0.29	-16.8
212-219 Other food, beverages & tobacco	0.16	0.07	0.11	0.16	-4.9
22 Textiles, clothing, footwear & leather	0.08	0.15	0.07	0.16	7.1
23 Wood & paper products	0.07	0.09	0.08	0.19	8.5
24 Printing, publishing & recorded media	0.17	0.38	0.07	0.05	-14.2
25 Petroleum, coal, chemical & assoc products	0.22	0.39	0.10	0.16	-8.3
26 Non-metallic mineral products	0.17	0.01	0.19	0.23	1.4
27 Metal products	0.81	2.54	0.18	0.27	-10.9
271-273 Basic metals	1.83	6.05	0.32	0.68	-9.7
274-276 Fabricated metal	0.09	0.02	0.11	0.06	-5.4
28 Machinery & equipment	0.22	0.14	0.17	0.27	-3.1
281-282 Transport equipment	0.35	0.15	0.31	0.39	-2.8
281 Motor vehicles & parts	0.32	0.16	0.35	0.35	-3.0
282 Other transport equipment	0.41	0.15	0.25	0.46	-3.3
283-286 Other machinery & equipment	0.12	0.12	0.08	0.18	-1.9
29 Other manufacturing	0.14	0.23	0.00	0.02	..
Total manufacturing	**0.35**	**0.61**	**0.14**	**0.19**	**-7.9**

[a] The data for each of the periods are the average over the three years (to smooth yearly variations). Each trend growth rate was estimated by regressing the logged values of the working days lost against a time trend for all the years from 1985 to 2000. Data on days lost from 1985 to 1994 were on an ASIC basis, while other data were on an ANZSIC basis. At the level of aggregation above, the classification change did not make a large difference to reported days lost. Employment data at end June (from the manufacturing census) in each calendar year were used as the basis for calculating days lost per employee (rather than generally less accurate data from the Labour Force Survey as used in table 5.12).

Sources: Unpublished ABS data based on ABS *Industrial Disputes, Australia* (Cat. No. 6321.0) and ABS *Manufacturing Census* data.

In general, working days lost have converged over time across manufacturing industries. This is reflected in much lower disparities in days lost per employee across industries over time. In this sense, the industrial relations (IR) environment in manufacturing has become less heterogeneous.[29]

Nevertheless, some industries exhibit rates of industrial stoppage that are persistently higher than others — particularly basic metals and transport equipment (including passenger motor vehicles), which have days lost per employee that are around two to three times the manufacturing average. This suggests that structural and cultural features of different industries are still a continuing source of industrial

29 The relative variation of working days lost between manufacturing industries (measured as the coefficient of variation) roughly halved between 1985 and 2000.

relations difficulties. (But interindustry differences in unionisation rates do not in themselves appear to explain variations in stoppage rates.)

While industry-specific factors are the main short-run drivers of the duration and scope of industrial stoppages, there was a significant systematic tendency for working days lost to move up or down together across different industries using monthly data in the 1990s, despite greater emphasis on enterprise bargaining arrangements during this period.[30] This may reflect the use of coordinated industrial campaigns across manufacturing industries when enterprise agreements expire at the same time.

5.6 Unionisation

Around one-quarter of manufacturing employees belong to a union. This is just above the average for the economy as a whole. But, it is:

- well below the high rates evident in public administration and defence and the formerly public sector-dominated utilities industries; and
- well above the rates in several service-oriented sectors that have never been highly unionised, such as retail, wholesale and business services (figure 5.7).

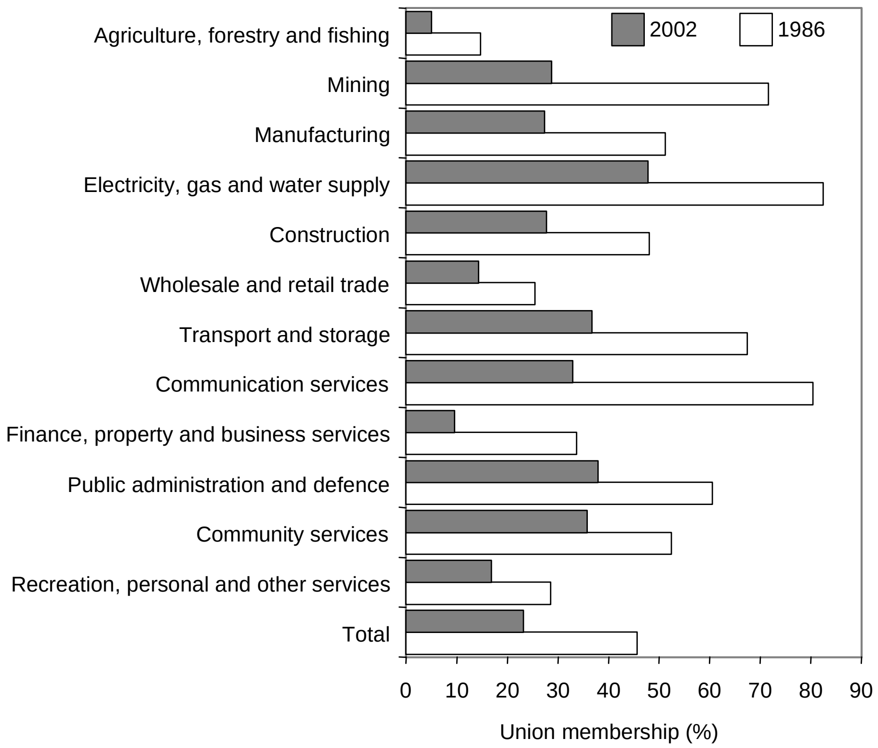
Within manufacturing, there are several significant inter-industry differences in union representation. Representation is greatest in the non-metallic mineral products industry (11.3 percentage points above the manufacturing average) and lowest in the TCF, Printing and publishing and Other manufacturing industries (5.5, 5.9 and 12.6 percentage points below the average, respectively).

As in all other sectors, unionisation has declined strongly in manufacturing, with the membership rate nearly halving between 1982 and 2002. Indeed, the rate of decrease in the membership rate has accelerated over time (figure 5.8).

30 Monthly data on days lost per employee (W) are available from December 1983 to January 2003 for two segments of manufacturing (the combined metal products and machinery and equipment subdivisions of manufacturing and the rest of manufacturing). There was no significant correlation between $\Delta \log W$ for the two manufacturing segments from December 1983 to January 1992 (an R^2 of two per cent only), while there was a significant association from February 1992 to January 2003. (It was found that $\Delta \log W_{metals} = -0.01 + 0.8 \Delta \log W_{Other}$, with an R^2 of 30 per cent and a t statistic of 7.5 on the focus variable.) The same pattern was not found for annual data.

Figure 5.7 **Union membership rate**

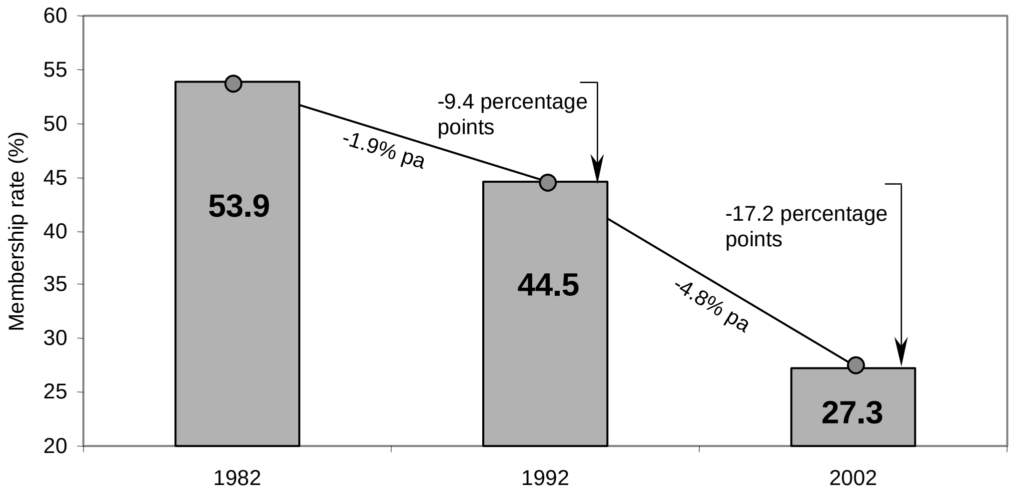
Australia, August 1986 and 2002



Data sources: ABS, *Trade Union Members, Australia* (Cat. No. 6325.0) and *Employee Earnings, Benefits and Trade Union Membership, Australia* (Cat. No. 6310.0).

Figure 5.8 **The decline in unionisation is accelerating**

Manufacturing 1982 to 2002[a]



[a] Growth rates are compound annual growth rates of the union membership rates.

Data source: As in figure 5.7.

There are many factors underlying the decline in unionism in manufacturing and other sectors (Wooden 2000). One aspect underlying the aggregate change is the shifting composition of the economy, and in particular, the trend away from activity in traditional goods-producing parts of the economy to services, where union representation has historically been lower. However, while industry structure could explain about 26 per cent of the decline in economy-wide union membership between 1986 and 1992, it explained only 12 per cent of the decline between 1992 and 2002.[31] This suggests that factors spanning sectors are the dominant force behind declining unionisation (ABS 2000, 1994; Wooden 2000). These include:

- changes in the 1990s to the legislative framework for industrial relations, which banned compulsory unionism, restricted industrial action, amended rights for union entry to workplaces and, more generally, increased the tendency for enterprise bargaining;
- an increase in the share of skilled white collar employees (who have lower propensities for union membership); and
- growth in all sectors of non-traditional employment, such as casual labour and own-account workers, where union representation is low.

5.7 Industrial accidents

Manufacturing workplaces have historically been perceived as dirty and dangerous. However, the evidence on new compensation cases for OH&S suggests that manufacturing workplaces are now much safer than in the past.[32] Over the period from 1992-93 to 2000-01, new compensation cases per million hours of work fell by 39 per cent (table 5.14).

Industries that have historically had lower rates of industrial accidents, such as health and community services and recreational, personal and other services, have exhibited much smaller reductions in compensation frequencies. As a result, there is currently much less dispersion among accident rates between industries. For example, the frequency of new cases in manufacturing was 73 per cent higher than

---

31 These calculations are based on estimating the ‘between industries’ effect on union membership: $\sum_{i=1}^{n}(S_{it} - S_{it-1}).U_{it-1}$ where S_{it} is the employee share of industry i in total employee numbers at time t and U_{it-1} is the union membership rate in the relevant base year.

32 ABS data (*Work-Related Injury, Australia*, Cat. No. 6324.0) on workplace injury, accidents and illnesses include non-compensated cases, but are less suited to considering industry-specific OH&S risks because they also include accidents arising from trips to and from work.

health and community services in 1992-93, but by 2000-01 this margin had fallen to 17 per cent.

Table 5.14 **Frequency of new compensated OH&S cases by selected industries[a]**

Cases per million hours worked

Industry	*1992-93*	*2000-01*
	cases/million hrs	cases/million hrs
Mining	36.4	15.3
Transport & storage	29.0	16.4
Agriculture	28.7	14.9
Construction	28.3	16.8
Manufacturing	24.9	15.2
Health and community services	14.4	13.0
Wholesale and retail trade	10.6	9.3
Finance, property & business services	6.3	4.8
Electricity, gas and water	24.5	8.1
Communication	18.2	5.7
Public administration	17.0	5.9
Recreation, personal and other services	14.6	11.4

a The data relate to new compensation cases resulting in one week or more off work, and typically only include employees and not employers. Other exclusions and facets of the data are explained in NOHSC (2002). The 2000-01 data are preliminary. Final figures are likely to be somewhat higher. There have also been other changes to the construction of the series that affect their comparability over time. Neither of these factors are likely to affect the qualitative assessment of the data. Data for 2000-01 have been re-categorised to concord with the ASIC basis of the data for 1992-93.

Sources: National Occupational Health and Safety Commission (NOHSC) 2002 and Worksafe Australia 1995.

Similar significant reductions have been apparent in compensated fatalities in manufacturing. The incidence has fallen from over seven fatalities per 100 000 employees in 1992-93 to four fatalities per 100 000 employees in 1999-2000.[33] The current incidence of fatalities is significantly lower in manufacturing than in Mining, Transport and storage, Construction and agriculture, and on a par with Cultural and recreational services.

That said, (compensated) working days lost per year as a result of work-related health problems in manufacturing in 2000-01 exceeded 1.4 days per employee and compensation costs exceeded $290 million. To place this in perspective, the days lost through OH&S accidents and injuries is more than seven times the number lost as a result of industrial disputes in manufacturing.

33 While fatality data for 2000-01 are available, the relevant industry is not recorded for many fatalities. Accordingly, the 2000-01 data have not been used.

5.8 The role of small business in manufacturing

Employment arrangements in small firms are different from those in larger enterprises in several distinctive ways (Revesz and Lattimore 1997):

- small firms tend to undertake less formal training;
- they are less unionised;
- wage rates and earnings are lower on average (as is labour productivity);
- employment tenure is less; and
- working arrangements are often more flexible.

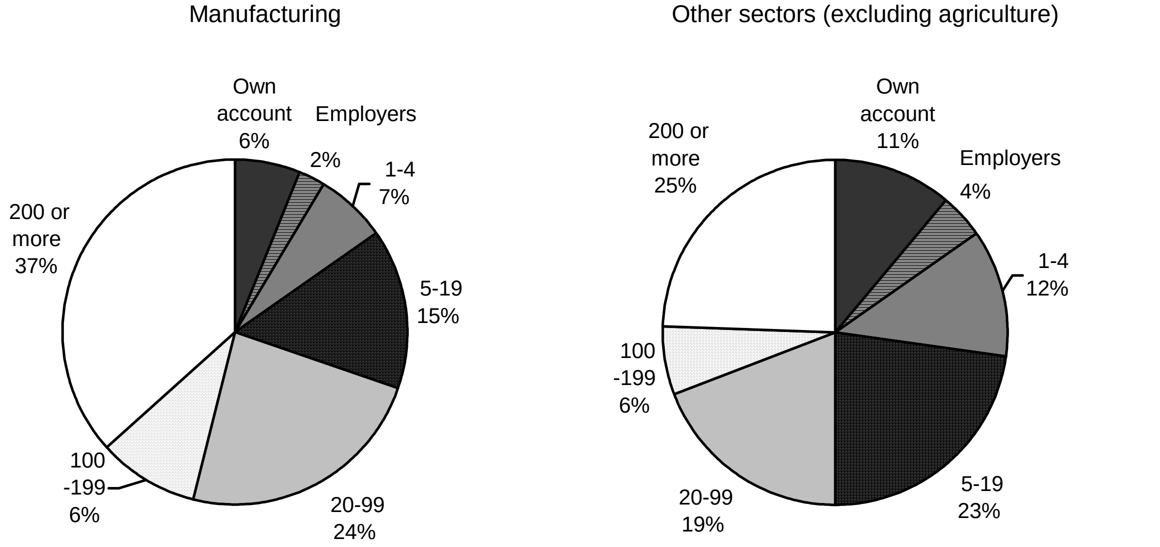
Quite apart from their labour market characteristics, small firms face greater obstacles in dealing with regulatory burdens, accessing financial capital for risky projects, expanding into export markets and undertaking innovation. These features of small business — and their apparent central role in employment generation — have underscored policy interest in this category of business.

In terms of enterprise numbers, small businesses dominate manufacturing. 47 per cent of manufacturing enterprises are non-employing businesses and a further 46 per cent employ less than 20 persons. But such small businesses account for a relatively small share of total employment in manufacturing:

- businesses employing less than 20 persons (the ABS definition of a small business) and own account workers collectively account for about 28 per cent of employment in manufacturing (figure 5.9); while
- small business plays a much less significant role in manufacturing than in other sectors, with small business and own account workers accounting for around 46 per cent of employment in sectors outside manufacturing.

Figure 5.9 The importance of small business employment

Distribution of employment by enterprise size, 2000-01[a]



[a] Other excludes enterprises in agricultural, forestry and fishing for which small business statistics are not compiled. Only private sector businesses are included.

Data source: ABS 2002, *Small Business in Australia, 2001* (Cat. No. 1321.0).

The changing role of small business

Over the last two decades, the role of small business has substantially increased in manufacturing in terms of both employment and enterprise shares (table 5.15):

- in manufacturing, small business and non-employing businesses have increased as a share of total enterprises. Relative employment growth has also been greatest in these categories, leading to a 6.1 percentage points increase in employment in small business. Conversely, large firms (those employing 100 or more employees) have declined in both relative employment and enterprise terms. For example, the employment share of large businesses fell by nearly 14 percentage points between 1983-84 and 2000-01; while
- in contrast, growth in enterprise numbers in the rest of the economy has been similar for different firm size categories, resulting in little change in enterprise shares. However, employment shares have grown across all *employing* firms by small, roughly similar, magnitudes, while employment shares of non-employing businesses have correspondingly fallen.

When compared with other individual broad industries, the relative expansion of small business in manufacturing is unremarkable (figure 5.10). Nearly half the industry divisions exhibited roughly comparable growth in the small business share of employment between 1983-84 and 2000-01. The exceptional feature of the changing size distribution of manufacturing is the decline in the relative importance of big business, with no other industry division showing a large decline.

Table 5.15 **Are small firms becoming more important?**
1983-84 to 2000-01

Percentage point change in share of enterprises by size category

Sector	Small				Medium	Large		
	Non-employing businesses	1-4	5-19	total	20-99	100-199	200 or more	total
	%	%	%	%	%	%	%	%
Manufacturing	6.1	6.4	-7.5	4.9	-3.1	-0.8	-0.9	-1.7
Other	-3.4	2.6	0.5	-0.3	0.2	0.0	0.0	0.1

Percentage point change in share of employment by size category

	Non-employees		Small business			Medium business	Large business		
	Own account workers	Employers	1-4	5-19	total	20-99	100-199	200 or more	total
	%	%	%	%	%	%	%	%	%
Manufacturing	3.4	0.0	3.4	2.7	6.1	4.2	-1.3	-12.4	-13.8
Other	-1.3	-3.2	0.4	1.4	1.8	1.2	-0.1	1.6	1.5

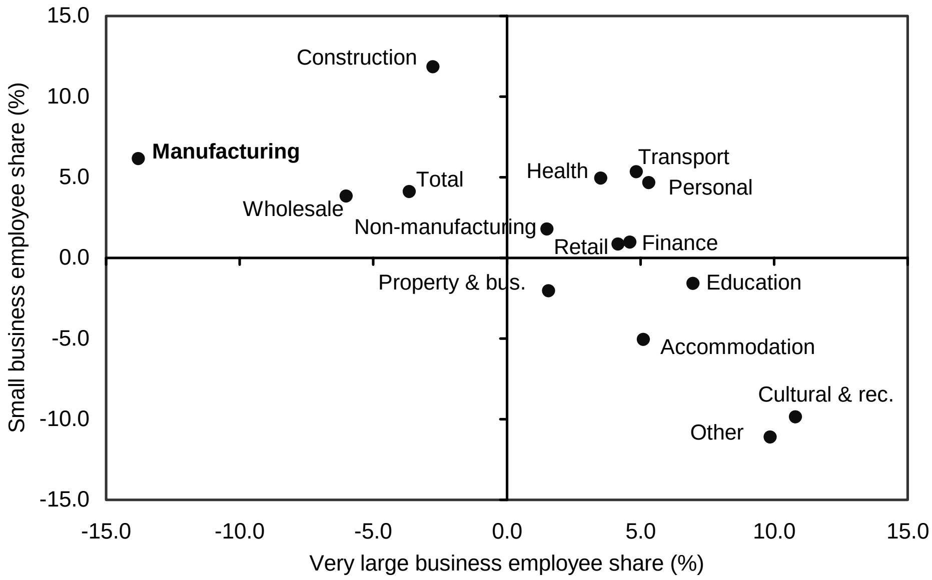
a Other is all other private sectors, excluding agriculture, forestry and fishing.

Source: ABS 2002, *Small Business in Australia, 2001* (Cat. No. 1321.0).

The shift in the size distribution of manufacturing from larger to smaller enterprises is consistent with anecdotal and input-output evidence about the growing importance of outsourcing (chapter 3).

The change may also partly reflect the importance of growing specialisation and increasing intra-industry trade (as discussed in chapters 4 and 6), which creates opportunities for new firm generation and associated small business employment growth. However, it is important to avoid equating an increasing role for small business in manufacturing as necessarily evidence of strong job generation by small business. When interpreting the changing size distribution of firms, two confounding factors — category hopping and changes in composition of industries — need to be considered.

Figure 5.10 **Big versus small business in different sectors**
Changes in employment shares, 1983-84 to 2000-01



Data source: As in table 5.15.

Category hopping

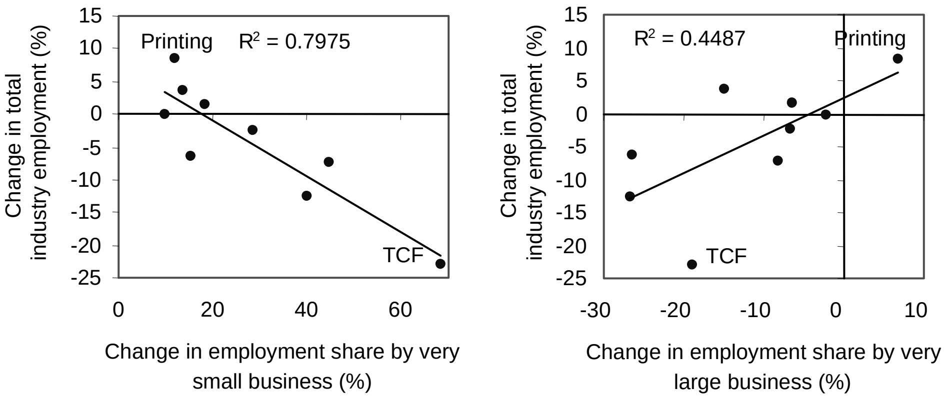
While some of the changed size distribution represents stronger job creation rates among small manufacturing businesses, others represent ‘category hopping’. This can occur when a large firm downsizes over time and shifts into a lower-sized employment category, creating the appearance of small business job creation. (A similar process that will tend to underestimate small business job creation can occur if small businesses grow into bigger firms.)

The fact that large firm enterprises numbers have actually fallen in manufacturing since 1983-84 suggests that category hopping is probably important, and that a proportion of apparent job creation by small business really reflects downsizing of large firms.

Other evidence that favours downsizing as a major factor is that those subdivisions of manufacturing that have recorded the greatest growth rates in very small business (businesses employing 9 or less employees) are those that have shown the largest declines in employment overall — the textiles, clothing and footwear industries being an extreme example (figure 5.11). Similarly, the decline of very large business as employers (those employing over 200 employees) is greatest in those subdivisions that have experienced the biggest overall employment reductions.

Figure 5.11 **Manufacturing subdivisions with rapidly growing small business shares have the slowest overall employment growth**

1992-93 to 1999-2000[a]



[a] The data relate to employees of employing businesses only. Unlike those for the economy as a whole, as shown in figure 5.10, data are based on establishment, rather than management unit information.

Data source: Unpublished data based on the ABS Census of Manufacturing (Cat. 8201.0).

Changes in the composition of industries

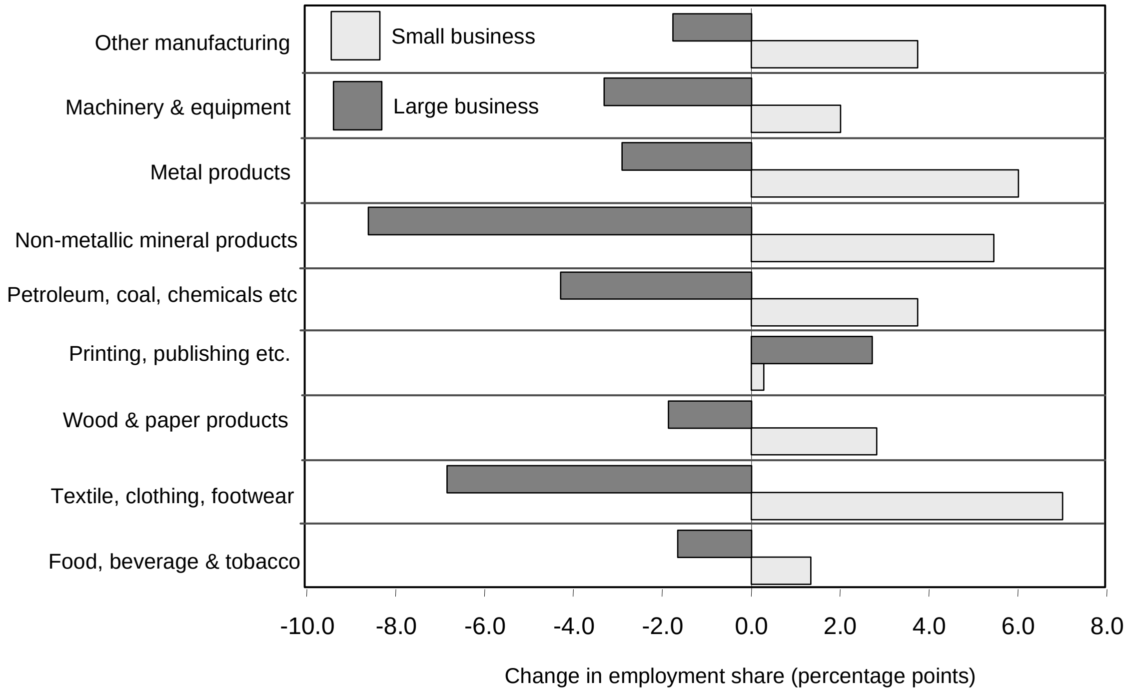
Around half of the economy-wide increase in the small business share reflects the growth of employment in industry divisions that are intensive in small businesses, rather than growth in small business shares within industries.[34] However, at least in the last decade, such compositional changes are largely unimportant in explaining the rise in the significance of small business in manufacturing.[35] The decline of big business and the growing importance of small business, while varying in magnitude, is common to most manufacturing subdivisions (figure 5.12). Indeed, compositional changes have slightly masked the extent to which small business shares have risen within individual manufacturing industries (table 5.16).

[34] Based on data from 1983-84 to 2000-01, 58 per cent of the economy-wide increase in the small business share can be ascribed to a 'within' industry effect, 52 per cent to a 'between' industry effect and about 10 per cent to the effects of simultaneously changing small business and sectoral shares. The methodology underlying these calculations is explained in Revesz and Lattimore (1997).

[35] Data for the period from 1983-84 to 2000-01 on the size distribution of manufacturing by subdivision are not available on a consistent basis.

Figure 5.12 **Changing small and big business shares *within* manufacturing**

1992-93 to 1999-2000



Data source: Unpublished data based on the ABS Census of Manufacturing (Cat. 8201.0).

Table 5.16 **The role of structural change in the rise of small business in manufacturing, 1992-93 to 1999-2000**[a]

	Within industry	*Between industry*	*Mix effect*	*Total*
	% points	% points	% points	% points
9 and under	3.31	-0.08	-0.17	3.07
10-19 persons	-0.03	-0.07	0.03	-0.08
Small business total	*3.28*	*-0.15*	*-0.14*	*2.99*
20-49 persons	-0.50	-0.04	-0.02	-0.57
50-99 persons	0.04	-0.06	0.00	-0.02
Medium business total	*-0.47*	*-0.10*	*-0.02*	*-0.59*
100-199 persons	-0.31	-0.05	0.05	-0.31
200+	-2.50	0.30	0.10	-2.09
Large business total	*-2.81*	*0.25*	*0.16*	*-2.40*

a The data relate to employees of employing businesses only. Unlike those for the economy as a whole, as shown in figure 5.10, data are based on establishment, rather than management unit information. The share of any particular firm size category (S) is:

$S_t = \sum_{i=1}^{n} \alpha_{it} \times \beta_{it}$ so that $\Delta S_t = \sum_{i=1}^{n} (\Delta\alpha_{it} \times \beta_{it-1}) + (\Delta\beta_{it} \times \alpha_{it-1}) + (\Delta\beta_{it} \times \Delta\alpha_{it})$ where α is the share of employment of the relevant size category and β is the employment share of subdivision i. The three effects that make up ΔS are the within, between and mix effect, respectively.

Source: Unpublished data based on the ABS Census of Manufacturing (Cat. 8201.0).

6 Openness and competitiveness of the Australian manufacturing sector

Key points

- Over four decades, growth in manufacturing trade has helped to transform Australian merchandise exports from a largely agricultural base into a mix of mining, manufacturing and agriculture, with agriculture becoming the least important among the three.
- Australian manufacturing is becoming increasingly open. In 1999-2000, over one-third of domestically sold manufactured goods were produced overseas and about one-quarter of domestically produced goods were sold overseas. This is up from, respectively, less than one-quarter and one-sixth a decade earlier.
- Intra industry trade — the extent to which similar products are concurrently exported and imported — has increased substantially over the past 30 years, particularly since the late 1980s. This is suggestive of the capacity for Australian manufacturing to develop capabilities within almost all areas of manufacturing, even those where competitiveness has been declining.
- The manufacturing sector derives a much greater share of its capital stock from foreign direct investment than do the primary and services sectors. While the share of inward FDI stocks in manufacturing has been declining over the past decade, the share of outward FDI stocks has been rising strongly over the same period.
- Australia has increasingly directed its manufacturing exports to Pacific rim countries. However, there are significant differences in trade patterns for elaborately transformed manufactures compared with simply transformed manufactures.
  - The share of STM exports accounted for by major Asian trading partners nearly doubled over the last two decades.
  - In contrast, major Asian trading partners accounted for only between one-fifth and one-quarter of Australia's ETM exports, without a clear upward trend.
- Developing countries have been an increasing source of both STM and ETM imports, particularly for goods where labour costs are significant.
- Greater global trade integration by Australian manufacturing has been partly facilitated by reductions in border protection. The average effective rate of assistance for manufacturing fell from 35 per cent in 1968-69 to five per cent in 2000-01.

Production and distribution of goods has become increasingly global. This has reflected waning transport costs, changing consumer preferences, increasing capabilities in developing economies and trade liberalisation at home and abroad. Increased openness of the Australian economy has had fundamental implications for the structure, nature and trajectory of Australian manufacturing.

This chapter explores some facets of this greater openness. Section 6.1 examines the trade-related indicators of an increasingly open manufacturing sector and of competitiveness. Section 6.2 complements this picture with a discussion of the increasing integration of productive resources, as evidenced by significant cross border ownership.

It is well established that Australian manufacturing exporters have decreased their reliance on UK markets and increasingly directed exports to Pacific rim countries. Section 6.3 confirms this trend and discusses some significant differences in trade patterns for elaborately transformed manufactures (ETMs) compared with simply transformed manufactures (STMs).

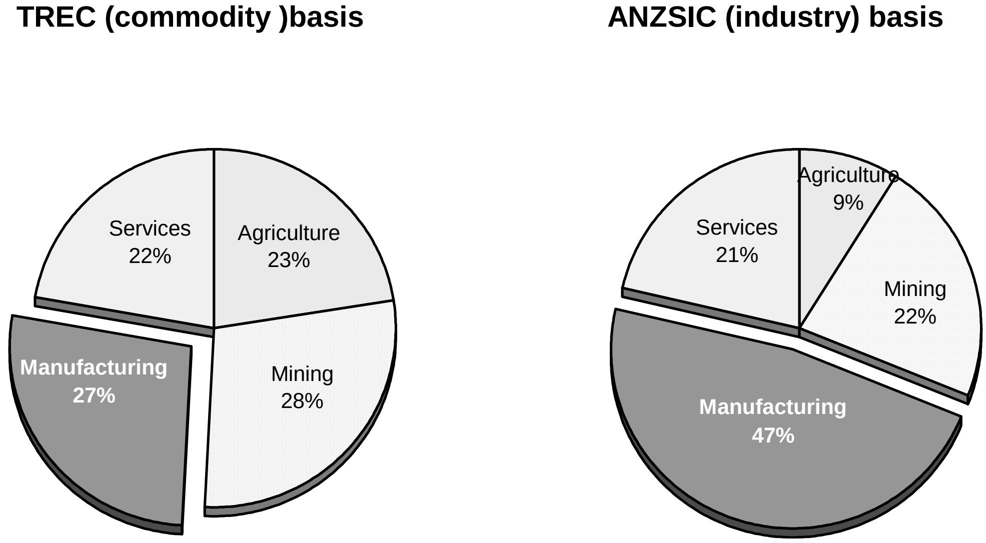
The increasing openness of the Australian manufacturing sector has been precipitated by many factors, including changing government assistance patterns and reduced transport and communication costs (section 6.4).

Classification issues

Trade data are aggregated using taxonomies that must be understood to interpret trends. Different classifications can materially affect their magnitude and interpretation. For example, the ABS classifies the manufacturing industries according to the Australian and New Zealand Standard Industrial Classification (ANZSIC). Using this classification to attribute exports to sectors of the economy can be misleading. Some goods are attributed to manufacturing, even if the manufacturing process involved is trivial relative to the value of the good that goes through a manufacturing process. For example, if a product passes through a flourmill, an abattoir or an oil refinery before export, its entire value is counted as a manufacturing export, thereby overestimating the contribution of manufacturing to exports.

To overcome this problem, a variety of commodity-based estimates of trade in manufactures have been constructed. These generally include only products that have undergone a significant share of their value added in manufacturing (Clark, Geer and Underhill 1996). The United Nations Standard Industrial Trade Classification (SITC) is one such commodities-based classification. The Department of Foreign Affairs and Trade (DFAT) uses a different commodity-based classification, the Trade Exports Classification (TREC), which essentially regroups SITC data, to allocate trade to the various sectors.[1] TREC was specifically designed to pick up the degree of value added by industries. The TREC and SITC estimates of manufacturing trade give similar results, whereas ANZSIC estimates are significantly larger, especially for exports,[2] where the ANZSIC system allocates nearly twice the amount of merchandise exports to manufactures than the TREC and SITC systems (figures 6.1 and 6.2).

Figure 6.1 **Two views of the importance of manufacturing to exports**
Australia, 2001-02



a In both TREC and ANZSIC there are some exports that cannot be allocated to industry or commodity groups (for example, due to confidentiality). These exports were not included in the total for estimation of sector shares.

Data sources: Exports of services are from ABS Balance of Payments data (Cat. No. 5302), while the TREC and ANZSIC data on merchandise trade are from DFAT (2003) and unpublished ABS trade data, respectively.

In general, TREC and SITC are more appropriate for estimating the contribution of manufacturing to trade relative to other sectors in the economy. However, they are not compatible with firm-based industry classification data available for domestic statistics. For example, commodities-based classifications are not directly compatible with value added, employment, investment and wages data, which are

[1] ABS, 'International Accounts and Trade Feature Article - ANZSIC and TREC - Two views of trade', *International Merchandise Trade, Australia 2002*, Cat. No. 5422.0.

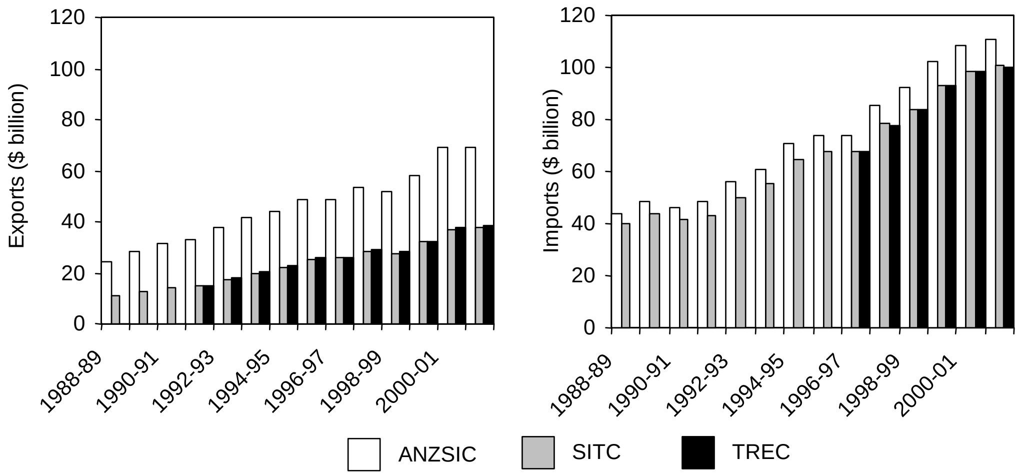
[2] This reflects the fact that most imports are of more transformed goods, which are classified by all taxonomies to manufacturing, whereas a sizeable share of Australia's exports consist of relatively lightly processed agricultural and mineral goods, which are allocated by ANZSIC to manufacturing and by TREC and SITC to agriculture or mining.

collected and published at the enterprise level by the ABS. Thus, depending on the context and data availability, different classifications are used in this paper.

In this context, it is worth noting, that independent of which classification of the manufacturing sector is used, the growth rates of imports and exports depicted in figure 6.2 are roughly equivalent.

Figure 6.2 **Manufacturing imports and exports by different trade classifications**

1988-89 to 2001-02



Data sources: Econdata, unpublished ABS data, DFAT 1997, DFAT 2002.

6.1 The increasing openness of the Australian manufacturing sector

Over four decades, growth in manufacturing trade has helped to transform Australian merchandise exports from a largely agricultural base into a mix of mining, manufacturing and agriculture, with agriculture becoming the least important among the three. A similar trend has emerged in world merchandise exports, albeit from a very different base (table 6.1).

As production and consumption patterns changed considerably over the same period, relative trade shares do not, by themselves, reveal whether the trade orientation of the manufacturing sector has changed. For instance, if manufacturing production had been growing at the same high rates as exports, the growth in manufacturing trade would simply be a reflection of structural change.

However, the evidence suggests that, internationally, manufacturing has become increasingly open. Between 1983 and 1989, world manufacturing output grew at an average annual rate of five per cent, while world trade in manufactures grew by 7.5 per cent a year.[3] More recently, world manufacturing output grew at a rate of around two per cent per year between 1990 and 1997, while world manufactured exports grew at a rate of seven per cent per year (WTO 1998).[4]

Table 6.1 **Composition of Australian and world merchandise exports[a]**
Share of total

	Australian exports			
Commodity type	*1963-64*	*1982-83*	*1989-90*	*1997-98*
	%	%	%	%
Agricultural produce	78.4	37.2	33.0	27.9
Minerals and fuels	4.9	39.4	39.1	37.2
Manufactures[a]	14.0	20.4	25.3	32.1
Unclassified and confidential	2.7	3.0	2.7	2.9
Total merchandise trade	100.0	100.0	100.0	100.0
	World exports			
Commodity type	*1963*	*1982*	*1989*	*1997*
	%	%	%	%
Agricultural products	29.2	15.2	13.6	10.9
Minerals and fuels	16.9	23.1	12.7	11.3
Manufactures[a]	53.2	59.3	71.4	74.1
Unclassified and confidential	0.7	2.4	2.3	3.7
Total merchandise trade	100.0	100.0	100.0	100.0

[a] Based on SITC industrial classification, which allocates processed food to agriculture rather than manufacturing.

Sources: BIE (1992), WTO (1998), ABS (*International Merchandise Trade, Australia,* Cat. No. 5422.0).

The strong growth in international trade in manufactures is commonly attributed to rising specialisation in manufacturing production at both the national and enterprise level. This is reflected in the increasing share of components and sub-assemblies passing across national boundaries. As exemplified by the motor-vehicle industry, specialisation is not so much between industries, but more at product level (PC 2002b). More generally, intra-industry and intra-firm trade are increasingly salient features of the globalisation of manufacturing (these are discussed further below).

[3] General Agreement on Tariffs and Trade (1990).

[4] The growth in international trade in primary products also outstripped the growth in corresponding world output, but to a much lesser extent than in manufacturing.

Export propensity and import penetration

A more nuanced perspective on the changing patterns of trade orientation in Australian manufacturing is given by *export propensity* and *import penetration*.[5] Export propensity measures the proportion of goods *produced* domestically that are exported, while import penetration measures the proportion of goods *sold* domestically that are imported.

A few measurement problems affect estimates of export propensity and import penetration:

- import and export data include a small, but increasing, proportion of goods that are imported to be re-exported with nothing (or very little) done to them in Australia. Including re-exports in the measures overstates export capability and exposure to competing imports;
- domestic production data (sales and exports) attribute all activity to the sector of final sale, even if other industries, or imported inputs, have substantially contributed to the production of the relevant goods. This is analogous to the difficulties posed in measuring overall exports of Australian manufacturing; and
- domestic sales data by manufacturing industry are often not directly available.

That said, there are several (partial) remedies for these measurement problems:

- a proxy for domestic sales can be constructed by adding imports to turnover and subtracting exports;
- export and import figures can be stripped of pure re-exports (goods that have no value added in Australia before re-export) to make them more accurate in representing the share of domestic sales and production that are imported or exported; and
- it is possible to obtain a ballpark figure for the fraction of imports embodied in manufacturing exports by using ABS input-output tables.

Reflecting the openness of the Australian manufacturing sector, in 1999-2000, over one-third of domestically sold manufactured goods were produced overseas and about one-quarter of domestically produced goods were sold overseas (table 6.2).

[5] This avoids using output growth relative to trade expansion, as commonly used in analysis of world trade trends. Output is a value added measure, whereas imports and exports are part of turnover. Relative trade to output changes can usefully be employed as proxies for trade to turnover changes only to the extent that the output to turnover ratio is stable over time. Export propensity and import penetration are better, more direct, measures of changing trade orientation.

Table 6.2 **Import penetration and export propensity**
1989-90 to 1999-2000

Industry	*Import penetration (IP)*			*Export propensity (EP)*			*Trend growth rates IP*[a]		*Trend growth rates EP*[a]		*Imported inputs*[b]
	1989-90	1994-95	1999-00	1989-90	1994-95	1999-00	10 yr	5 yr	10 yr	5 yr	1996-1997
	%	%	%	%	%	%	%	%	%	%	%
Food, beverages and tobacco	7.4	8.9	10.4	22.1	25.6	25.8	3.4	3.0	1.3	-0.4	3.9
Textiles, clothing, footwear & leather	29.7	41.1	49.3	13.5	26.2	26.6	5.1	3.7	7.3	-0.2	16.0
Wood & paper products	19.5	20.7	22.4	6.1	8.4	10.1	1.9	1.7	5.0	3.9	13.8
Printing, publishing & recorded media	9.2	10.9	10.4	1.8	2.3	2.4	1.1	0.6	4.3	1.5	12.1
Petroleum, coal, chemicals etc.	25.0	29.7	35.9	9.1	13.8	18.2	4.0	3.6	5.9	4.2	25.3
Non-metallic minerals	10.3	10.8	12.0	1.5	3.3	2.8	2.3	2.4	6.8	-6.1	5.1
Metal products	12.3	19.1	25.8	31.8	40.3	44.8	7.2	8.3	2.8	2.2	7.6
Machinery and equipment	45.0	54.1	61.6	9.1	18.6	24.5	3.2	2.5	8.7	4.0	21.2
Other manufacturing	21.6	24.7	32.5	9.9	10.3	9.8	4.1	5.8	-1.2	-1.6	11.3
ETMs	30.7	37.7	44.1	6.1	11.3	14.3	3.8	3.3	7.7	3.5	16.8
STMs	16.5	20.0	23.1	23.8	29.7	31.9	3.5	3.1	2.7	1.0	10.5
All manufacturing	**24.6**	**30.5**	**35.9**	**15.5**	**20.9**	**23.5**	**4.1**[c]	**3.4**	**3.7**	**1.6**	**13.5**

a Import penetration and export propensity trend growth rates over ten years beginning in 1989-90 and over five years beginning in 1994-95. Pure re-exports were netted out. **b** Imported input proportions are sourced from the ABS 1996-97 Input-Output tables. These input proportions are not specific to exports, but rather apply to the entire domestic sector for which they are reported. An approximate measure of an export propensity adjusted for imported inputs can be obtained by multiplying the standard export propensity measure by one minus the imported input proportions. **c** The fact that the reported import penetration trend growth for ETMs and STMs is larger than for total manufacturing reflects the approximate nature of trend estimation.

Sources: ABS (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0; *Australian National Accounts: Input-output Tables (Product Details) 1996-97,* Cat. No. 5215.0) and unpublished trade data from the ABS. Exports and imports are on a free-on-board basis.

The rate at which the manufacturing sector has become increasingly traded is also striking (table 6.2). Over the decade beginning 1989-89, an extra 11.3 cents of every dollar of domestic sales were attributable to imports. Similarly, of every dollar of revenue obtained by domestic manufacturing producers, an additional 8 cents was earned overseas.

However, it is notable that the growth in export propensity slowed considerably in the second half of the decade. Some industries — Food, beverage and tobacco manufacturing, Textile, clothing, footwear and leather manufacturing and Non-metallic mineral product manufacturing — posted negative export propensity trend growth rates from 1994-95 to 1999-2000. On the other hand, export propensity growth in ETMs outstripped import penetration growth in ETMs, even in the second half of the decade.

Are Import penetration and export propensity good indicators of competitiveness?

A high export propensity is often seen as indicator of industry competitiveness, while a high import penetration is often interpreted as an indicator of non-competitiveness. However, the measures have to be interpreted carefully. Trade measures are not relevant to industries whose products are traded very little, such as ready mix concrete. This is because, for goods with very high transport and/or communication costs, both import penetration and export propensity are likely to be and remain low, no matter how competitive an industry is in terms of its production technology and its distribution and marketing efficiency.

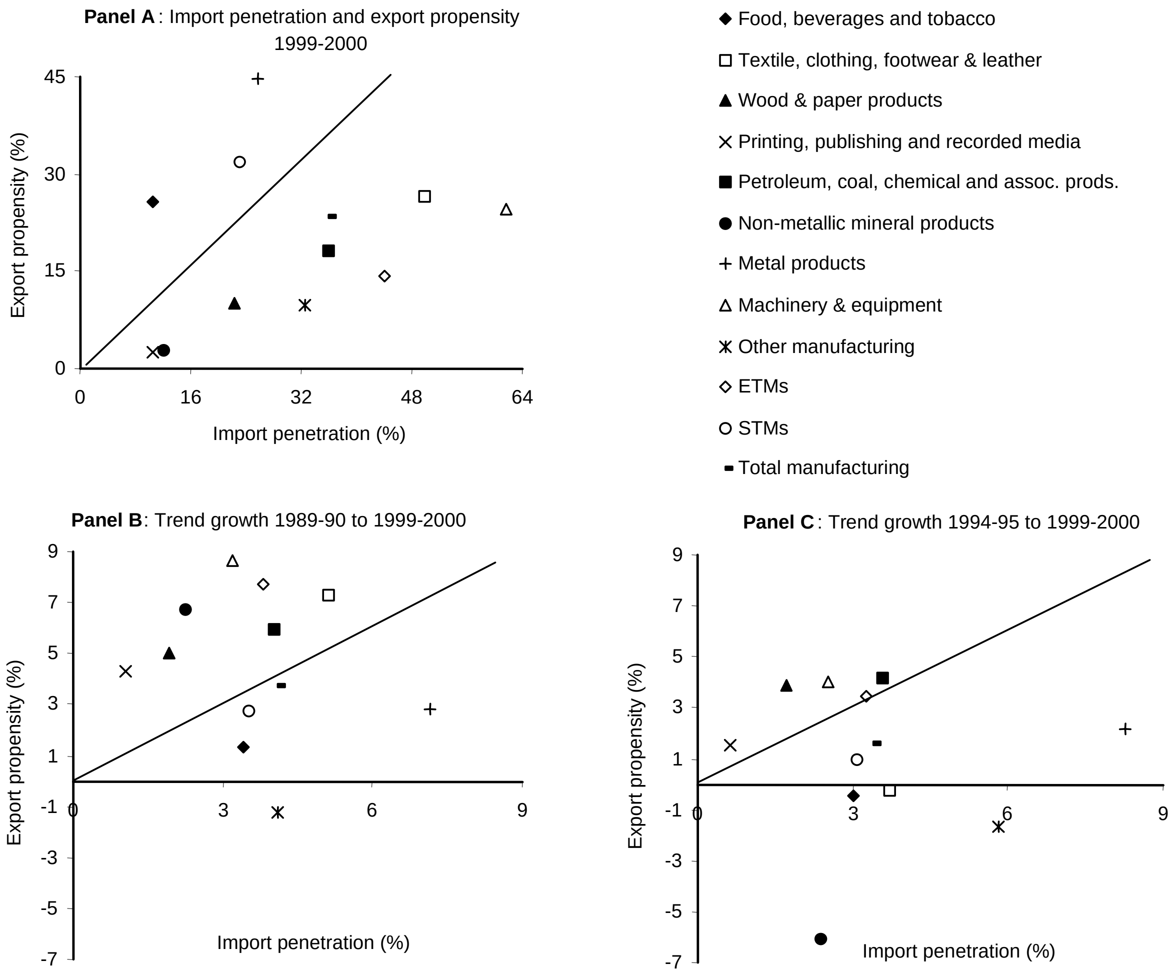
Even for highly traded goods, the two measures need to be jointly examined when assessing competitiveness, as each by themselves can be misleading. For example, the textile, clothing, footwear and leather manufacturing (TCF) subdivision has approximately the same export propensity as the food, beverage and tobacco (FBT) subdivision. But, few would argue that TCF is internationally as competitive as FBT. And indeed, TCF has an import penetration about five times that of FBT.

Nonetheless, *if interpreted carefully*, import penetration and export propensity can be informative measures of international competitiveness. And changes to import penetration and export propensity can be useful in assessing changes to the international competitiveness of industries through time.[6] This is not dissimilar to the use of market share figures for firms to ascertain competitiveness.

As a rule, the lower the import penetration relative to export propensity, the more competitive are the goods produced relative to their international counterparts (figure 6.3, panel A). A similar interpretation ensues for trends in these measures (panels B and C), except that they reveal gains or losses to competitiveness and/or tradeability.

6 It should be noted that, as measures of competitiveness, export propensity and import penetration are ‘blind’ to the source of competitiveness. If, for example, an enhanced export propensity is brought about by government programs, interpreting it as an improvement to the competitiveness of an industry may be misleading.

Figure 6.3 **Competitiveness indicators, 1989-90 to 1999-2000**[a]



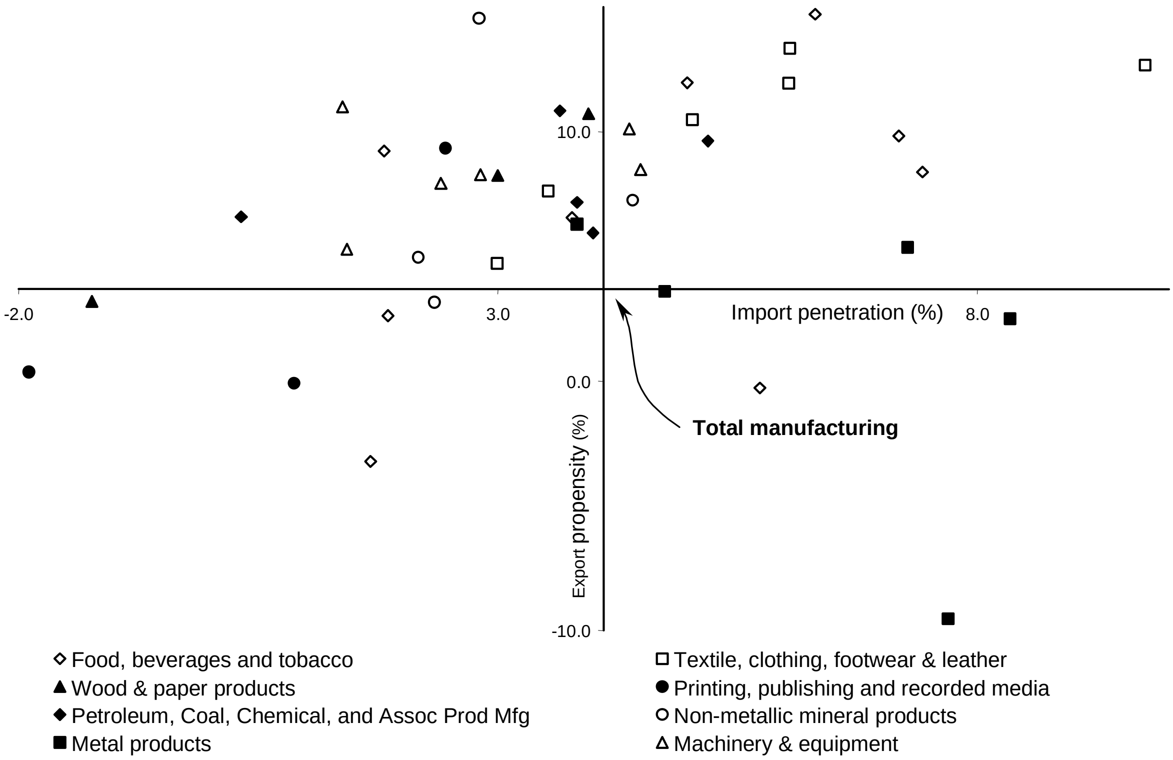
[a] For each panel, the further north-east an industry is on the graph, the more highly traded it is (or the greater the rate of change towards higher tradeability). The further above (below) the 45 degree line an industry is, the more (less) internationally competitive it is likely to be.

Data sources: ABS (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0; unpublished data on prices and trade).

However, it is important to avoid generalisations based on simple diagrams such as those in figure 6.3 because of the underlying heterogeneity of sub-industries and firms within a given ANZSIC. For example, TCF (a two digit ANZSIC subdivision) is made up of six (three digit ANZSIC) groups, each of which has a different import penetration and export propensity. Thus, a conclusion drawn about the competitiveness of the leather and leather products or the knitting mills groups on the basis of the overall TCF import penetration of 49 per cent and export propensity of 27 per cent would be misleading. For example, in 1999-2000, the knitting mills group had an import penetration of 31 per cent and an export propensity of seven per cent and the leather and leather products group had an import penetration of 65 per cent and an export propensity of 63 per cent.

The same problem is also evident when looking at trend growth rates. Over the decade beginning 1989-90, the ANZSIC industry groups experienced varied import penetration and export propensity trend growth rates within their respective manufacturing subdivisions. Figure 6.4 depicts this by displaying all (three digit) groups within a given (two digit) subdivision under their respective subdivision symbol (with the trend for manufacturing as a whole at the origin in the diagram).

Figure 6.4 **Import penetration and export propensity trend growth**
ANZSIC industry groups, 1989-90 to 1999-2000[a]



[a] The petroleum and petroleum products not elsewhere classified group was excluded from the petroleum, coal, chemical and associated products subdivision for illustrative convenience (it had an import penetration trend growth of -26 per cent and an export propensity trend growth of –32.7 per cent per annum). Data for non-ferrous basic metals were excluded because exports exceeded turnover (reflecting under-enumeration of domestic activity due to commission work undertaken by other industries — see Industry Commission 1995, pp. 25-26).

Data sources: ABS (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0; unpublished data on prices and trade).

The dispersion of groups within subdivisions is so large that conclusions about (three digit) groups on the basis of the position of their (two digit) subdivision could be misleading. For example, Food, beverages and tobacco groups (represented by ◊ symbols in figure 6.4) can be found in every quadrant of figure 6.4, underlining the heterogeneity within the broader subdivision.

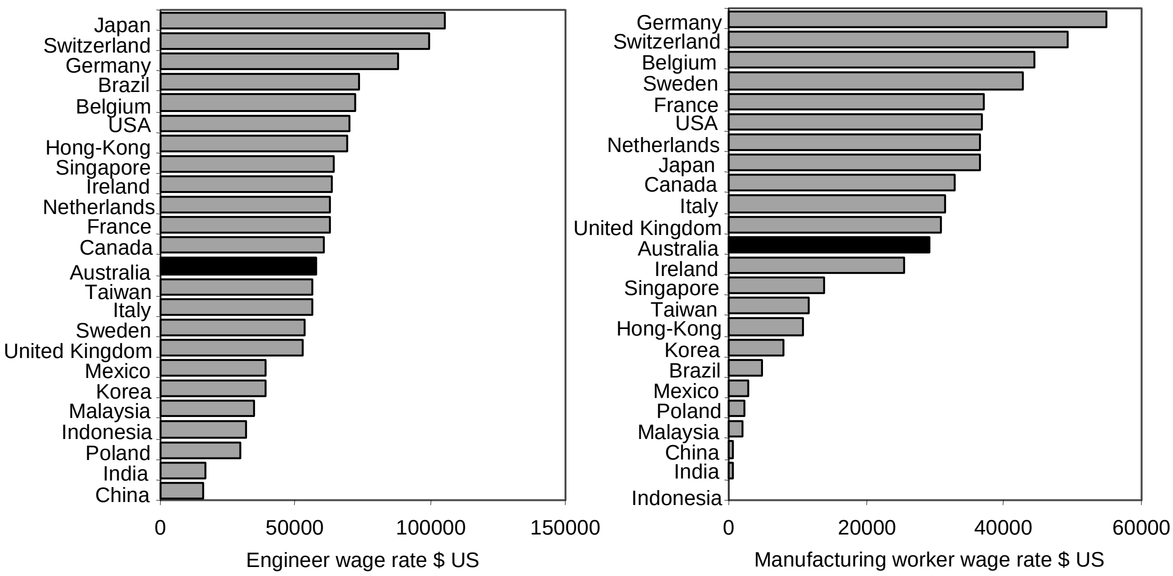
This pattern is replicated as further levels of disaggregation are considered. The ANZSIC three digit groups are made up of various four digit classes. Just as the figures for subdivisions are not well suited to inferring the competitiveness of groups within their respective subdivisions, the group figures are not reflective enough of their constituting classes. The classes themselves are also often broad and can contain a wide range of diverse activities that often do not share crucial productivity characteristics that are at the heart of international competitiveness.

Thus, in order to assess the international competitiveness of industries, it is important to develop a framework that groups firms on the basis of relevant attributes. Ultimately, the price of inputs relative to their productivity is what drives international competitiveness.

For example, given its high labour intensity overall, it is not surprising that the Australian clothing industry is declining. Chinese clothing workers have caught up with their Australian counterparts in terms of labour productivity, but continue to be paid much lower wages (PC 2003c).

In general, given international wage relativities, the Australian manufacturing sector cannot compete in non-differentiated traded goods that rely on low skill, highly labour intensive processes (figure 6.5).

Figure 6.5 **Relative wages of manufacturing labour**[a]



[a] The hourly wage rate for manufacturing workers reported by IMD was converted to an annual rate by multiplying by 40 hours per week by 52 weeks, so as to be on a comparable basis with engineers' salaries.

Data source: IMD (1998).

However, the large cross-country disparities in manufacturing worker wage rates are not matched by similar disparities in the salaries of engineers, indicating that cost competitiveness in processes that draw more on high skilled workers is less affected by wages (Other data on gross salaries for directors of manufacturing operations reveal a similar picture.)

In any case, competitiveness relies on many other facets of product, firm and country characteristics such as product differentiation, local demand conditions, innovation and entrepreneurial culture (Porter 1990). The role such factors can play is exemplified by the brand-name end of the clothing market — a few firms were able to establish themselves, for example in branded surf wear, and expand exports as well as domestic sales, despite wage cost pressures (PC 2003c).

Box 6.1 describes potential sources of competitiveness in the TCF sector, as identified in a recent Commission inquiry into TCF assistance arrangements. This highlights that the attributes of competitiveness do not fit into the traditional sectoral classifications.

Does size matter?

A reliance on capital intensive and niche products for competitive success, and less reliance on labour intensive, standardised products is not limited to TCF, but is consistent across industries. The growing importance of niche products has led some commentators to identify firm size as a factor that affects export potential.

For example, the Australian Manufacturing Council's (1993) report on manufacturing exporters highlighted the importance of small to medium-sized niche market exporters in Australia, chiefly among medical and scientific instruments manufacturers, aircraft components manufacturers, shipbuilders, electronic equipment manufacturers and production machinery manufacturers.[7] And, a study by Gabbitas and Gretton (2003) found that, among exporting firms, export intensity (exports over total sales) is negatively related to domestic sales. This finding suggests that many small niche exporters are concentrating mainly on export markets, while large firms tend to diversify their sales between domestic and export markets. Of course, large firms may still export to niche markets overseas.

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7 Niche markets can be defined as small market segments occupied by few competitors even on a global scale. Typical niche markets include components, sub-assemblies, consumer goods with unique characteristics (including brand names), as well as highly specialised (dedicated) machinery, equipment and instruments. Increasing specialisation and vertical disintegration in manufacturing are considered to be potential causes of the increasing importance of niche markets around the world.

Box 6.1 **Sources of competitiveness in textiles, clothing and footwear**

TCF manufacturing in Australia covers a diverse range of activities. This includes: early stage processing of leather and various natural fibres; the production of textiles; and the transformation of leather, yarns, textiles and fabrics into clothing and footwear, carpets, home and commercial textiles, and technical textiles such as shade cloth, medical and sanitary products, and insulation materials.

To understand the competitive pressures the TCF sector is facing and how it fares in terms of its competitiveness, it is not sufficient to simply look at the import penetration or export propensity of the ANZSIC 22 classification. A far more disaggregated approach is necessary. For example, in terms of specific TCF products, the Commission (2003c) compiled a list of emerging or continuing opportunities as identified by participants in the review:

- lightly processed raw materials (eg wet blue hides, scoured wool);
- wool based products such as carpets and knitting wool for home use;
- specialist nonwoven fabrics (eg medical and sanitary applications);
- industrial textiles, defined to include products such as shade cloth and geotextiles, and often using nonwoven fabrics;
- supply to the automotive industry;
- surf wear and 'wearable' art where cultural recognition is a marketing factor;
- quick-response fashion garments and fabric for those garments;
- complex, high fashion low-volume garment production, where proximity of the fabric provider to the Australian designer/producer is important;
- niche fabric and garment/footwear production such as defence apparel, fire retardant clothing, coated furnishing products and industrial footwear, where Australian firms have developed expertise; and
- the corporate apparel market where service is an important part of the product offering and where 'buy local' policies sometimes provide an additional measure of support.

More generally, the review identified highly labour intensive production processes as being particularly uncompetitive because the labour productivity in countries with significantly lower wages had caught up with Australian labour productivity. As a result, the mix of domestic TCF production has changed, with greater emphasis on high value added, capital intensive and niche products, and less on labour intensive, standardised products (2003c, p. 22).

Source: Productivity Commission 2003c.

Recent ABS evidence[8] suggests that Australia's goods exports are dominated by a relatively small number of exporters, with 109 businesses exporting goods to a value of $100 million or more each. These businesses accounted for almost 60 per cent of the value of goods exports during the six months ending December 2001. Conversely, the ABS found that the smallest exporters (about 13 000 businesses with exports valued between $10 000 and $100 000, representing 57 per cent of the number of goods exporters) accounted for less than one per cent of the value of goods exports over the same period (table 6.3).

Table 6.3 **Goods exporters' contribution to total goods exports, by firm size[a]**

Six months to December 2001

Goods exporters with exports of:	*Exporters (number)*	*Total exports ($ million)*	*Share of total exports (%)*
$100m or more	109	36 979	58.9
$1m and less than $100m	2 637	22 066	35.1
$100 000 and less than $1m	6 913	2 167	3.5
$10 000 and less than $100 000	12 922	477	0.8
Other goods exporters[b]	..	1 098	1.7
Total goods exporters	22 581	62 787	100

a Firm size is determined by their total exports for the period. **b** This is a residual category. It includes some overseas entities with large exports; aircraft and ships' fuel and stores used in transit; and firms that exported less than $10 000 per year (the combined exports of these small exporters is estimated to total $55 million).

Source: ABS (*International Merchandise Trade, Australia,* Cat. No. 5422.0, June Qtr. 2002).

Intra-industry trade

Intra-industry trade refers to the export and import of similar products by a country (box 6.2). The evidence suggests that intra-industry trade in manufactures has generally increased among developed economies from the 1970s (OECD 2002). This reflects greater integration of global production, the effects of trade agreements and the dismantling of trade barriers, and the growing complexity in the nature of consumer demand.

8 ABS, 'Experimental Statistics on Australia's Exporters and Importers', *International Merchandise Trade, Australia,* Cat. 5422.0, June quarter 2002.

Box 6.2 **Calculating intra-industry trade**

The usual measure of intra-industry trade is the Grubel-Lloyd index based on comparing export and import flows within reasonably disaggregated trade classifications. For the i^{th} trade classification, the value of intra-industry trade (VIIT) is:

$$VIIT_i = (X_i + M_i) - |X_i - M_i|$$

While the Grubel-Lloyd index (IIT) is:

$$IIT_i = \left[\frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)}\right] \times 100$$

where *X* are exports and *M* are imports of good *i*. This implies that if exports or imports are zero, IIT will be zero. If exports and imports are exactly matched, then the measure will be equal to 100. So, the measure is bounded by 0 and 100.

The overall intra-industry trade index for manufacturing in Australia is calculated as a weighted average of the individual intra-industry trade measures:

$$IIT = \sum_{i=1}^{n} \left\{ \frac{(X_i + M_i)}{\sum_{i=1}^{n}(X_i + M_i)} \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \right\} \times 100$$

$$= \left\{ \frac{\sum_{i=1}^{n}\left((X_i + M_i) - |X_i - M_i|\right)}{\sum_{i=1}^{n}(X_i + M_i)} \right\} \times 100$$

This has the interpretation of the percentage of total manufacturing trade accounted for by intra-industry trade. There are several criticisms of the Grubel-Lloyd index. In particular, the greater the trade imbalance, the smaller will be the share of intra-industry trade. However, alternative measures also have problems and the Grubel-Lloyd measure remains the measure most commonly applied.

It should be noted that the intra-industry trade index can give a different perspective on patterns of trade than the comparison of export and import penetration ratios. For example, at a disaggregated commodity level, it is possible to have high intra-industry trade with a lowly traded good, simply because exports and imports are small, but similar in magnitude. However, such a commodity grouping would have little weight in calculating the overall IIT index.

The phenomenon has several strands. It reflects:

- increasing product differentiation and branding, so that horizontal trade in basically similar products increases (exemplified by the sale of different brands of beers, wines and spirits across borders);

- sales of similar items, separated by quality or design differences (so that Australia may export fashion garments, but import other high quality fashion garments form Europe, and cheaper mass-produced clothing from Asia);

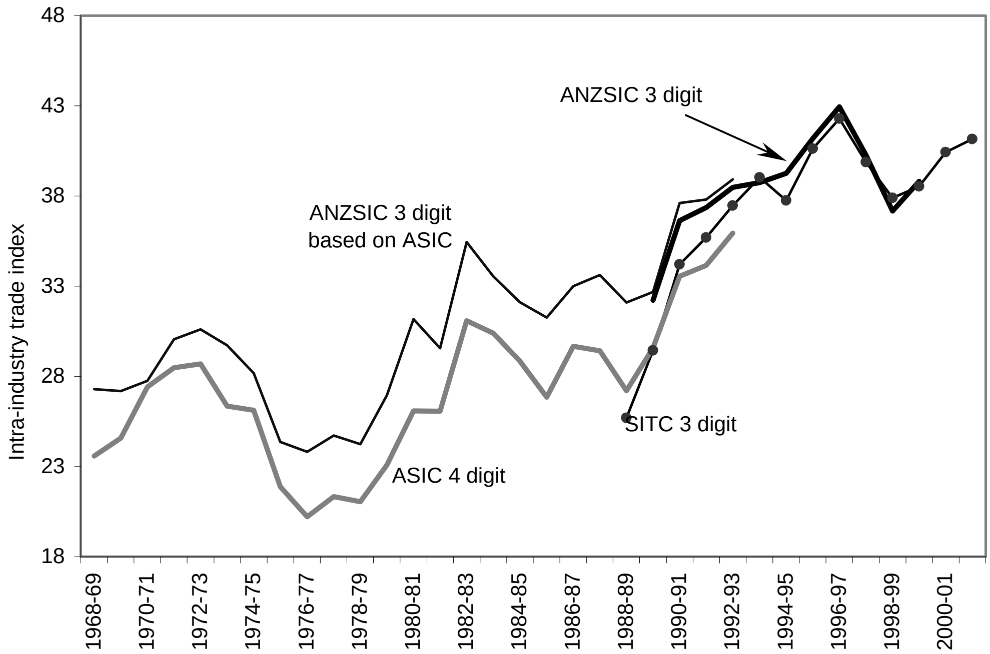
- sales of elaborate, highly specialist goods that bring similar technologies and inputs to bear, but which have different functions and underlying intellectual property. For example, Australia exports specialist optical instruments for highly specific uses (astronomy and defence), but imports other specialist optical instruments;
- greater global integration of production, imports and exports may represent products in different parts of a production chain (in Australia this is exemplified by imports of active pharmaceutical ingredients and exports of formulated and packaged pharmaceuticals). This will often also correspond to intra-firm trade across international borders; and
- the fact that the actual measures used for detecting intra-industry trade are sensitive to the taxonomies used for categorising goods. The broader the categories, the more likely it is that measured intra-industry trade really reflects trade in quite different goods that fall under the same rather wide classification (for example, bicycles and cars under transport equipment).

Different classifications of tradeable manufactured goods at varying levels of aggregation provide a similar picture of trends in intra-industry trade in manufacturing for Australia. While clearly volatile at times, the index has increased substantially over the past 30 years, particularly since the late 1980s (figure 6.6).[9]

This is suggestive of the capacity for Australian manufacturing to develop capabilities within almost all areas of manufacturing, even those where generally competitiveness has been declining.

[9] Unlike the findings above, the OECD (2002) claims that Australia has had a stable level of intra-industry trade in manufacturing from 1988-91 to 1996-2000. Its calculations suggest that the IIT index increased by only 1.2 percentage points over this period. However, the calculations are apparently based on all of SITC revision three product classes (not just SITC five to eight), and also are at the two digit level (the former difference in data source will tend to depress the IIT index since it includes many primary commodities, while the latter would increase the index, since its level of aggregation is higher). Our set of calculations based on the three digit SITC for all commodities still shows a substantial increase in the IIT index in the 1990s, so the source of the difference between the OECD and our results is not clear. Calculations based on two digit SITC (five to eight) reveal a similar pattern to the three digit results.

Figure 6.6 **Intra-industry trade in Australian manufacturing**[a]
1968-69 to 2001-02[b]



a Re-exports present a conceptual problem when calculating intra-industry trade. Re-exports usually do not reflect any comparative advantage in Australia (for example, often they represent the same product flowing in and out of Australia following warehousing). In that context, ideally they should be excluded from both exports and from imports. On the other hand, to the extent that re-exports identify the advantage of a country as a regional distributor of certain goods, then their inclusion may be sometimes warranted. For the ANZSIC three digit data, re-exports have been removed. However, the SITC data available did not exclude re-exports and so no adjustments could be made for this dataset. In the case of the four digit ASIC data, while re-exports were available, data problems for a few classes at the four digit ASIC level meant that they were not excluded. Clearly, the qualitative story does not change whether they are excluded or not, as apparent from the closeness of the SITC and the ANZSIC results. **b** The ANZSIC three digit data for 1968-68 to 1992-93 are based on a concordance between the ASIC and ANZSIC three digit classifications (appendix A). The SITC three digit data include all three digit items between SITC five and SITC eight inclusive. The ANZSIC and SITC classifications do not match for some goods — such as food, beverages and tobacco.

Data sources: Unpublished ABS data on trade and Industry Commission (1995).

The strongest contributors to the expansion in intra-industry trade have been elaborate goods, such as motor vehicles and parts, and pharmaceuticals (table 6.4). This is partly driven by global integration of production (as in pharmaceuticals and motor vehicles), but also by highly specialised niches within certain goods (such as medical and scientific equipment). Increasing intra-industry trade among just six categories of goods is enough to account for more than the total change in intra-industry change observed from the late 1990s. Their impacts are offset by a decline in intra-industry trade for a few, typically more simple, goods — such as Petroleum refining, Textile fibres and yarns and Iron and steel.

Table 6.4 **Contributions of specific industry groups to changes in the intra-industry trade index 1989-90 to 1999-2000**[a]

Industry group description	*ANZSIC code*	*Percentage points contribution to change in intra-industry trade*	*Percentage contribution to change in intra-industry trade*
		points	%
Motor vehicles & parts	281	2.17	32.8
Other chemical products	254	1.78	27.0
Electronic equipment, recorded media & electrical equipment & appliances	284/243/285	1.13	17.1
Other transport equipment	282	1.05	16.0
Photographic & scientific equipment	283	0.90	13.7
Industrial machinery & equipment	286	0.73	11.0
Petroleum refining	251	-0.50	-7.6
Iron and steel	271	-0.61	-9.2
Miscellaneous manufacturing	294	-0.68	-10.3
Textile fibres, yarn & woven fabric	221	-0.81	-12.2
Other	Rest	1.43	21.7
Total manufacturing	**C**	**6.59**	**100.0**

a These calculations are based on the three digit ANZSIC codes used in figure 6.6.

Source: As in figure 6.6.

The OECD (2002) has suggested that Australia is one of several primary commodities-based OECD countries (including New Zealand, Norway, Iceland, Greece and Turkey) where intra-industry trade is low. Generally, the evidence points to higher levels of intra-industry trade in highly developed European countries, North America and some selected Eastern European countries. This is not surprising, reflecting their close proximity to other countries, the effects of free trade agreements and the bias in the composition of their manufacturing output towards elaborate goods, where specialisation, branding and niche comparative advantages are likely. However, if the intra-industry trends apparent for Australian manufacturing continue, then Australia will have a trade structure much more similar to some European countries (such as Finland and Ireland).

The growing trend towards intra-industry trade has policy implications. It underlines the fact that comparative advantage often relies on highly specific factors — such as particular local endowments, knowledge, workforce quality and reputation — rather than which industry firms belong to. In that context, industry policy that targets industries will often be blunt and ineffective because it cannot take account of the highly specific, changing factors that shape competitiveness at the level of individual firms. Micro-management by government of specific parts of industries is too informationally demanding and corrosive of incentives. That suggests that more effective industry policy should address the fundamentals, encouraging flexible responses by those decision-makers who have the local knowledge about where and how to invest in physical, knowledge or human capital. This points to the relevance of microeconomic policies that facilitate flexibility — appropriate regulations, efficient utilities, a well-designed and responsive education sector — and stable macroeconomic policy that decreases uncertainty.[10]

6.2 Cross border ownership — evidence of an increasingly open manufacturing sector

Over the last few decades, there has been considerable integration of production by manufacturing enterprises across national boundaries. Cross border ownership of productive resources has risen significantly. The increasing role of cross border ownership provides additional evidence of an open manufacturing sector.

Today, large transnational corporations compete for customers around the world with components of their production chain strewn across nation states.[11] The United Nations Conference on Trade and Development (UNCTAD 2003a) estimated that intra-firm trade accounted for about one-third of world trade in 2002. There is some evidence to support the view that it accounts for a similar proportion of Australian trade. In a study of intra-firm trade in the US, Zeile (1997) estimated that:

- about 34.5 per cent of US exports to Australia were accounted for by internal trades within TNCs (31.4 per cent by US parent companies to their majority owned affiliates and 3.1 per cent by US affiliates to their foreign parents); and
- about 33.2 per cent of US imports from Australia were accounted for by intra-firm imports (14.8 per cent by US parent companies from their majority owned affiliates and 18.4 per cent by US affiliates from their parents).

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[10] It is also sometimes argued that greater intra-industry trade ameliorates the adjustment costs that arise from trade pressures on industries because workers' job skills are more portable between firms in a given industry than between different industries (Dixon and Menon 1997). However, while some empirical support has been found for the nexus, in other cases only weak or non-existent links have been apparent, while others have questioned the theoretical link (Lovely and Nelson 2002). At best, the notion that increased intra-industry trade has reduced adjustment pressures should be viewed cautiously.

[11] Some TNCs have reached extremely high levels of value added, rivalling the GDP of some nations. Of the 100 largest 'value added generating entities' (countries and corporations) in the world, 29 were TNCs in 2000 (UNCTAD 2002), most of which have a presence in Australia.

As a result of particularly widespread integration of the production chain across national boundaries in manufacturing, intra-firm trade appears to be especially high in the manufacturing sector (Zeile 1997).[12]

A further indication that the Australian manufacturing sector is highly internationalised is that TNCs play a large role as employers. For example, in 1996-97, over one-quarter of private sector employment in manufacturing in Australia was in majority foreign owned enterprises (table 6.5).

Table 6.5 **Private sector employment (non-farm) by industry and foreign ownership, 1996-97[a]**

Industry	*Percentage of foreign ownership*					
	Less than 50 per cent (including none)		*50 per cent or more*		*Total*	
	Employment	*Share of total*	*Employment*	*Share of total*	*Employment*	*Share of total*
	'000	%	'000	%	'000	%
Mining	62	83	24	7	86	100
Manufacturing	741	79	215	21	956	100
Services	3516	92	391	8	3906	100
Total	4318	87	529	13	4948	100

a The survey excludes government enterprises and businesses in the agriculture, education and health and community services industries. It covers around 60 per cent of total employment (as measured by the ABS Labour Force Survey); but includes all industries for which foreign direct investment is important.

Source: ABS unpublished data (Small and Medium Enterprises: Business Growth and Performance Survey), quoted in DFAT (1999).

International investment stocks provide another perspective on increasing globalisation. Foreign direct investment (FDI) is a generally accepted measure of investment effected by entities in one country to acquire a significant amount of

12 For example, in 2002, intra-firm imports of transport equipment in the US accounted for 75.9 per cent of such imports. Similarly, intra-firm imports in the US accounted for 67.5 per cent of computer and electronic products, 54.9 per cent of chemicals, 50.8 per cent of machinery (except electrical) and 48.2 per cent of electrical equipment appliances and components. For the same year, intra-industry exports from the US accounted for 40.0 per cent of chemical exports, 39.1 per cent of plastics and rubber product exports, 37.9 per cent of transportation equipment exports and 37.9 per cent of computer and electronic products (United States Department of Commerce 2003).

influence over firms of another country.[13] Thus, FDI proxies investment (or divestment) by TNCs.[14]

Foreign direct investment

The manufacturing sector derives a much greater share of its capital stock from FDI than primary production and the tertiary sector. The ratio of FDI inward stocks to net capital stock in manufacturing ranged from 0.49 in 1990-91 to 0.69 in 1998-99. This compares with a range for primary production of 0.16 in 1990-91 to 0.22 in 2000-01 and a range for services of 0.11 in 1990-01 and 0.16 in 1996-97 (figure 6.7, panel A).[15]

The amount of inward FDI stock per 1000 persons employed in the Australian manufacturing sector was similar to that in the primary sector for most of the past decade[16] and considerably higher than in the services sector (figure 6.7, panel B).

The inward FDI stock into manufacturing began to fall from 1998-99 (as apparent from both panels of figure 6.7). This decline partly reflects changes in asset prices. FDI stocks are valued on the basis of market prices, including the price of equities, and these fell during this period. However, the decline in stocks can also be partly attributed to a dwindling *flow* of inward FDI.

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13 Generally, if a foreign investment results in the acquisition of 10 per cent or more of the voting stock of a company, the investment is considered to be foreign direct investment. The ABS uses this 10 per cent rule.

14 FDI does, however, systematically omit other avenues for TNCs to invest, such as raising funds within the host countries of their affiliates.

15 Direct indicators of the importance of FDI are not generally available for Australia because the ABS does not usually maintain links between the companies for which FDI data are collected and the enterprises for which operations data, such as employment or sales, are collected. Furthermore, the ABS changed the definition of FDI in 1997 to bring it in line with the recommendations of the 5th edition of the Balance of Payments Manual of the International Monetary Fund (since then, it also includes loans between affiliated enterprises, except between banks; the private purchase and sale of real estate and property; and reinvested earnings). Data have been revised back to 1990-91, but previous data are not comparable.

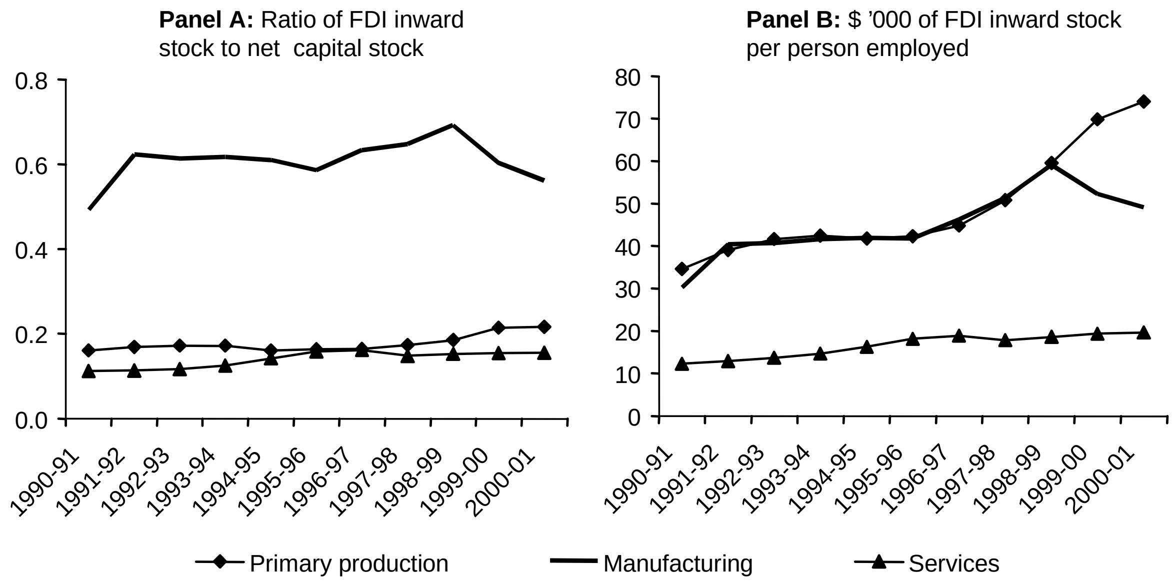
16 This may seem at odds with the employment figures for TNCs presented in table 6.5 above. One reason for the difference is that the data on TNCs concern the share of employed persons in TNCs, not the capital to employment ratio. It is worth noting, however, that the definition of TNCs above requires majority ownership, whereas the definition of FDI only requires ownership of 10 per cent or more. According to the Business Growth and Performance Survey cited in DFAT (1999), 28 per cent of persons employed in mining in 1996-97 worked for companies with ten per cent or more foreign ownership, compared with 23 per cent in manufacturing. As reported in table 6.5, the same survey also found that the equivalent figures for majority foreign owned enterprises were 7 and 21 per cent, respectively.

Indeed, inward FDI flows into the Australian manufacturing sector fell from about $11 billion for the five years ending 1995-96 to about $9.5 billion for the five years ending 2000-01. For the same periods, the share of FDI inflows that went to manufacturing fell from 24 to 15 per cent, while FDI inflows into primary production rose from 7 to 27 per cent (table 6.6).

It is worth emphasising, however, that investment flows are highly volatile and that no reliable trends can be identified given the short timeframe. For example, FDI inflows into Australian manufacturing ranged from -$2 958 million in 1999-2000 to $5 413 million in 2000-01 (figure 6.8).

Nonetheless, the smaller than proportional inward FDI flows have contributed to the decline of the manufacturing FDI inward stock to total FDI inward stock from 33 per cent in 1990-91 to 26 per cent of in 2000-01 (figure 6.9, panel A).

Figure 6.7 **Relative size of FDI inward stock by industry sector, 1990-91 to 2000-01[a, b]**



[a] The services sector as defined here comprises: electricity, gas and water supply; construction; wholesale trade; retail trade; accommodation, cafes and restaurants; transport and storage; communication services; finance and insurance; and property and business services. It excludes: government administration and defence; education; health and community services; cultural and recreational services; personal and other services; ownership of dwellings; and ownership transfer costs. [b] Net capital stock and FDI are not directly comparable. FDI is valued at market prices and includes the goodwill and other intangibles embodied in share prices. Net capital stock, in contrast, represents the net present values of the future capital services to be provided by the stock of productive capital. In publishing these figures, the ABS also warns that in classifying the data by industry groups, it uses the predominant activity of enterprises, even though an enterprise may be involved in a broad range of activities.

Data sources: UNCTAD 2003b, ABS (*Australian System of National Accounts*, Cat. No. 5204.0) and. unpublished ABS data (from Labour Force Survey).

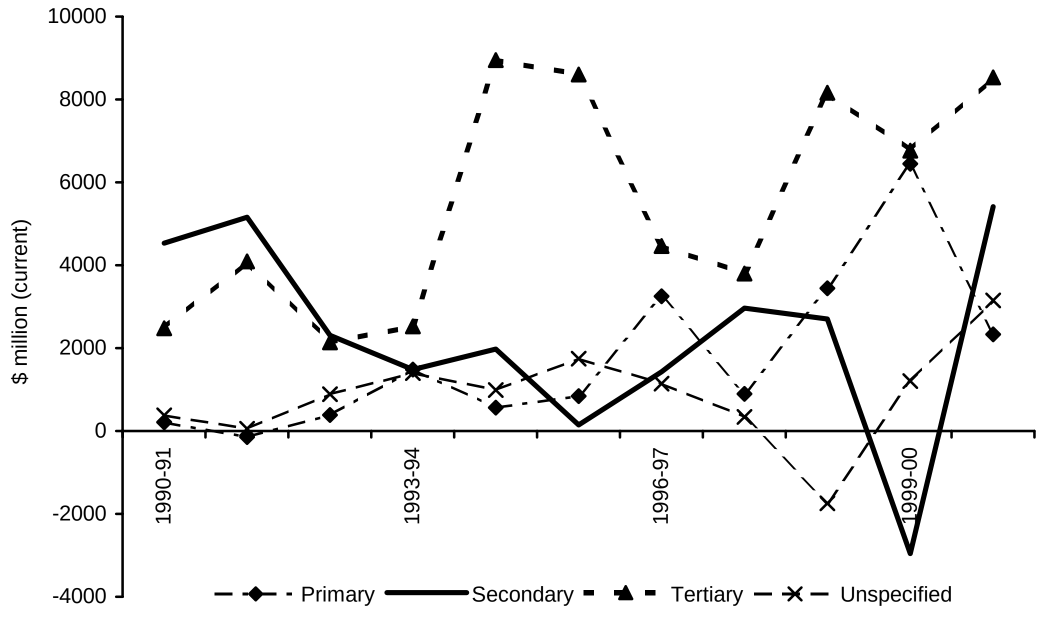
Table 6.6 **FDI inflows into Australia, by sector**

Sector	*Cumulative FDI inflows 1991-92 to 1995-96*	*Cumulative FDI inflows 1996-97 to 2000-01*	*Share of FDI inflows 1991-92 to 1995-96*	*Share of FDI inflows 1996-97 to 2000-01*
	$ m	*$ m*	*%*	*%*
Primary	3 133	16 377	7	27
Manufacturing	11 075	9 548	24	15
Services [a]	26 300	31 723	58	51
Unallocated	5 072	4 090	11	7
Total	**45589**	**61738**	**100**	**100**

a The services sector as defined here comprises: electricity, gas and water supply; construction; wholesale trade; retail trade; accommodation, cafes and restaurants; transport and storage; communication services; finance and insurance; and property and business services. It excludes: government administration and defence; education; health and community services; cultural and recreational services; personal and other services; ownership of dwellings; and ownership transfer costs.

Sources: UNCTAD 2003b, unpublished ABS data.

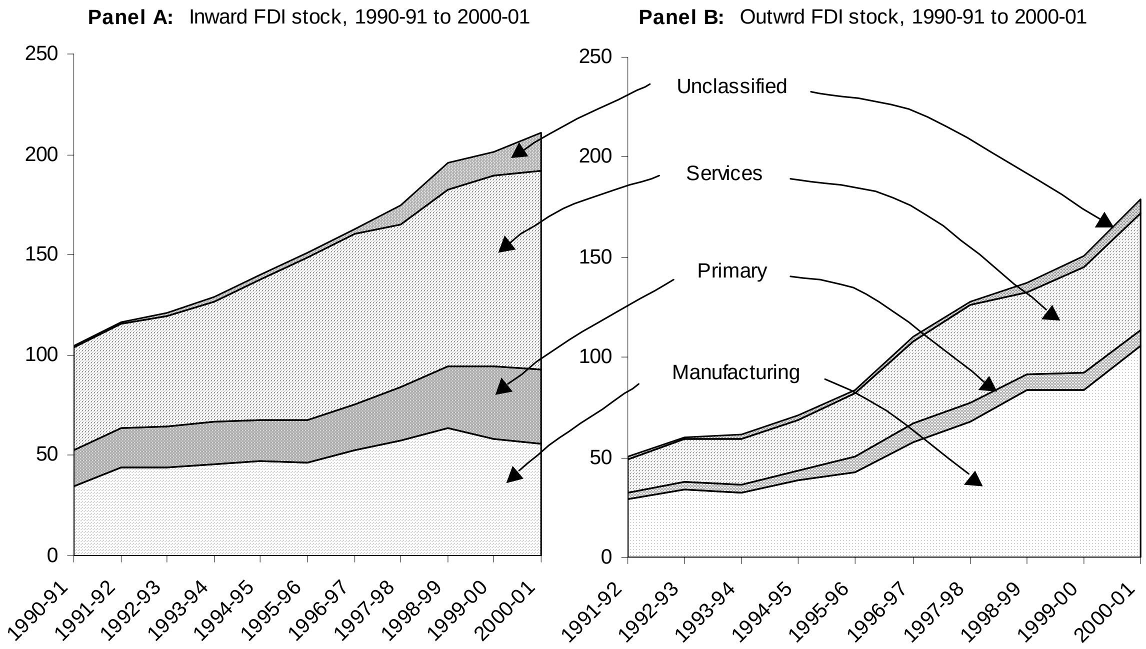
Figure 6.8 **Inward FDI flows, by sector, 1990-91 to 2000-01**[a]



a The services sector is defined here as in note a of table 6.6.

Data source: UNCTAD 2003b.

Figure 6.9 **FDI stocks, Australia ($ billion)[a]**



a The services sector is defined here as in note a of table 6.6.

Data source: UNCTAD 2003b.

More generally, compared with the rest of the world, FDI inflows into Australia across all sectors have been weak over the last decade. FDI inflows into Australia posted an annual growth rate of 13.2 per cent over the period 1990-91 to 1994-95, compared with a world average of 20 per cent per annum. Over the subsequent five-year period (1995-96 to 1999-2000), FDI inflows into Australia stagnated, with an annual trend growth rate of 0.3 per cent, while worldwide FDI inflow growth accelerated to a trend growth rate of 40 per cent per year (UNCTAD 2002).

As a result, Australia's relative position on the UNCTAD inward FDI performance index has declined substantially. Of 140 countries ranked, Australia went from 22nd in the 1988-1990 performance index to 88th in the 1998-2000 index. That is, the share of inward FDI to GDP for Australia has fallen considerably relative to other countries. Underlying this result is Australia's relatively strong economic performance over the relevant period, coupled with a relatively small rise in inward investment flows. Compared with the attractiveness of Australia as a destination for FDI, as assessed by the UNCTAD's inward FDI potential index, the 1998-2000 performance index result is particularly low (according to the 'potential' index, Australia ranked 15th in the 1988-90 index and 16th in the 1998-2000 index) (UNCTAD 2002).[17]

However, when comparing the relative openness of the Australian economy in terms of the importance of foreign owned productive capacity, rather than FDI inward flows, Australia remains highly open. Amongst 23 developed countries listed, Australia ranked fourth highest in 1996 and ninth in 1999 (UNCTAD 1999 and UNCTAD 2002).[18]

In contrast to the picture that emerges for manufacturing inward FDI, outward FDI flows rose continuously over the past decade. Manufacturing also maintained its high share of total outward FDI stocks over the same period (rising from 58 per cent in 1991-92 to 59 per cent in 2000-01, figure 6.9, panel B). Note that outflows, though less pertinent to Australian manufacturing operations, are nonetheless an indication of international linkages. This is particularly apparent in light of the fact that a large fraction of exports are accounted for by intra-firm trade.

Foreign assets and liabilities

Another way to look at foreign ownership of productive resources in the Australian economy is to abstract from who controls activities and simply to look at liabilities to, and total assets in, foreign entities.

Foreign liabilities and assets in manufacturing — the amount of Australian manufacturing assets owned by foreign entities and the amount of foreign productive assets owned by Australian manufacturing businesses, respectively —

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17 To provide an indication of the relative inward FDI performance and potential of host economies, UNCTAD (2002) constructed country rankings using an *inward FDI performance index* (the ratio of a country's share in global FDI flows to its share of global GDP) and an *inward FDI potential index* (which uses the average of eight values and is designed to capture variables expected to affect inward FDI, namely: the growth rate of GDP; per capita GDP; share of exports in GDP; telephone lines per 1000 inhabitants; commercial energy use per capita; share of R&D expenditure in gross national income; share of tertiary students in the population; and country risk). It is important to note that the FDI flow data vary substantially from year to year. Even three-year averages (as UNCTAD used for its indexes) remain highly variable and responsive to large 'one off' investment events. The inward FDI potential index also has to be interpreted with caution because the factors affecting investment decisions are varied and not fully understood. The factors that were finally chosen are also subject to data limitations.

18 This is based on the *transnationality index*, which is constructed by taking the simple average of: FDI inflows as a percentage of gross fixed capital formation; FDI inward stock as a percentage of GDP; value added of foreign affiliates as a percentage of GDP; and employment by foreign affiliates as a percentage of total employment. Value added and employment data were not available for all countries (including Australia), so that UNCTAD estimated these values.

also show an increasing internationalisation of manufacturing operations in Australia.

From 1988-89 to 2001-02, the amount of Australian manufacturing assets owned by foreign entities (foreign liabilities) grew at a trend rate of 6.3 per cent per annum, significantly outstripping growth in net capital stock (3.5 per cent per annum). Concurrently, the stock of overseas manufacturing activities acquired by Australian entities (foreign assets) grew at an even faster trend rate of 9.1 per cent per year.[19] Thus, the ownership structure of Australian manufacturing is becoming more international when assessed relative to the net capital stock in manufacturing.[20]

However, these growth rates were surpassed by total investment into Australia (with an annual growth rate of 9.7 per cent per annum) and by total Australian investment abroad (13.1 per cent per year). Accordingly, the ownership structure of the Australian economy as a whole (particularly services), is globalising at a faster rate than manufacturing.

6.3 Destination and sources of trade flows

Exports

It is well established that Australia has increasingly directed its manufactured exports to Pacific rim countries and away from the UK. It is less well known that there are significant differences in trade patterns for ETMs compared with STMs. In particular, while Asian countries have been a rapidly growing destination for STMs (figure 6.10), this has not been true for ETMs (figure 6.11). Accordingly, the share of STM exports accounted for by major Asian trading partners increased from under 30 per cent in 1982-83 to over 55 per cent by 2001-02. In contrast, major Asian trading partners have accounted for only between one-fifth and one-quarter of

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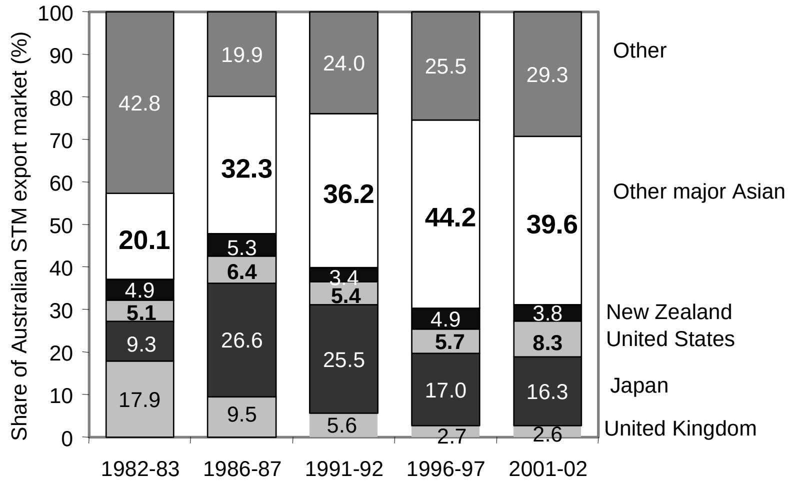
19 ABS, *Australian System of National Accounts,* Cat. No. 5204.0; *Balance of Payments and International Investment Position, Australia,* Cat. No. 5302.0.

20 Note that net capital stock and foreign assets and liabilities are not directly comparable. The relative growth rates only give an indication of the importance of foreign ownership of total Australian assets. This is because foreign liabilities are valued at market prices and include the goodwill and other intangibles embodied in share prices. In contrast, net capital stock represents the net present values of the future capital services to be provided by the stock of productive capital. In publishing these figures, the ABS also warns that in classifying the data by industry groups, it uses the predominant activity of enterprises, even though an enterprise may be involved in a broad range of activities. For foreign investment in Australia, for example, it is particularly problematic to interpret industry statistics, as a significant proportion of the total level of foreign investment in Australia is in the form of borrowing by enterprises classified to the finance and insurance industries.

Australia's exports of ETMs, without a clear upward trend. The United States has been the major single trading partner that has assumed greater importance as a destination of Australian ETMs.

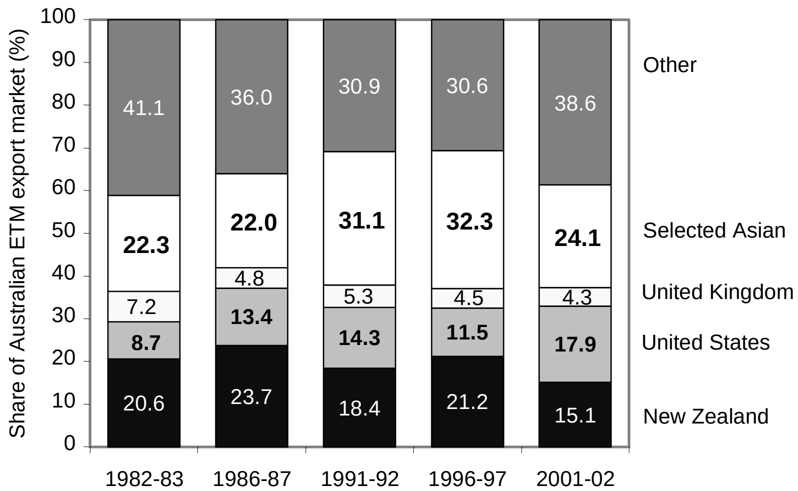
Figure 6.10 **Export destinations of simply transformed manufactures**
1982-83 to 2001-02[a]



[a] Exports are of Australian produce (ie they exclude re-exports). The countries whose geographic area is shown were in the top 12 ranked export destinations for STMs in 2001-02. 'Other major Asian' are the major Asian export destinations of STMs outside of Japan. They are: China; Indonesia; Thailand; Republic of Korea; Hong Kong; Taiwan; and Malaysia.

Data source: DFAT (various issues), *Exports of Primary and Manufactured Products, Australia*.

Figure 6.11 **Export destinations of elaborately transformed manufactures**
1982-83 to 2001-02[a]



[a] Exports are of Australian produce (ie they exclude re-exports). The countries whose geographic area is shown were in the top 12 ranked export destinations for ETMs in 2001-02. Selected Asian are the major Asian export destinations of ETMs. They are: Singapore, Hong Kong, Malaysia, Indonesia, China, Japan and the Republic of Korea.

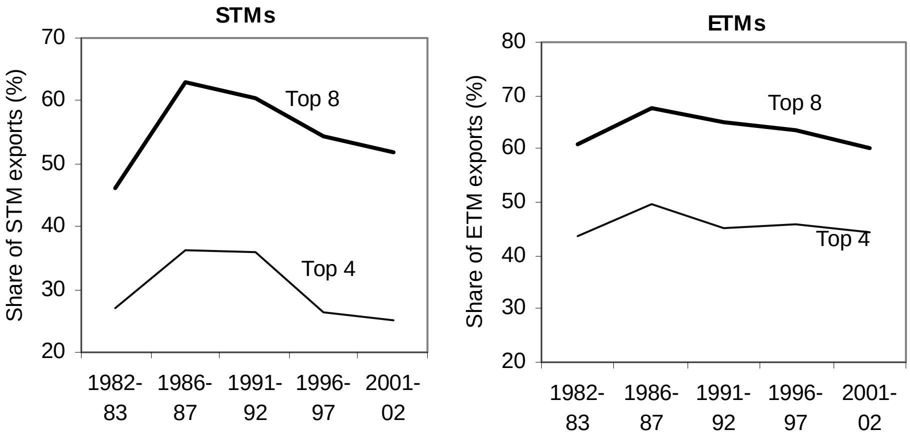
Data source: As in figure 6.10.

The differential pattern is likely to reflect resource endowments and preferences in both Australia and its trading partners. In essence, STMs represent transformation of raw materials that Australia has in abundance, and which are either less abundant or less efficiently produced among Asian trading partners. In contrast, the ETMs produced by Australia are often geared towards Western preferences and states of development, or have a role in global production chains that have their apexes in Europe or the United States (which are prominent sources of FDI and intra-firm trade in Australia).

Globalisation and increased country specialisation might be expected to widen trading opportunities and reduce export concentration among a few destinations. However, concentration of Australia's manufacturing exports by destination has declined only relatively slightly in ETMs, though a steeper decline is observed for STMs (figure 6.12).

Figure 6.12 **Concentration of manufactured exports in particular destination markets**

1982-83 to 2001-02[a]



[a] The figures show the percentage of total STM and ETM exports accounted for by the top ranking four and eight country destinations in each year.

Data source: As in figure 6.10.

Imports

Not surprisingly, there are links between export destination patterns and import sources. Asian countries are less important as sources of STMs than they are as destinations. On the other hand, those Asian countries with lower wages and rapidly increasing technological capabilities, such as China, have been an increasing source of more highly transformed manufactures (table 6.7).

Overall, developing countries — regardless of their location — have been an increasing source of both STMs and ETMs (figure 6.13).

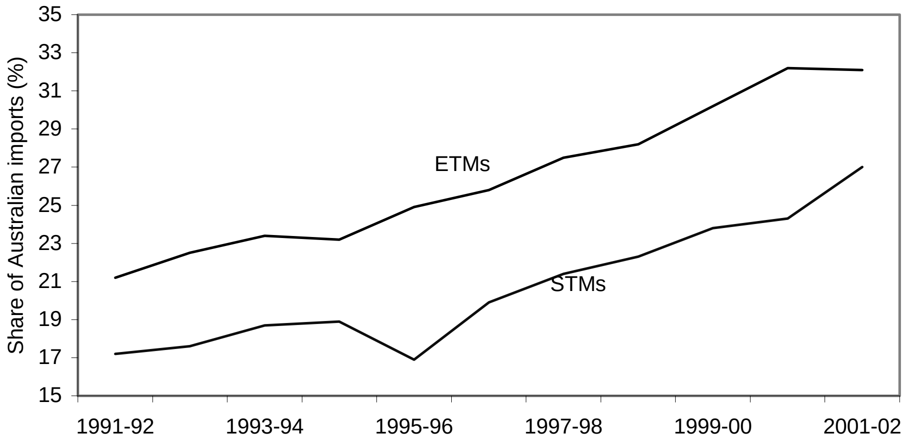
Table 6.7 **Major import sources for manufactures, Australia**
Share of Australian imports, 1991-92 to 2001-02

	1991-92	*1996-97*	*2001-02*
	%	%	%
Simply transformed manufactures			
United States	18.4	20.9	17.3
Japan	8.3	5.5	5.8
New Zealand	6.3	5.5	5.1
China	1.8	2.4	6.5
Selected other Asian[a]	4.1	6.4	6.6
Selected European[b]	25.7	23.5	18.7
Other	35.4	35.9	40.0
Total	**100.0**	**100.0**	**100.0**
Elaborately transformed manufactures			
United States	25.6	24.6	20.2
Japan	22.9	16.0	16.0
China	4.7	6.4	11.2
Selected other Asian[c]	13.4	15.4	16.0
Selected European[d]	19.9	21.3	19.5
Other	13.5	16.3	17.2
Total	**100.0**	**100.0**	**100.0**

a These are Indonesia, Republic of Korea and Malaysia. **b** These are Germany, UK, Italy, Finland and France. **c** These are Republic of Korea, Taiwan, Malaysia, Singapore, Thailand and Hong Kong. **d** These are Germany, UK, Italy, France and Sweden.

Source: As in figure 6.10.

Figure 6.13 **Imports of manufactures from developing countries**
1991-92 to 2001-02



Data source: As in figure 6.10.

Developing countries are a particular source of imports for goods where labour costs are significant. They are particularly dominant in imports of Textiles, clothing and footwear, Small electrical fittings and appliances and Consumer electronics (table 6.8).

Table 6.8 **The role of developing economies as sources of specific elaborately transformed manufactures imports into Australia[a]**
2000-01

SITC code	*Commodity description*	*Share of imports by selected developing countries[b]*
		%
843	Men's or boys' clothing of textile fabrics, knitted or crocheted	92.8
844	Women's or girls' clothing of textile fabrics, knitted or crocheted	92.5
845	Clothing of textile fabrics	91
842	Women's or girls' clothing of text fabrics, not knitted or crocheted	87.8
841	Men's or boys' clothing of text fabrics, not knitted or crocheted	87.2
658	Made-up articles, wholly or chiefly of textile materials, nes	81.5
851	Footwear	77.5
831	Travel goods, handbags and similar containers	76
848	Articles of apparel and clothing accessories	71.8
667	Pearls, precious and semi-precious stones, unworked or worked	70.1
762	Radio-broadcast receivers	70
652	Cotton fabrics, woven (excl. narrow or special fabrics)	67.3
885	Watches and clocks	66
666	Pottery	65.1
894	Baby carriages, toys, games and sporting goods	60.7
821	Furniture and parts thereof, bedding and mattresses	59.8
846	Clothing accessories of textile fabrics	59
711	Steam or other vapour generating boilers, parts	58.5
763	Sound recorders or reproducers	58.3
813	Lighting fixtures and fittings, nes	53.1

a nes is not elsewhere specified. The table shows those ETMs where imports from the selected developing economies exceeded 50 per cent of total imports of these goods into Australia. **b** The relevant countries are China, Hong-Kong (special administrative area of China), Malaysia, Thailand, Indonesia, Philippines, Papua New-Guinea, Pakistan, India and Vietnam. While Hong-Kong is a high-wage economy, it was included among this group because it serves as a transit port for trade with China.

Source: Unpublished ABS data.

6.4 Barriers to trade

A host of barriers to trade have affected Australian manufacturing. Historically, quotas, tariffs and other government protectionist policies discouraged import competition (and exporting), and made Australian manufacturing inward looking. This was accentuated by comparable measures adopted by many trading partners and by steep transport and communication costs. However, in one generation, many of these barriers have fallen or dwindled in importance — constituting one of the key forces behind the increasing trade orientation of manufacturing.

Border protection

Assistance by Commonwealth, State and Territory Governments has been an important factor in shaping the structure of some sections of Australian manufacturing, particularly those exposed to trade. Such assistance includes border protection measures (such as tariffs and quotas), investment incentives, research and development subsidies, tax concessions, public research agencies, procurement preferences and the provision of infrastructure facilities such as land, electricity, waste disposal and access roads at below market prices. The wide range of State, Territory and Commonwealth budget measures supporting manufacturing are discussed in appendix H. This section concentrates on measures that have a focus on restricting import competition.

For many years, border protection — mainly tariffs and quotas — was the dominant form of assistance to manufacturing. However, in the last three decades border protection has been reduced markedly:

- the nominal rate of assistance on manufacturing output fell from an average of 23 per cent in 1968-69 to about 3 per cent in 2000-01; and[21]
- the effective rate of assistance fell from an average of about 35 per cent in 1967-68 to below 5 per cent in 2000-01 (figure 6.14).[22]

These average assistance figures mask large variations between different manufacturing industries. All other things being equal, these variations distort resource allocation within manufacturing (PC 2000b). Such variation increased until the mid 1980s, with effective rates of tariff assistance increasing in the TCF and Motor vehicle industries, while rates for other industries dwindled (table 6.9).

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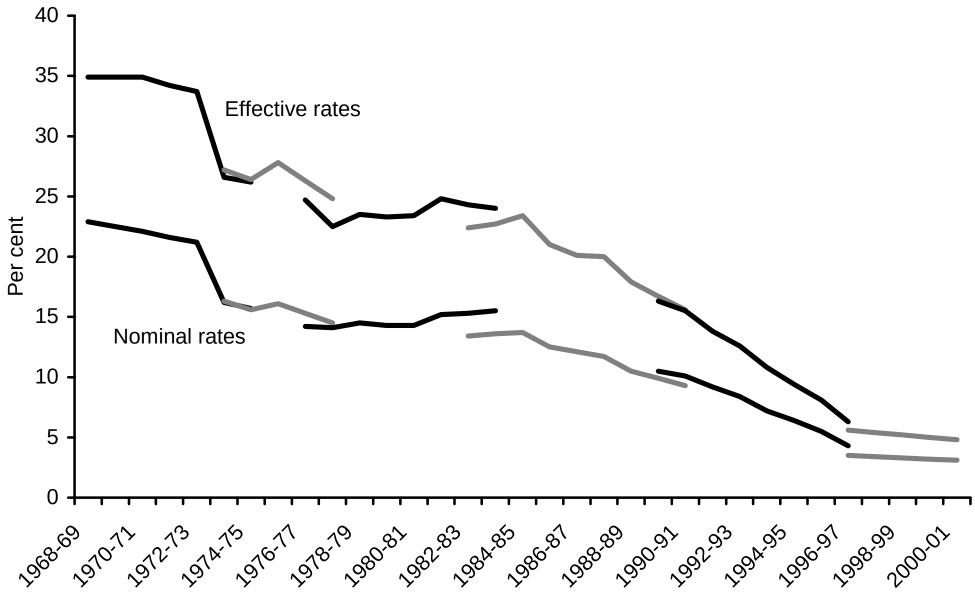
[21] The nominal rate of assistance on outputs is the percentage change in gross returns per unit of output relative to the (hypothetical) situation of no assistance. The nominal rate measures the extent to which consumers pay higher prices and taxpayers pay subsidies to support local output.

[22] The effective rate of assistance is the percentage change in returns per unit of output to an activity's value-adding factors due to the assistance structure. The effective rate measures net assistance, by taking into account the costs and benefits of assistance to inputs, direct assistance to value adding factors and output assistance. For details on the methodology, as well as limitations to the effective rates of assistance estimates, see PC (2000a).

Figure 6.14 **Falling rates of assistance to manufacturing**[a]

1968-69 to 1996-97



[a] Breaks in the series reflect periodic revisions to industry input and output tables used in these estimates. These changes occur gradually over time, due to factors such as changing technology and relative input and output prices.

Data source: PC 2000a.

Table 6.9 **Average effective rate of assistance to manufacturing industries**

1968-69 to 2000-01, per cent

ANZSIC industry grouping							
Code	*Description*	*1968-69*	*1977-78*	*1984-85*	*1989-90*	*1995-96*	*2000-01*
21	Food, beverages and tobacco	14.0	10.4	6.1	4.5	2.6	4.6
22	Textiles, clothing, footwear and leather	71.0	88.4	156.7	85.5	42.2	23.2
23	Wood and paper products	39.5	19.1	21.5	13.9	7.0	5.6
24	Printing, publishing and recorded media	35.5	23.3	12.4	6.5	2.5	0.9
25	Petroleum, coal, chemical and assoc. prod.	26.6	20.7	15.2	11.0	5.4	3.9
26	Non-metallic mineral products	13.5	4.2	3.4	4.1	2.5	2.7
271-3	Basic metal products	28.1	10.1	9.4	7.5	5.1	3.0
274-6	Fabricated metal products	58.7	28.4	23.0	20.0	8.7	4.6
281	Motor vehicles and parts	48.6	70.2	139.7	54.9	33.3	14.1
282	Other vehicles	39.1	10.8	15.2	10.0	3.4	-0.6
283-6	Other machinery and equipment	41.9	18.7	24.1	19.8	8.1	2.1
29	Other manufacturing	54.4	32.3	24.6	24.7	9.5	4.7
21-29	**Total manufacturing**	**34.9**	**22.5**	**23.4**	**16.3**	**8.1**	**4.8**

Source: PC 2000a.

However, from the mid 1980's, the largest tariff reductions occurred in sectors that were most heavily protected. This reduced the dispersion. Nonetheless, relatively high effective rates of assistance remain in place for the TCF and Motor vehicle industries.

Anti-dumping and countervailing measures — mainly 'temporary' customs duties — imposed on 'dumped' imports assist some industries and, like other forms of border protection, impose higher costs on other domestic industries and consumers.[23] The assistance estimates above (both nominal and effective) do not include anti-dumping and countervailing measures.

The Commission (2002a) reports the number of new dumping and countervailing measures cases initiated, measures in force and measures imposed by year (figure 6.15).

Figure 6.15 **Anti-dumping and countervailing activity, 1991-92 to 2001-02[a]**

a A measure or case is counted as an action applying to one commodity from one economy. If multiple economies are involved, they are counted as separate actions.

Source: PC (2002a).

23 Dumping is said to occur when a foreign supplier exports goods at a price below the 'normal' value of the goods in the supplier's home market. WTO rules allow countries to apply anti-dumping measures on 'dumped' imports if they cause, or threaten to cause, material injury to a competing domestic industry. Similar measures (countervailing duties) may also be applied to imports that benefit from certain forms of subsidies in the country of origin, but are not necessarily dumped.

Aside from a rise in 1997-98, the number of new anti-dumping and countervailing cases *initiated* in Australia has been stable and, compared with the early 1990s, relatively small. Of the 16 new anti-dumping cases in 2001-02, three firms in the Petroleum, coal, chemical & associated products industry were responsible for 10 initiations, with firms in the Wood & paper products and Metal product manufacturing industries accounting for the remainder. This pattern of initiations is similar to that of previous years.

The actual number of anti-dumping and countervailing measures *imposed* by the government, and the number of measures *in force*, have broadly followed the trend in the number of cases initiated, albeit with slight lags (figure 6.15).

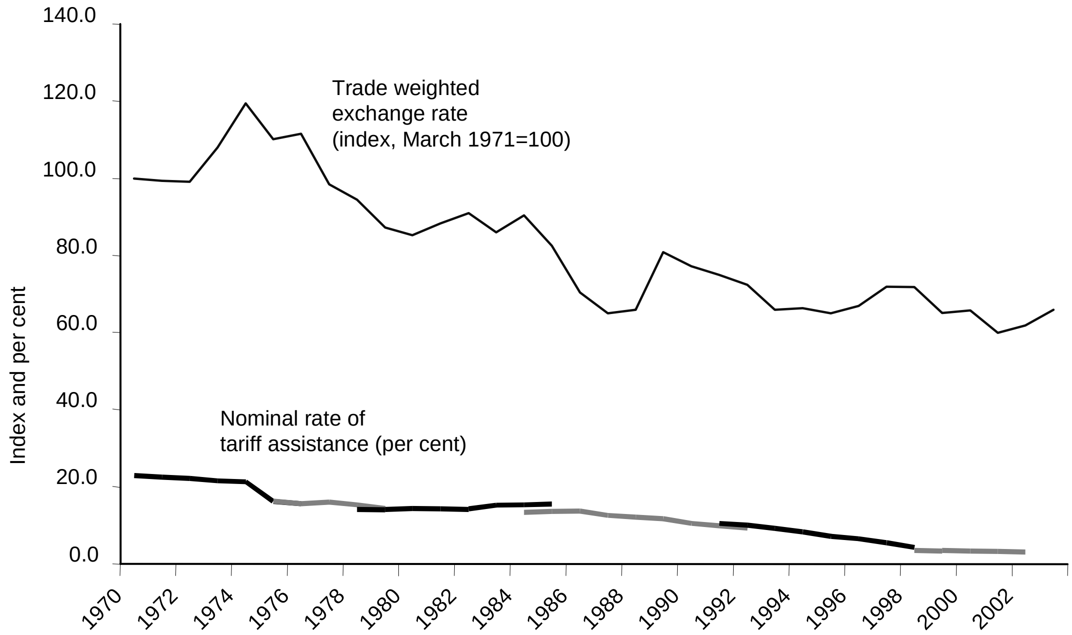
The effects of reduced border protection

The effect of diminishing border protection on affected industries is difficult to discern. By itself, a reduction in tariff assistance to manufacturing can be expected to reduce profitability (and hence output), at least in the short run for the assisted segments (PC 2000b, pp. 19). However, other factors (which themselves can be affected by the structure and rates of tariff assistance) can mitigate the effects of tariff reductions. For example:

- productivity in assisted industries may increase as firms eliminate inefficient practices and rent-seeking that were facilitated by made-to-measure assistance measures;
- firms may benefit from reduced costs of imported inputs; and
- a depreciation of the real exchange rate — which makes domestic products cheaper relative to their overseas counterparts — can boost the output and profitability of domestic producers. The real exchange rate has depreciated considerably over the past 30 years, providing an offsetting effect to the impacts of reductions in tariff rates (figure 6.16).

Figure 6.16 **The real exchange rate and the average nominal rate of tariff assistance**[a]

March 1971 to March 1997, index points and per cent



a The real exchange rate base index is March 1971 = 100. The nominal rates of assistance are given for the financial year ending in the respective years and the real exchange rate is for the March quarter of the respective years in the figure. The real exchange rate (estimated by the Reserve Bank) is defined as a weighted product of nominal exchange rates, adjusted by the price level in the home country relative to foreign countries (RBA 2001b).

Data sources: PC 2002a and RBA 2003.

Transport and communication costs

The 'tyranny of distance' has been weakened. Distance acted as a major barrier to trade at the turn of the 20th century, when most imports were sourced from the UK and freight costs were substantial. But changing trade patterns, different commodity types and cheaper transport costs make distance a less important constraint on trade. For example, freight costs relative to value for imported goods almost halved over the last two decades alone (table 6.10).

Table 6.10 **Estimated freight and insurance costs of imports**[a, b, c]

Percentage of the free-on-board value (FOB) of total imports

	Sea freight and insurance[b]	*Air freight and insurance*[b]	*Total freight and insurance*	*Air FOB of total FOB*[c]
	% of FOB value	% of FOB value	% of FOB value	% of total
1988-89	8.50	7.42	8.24	23.6
1991-92	8.23	6.20	7.65	28.2
2001-02	5.21	3.86	4.71	37.0

a Free-on-board (FOB) values exclude freight and insurance costs. **b** The reason for lower air freight costs relative to sea freight is that more expensive items per unit weight are carried by air freight (according to Bureau of Transport Economics estimates, the average air freight product is worth about 300 times more per kg than the average sea freight product). **c** Value of imports by air as a share of the value of all imports.

Source: Unpublished ABS data.

Communications costs have also declined substantially. New communication channels, such as video-conferencing, e-mail and the Internet have emerged and existing technologies, such as the telephone, have become considerably cheaper.

Overall, the costs of sourcing goods internationally have declined substantially and, as a result, the ‘natural’ protection available to domestic industries from international competition has fallen. Conversely, barriers to Australian exports posed by transport and communication costs have also dwindled.

However, for some low value per weight items, such as bricks and glass, freight costs still provide a measure of protection. And, for some high technology activities, where the feedback requirements between R&D and manufacturing activities are often intense, communication costs still prevent companies from situating parts of the production chain in the lowest cost location (communications costs excluded).

These changes to the assistance structure and ‘natural’ barriers to trade have resulted in the Australian manufacturing sector being more open and more closely integrated in the global economy.

7 Productivity

Key points

- Over the last forty years, annual labour productivity growth in manufacturing has averaged 3 per cent.
- While a significant part of this can be explained by increasing capital intensity, about half of the productivity gain can be ascribed to *multifactor* productivity. This has produced an estimated ‘dividend’ to Australia of around $400 billion.
- Over the long run, annual average multifactor productivity growth in manufacturing has exceeded that of the market sector generally by around 0.6 percentage points.
- However, the manufacturing sector does not appear to have experienced the multifactor productivity surge that characterised the market economy as a whole from the early 1990s.
  - Part of the explanation is the positive impacts on total market sector performance of sweeping reforms to utilities and the uptake of logistics and new technologies in the wholesale sector.
  - But part of the divergence reflects the reduction in manufacturing multifactor productivity growth below its long run historical trend, the reason for which is not clear.
  - In 2000-01 and 2001-02, multifactor productivity growth in manufacturing increased to roughly its long run trend rate.
- While multifactor productivity growth was modest in the 1990s, manufacturing labour productivity growth — an important driver of competitiveness and economic benefits — was strong.
- International data, while flawed, suggest that labour productivity *levels* in Australian manufacturing remain well below those of the US and many other OECD countries.

The importance of productivity

Productivity growth has played a major role in shaping the performance of Australian manufacturing. Whereas some of the growth of output in the services sector in Australia has been driven by movements in labour to that sector[1],

[1] Roughly 20 per cent of the change in (the log of) market sector value added from 1964-65 to 2001-02 can be attributed to the change in labour input (weighted by its factor share).

manufacturing output levels have grown in the face of significant falls in employment.

Average annual labour productivity in manufacturing rose by in excess of 3.1 per cent from 1964-65 to 2001-02. A significant share of this increase in labour productivity can be attributed to the increasing capital intensity of manufacturing. However, the growth in capital service inputs merely offset the impact of declining labour inputs. Over the period from 1974-75 to 2001-02, aggregate inputs into manufacturing did not change,[2] yet real output still increased by nearly 60 per cent. As a consequence, the increase in real manufacturing output after accounting for the effects of changing labour and capital inputs — so-called *multifactor productivity* (MFP) — was around 1.6 per cent per annum. This represents a manufacturing productivity 'dividend' to Australians of nearly $400 billion over the period.[3] In summary, MFP accounted for effectively all of the observed manufacturing output growth in Australia over the last quarter century and produced sizeable benefits for Australians.

Given the significance of manufacturing productivity to manufacturing output and market sector productivity, it is important to understand:

- what has happened to the various measures of manufacturing productivity at various times and in different industry segments; and
- why these patterns have prevailed.

This requires benchmarks by which to assess whether manufacturing productivity has been high or low. One benchmark is simply time — the extent to which productivity has changed in different time periods — the subject of section 7.1 Another benchmark is the comparative performance of different sub-groups within manufacturing (section 7.2). This is also valuable in that it draws out the heterogeneity of productivity experiences within manufacturing, may help trace some of the sources of different productivity growth rates, and helps explain which parts of manufacturing have contributed most to the overall manufacturing productivity performance.

[2] The aggregate input index is a weighted multiple of capital and labour inputs, using factor shares under (assumed) constant returns to scale as the weights. This chapter uses the standard definition of multifactor productivity.

[3] The trend growth rate was calculated by using ordinary least squares to regress the log of output against a time trend. The estimate — more precisely, $383 billion — in productivity dividend was estimated by examining the cumulative annual difference from 1974-75 between value added (in 2000-01 prices) actually observed and that which would have been observed had there been only changes in inputs (ie no MFP growth). The data are from the National Accounts.

In section 7.3, the productivity performance of other Australian industries over the same time period is provided for comparative purposes. This is appealing because the industries were operating against the same broad macroeconomic and policy backdrop — such as the widespread microeconomic reforms that took place in the 1990s.

One drawback of inter-industry comparisons is that they do not control for industry-specific factors that influence labour and multifactor productivity performance. For example, new technologies, such as numerically controlled machines, have been a particular source of productivity improvement in much of manufacturing. One frequently applied, albeit ‘rough and ready’[4], way of controlling for differences in industry-specific technologies or other factors affecting the productivity performance of different sectors is to compare productivity performance in a given sector across countries (part of section 7.3).

Section 7.4 pulls together the leading features and sources of productivity change in Australian manufacturing. A technical appendix is attached, which examines productivity growth in manufacturing using econometric techniques, explores the extent and implications of data errors, and provides data on the major input and output information used to construct productivity estimates (appendix I).

7.1 Aggregate manufacturing productivity over time

Long run trends

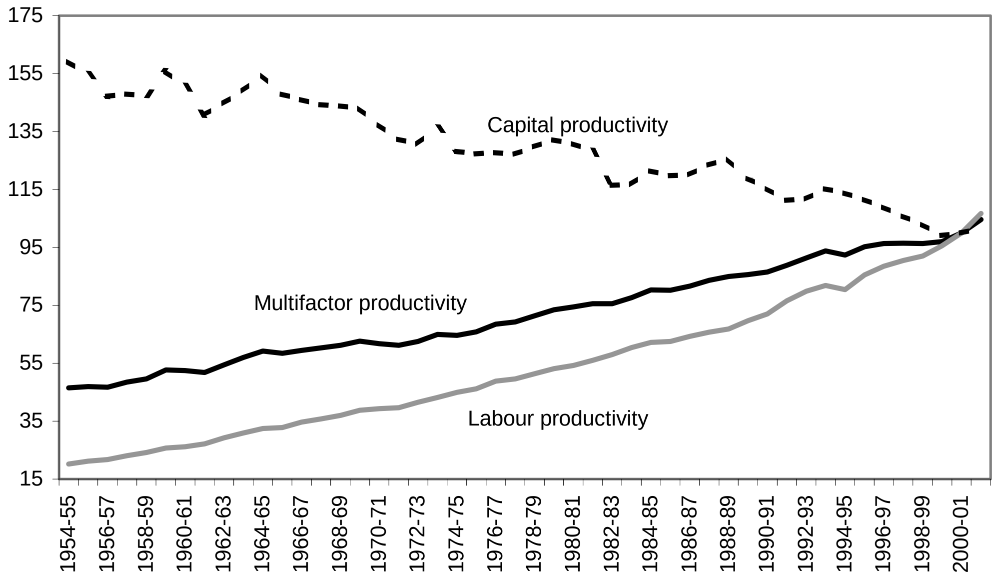
Labour and multifactor productivity — the two major measures of productivity performance — have steadily increased over the past half-century. Since 1954-55, real output for a given labour input has increased more than fivefold in manufacturing, while real output for a given measure of overall inputs has increased by 2.25 times (figure 7.1).[5]

4 The comparisons are ‘rough and ready’ to the extent that choices of technologies in manufacturing could vary between countries, depending on scale, output mixes, factor input prices and the availability of complementary inputs (such as skilled labour). However, these problems of comparability are less severe so long as advanced industrial countries only are considered.

5 Trend growth rates for labour productivity were 3.11 per cent per annum and about half that, 1.64 per cent, for MFP.

Figure 7.1 **Productivity trends in manufacturing**[a]

Indexes, 2000-01=100, 1954-55 to 2001-02



a The data prior to 1974-75 do not incorporate some of the novelties employed by the ABS (as described by Parham 1999) in calculating output or capital stocks, such as accounting for intangible expenditure (like software) or taking into account the extent to which older capital remains productive. Nor are the output measures chain weighted in the earlier period. The extent to which these differences were likely to matter was tested for an overlapping period of the data (from 1974-75 to 1981-82). The correlation coefficient for changes in log (MFP) was 0.91, while the trend growth rates were relatively close at 2.3 and 2.8 per cent per annum for the relevant period for the ABS and Bureau of Industry Economics (BIE) series, respectively. Nevertheless, trends prior to 1974-75 should be viewed with more caution given the different methodologies underlying the MFP calculations.

Data sources: The data from 1974-75 to 2001-02 are from the PC (2003a). Data from 1954-55 to 1974-75 were estimated by splicing data from the BIE (1985).

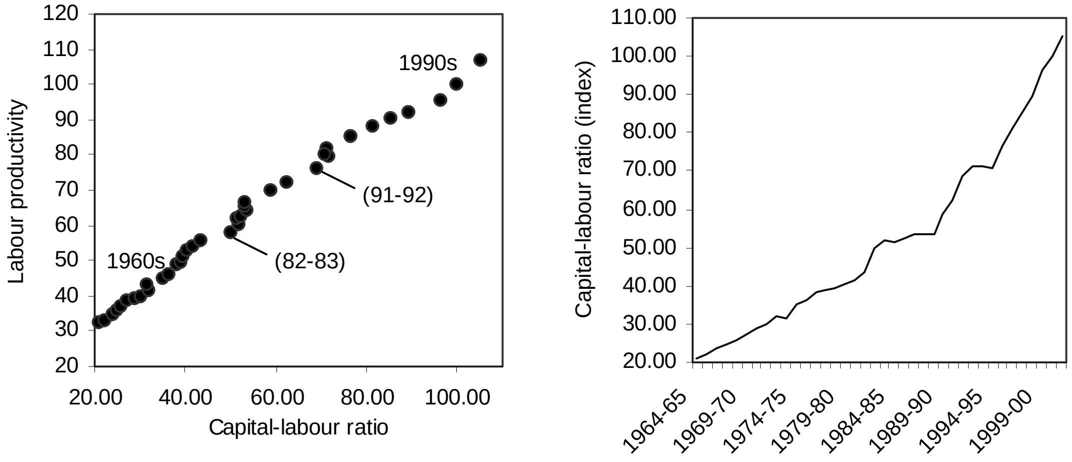
A large amount of the increase in labour productivity[6] observed over time can be explained by the increased use of capital for a given amount of labour. Over the period from 1964-65 to 2001-02, (the log of) labour productivity increased by 0.52. Of that change, more than 50 per cent can be explained by changes in the capital-labour ratio weighted by the share of capital services in total factor incomes, and the remainder by increased MFP.[7] The decline in capital productivity shown in figure 7.1 is testimony to the increased substitution of capital for labour (figure 7.2)

[6] Measured as the change in the natural log of labour productivity (approximately the percentage growth rate in labour productivity for small changes).

[7] This is because of the identity underlying MFP estimation. The change in labour productivity between any two time periods can be expressed as $\Delta(\ln Y_t / Y_{t-n}) - \Delta \ln(L_t / L_{t-n}) = \tilde{\alpha}\{\Delta(\ln K_t / K_{t-n}) - \Delta \ln(L_t / L_{t-n})\} + \Delta \ln(MFP_t / MFP_{t-n})$ where Y is real output, L and K are measures of labour and capital inputs, respectively, and α is the average capital share of factor income over the period from t-n to t.

— raising capital requirements for producing a given amount of output (or reducing capital productivity).

Figure 7.2 **Capital intensity in manufacturing and labour productivity**
1964-65 to 2001-02



a The capital-labour ratio is indexed to 100 in 2000-01.

Data source: As in figure 7.1.

The capital-labour ratio grew relatively slowly from the mid 1970s to the late 1980s (at a trend growth rate of 3.4 per cent from 1974-75 to 1988-89). But, from 1988-89 to 2001-02, it grew much more strongly (at a trend growth rate of 4.8 per cent). In that context, growing capital intensity in the 1990s has been a much more important driver of increased labour productivity in manufacturing than it was in the past period. Accordingly, from 1974-75 to 1988-89, the change in the capital-labour ratio contributed about 30 per cent of the increase in labour productivity (with MFP change contributing the rest). From 1988-89 to 2001-02, increased capital intensity contributed nearly double this — accounting for some 56 per cent of the change in labour productivity (in log terms).

This is an important feature of the productivity story in manufacturing because many technical gains are embodied in capital. Technical change that improves the capabilities and capacities of capital — such as robotics, numerical control devices and automatic diagnostics (box 7.1) — will increase labour productivity.

Box 7.1 Computers and numerical control technology in manufacturing

Computing and numerical control technology have had a profound impact on manufacturing (BIE 1990, IC 1996b). Cheaper computer power and telecommunications have helped to reduce the cost of various administrative activities in manufacturing firms, such as ordering, invoicing, accounting, stock control, scheduling and the like. In addition, computers reduced the cost of engineering drafting and design. But stand alone computers and communications technologies — the source of big gains in some other sectors — have been less important to manufacturing than technological changes arising from their incorporation *within* other machines.

A whole new generation of computer controlled machinery has appeared on the market in the last thirty years. The small computers controlling the operation of industrial equipment are often referred to as numerical controllers. Early applications of numerically controlled equipment were in high precision metal cutting machines, welding machines and the control of gas and fluid flow through valves in oil refineries and other chemical plants. In more recent years, the applications of numerical controllers has extended to almost all areas of manufacturing from steel plants to cloth cutting. Numerical controllers are well suited for accurate positioning of tools and materials, the control of motor speed, valves, electric current and the performance of machinery diagnostics.

A widespread application of numerical controllers is in controlling fuel injection and spark plug ignition in motor vehicles. More complex applications are found in many types of modern machinery. Large modern plants (such as metal smelters and oil refineries) are partly controlled by a central computer linked through optical fibre cables to a network of satellite numerical controllers or small computers.

The application of numerical controllers has moved in parallel with the development of various electronic sensory devices that indicate through electric pulses position, speed, pressure, proximity, temperature, light intensity, chemical composition and the like. Nowadays, even eye-hand type coordination is technically feasible with computer controlled equipment, though such complex equipment is still too expensive in a commercial environment.

Numerical controllers opened the way for further improvements in industrial automation, resulting in reduced labour requirements.

Whether they increase MFP is less certain. The ABS method for calculating capital stocks takes (some) account of embodied technological change by altering the price indexes of capital.[8] This has the effect of increasing the capital stock and increasing

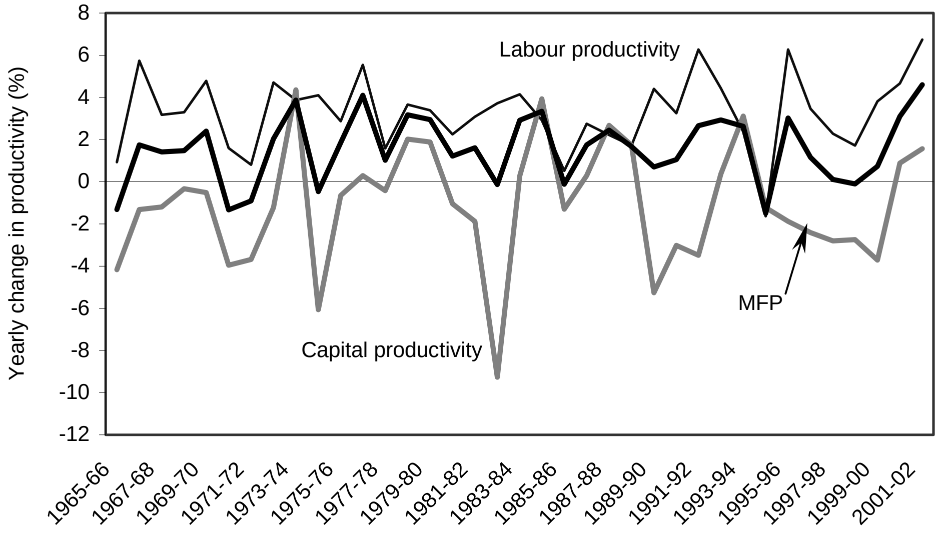
8 The ABS advised that price indexes for all components of the capital stock were adjusted for quality changes over time, such as motor vehicles and production equipment. However, the degree and sophistication of the quality adjustment varies. For example, for information and communication technologies, hedonic methods have been used, but this is not the norm.

measured capital intensity, so that MFP may not rise. On the other hand, the adjustments to capital that take account of quality improvements may also sometimes apply to outputs. For example, this would be true for a manufacturer of the relevant capital inputs. In that case, the net effect may still be a gain in MFP. However, the high technology outputs where such quality adjustments are most relevant (such as computers, numerical controllers and robots) are a small component of total production in Australian manufacturing.

Interpreting cycles and deviations from trend

While the trends in MFP shown in figure 7.1 look roughly constant over time, in fact there are regular deviations from historical average productivity trends (figure 7.3). These can arise for several reasons, each of which has different implications for interpreting productivity movements.

Figure 7.3 **Manufacturing productivity growth, 1965-66 to 2001-02**



Data sources: Data from 1974-75 to 2001-02 are from PC (2003a). Previous years are estimated by splicing data for 1964-65 to 1974-75 from the BIE (1985).

First, the most obvious source of deviations stems from short-term shifts in demand arising from the business cycle, which result in capital or labour being under-utilised. During economic downturns, firms do not retire capital that has a good prospect of being used later, hence the significant deviations in capital productivity apparent in figure 7.3. A similar, but weaker, effect is apparent for labour productivity, reflecting the fact that hiring, training and firing costs are high for firms, so that it pays them to ‘hoard’ labour when they face a downturn in demand. This feature of firms’ behaviour means that productivity is pro-cyclical — tending to fall as the economy moves into a recession. Such productivity movements are temporary and reveal little about the existence of technical progress or the extent to which firms at full capacity efficiently utilise their resources. For that reason, it is common for measures of productivity improvement to attempt to abstract from these short-run cyclical deviations by calculating productivity changes between productivity peaks (appendix G).

Second, transitory supply shocks, such as strikes or droughts, have similar effects to demand shocks. Their effects can also be largely removed using the peak-to-peak method.

Third, there may be other shocks that have longer-term effects, such as adoption of new technologies, the impact of large factor price changes and the effects of microeconomic reforms that raise technical efficiency. For example, it has been argued that the oil shock of the 1970s had long-term adverse effects on productivity in many industrial countries, while the computing revolution in the 1990s enhanced productivity growth (though as we explore later, neither of these seems apparent for Australian manufacturing). A major ambition of productivity analysis is to identify any such (varying) trends. This is not always easy, since any ‘break’ in a trend may not occur at one clearly discernible point, but occur gradually, as, for example, when technologies diffuse. Random movements may also make some permanent or enduring shocks appear to be transitory.

There are several methods for isolating such trends. As noted above, the typical approach is to examine peak-to-peak productivity trends and examine whether these have changed over time. Using this approach, the early 1960s, 1970s and the early 1980s exhibited generally strong productivity growth in manufacturing, while the later 1960s and early 1990s have shown poor relative productivity growth in manufacturing (table 7.1). Expressed as percentages, the differences appear small, but their effects on economic well being are large. For example, the trend growth rate in MFP was 0.94 per cent from 1964-65 to 1973-74, compared with a long-run MFP growth rate of 1.68 per cent from 1964-65 to 2001-02. Had the long-run rate applied for the years from 1964-65 to 1973-74, Australians would be cumulatively better off by around $120 billion (in constant 2000-01 prices) by 2001-02.[9] Consequently, small apparent productivity differences have big effects.

9 This is the undiscounted sum of the stream of additional manufacturing gross product that would have been obtained. Were the figure expressed in present value terms, it would be significantly larger.

Table 7.1 Growth rates in multifactor productivity (MFP) and labour productivity (LP) for manufacturing and the market sector

Manufacturing			*Market sector*[a]		
Peak-to-peak periods[b]	LP trend[c]	MFP trend[c]	Peak-to-peak periods[b]	LP trend[c]	MFP trend[c]
	%	%		%	%
1954-55 to 1959-60	4.98	2.53	1964-65 to 1968-69	2.58	1.23
1959-60 to 1964-65	4.82	2.37	1968-69 to 1973-74	2.93	1.51
1964-65 to 1969-70	3.57	1.13	1973-74 to 1981-82	2.41	1.04
1969-70 to 1973-74	2.73	0.90	1973-74 to 1976-77	3.27	1.62
1973-74 to 1984-85	3.38	1.95	1976-77 to 1978-79	2.43	1.32
1973-74 to 1976-77	4.17	1.82	1978-79 to 1981-82	1.54	0.27
1976-77 to 1979-80	2.87	2.38	1981-82 to 1984-85	2.21	0.81
1979-80 to 1984-85	3.22	1.79	1984-85 to 1988-89	0.83	0.42
1984-85 to 1993-94	3.09	1.74	1988-89 to 1998-99	2.60	1.27
1984-85 to 1988-89	1.80	1.43	1988-89 to 1993-94	2.03	0.71
1988-89 to 1993-94	4.14	1.99	1993-94 to 1998-99	3.17	1.83
1993-94 to 2001-02	3.38	1.37	1998-99 to 2001-02[d]	1.82	0.49
1993-94 to 1996-97	2.65	0.88	1964-65 to 2001-02[d]	2.31	1.06
1996-97 to 2001-02	3.83	1.67	1964-65 to 1998-99	2.36	1.11
1964-65 to 2001-02	3.27	1.55			

[a] The market sector excludes some sectors where output is measured by reference to inputs. [b] Minor peaks are indented. The methodology used for determining peaks is set out in appendix G. [c] Trend growth rates were calculated as the average compound percentage growth rates between peaks (which is the method used by the ABS). Trends were also calculated by regressing the logged value of MFP against a time trend across the peaks, since this method makes use of all the information in the productivity series. The results were very similar to those derived by calculating the compound growth rates. [d] While the trends ending in 2001-02 are shown for comparative purposes, it should be noted that 2001-02 is not a peak year for the market sector. This is why growth over the period from 1964-65 to 1998-99 is also shown.

Sources: The market sector data are from ABS (*Australian System of National Accounts*, Cat. No. 5204.0, November 2002) and the manufacturing data are from same source as figure 7.1. The ABS applied the smoothing algorithm to the original data to derive the trend and cycle series from which the peaks were identified.

The manufacturing sector does not appear to have experienced the productivity surge that characterised the market economy as a whole from 1993-94 to 1998-99. Indeed, over the comparable peak-to-peak period (1993-94 to 1996-97), manufacturing MFP was well below both its historical trend and well below the productivity growth achieved in the rest of the Australian market economy. On the other hand, MFP growth in manufacturing in the later 1990s increased to a rate just below its long-run historical trend. It has again eclipsed growth rates apparent in the market sector as a whole.[10]

[10] Though it should be emphasised that 2001-02 is not a peak in market sector productivity, so that the comparison of productivity growth between manufacturing and the market sector ending in that year will tend to exaggerate the relative performance of manufacturing.

Nevertheless, the productivity slump in the mid-1990s is perplexing given the strong performance of the market sector at this time. Some of the possible sources of this contrast in performance are explored later in the chapter.

While the peak-to-peak trends appear to vary over the last half century, the question remains whether these reflect genuine changes in the *underlying* trends in productivity or random errors around a more or less fixed trend. There are several methods for assessing this (appendix I), but, overall, the results suggest that a reasonable depiction of aggregate manufacturing MFP is that it followed a trend with occasional structural breaks in this trend. From the mid-1950s, MFP growth was three per cent per annum until the mid-1960s when it shifted to just below 1.7 per cent per annum. The changes in manufacturing MFP trends since the mid-1960s (as shown in the varying peak-to-peak growth rates in table 7.1) are, in that context, best visualised as short-term perturbations, rather than as real structural shifts in the underlying productivity rate.

The picture for manufacturing appears to differ from that applying to the market sector as a whole. MFP trends in the market sector are best seen as evolving slowly over time (so-called 'stochastic' or variable trends), rather than following a fixed trend (appendix I). There was a striking increase in the underlying productivity trend over the 1990s.

To sum up, since the mid 1960s, the underlying trend in MFP is best seen as roughly fixed in manufacturing and as roughly u-shaped in the market sector. Over the very long run, manufacturing MFP has still exceeded that of the market sector as a whole — by a margin of around 0.6 percentage points.[11] The long run margin between labour productivity growth rates in these sectors has been nearly one percentage point.

7.2 Productivity within manufacturing

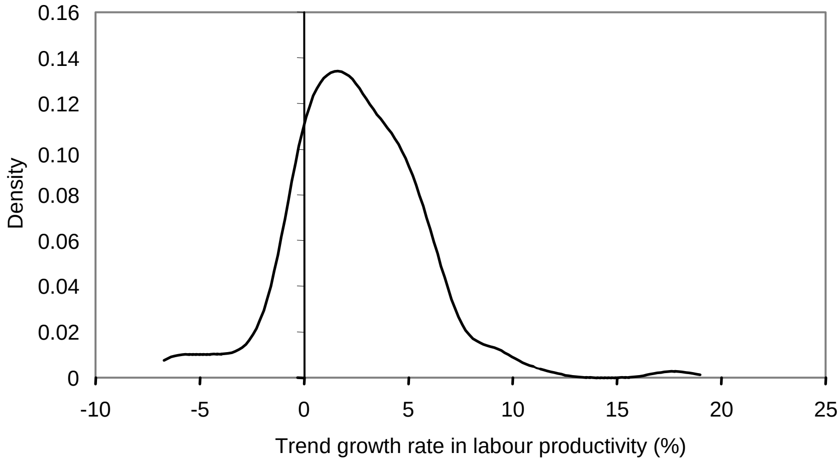
Labour productivity

At a highly disaggregated level, there are dramatic differences in measured labour productivity performance within manufacturing. Nearly one in five of the 153 ANZSIC industry classes recorded negative productivity growth from 1989-90 to

[11] Based on trends from 1964-65 to 2001-02 and 1964-65 to 1998-99 for the manufacturing and market sectors, respectively. The end periods were determined by the most recent peak years for the respective sectors.

1999-2000, while around one in five recorded annual productivity growth over 5 per cent (figure 7.4 and table 7.2).[12]

Figure 7.4 **Distribution of labour productivity growth trends for four digit ANZSIC manufacturing industry classes[a]**



a The density function of trend growth rates in labour productivity from 1989-90 to 1999-2000 was estimated using a Gaussian kernel. The labour productivity series were estimated as the chain volume gross product (1999-2000 constant prices) divided by employment (not hours). However, other evidence suggests that average hours worked per employee did not change by as much in manufacturing than in some other sectors.

Data source: Based on unpublished chain volume estimates of gross product and employment from the ABS (revised from the ABS manufacturing census).

The industry classes in each group are highly heterogeneous. For example, economic circumstances were buoyant for recorded media manufacturing, with strong output growth (employment growth was so buoyant, it outstripped output growth, leading to a low productivity growth outcome). On the other hand, in the case of shipbuilding, falling demand and slow adjustment of the labour supply to the change in demand eroded labour productivity.

Nevertheless, there are a few systematic, if weak, factors separating the experiences of strong versus low productivity performing industries. On average, output growth has been stronger in high versus low productivity growth industries and (contrary to the Salter hypothesis — chapter 4), average employment growth has been negative

12 These disaggregated estimates are based on value added and employment data from 1989-90 to 1999-2000 provided by the ABS, based on revised Manufacturing Census data. Since the provision of these data, a further year of Manufacturing Census data has become available. There are also estimates of overall manufacturing productivity based on National Accounts data. Due to revisions and a different underlying basis for these different series, they do not give the same productivity estimates for total manufacturing. Nevertheless, for data analysis at the four and three digit level, the 1989-90 to 1999-2000 series has been employed, since more recent data does not go down to that level. It is likely that the qualitative results from these data would still be valid.

in high performers relative to average positive employment growth among low performers.[13]

Table 7.2 **Low and high labour productivity growth industry classes within manufacturing[a]**

1989-90 to 1999-2000

High productivity growth	*Trend*	*Low productivity growth*	*Trend*
	%		%
Basic iron & steel	5.9	Recorded media & publishing	-6.6
Aircraft	6.0	Textile products n.e.c.	-6.0
Non-ferrous pipe fitting	6.3	Shipbuilding	-6.0
Pesticides	6.5	Other periodical publishing	-4.8
Ceramic tiles & pipes	6.7	Plastic products rigid fibre reinforced	-4.2
Medical & surgical equipment	6.8	Industrial gases	-4.0
Cement & lime	6.9	Ice cream	-2.8
Medicines & pharmaceuticals	6.9	Pumps & compressors	-2.5
Beer & malt	7.0	Services to printing	-1.9
Motor vehicles	8.0	Books & other publishing	-1.6
Spirits	8.9	Leather tanning & fur dressing	-1.2
Tobacco products	8.9	Electric light & signs	-1.1
Telecommunication, broadcasting & transceiving equipment	9.1	Prefabricated buildings n.e.c.	-1.1
Basic non-ferrous metals n.e.c.	9.7	Plaster products	-1.0
Photographic & optical goods	11.2	Log sawmilling	-0.8
Computer & business machines	17.7	Metal coating & finishing	-0.7

a Data sources and methods are described in figure 7.4. The low and high productivity performing industries represent the five and 95 percentiles of the distribution of labour productivity growth rates.

Other analysis (appendix I) points to the likely importance of receptiveness to new knowledge or technologies as an important factor behind labour productivity growth. This was linked to whether an industry had a high R&D intensity. However, *changes* in the R&D intensity did not appear to have significantly affected labour productivity growth over the 1990s.[14]

There is also evidence that industries with greater material shares of turnover (or lower value added shares) exhibited significantly faster labour productivity growth. Over the relevant period, this pattern is reflected in higher labour productivity growth in simply transformed manufactures (STMs) compared with elaborately transformed manufactures (ETMs) (figure 7.5). However, the source of the

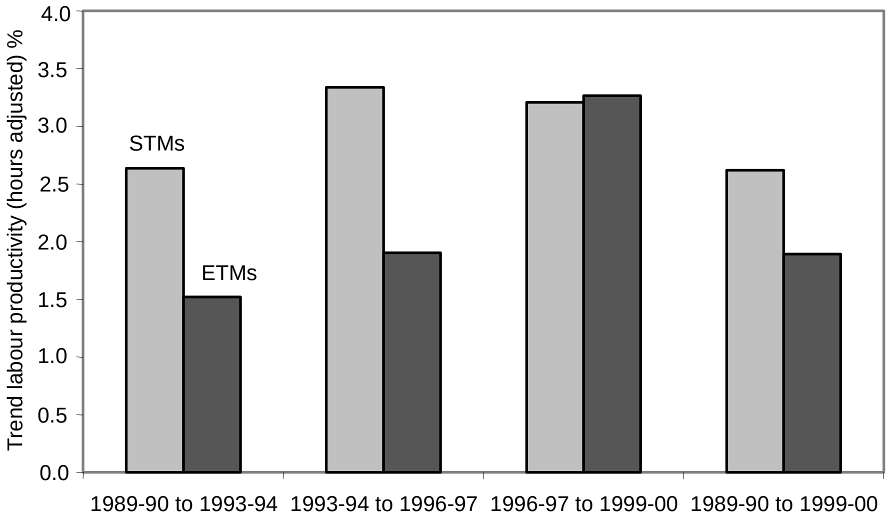
[13] Averages based on unweighted data.

[14] This does not mean that changes in R&D have no effects on productivity, but rather that their effects may be difficult to disentangle from the impacts of omitted variables (such as capital) and 'noise' in the data. As well, the analysis in appendix I is based on R&D flows, not R&D capital stocks and could not take into full account the likely lagged responses of productivity to R&D.

differences in productivity performance between high and low value added industries is not clear. One possible explanation is that lower value added industries have been more amenable to automation and improved handling of a larger throughput of materials, which would tend to also elevate value added per employee.

Figure 7.5 **Labour productivity trends in elaborately transformed and simply transformed manufactures**

1989-90 to 1999-2000[a]



[a] The productivity estimates take account of changing average hours over time. The estimates are based on aggregating the four digit data described above, with the exception of hours data which were only available at the three digit level.

Data source: As in figure 7.4.

Differences in (unmeasured) growth in capital intensity might also explain some of the variations between the productivity performance of individual industries. However, MFP and labour productivity growth estimates are usually correlated, so this is unlikely to explain away all of the variations.[15] In the case of one group of industries that have consistently exhibited low labour productivity — those in printing, publishing and recorded media — evidence on MFP (discussed later) confirms low MFP estimates as well as low labour productivity growth.

[15] In the case of the MFP and labour productivity data on eight groups of manufacturing industries, the correlations between MFP trend growth rates and labour productivity growth rates over various peak-to-peak periods were usually very high (the exception being structural and sheet metal products). The correlations between the labour productivity and MFP trends shown in table 7.3 were 0.91, 0.90, 0.99, 0.88, 0.89, 0.02, 0.82 and 0.997 for the food, beverages and tobacco industry to the rest of manufacturing, respectively.

Finally, in some cases, the differences in productivity performance may simply reflect data errors as the level of industry disaggregation grows. Data errors are a potentially large confounding factor in productivity analysis — appendix I.

Updated data based on the methodology of Gretton and Fisher (1997) provide another view of labour productivity within manufacturing subdivisions (table 7.3), albeit not at the same level of detail as the data described above.[16] The Gretton and Fisher data have several advantages over the simple measures based on three and four digit ANZSIC data. First, they encompass a longer period. Second, the dataset includes capital intensity and MFP estimates, so that labour productivity outcomes can be placed in a wider context (see the next section).

However, because of differences between successive revisions to Manufacturing Census data, they give different estimates of labour productivity growth for subdivisions than those derived by aggregating the three and four digit series. They also will give different estimates of productivity growth for total manufacturing than estimates based on the National Accounts (the basis for the data reported in table 7.1). This stems from the fact that output data in the National Accounts are balanced with data on the use of commodities to improve their accuracy. Accordingly, the Gretton and Fisher data probably provide a less accurate view of overall manufacturing productivity change than National Accounts data, but a better one than that provided by the three and four digit ANZSIC series used in the highly disaggregated analysis.[17]

This is why some of the numbers in the Gretton and Fisher dataset reveal different patterns to the highly disaggregated data shown above and to the less disaggregated data for the entire manufacturing division in section 7.1.[18]

The data suggest that productivity growth rates are rarely maintained — at either low or high rates over decades. For example, the printing and publishing industry was a low labour productivity performer from the mid-1980s, but had high productivity rates in the 1970s and early 1980s. Only the structural and sheet metal products industry appears to have had consistently sluggish labour productivity performance over the last thirty years.

[16] Due to the lack of suitable data in early years on the sectoral allocation of capital stock, the residual category — the 'rest of manufacturing' — includes a wide range of industries, such as wood and paper, non-metallic minerals, electronics, electrical, medical and scientific instruments, production machinery and other manufacturing.

[17] Other limitations of the data are outlined in Gretton and Fisher (1997 pp. 3-8).

[18] The contrast between total manufacturing MFP based on Gretton and Fisher and that based on National Accounts data are shown as the last 2 columns of table 7.4.

Table 7.3 **Productivity trends for eight manufacturing subdivisions[a]**

Compound growth rates, 1969-70 to 2000-01

Subdivision	1969-70 to 1973-74	1973-74 to 1984-85	1984-85 to 1993-94	1993-94 to 2000-01	1969-70 to 2000-01
Labour productivity	%	%	%	%	%
Food, beverages & tobacco	1.4	3.6	1.9	2.2	2.5
Textiles, clothing, footwear & leather	5.3	3.8	2.2	0.5	2.8
Printing, publishing & recorded media	3.7	3.5	0.0	1.4	2.0
Petroleum, coal, chemicals etc.	4.9	3.5	2.1	1.7	2.9
Basic metal products	2.7	4.6	5.7	1.6	4.0
Structural & sheet metal products	2.7	1.4	0.6	0.0	1.0
Transport equipment	0.6	2.3	4.5	3.3	2.9
Rest of manufacturing	-2.4	-4.0	-0.1	-1.4	-2.1
Total manufacturing	2.9	3.6	1.9	1.8	2.6
National Accounts[b]	2.7	3.4	3.1	2.9	3.1
Multifactor productivity					
Food, beverages & tobacco	-0.2	1.3	0.7	0.8	0.8
Textiles, clothing, footwear & leather	3.6	2.9	0.2	-0.2	1.5
Printing, publishing & recorded media	3.7	2.5	-2.2	-0.2	0.7
Petroleum, coal, chemicals etc.	6.1	2.2	0.4	0.8	1.8
Basic metal products	0.0	1.3	3.6	0.3	1.6
Structural & sheet metal products	0.8	0.1	0.6	0.3	0.4
Transport equipment	-0.5	1.5	1.6	3.0	1.6
Rest of manufacturing	1.1	3.0	-1.5	0.1	0.8
Total manufacturing	1.5	2.0	0.3	0.6	1.1
National Accounts[b]	0.9	2.0	1.7	0.9	1.5

a The data are reported for the key peak-to-peak cycles identified for aggregate manufacturing, with the exception that lack of availability of data for 2001-02 means that 2000-01 is used as the endpoint. Individual manufacturing industries sometimes have different peak-to-peak periods compared with manufacturing as a whole. However, since one of the purposes of the table is to assess the role of compositional effects on aggregate manufacturing trends, this is not taken into account in this table. Tables I.18 and I.19 in appendix I provide MFP and labour productivity trends based on smoothed data to overcome any differences in peak-to-peak periods between subdivisions. The labour productivity estimates adjust for hours worked. **b** As noted in footnote 12, different data sources show different productivity trends. The sum of the individual subdivision value added, capital and hours data do not equal the aggregate manufacturing data — based on National Accounts data (NAC) that were used in table 7.1, reflecting different sources and methodologies. The data in table 7.1 are the most recent and authoritative — and for comparison the relevant growth rates are shown in parentheses in this table.

Source: Updated estimates from Gretton and Fisher (1997).

Multifactor productivity

MFP estimates provide a more comprehensive picture of productivity change within manufacturing, but reveal the same general relativities in performance between subdivisions, with particularly low apparent productivity achievement in printing and publishing (table 7.3). The performance of this subdivision is puzzling since there have been a range of technological changes that should have enhanced productivity (such as computer-based typesetting, composing and manipulation — as cited by the Industry Commission 1996c, p. 24). However, Australia is not unique — other OECD countries also appear to have experienced low productivity growth rates in printing and publishing in the last decade (OECD 2001). It may be that shifts in the composition of output made economic by technological change — for example, to lower and more flexible print runs — have affected output to input ratios and thereby measured productivity growth.

The data for the subdivisions identify the sources of output gains in manufacturing attributable to MFP (table 7.4). Three industries — Petroleum and chemicals etc, Basic metal products and Transport equipment — account for 54 per cent of the output gains attributable to the sector's productivity growth from 1969-70 to 2000-01 (though they only account for 36 per cent of manufacturing output over that period).

Table 7.4 **Contribution of different manufacturing industry divisions to MFP-generated output growth, 1969-70 to 2000-01**

Industry subdivisions	*1969-70 to 1973-74*	*1973-74 to 1984-85*	*1984-85 to 1993-94*	*1993-94 to 2000-01*	*1969-70 to 2000-01*	*Average output share*
Food, beverages and tobacco	-3	12	59	27	17	18
Textiles, clothing, footwear & leather	18	9	5	-1	5	6
Printing, publishing & recorded media	14	9	-95	-3	5	7
Petroleum, coal, chemicals, etc	49	15	28	19	23	14
Basic metal products	0	8	199	5	15	11
Structural and sheet metal products	5	1	22	3	3	8
Transport equipment	-4	8	74	49	16	11
Other manufacturing	20	37	-193	2	17	25
Total manufacturing	100	100	100	100	100	100

a In any period from t-n to t, the output attributable to MFP growth in a particular division i is: $C_i = Y_{it}(m_{it}/(1+m_{it}))$ where m_{it} is the percentage change in multifactor productivity from t-n to t for division i. The contribution to total output generated by MFP in a particular division can then be estimated as $C_i/\Sigma C_i$.

Source: Updated estimates from Gretton and Fisher (1997).

The disaggregated MFP results also show that the story for the whole of manufacturing is not replicated for each of the parts. Thus, while MFP has followed a roughly constant trend in manufacturing as a whole, this is not true for many of the industry groups making up manufacturing. Analysis suggests that, in some industries, there have been significant shifts in underlying MFP trends (appendix I). For example, in the basic metal products industry, the underlying growth rate in MFP appears to have accelerated from the late 1970s to around 1990, and then fallen to more moderate levels since. The overall relatively fixed trend for MFP in manufacturing appears to reflect a compositional story — high MFP growth periods by some industry groups are nullified by low MFP growth periods for others.

7.3 Comparisons with other industries and countries

Manufacturing MFP and labour productivity growth rates have been above most other sectors of the economy, ranking between third and ninth in each period — with the most common outcome being fifth (tables 7.5 and 7.6). While there have been significant annual swings in MFP growth in manufacturing,[19] growth has been less volatile than in other industries. Of the 12 industry sectors, manufacturing has the lowest relative variance in multifactor and labour productivity growth, suggesting less sensitivity to short-term demand and supply shocks.

Table 7.5 **Growth rates in trend multifactor productivity**[a]

Compound annual growth rates, 1974-75 to 2001-02[b]

Industry division	*1974-75 to 1976-77*	*1976-77 to 1979-80*	*1979-80 to 1984-85*	*1984-85 to 1988-89*	*1988-89 to 1993-94*	*1993-94 to 1996-97*	*1996-97 to 2001-02*	*1974-75 to 2001-02*
	%	%	%	%	%	%	%	%
Agriculture	4.0	1.0	0.9	1.1	2.4	4.0	4.3	2.4
Mining	0.8	-1.6	-1.6	3.4	2.5	1.7	0.7	0.9
Manufacturing	**2.1**	**2.5**	**1.7**	**1.6**	**1.8**	**1.2**	**1.3**	**1.7**
Electricity, gas & water	2.2	1.3	1.7	5.5	3.8	3.0	-0.8	2.3
Construction	1.7	1.7	0.8	-0.8	-0.5	1.4	-0.5	0.3
Wholesale trade	1.9	-1.0	-1.1	0.6	-0.7	6.4	2.0	0.8
Retail trade	-0.5	-0.1	2.8	-2.2	0.4	1.4	1.0	0.6
Accom., cafes & restaur.	-0.5	-0.5	-0.9	-2.2	-1.8	0.0	0.2	-0.9
Transport & storage	3.5	3.5	1.0	0.8	1.1	3.0	1.5	1.8
Communications	1.9	7.7	5.1	4.4	5.9	3.2	1.4	4.3
Finance & insurance	-2.7	-2.0	-2.1	1.8	0.2	0.7	0.3	-0.4
Cultural & rec. services	-0.6	-1.1	-1.8	-3.7	-2.5	-4.1	-1.9	-2.3

a A major problem in comparing trends in MFP across different sectors is that the timing of peaks differ. To assess this quantitatively, trends were estimated using a smoothing algorithm (a kernel estimation technique using an Epanechnikov kernel with automatic bandwidth selection). Peaks were then calculated using the decision rule described in appendix G. Peaks were designated by a one and non-peaks by a zero. The correlation coefficient was then calculated between the peak dummy variable for manufacturing and each other sector. Going from top to bottom through the industries shown in the table (including manufacturing itself), the coefficients were: 0.07; -0.24; 1.0; 0.14; 0.33; 0.04; 0.52; 0.01; 0.44; 0.29; -0.18; and 0.10. These were too low to warrant using a common set of periods for calculating trends based on *observed* MFP estimates. Instead, compound growth rates were calculated over a common set of periods, based on the *trend* values, rather than the observed ones. **b** Data for all 12 divisions were only available from 1974-75, rather than from 1954-55 as for manufacturing.

Data source: PC (2003a).

19 The coefficient of variation (the standard deviation normalised by the average productivity change) for manufacturing MFP growth rates was about 0.8 from 1975-76 to 2001-02, while the standard deviation was about 1.5 per cent. For around one-quarter of the years, manufacturing MFP was either double the observed long run growth rate or zero or below.

Table 7.6 **Growth rates in trend labour productivity**[a]

Industry division	*1974-75 to 1976-77*	*1976-77 to 1979-80*	*1979-80 to 1984-85*	*1984-85 to 1988-89*	*1988-89 to 1993-94*	*1993-94 to 1996-97*	*1996-97 to 2001-02*	*1974-75 to 2001-02*
	%	%	%	%	%	%	%	%
Agriculture	3.8	1.2	2.0	1.9	2.8	3.2	3.8	2.6
Mining	1.3	1.0	1.0	4.2	6.1	5.6	5.2	3.7
Manufacturing	**3.0**	**3.1**	**3.1**	**2.2**	**3.7**	**2.9**	**3.3**	**3.1**
Electricity, gas & water	2.7	1.3	2.9	8.8	7.1	10.9	0.1	4.7
Construction	2.8	2.7	2.0	-0.2	0.3	1.6	-0.7	0.9
Wholesale trade	2.9	-0.2	-0.1	0.8	0.2	7.1	2.9	1.6
Retail trade	0.2	0.3	3.7	-1.9	1.3	2.4	1.8	1.3
Accom., cafes & restaur.	-0.4	-0.2	-0.2	-1.3	-1.2	0.6	0.8	-0.3
Transport & storage	4.5	4.7	2.2	1.8	2.3	3.2	2.4	2.7
Communications	3.0	9.1	6.7	7.4	9.4	3.9	4.8	6.6
Finance & insurance	0.0	0.3	-0.9	3.3	3.8	2.8	3.3	2.0
Cultural & rec. services	0.0	0.0	-1.3	-2.2	-0.5	-1.3	0.9	-0.6

a The compound annual growth rates were calculated on trend labour productivity data (based on the technique described in table 7.5). See table 7.5 for source and other relevant notes.

However, communications and utility industries eclipsed the performance of manufacturing — likely testimony to the sweeping technological, regulatory and organisational changes that have affected these industries. In the mid-1990s, other sectors — particularly the Wholesale and Transport and storage sectors — have exhibited stronger productivity growth than manufacturing.

Indeed, the inversion in the mid-1990s of the historical supremacy of manufacturing MFP growth over the market sector can be largely traced to the strong performance of the latter two industries. As explained in Johnston et al. (2000), the wholesale industry benefited from a raft of productivity-enhancing technologies and organisational changes in the 1990s, such as improved logistics, scanning equipment, just-in-time inventory techniques and consolidation of distribution networks. So, while observed manufacturing MFP did slow during the early 1990s, a significant reason for its low relative performance against the market sector is the strong performance of just a few other market sector industries. This is apparent when the contributions of different industry divisions to output growth resulting from MFP are estimated for the period from 1993-94 to 1996-97 (table 7.7).

It is notable that in the period after 1996-97, manufacturing MFP slipped back to its historical average — and indeed accounted for a disproportionate share of MFP-generated output growth in the market economy.

Table 7.7 **Contribution of different industry divisions to MFP-generated output growth[a]**

Industry division	*1993-94 to 1996-97*	*1996-97 to 2001-02*
	%	%
Agriculture	10	19
Mining	12	4
Manufacturing	11	28
Electricity, gas & water	7	-4
Construction	3	2
Wholesale trade	38	16
Retail trade	6	8
Accom., cafes & restaur.	-1	4
Transport & storage	16	13
Communications	6	10
Finance & insurance	6	5
Cultural & rec. services	-12	-5

a In any period from t-n to t, the output attributable to MFP growth in a particular division i is: $C_i = Y_{it}(m_{it}/(1+m_{it}))$ where m_{it} is the percentage change in multifactor productivity from t-n to t for division i and Y is the gross product in constant prices. Then the contribution to total output generated by MFP in a particular division can be estimated as $C_i/\Sigma C_i$. Since it is attempting to explain the relative contribution of manufacturing to observed output gains in the market sector, the results for this table are based on observed gross product and MFP (not trend values as in tables 7.5 and 7.6), using periods based on peaks for manufacturing productivity.

Sources: Gross product data used for Y_{it} are from the National Accounts (Cat. 5204.0), while the sources for the MFP estimates are as described in table 7.5.

International comparisons

International comparisons of productivity are another way of benchmarking the performance of Australian manufacturing and are also relevant, at given exchange rates, to the international competitiveness of Australian manufacturing.

Comparison of growth rates

Over last 40 years, growth in Australian manufacturing labour productivity[20] has been similar to some other developed countries, such as Canada and the United States (table 7.8). However, it has been lower than many European countries and Japan, and significantly below that of the developing Asian economies over the 1980’s and 1990’s.

[20] These data are based on value added per employee and do not take account of changes in hours worked.

Table 7.8 **Manufacturing labour productivity growth rates for selected countries**

Trend annual growth rates

Country	1960-70	1970-80	1980-90	1990-00	1960-00
	%	%	%	%	%
OECD					
Australia	3.2	3.8	1.9	2.1	2.8
Belgium	5.3	5.0	4.0	3.9	4.7
Canada	3.7	2.5	2.6	2.5	2.6
Finland	4.4	2.9	5.1	6.4	4.4
France	6.5	3.5	2.9	3.8	3.7
West Germany	5.1	3.4	1.7	3.7	2.8
Japan	9.3	4.6	3.8	2.6	4.7
Netherlands	6.2	4.7	3.1	3.0	4.1
Portugal	6.8	3.0	2.9	2.8	3.5
Spain	7.8	3.3	2.8	1.4	3.7
Sweden	7.3	1.4	3.2	5.9	3.6
UK	3.9	1.6	5.2	2.0	3.2
USA	2.8	2.2	3.8	4.3	2.8
Latin America					
Brazil	2.0	1.5	-1.3	4.7	1.5
Mexico	3.7	2.6	0.8	2.2	2.0
Asia					
China	4.6	-1.5	4.7	10.3	3.2
India	4.4	1.2	3.9	5.9	3.1
Indonesia	..		4.2	4.1	..
Korea	..	5.5	5.4	9.2	..
Taiwan	..	3.9	5.2	5.1	..

Source: ICOP Industry Database, (http://www.eco.rug.nl/GGDC/icop.html). .. = not available.

While indicative, the comparative measures will be relatively imprecise since measurement problems are exacerbated in international comparisons. This reflects differences in statistical procedures,[21] the timing of business cycles, stages of development and in industrial structure between countries. A major factor affecting comparisons over the 1990s is that Australian manufacturing has relatively little production of information and communication technology (ICT) goods relative to the United States and some other advanced industrial economies (Banks 2001). Because of rapid technological advances in ICTs, the quality of these goods has increased dramatically, and this has been reflected in recent productivity figures for ICT-producing nations, particularly the United States.

Comparison of the levels of productivity

Whilst comparisons of growth rates provide a benchmark for the relative performance of Australian manufacturing over time, it is also revealing to consider

21 For example, with respect to survey methods and scope, and differences in methods used for constructing price indexes.

absolute productivity levels between countries. These, with prices and exchange rates, determine the international competitiveness of Australian manufacturing. Comparing the levels of productivity across counties requires value added to be expressed in a common currency, usually exchange rates based on purchasing power parities (PPP).

The most comprehensive estimates[22] of PPP-based labour productivity-levels between countries suggest that, in 1960, Australian manufacturing productivity was less then half the US level, but was similar to the level of other developed countries (table 7.9). While measurement errors may affect the comparisons,[23] the data suggest that Australia was one of a small group of OECD countries, including Canada and the UK, that slipped further behind the US by the year 2000. Many other OECD countries — including small open economies — converged towards the US level.

Even so, Australia's level of productivity is still significantly higher than developing countries experiencing rapid productivity growth. While the influence of the ICT 'revolution' on US manufacturing productivity levels will exaggerate the measured gap in productivity between Australia and the US for non-ICT goods, the data point to the scope for considerable future gains in manufacturing productivity.

Given the imprecision involved in converting value added into a common currency, alternative international comparisons have been undertaken, which compare outputs that are not measured in dollar terms. Comparisons based on the number of cars, amount of steel, cement and photographic paper produced are reported in Lattimore (1990). The results reveal substantial differences between these manufacturing industries.

Demura (1995) examined BHP's comparative steel productivity from 1983 to 1993, finding that its absolute productivity per employee more than doubled over this period to just under 500 tonnes per employee year. Nevertheless, in absolute terms, productivity at BHP Steel in 1983 shifted from 30 per cent of the prevailing world best (POSCO) to still some 50 per cent of this level one decade later.

[22] The Groningen Growth and Development Centre has developed unit value ratios to convert manufacturing value added from a number of countries into US dollars.

[23] There are several potential measurement problems involved in these comparisons. The results depend crucially on the construction of appropriate currency conversion rates. Different PPP measures developed by different researchers throw a very different light on absolute productivity differences (van Ark 1996; Sharpe 2002, p. 35; Schreyer 1996). Schreyer compared output price levels relative to the US for several countries using expenditure PPP (EPPP), unit value ratio (UVR) and PPP for total GDP, finding large discrepancies. For example, relative output prices for Japan were 150 for the EPPP, but only 107 for UVR (with the US=100).

Table 7.9 **Comparative levels of manufacturing labour productivity**
USA = 100

	1960	1970	1980	1987	1990	1998	2000
	Index	Index	Index	Index	Index	Index	Index
OECD							
Australia	45.2	50.1	56.9	48.4	48.2	42.5	38.1
Belgium	44.9	58.5	79.5	78.5	83.7	83.9	75.4
Canada	75.8	84.2	85.5	77.5	77.3	70.9	64.1
Finland	48.8	58.4	63.8	65.9	72.1	86.4	88.9
France	50.8	74.3	83.1	71.2	77.6	79.4	72.2
West Germany	65.6	82.1	87.2	70.2	72.7	71.3	67.4
Japan	32.3	64.9	82.1	76.4	84.8	73.6	71.6
Netherlands	51.3	71.5	89.1	83.3	84.1	78.0	72.3
Portugal	17.1	24.2	27.6	24.5	25.1	23.5	
Spain	25.8	42.0	48.1	45.0	44.4	38.4	33.8
Sweden	52	78.8	73.3	68.4	70.0	83.9	79.2
UK	48.3	53.7	49.1	53.6	57.0	50.1	47.9
USA	100	100	100	100	100	100	100
Latin America							
Brazil	51.9	53.8	54.9	38.5	32.7	35.1	..
Mexico	34.3	37.4	37.2	27.9	28.8	25.8	..
Asia							
China	6.8	6.8	4.7	4.5	5.0	7.9	..
India	2.2	2.6	2.4	2.2	2.5	8.3	..
Indonesia	3.3[a]	2.5[c]	4.8	4.6	5.1	5.2	..
Korea	11.3[b]	16.2	23.3	26.5	28.9	43.1	..
Taiwan	11.9[b]	18.9	23.2	24.9	27.1	30.5	..

a 1961. **b** 1963. **c** 1991.

Source: ICOP Industry Database, (http://www.eco.rug.nl/GGDC/icop.html).

More recently, the PC (2003d) found convergence in productivity levels between Australia and developing countries for some manufacturing items, such as TCF products produced by China. While this is not typical of manufacturing, it highlights the capacity for technological catch-up in developing countries, at given exchange rates, to put competitive pressure on vulnerable pockets of Australian manufacturing.

7.4 Explanations for the productivity experiences of manufacturing

The strong labour productivity growth apparent in manufacturing can be ascribed to a mix of rising capital intensity and MFP. However, the striking feature of the manufacturing experience is the gap between its MFP experience and that of the market sector as a whole. During the mid-1990s, MFP for the market sector was around 0.7 percentage points above its long-run growth rate, while manufacturing was around 0.7 percentage points below its long-run growth rate.

In making comparisons between the MFP performance of manufacturing and the market sector as a whole, it should be emphasised that MFP growth reflects many factors simultaneously. These include the influence of microeconomic reforms that increase technical efficiency, unmeasured changes in the quality of factor inputs, technological progress, compositional shifts of resources among industries within manufacturing and improved organisational forms and logistics. MFP estimates by themselves are not informative about the potential contribution of individual components.

The use of ICT

The use of ICT has been a major contributor to productivity growth in the market sector in the 1990s. The absence of a productivity surge in manufacturing does not mean that these factors were not also at work in manufacturing. As noted in chapter 3, the IT intensity of manufacturing increased markedly in the 1990s — roughly at the rate of services as a whole (and well above the mining and agricultural sectors).

When other influences are taken into account, ICT appears to make a contribution to manufacturing MFP growth. Gretton, Gali and Parham (2002) found that, for a large sample of manufacturing firms, the use of ICTs contributed 0.14 per cent of the annual growth in manufacturing MFP. They found that the use of ICTs alone was not the key to improving productivity, but rather it complemented other organisational factors, like the education of managers and age of the firm. With these factors taken into account, MFP was increased by a further 0.14 per cent each year. (Other aspects of computerisation incorporated into existing manufacturing equipment will have also played a role in increasing labour productivity, if not MFP.[24]) The fact that ICT use did not increase MFP growth in manufacturing in the 1990s is testimony to other offsetting influences.

The role of industrial relations reform

A similar story can be mounted for the effects of industrial relations (IR) reform in manufacturing. IR reform — changed bargaining arrangements that have

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[24] Such quality improvements to equipment are taken account of by the ABS when calculating price deflators and may partly lie behind the high growth rate in capital intensity in manufacturing.

emphasised a devolved approach to negotiation between employees and management — was initiated in the later 1980s to increase workplace productivity levels (and wage rates). While some case studies have found positive impacts of IR reform on productivity (Mealor 1997), others have not (Arsovska 2001), or have been unable to separate the effects of IR reforms from other enterprise changes that were introduced simultaneously. Attitudinal surveys of managers (summarised in Wooden et al. 2001) suggest that IR reform is likely to have improved productivity gains overall, but these studies are subject to possible bias.

More recent data (Fry et al. 2003) suggest that large manufacturing firms have been more likely to embrace IR reforms than firms in many other industries (with the exception of the Transport, Communications and Mining industries). And those manufacturing firms undertaking reform more frequently reported successful reform than those in most other industries. Analysis that controlled for other factors that might affect labour productivity suggest that firms embracing IR reform had significantly higher levels of self-assessed productivity relative to their competitors (Fry et al. 2002). So, as with ICT, the absence of an MFP surge in the 1990s in manufacturing does not imply the absence of productivity benefits from IR reform, but points to the cocktail of influences that affect productivity performance.

Could compositional changes explain the slowdown?

One possible source for the relative productivity stagnation in manufacturing is the changing composition of manufacturing:

- aggregate productivity change in manufacturing is a function of changes in productivity in each industry class and shifts between classes with different productivity levels. However, as discussed in chapter 4, shifts between industry classes in manufacturing explain very little of the change in aggregate labour productivity between 1989-90 and 1999-2000.

- the small business share of manufacturing has increased significantly in manufacturing, while large firms' share has declined (chapter 5). The contraction in big business shares has been greater in manufacturing than other sectors. The shifting size distribution of firms within manufacturing may have productivity effects, because larger businesses have significantly higher average labour productivity levels than smaller businesses. However, the changing size distribution had modest effects on labour productivity. If there had been no change in the size distribution, it is estimated that real turnover per employee would have increased by around 20 per cent from 1992-93 to 1999-2000. The actual increase was around 18 per cent, suggesting that shifts in the size distribution might have reduced labour productivity by 2 percentage points.[25]

While the evidence on the impacts of compositional changes within manufacturing relate to labour productivity rather than multifactor productivity, they suggest that such changes have had second-order effects on productivity trends in manufacturing in the 1990s.

The impact of R&D

The acquisition and use of new knowledge is a major source of long-run productivity improvement. Technological innovation achieved through R&D is an important driver of changes to manufacturing products and processes, and accordingly a source of productivity improvement.

Empirically, the links between R&D and productivity growth are now well established (although the magnitude of the effects are still in doubt). For example, a recent OECD cross-country study found that a one per cent increase in the domestic business R&D capital stock generates 0.13 per cent in MFP growth, while a one per cent increase in foreign R&D stocks generates 0.44 per cent in MFP growth (Guellic and van Pottelsberge de la Potterie, 2001).

(Domestic) R&D capital stocks grew strongly in Australian manufacturing from the early 1980s, increasing by a trend growth rate of:

- around 5.7 per cent per year from 1980-81 to 1990-91; and
- by 7.0 per cent per year from 1990-91 to 2000-01 (figure 7.6).[26]

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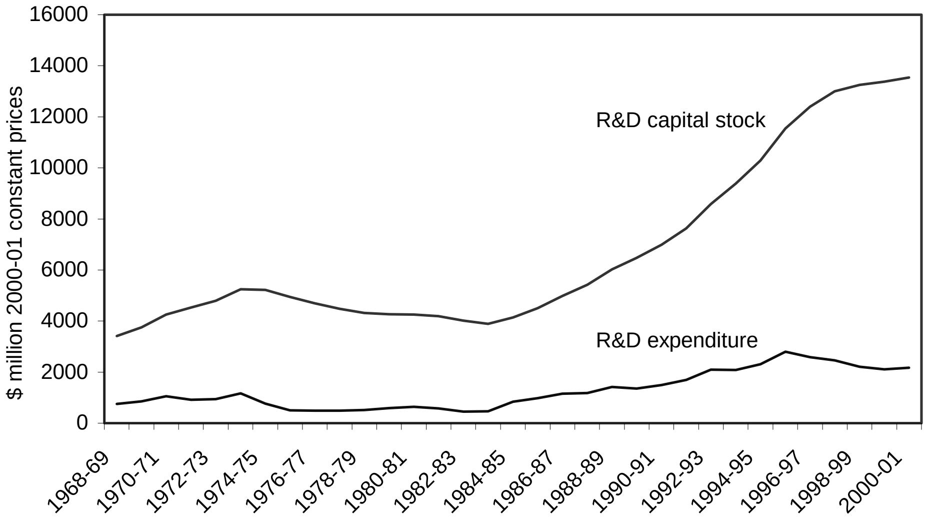
25 The analysis was based on a decomposition of labour productivity change into 'within' size category effects, 'between' size category effects and a mix effect (which takes accounts of simultaneous changes in the size distribution of firms and productivity change within size categories). Labour productivity (V) in manufacturing can be defined as: $V_t = \sum_{i=1}^{n} g_{it} \times s_{it}$ where g is the labour productivity of the ith firm size category and s is the employment share of that category in total manufacturing. The percentage change in labour productivity can be calculated as: $\Delta V_t / V_{t-n} = 1/V_{t-n} \times \sum_{i=1}^{n} (\Delta g_{it} \times s_{it-n}) + (\Delta s_{it} \times g_{it-n}) + (\Delta g_{it} \times \Delta s_{it})$. The three effects that make up this expression are the within, between and mix effect, respectively, and were found to be 19.8, 2.0 and 0.3 per cent, respectively for the period from 1992-93 to 1999-2000. Real turnover per employee was the labour productivity measure.

26 Unfortunately, there are various gaps in the R&D data, especially prior to 1976-77. A regression approach was used for interpolating data for these missing years. The regression prediction model gave estimates close to the actual R&D figures for those years where actual values were available, suggesting reasonably accurate interpolation. But other interpolation methods would give different results. Differences in interpolation methods have significant effects on capital

Assuming that the effects of accumulating R&D on MFP estimated by the OECD hold for Australia, this suggests that, all other things being equal, manufacturing MFP growth rates should have *increased* by around 0.2 percentage points per year in the 1990s compared with the previous decade. Accordingly, it does not appear likely that changes in R&D accumulation can explain slower manufacturing MFP growth in the mid-1990s.[27]

Figure 7.6 **R&D in manufacturing**

1968-69 to 2000-01



[a] The stock (S) was calculated as $S_t = S_{t-1}(1\text{-}d)+r$,, where r is the real R&D expenditure and d is a depreciation rate (set at 15 per cent, as in Guellic and van Pottelsberge de la Potterie 2001). This permanent inventory method requires a reasonable set of R&D expenditure values prior to the starting year of the capital stock. These values, and the few R&D values that were missing after 1968-69, were interpolated and extrapolated using regression modelling techniques. Accordingly, the data are only estimates.

Data source: PC estimates based on ABS, *Research and Experimental Development*, Cat. 8104.0 (various issues) and unpublished data from the PC.

The role played by other industries

It should also be noted that at least part of the explanation of the difference between manufacturing and the market sector productivity performance reflects unique factors affecting the productivity of some non-manufacturing segments of the

stock estimates during the 1980s, but are unimportant for estimates for the 1990s. Given this sensitivity, it is not possible to measure with precision the change in rates of R&D stock accumulation rates from the 1980s to the 1990s.

27 It is unlikely that the slowdown in Australian manufacturing MFP growth in the 1990s reflects changes in foreign R&D stocks. The OECD (2003, p. 63) indicates that, across OECD countries, business R&D intensities were generally greater in the 1990s compared with the 1980s, although it is possible that this may have been in knowledge that was less assimilable by Australian firms.

market sector. For example, there were major reforms in the 1990s related to the provision of infrastructure services — gas, electricity, water, transport, rail, post and communication services.[28] While manufacturing is a major user of some of these services, efficiency dividends would be expected to mainly accrue to these services. These could help explain why market sector MFP growth rates exceeded the historical norm. (It does not explain why the manufacturing MFP growth rate fell below its historical average.)

Data errors?

Another possible explanator for the apparently marked divergence of manufacturing from its historical average during the 1990s are data errors. MFP estimates are residuals that are very open to data errors, particularly at the industry (rather than the market sector) level and over short periods of time (such as the mid-1990s). Appendix I reveals that it is conceivable that manufacturing has in fact had rather higher productivity growth during the earlier 1990s. But it is equally conceivable that the real performance might have been worse.

Summing up and interpretation

There does not appear to be a decisive factor underlying the slowdown in manufacturing MFP in the mid 1990s. In any case, the evidence of the later 1990s suggests an acceleration of MFP growth in manufacturing. The MFP growth figures for 2001-02 and 2000-01 are the first and second highest (respectively) in the last 17 years. Whether these high growth rates merely take MFP back to the level predicted by the long-run historical path, or they represent a real shift in the underlying trend of MFP (as in the market sector), is not yet clear.

It is also worth emphasising the importance of labour productivity, which has recorded very strong growth rates for manufacturing over the 1990s. A major reason for this has been increasing measured capital intensity. In part, the increase in intensity reflects the influence of technical change embodied in physical capital, thus increasing capital inputs (all other things being equal). One reading of (at least a portion of) the labour productivity gains in manufacturing apparent over the 1980s

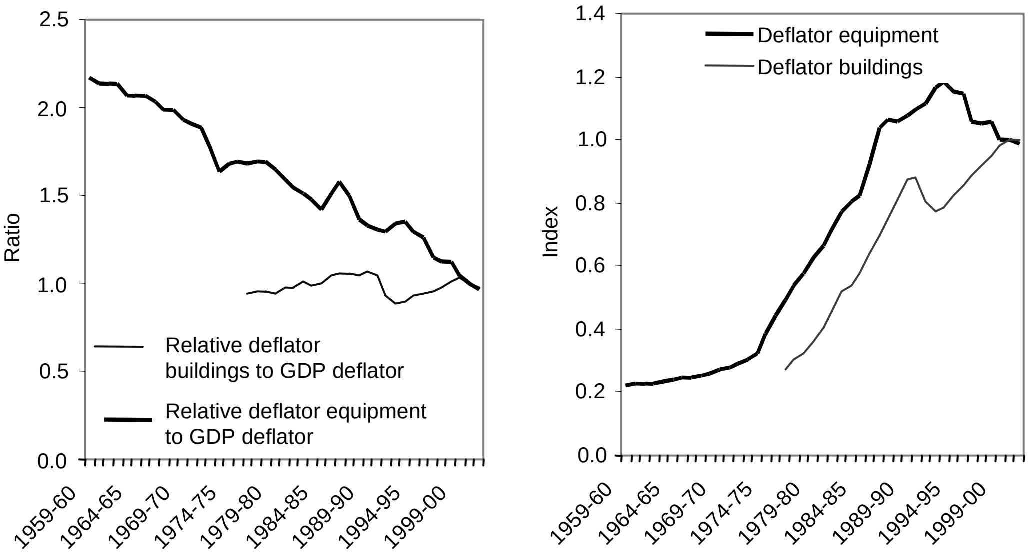
[28] Microeconomic reforms appear to have stimulated manufacturing MFP above what it would have been otherwise, but in a preceding period. The reforms included greater integration with the world economy generally, large reductions in assistance for all industries and agreement on a pathway to low long-run assistance levels — reforms that were substantially undertaken in the 1970s and 1980s. Karunaratne (2001) found that the average technical efficiency in manufacturing increased from 72 to 92 per cent and that the increases coincided with the implementation of reform in the earlier years. Further, the industries with the highest level of assistance had the lowest average technical efficiency.

and 1990s is that technical change in the global production of capital equipment has enabled Australian manufacturing sector to acquire an effectively greater stock of capital at given market prices. The effect of technical change in capital is greater labour productivity and lower output prices.

However, these benefits will not necessarily show up in the MFP figures. Such technical change in inputs is taken into account by the ABS as a quality adjustment to the price of plant and equipment inputs. It is notable that equipment and machinery prices have fallen relative to goods and services for the last forty years (figure 7.7). In the low inflation era of the 1990s, absolute equipment prices have actually fallen (in quality adjusted terms). Thus, increased capital productivity of equipment at market prices is translated into lower prices at a given productivity, increasing measured capital inputs. As Australian manufacturing is not a large producer of the relevant capital goods, there is no significant corresponding increase in quality-adjusted outputs. Accordingly, the gains to labour productivity are ascribed to greater capital inputs in a MFP growth accounting framework, and MFP may not be much affected.

Figure 7.7 **Price movements of private gross fixed capital formation in buildings and equipment relative to the GDP deflator**

1959-60 to 2001-02



Data source: ABS (*Australian System of National Accounts*, Cat. No. 5204.0).

It should be emphasised that this is not a weakness of the MFP growth accounting approach. There are no overlooked gains from productivity. However, when interpreting MFP results it is important to separate what is a good framework for isolating the multiple sources of output changes in a sector and the economic benefits that can be ascribed to labour (or other factor) productivities by themselves.

After all, if all possible inputs into productivity gains were identified — labour, capital, skill, management and R&D, innovation and other knowhow — MFP growth would be zero. The key to economic welfare would be the returns associated with these inputs. In that context, some of the labour productivity gains emanating from capital-deepening in manufacturing can be interpreted as a dividend from cheaper capital.

An associated point is that technological gains made in materials science or in manufacturing design (box 7.2), which improve materials productivity, will not necessarily show up in labour or MFP growth estimates, while still being beneficial to Australians. This is because any reduction in the required material to gross output ratio need not have any impact on value added, which is the basis for the present estimates of productivity in manufacturing.[29]

Box 7.2 **Materials: the quiet revolution**

There have been many changes to the nature and use of material and energy inputs to manufacturing:

- There has been a shift toward lighter and stronger materials in many manufactured products (Wernick et al. 1997). The increasing usage of high tensile steel, which can provide the same strength for less weight than traditional carbon steel, reduced the demand for steel in terms of weight. This has been one of the reasons for the chronic over-supply problems afflicting the world steel industry.
- Other light materials, such as aluminium and various plastic composites, have became more widely used. The same applies to various metallic-ceramic composites, carbon fibre and other new materials with unique properties. The development of new, cheaper, stronger and, in many cases, easier to fabricate materials, has improved productivity by reducing the cost of material inputs and fabrication.
- There was also some progress made in reducing energy requirements in manufacturing. This was achieved by more accurate fabrication of engine and machine parts to reduce friction, the application of low friction bearings and improvements in the thermal efficiency of metallurgical and chemical processes.[30]

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29 It should be noted that, if MFP were calculated as the residual amount of sales output after taking account of capital, labour, energy and materials (a so-called KLEM approach), then this could still be true (indeed MFP could fall if the gains are mainly due to superior materials rather than better design). The issue is not the MFP framework, but how it is sometimes interpreted.

30 More information about recent and projected technological developments can be found in a collection of papers edited by Ausubel and Langford (1997).

A Industry classifications

This appendix outlines the various industry classifications used in this report and the concordances between ASIC and ANZSIC.

The main classifications used

The report uses various levels of aggregation for analysis of manufacturing trends. The most common classification is an elaboration of the two digit ANZSIC that provides greater detail on four ANZSIC subdivisions (subdivisions 22, 25, 27 and 28), since these are often the focus of policy interest (table A.1). For some analysis, such as that of manufacturing labour productivity trends and structural change within manufacturing, data covering roughly 50 three digit ANZSIC groups and 150 four digit industry ANZSIC classes are also used.

A further useful classification system, developed by the Department of Foreign Affairs and Trade (DFAT), classifies commodities by the degree and complexity of their transformation (ABS 1996). In particular, the classification system (the Trade Exports Classification or TREC) allows trade in simply transformed manufactures (STMs) to be distinguished from elaborately transformed manufactures (ETMs).

However, TREC is not based on ANZSIC, but on detailed commodity classifications. While there is an approximate concordance, the two classification systems do not match perfectly. For example, pesticides are classified as a STM, while paints are classified as a ETM, despite both being part of ANZSIC 254 (other chemicals). While the TREC is used in this report for reporting exports of STMs and ETMs, it is useful to have a roughly parallel classification at the manufacturing ANZSIC subdivision level for reporting performance trends by the level of transformation. Accordingly, industries in table A.1 were classified as ETMs or STMs in a way that is as close as possible to the TREC.

Another useful taxonomy relates to the distinction between low, medium and high technology industries. This classification is based on the average R&D intensity of the sector in OECD countries:

- High-tech industries include Photographic and optical manufacturing, Medical and surgical equipment, Professional and scientific equipment, Computer and business machine manufacturing, Telecommunications, broadcasting and transceiving equipment, Electronic equipment, Medicines and pharmaceuticals and Aircraft.

- Medium-tech industries include Motor vehicles, Electrical equipment, Shipbuilding, Railway equipment and Chemicals.
- Low-tech industries include Processed food, Textiles, clothing, footwear and leather, Printing and publishing, Iron and steel, Non-ferrous metals and non-metallic minerals and Other manufacturing (furniture, toys, sporting goods and miscellaneous small articles).

Table A.1 **Sectoral classification of manufacturing**

ANZSIC code	*Industry description*	*Degree of transformation*[a]
21	Food, beverages and tobacco	STM
22	Textiles, clothing, footwear	
223-225	Clothing & footwear	ETM
Rest of 22	Textiles and leather	STM
23	Wood and paper products	STM
24	Printing publishing and recorded media	ETM
25	Chemicals and petroleum products	
251-253	Simply transformed chemicals (petroleum refining, fertilisers, industrial chemicals)	STM
254-256	Elaborately transformed chemicals (plastics, rubber, paints, soaps, pesticides)	ETM
2543	Pharmaceuticals	ETM
26	Non-metallic mineral products	STM
27	Metal products	
271	Iron and steel	STM
272-273	Non-ferrous metals (aluminium, alumina, copper, zinc, silver, tin)	STM
274-276	Simple metal fabrications (structural members, sheet metal work, tubes, wires, fasteners)	ETM
28	Machinery and equipment	
281	Motor vehicles	ETM
282	Other transport equipment (ships, aircraft, railway equipment)	ETM
283	Photographic, medical and scientific equipment	ETM
284	Electronic equipment (telecommunications and computers)	ETM
285	Electrical equipment (whitegoods, appliances, electric motors, transformers)	ETM
286	Production equipment (for agriculture, mining, construction and manufacturing)	ETM
29	Other manufacturing[b]	ETM

a STM denotes simply transformed manufactures (based on an industry-based classification system), while ETM denotes elaborately transformed manufactures (industry-based). The definition of transformed manufactures is similar to that used by the Department of Foreign Affairs and Trade (DFAT) (2001). However, unlike the DFAT classification, the definition used here is based on industries rather than commodities. **b** Other manufacturing includes prefabricated buildings, furniture manufacturing, toys, sporting goods, eye glasses, orthopaedic appliances and unclassified small articles.

Concordances

The classification system for industries changed with the introduction of ANZSIC in the 1990s. The following tables provide concordances between the ASIC and the ANZSIC codes used in this report. These are not exact because some activities shifting from ASIC to ANZSIC were split between various categories. This is particularly serious for the three digit category 'other manufacturing'. Except at a highly aggregated level, growth rates are usually not calculated across ASIC and ANZSIC-based data, even those adjusted for changes in the classification system, because of the risk of significant data errors.

Table A.2 **ASIC/ANZSIC concordance for industry divisions[a]**

ANZSIC classification	*Main corresponding ASIC sectors*
A Agriculture, forestry and fishing	A Agriculture, forestry and fishing
B Mining	B Mining
C Manufacturing	C Manufacturing
D Electricity, gas & water supply	D Electricity, gas & water supply
E Construction	E Construction
F Wholesale trade	F Wholesale and retail trade
G Retail trade	F Wholesale and retail trade
H Accommodation cafes and restaurants	L Recreation, personal & other services
I Transport and storage	G Transport & storage
J Communications services	H Communication
K Finance and insurance	I Finance, property & business services
L Property and business services	I Finance, property & business services
M Government administration and defence	J Public administration and defence
N Education	K Community services
O Health and community services	K Community services
P Cultural and recreational services	L Recreation, personal & other services
Q Personal and other services	L Recreation, personal & other services

a The concordance is good, but approximate. For example, certain services classified to manufacturing in ASIC were re-classified to non-manufacturing divisions in the ANZSIC (such as photographic processing).

Source: Based on ABS (1993, *Australian and New Zealand Standard Industrial Classification,* Cat. No. 1292.0).

Table A.3 **Nine subdivision concordance between ANZSIC and ASIC**

ANZSIC description	*ANZSIC code*	*ASIC code concordance*
Food, beverages and tobacco	21	21
Textiles, clothing and footwear	22	23 (less 2341), 24 & 345
Wood and paper products	23 & 2919	263 & 253
Printing, publishing and recorded media	24 less 2430	264
Petroleum, coal, chemicals & associated products	25	27, 346 & 347
Non-metallic mineral products	26	28
Metal products	27 & 2911	29 & 31 (less 3152)
Machinery and equipment	28 & 2430	32, 33, 3481, 3484 (less 3342)
Other manufacturing	29 less (2919 & 2911)	348, 2541, 2542 & 3152 less (3481 & 3484)
Non-manufacturing		
Cotton ginning (non-manufacturing — now part of agriculture)	A0211	2341
Photographic film processing (Non-manufacturing - now part of services)	9522	3342

Source: Table A.1.

Table A.4 **19 industry breakdown of manufacturing: ANZSIC/ASIC concordance**

ANZSIC description	*ANZSIC code*	*ASIC concordance*
Food, beverages and tobacco	21	21
Textiles, clothing and footwear	22	23 (less 2341), 24 & 345
Clothing & footwear	223-225	24
Textiles & leather	Rest of 22	23 & 345, less 2341
Wood and paper products	23 & 2919	263 & 253
Printing and publishing	24 less 2430	264
Petroleum, coal, chemicals & associated products	25	27, 346 & 347
Simply transformed chemicals	251-253	277, 278 & 275
Elaborately transformed chemicals	254-256	276 (excluding 2763), 346 & 347
Medicinal and pharmaceutical product manufacturing	2543	2763
Non-metallic mineral products	26	28
Metal products	27	29 & 31 (less 3152)
Iron and steel	271	294
Non-ferrous metals	272-273	295 & 296
Simple metal fabrications	274-276, 2911	31
Machinery and equipment	28 & 2430	32, 33, 3481, 3484 (less 3342)
Motor vehicles	281	323
Other transport equipment	282	324
Photographic, medical and scientific equipment	283	334 & 3481 less 3342
Electronic equipment	284 & 2430	3351 & 3352
Electrical equipment	285	3353 to 3357, 3484
Production equipment	286	336
Other manufacturing	29 less (2919 & 2911)	348, 2541, 2542 & 3152 less (3481 & 3484)
Non-manufacturing		
Cotton ginning (non-manufacturing — now part of agriculture)	A0211	2341
Photographic film processing (non-manufacturing — now part of services)	9522	3342

Source: Table A.1.

Table A.5 **Concordance between ANZSIC and ASIC at the 3 digit ANZSIC level**

ANZSIC 3 digit description	*ANZSIC*	*ASIC*
Meat and meat products	211	211
Dairy products	212	212
Fruit and vegetable processing	213	213
Oils and fats	214	214
Flour mill and cereal foods	215	215
Bakery products	216	216
Other food	217	217
Beverages and malts	218	218
Tobacco products	219	219
Textile fibres, yarns and woven fabrics	221	234
Textile products	222	235
Knitting mills	223	244
Clothing	224	245
Footwear	225	246
Log sawmilling and timber dressing	231/232	253
Furniture	292	254
Paper and paper products	233	263
Printing and services to printing and publishing	241/242	264
Basic chemicals	253	275
Other chemical products	254	276
Petroleum refining	251	277
Petroleum and coal products	252	278
Glass and glass products	261	285
Ceramics	262	286
Cement, lime, plaster and concrete products	263	287
Non-metallic mineral products nec	264	288
Iron and steel	271	294
Basic non-ferrous metals	272	295
Non-ferrous basic metal products	273	296
Structural metal products and prefabricated buildings	274/291	314
Sheet metal products	275	315
Fabricated metal products	276	316
Motor vehicles and parts	281	323
Other transport equipment	282	324
Photographic and scientific equipment	283	334
Electronic equipment, recorded media & electrical equipment & appliances	284/243/285	335
Industrial machinery and equipment	286	336
Leather and leather products	226	345
Rubber products	255	346
Plastic products	256	347
Miscellaneous	294	348

Source: Table A.1.

Table A.4 98 industry concordance between ANZSIC and ASIC[a]

ANZSIC description	*ANZSIC code*	*ASIC/IC code concordance*
Meat products	2111	2115*
Poultry processing & bacon, ham and small goods	2112, 2113	2116, 2117
Milk products	2121-2129	2120 (comprising 2121-2125)
Fruit and vegetable processing	2130	2131, 2132
Margarine and oils and fats nec	2140	2140
Flour milling	2151	2151, 2152
Cereal food and baking mix	2152	2153
Bread	2161	2161*
Cakes and pastries	2162	2162
Biscuits	2163	2163
Sugar manufacturing and foods nec	2171, 2179	2171, 2176
Confectionaries	2172	2173*
Seafood processing	2173	2174*
Prepared animal and bird feeds	2174	2175
Soft drinks, cordials and syrups	2181	2185
Beers and malts	2182	2186, 2187
Wines and spirits	2183, 2184	2188, 2189
Tobacco products	2190	2190
Textile fibres, yarns and woven fabrics	221	2342- 2349
Ropes, cordage and twines	2223	2355
Other textile products	2221, 2222, 2229	2351, 2352, 2353, 2354, 2356
Hosiery	2231	2441
Cardigans and pullovers	2232	2442
Other clothing and knitted goods	2239, 2241, 2242, 2243, 2249	2459 (comprising 2443, 2453, 2455), 2451, 2452,2454,2456
Leather tanning and fur dressing	2261	3451*
Leather and leather substitute products	2262	3452*
Footwear	2250	2460*
Plywood, veneer and fabricated woods	2321, 2322	2533
All other wood manufacturing	2311, 2312, 2313, 2323, 2329, 2919	2534-2538, 2539 (comprising 2531,2532)
Pulp, paper and paperboard	2331	2631*
Paper bags and paperboard manufacturing	2332, 2333, 2334	2636 (comprising 2632, 2633, 2634)
Paper product manufacturing nec	2339	2635

(continued next page)

Table A.4 **continued**

ANZSIC description	*ANZSIC code*	*ASIC/IC code concordance*
Paper stationary manufacturing	2411	2643
Publishing and printing	2421, 2422, 2423, 2412, 2413	2645, 2646 (comprising 2641, 2642, 2644)
Petroleum refining	2510	2770
Petroleum and coal products nec	2520	2780
Chemical fertilisers	2531	2751*
Industrial gases & chemicals	2532, 2534, 2535	2756 (comprising 2752, 2754, 2755)
Synthetic resins and rubber	2533	2753
Paints	2542	2762
Medicinal and pharmaceutical products	2543	2763*
Pesticides	2544	2764
Soaps, detergents, cosmetics and toiletries	2545, 2546	2765, 2766
Inks	2547	2767
Other chemical products	2541, 2549	2769 (comprising 2761 and 2768)
Rubber tyres and rubber products nec	2551, 2559	3461, 3462
Plastic and related products	2561, 2562, 2563, 2564, 2565, 2566	3475 (comprising 3471, 3474), 3472-3
Glass and glass products	2610	2850*
Clay bricks	2621	2861
Ceramic tiles and pipes	2623	2863
Ceramic products nec	2629, 2622	2862, 2864
Cement and lime	2631	2871
Ready-mix, pipes & box culverts, prods. nec	2633, 2634, 2635	2876 (comprising 2872, 2873, 2874)
Other non-metallic products	2632, 2640	2885 (comprising 2881, 2883), 2882, 2884
Basic iron and steel	2711	2941*
Iron and steel casting & forging	2712	2942, 2943, 2944
Steel pipes and tubing	2713	2945
Basic non-ferrous metals	2721, 2722, 2723, 2729	2950 (comprising 2851, 2952, 2953, 2954, 2955, 2956, 2957)
Aluminium rolling, drawing, extruding	2731	2961*
Non-ferrous metal rolling nec	2732	2962*
Non-ferrous metal casting	2733	2963
Structural steel fabrication, prefab metal buildings and architectural metal products nec	2741, 2911, 2749	3145 (comprising 3141, 3143)
Architectural aluminium products	2742	3142

(continued next page)

Table A.4 **continued**

ANZSIC description	*ANZSIC code*	*ASIC/IC code concordance*
Metal containers	2751	3151
Hand tools and general hardware	2761	3161
Nuts, bolts, screws and rivets	2763	3163
Metal coating and finishing	2764	3164
Non-ferrous pipe fittings	2765	3165
Miscellaneous metal products	2769, 2762, 2759	3169 (comprising 3153, 3162, 3168), 3166, 3167
Motor vehicle bodies	2812	3232
Automotive electrical and instruments	2813	3233
Motor vehicle parts and other manufacturing	2819, 2811	3235 (comprising 3231 and 3234)
Shipbuilding	2821	3241
Boatbuilding	2822	3242
Railway equipment	2823	3243
Aircraft	2824	3244
Transport equipment nec	2829	3245*
Photographic and optical goods	2831	3341, 3481*
Medical, surgical, professional and scientific equipment	2832, 2839	3343
Recorded media, Electronic equipment nec, Computers and business machines and Telecommunications equipment	2430, 2841, 2842, 2849	3351, 3352*
Household appliances	2851	3353, 3354*
Electric cable and wire	2852	3355
Batteries	2853	3356
Lights and signs and electrical equipment nec	2854, 2859	3357*, 3484
Agricultural machinery	2861	3361*
Mining and construction machinery	2862	3362*
Lifting and material handling equipment	2865	3363*
Pumps and compressors	2866	3365
Commercial space heating and cooling equipment	2867	3366
Food processing machinery	2863	3368
Other industrial machinery	2864, 2869	3364, 3367, 3369*
Jewellery and silverware	2941	3482*
Toys and sporting goods	2942	3485*

(continued next page)

Table A.4 **continued**

ANZSIC description	*ANZSIC code*	*ASIC/IC code concordance*
Wooden furniture and other furniture	2921, 2922, 2929	2543 (comprising 2541 and 3152)
Mattress manufacturing	2923	2542
Manufacturing nec	2949	3487, 3486, 3483
Non-manufacturing		
Photographic film processing (non-manufacturing — now part of services)	9522	3342
Cotton ginning (non-manufacturing — now part of agriculture)	A0211	2341

Source: Table A.1.

a This is an attempt to match 4 digit categories across the different classifications systems. It is less reliable than concordances at a greater level of aggregation. nec denotes not elsewhere classified.

B Output measures for manufacturing

As discussed in appendix I and in the main report, there are two major data sources for chain volume measures of manufacturing value-added that are used to examine trends in output and to derive productivity estimates. One is from the National Accounts, which is available at the two digit ANZSIC industry classification level from 1977-78. The other is from the Manufacturing Census/Survey, which has chain volume estimates from 1989-90. In order to circumvent data consistency problems in the Manufacturing Census, due to changes in reporting units from establishments to enterprises in 2000-01, comparisons between the series were made only until 1999-2000 (table B.1).

Generally, the long run perspective on output growth provided by the two series is very similar (with the exception of Other manufacturing). However, there are significant variations in the year to year growth rates of the series. This is revealed by only moderate correlations between annual output growth rates between the series. This is worst in the textiles, clothing, footwear and leather sub-division, with variations of growth rates in one series only explaining around 37 per cent of the variation in the other. This suggests particular caution in reaching strong conclusions about patterns based on short-term changes in manufacturing.

Of the two series, the National Accounts is generally preferred on conceptual grounds. The National Accounts data are primarily based on the Manufacturing Census/Survey data, but involve stock adjustments and data reconciliation and integration from various sectors of the economy. However, the National Accounts data are only available at a reasonably aggregated level, and so the Manufacturing Census data must be used for any disaggregated analysis. Both series are used in this report.

Table B.1 **Different measures of value added (VA) in manufacturing**

Industry sub-division	*Correlation between Δ log (VA) from 1990-91 to 1999-2000 in the two series*	*Trend growth rate per annum from 1989-90 to 1999-2000*	
		Census[a]	NAC
	ρ	%	%
Food, beverage & tobacco	0.80	2.23	2.69
Textile, clothing, footwear & leather	0.61	-1.63	-1.91
Wood & paper products	0.81	1.42	1.23
Printing, publishing & recorded media	0.89	1.45	2.14
Petroleum, coal, chemical, etc	0.86	2.29	2.58
Non-metallic mineral products	0.98	0.56	0.78
Metal products	0.64	1.29	1.03
Machinery & equipment	0.92	2.67	2.65
Other manufacturing	0.91	0.44	1.36
Total	**0.86**	**1.67**	**1.84**

a This is from the ABS 'supertable' based on Manufacturing Census and Surveys (ABS *Manufacturing Industry, Australia,* Cat. No. 8221.0). NAC denotes data from the National Accounts (ABS *Australian System of National Accounts*, Cat. No. 5204.0). The NAC data are more recent, so part of the difference between the two series reflects revisions. The trend growth rates were calculated by regressing the logged values of the chain volume value added against a time trend. The correlation coefficient, ρ, was computed between the NAC and the Census series of annual growth rates from 1990-91 to 1999-2000. A measure of the extent to which the series move together over the long run is the correlation between the sub-division trend growth rates from 1989-90 to 1999-2000 for the two series. This was 0.957.

Sources: ABS (*Manufacturing Industry, Australia,* Cat. No. 8221.0; *Australian System of National Accounts*, Cat. No. 5204.0).

C Trends in State and Territory manufacturing

Table C.1 **Change in share of Australian manufacturing employment**
1979-80 to 2000-01[a]

ANZSIC industry	*Share of total manufacturing employment*							
	NSW	VIC	QLD	SA	WA	TAS	NT & ACT	Aust-ralia
	Percentage points							
Food, beverage & tobacco	0.4	1.0	1.4	0.6	0.4	0.2	0.0	3.90
Textile, clothing, footwear & leather	-1.6	-2.7	0.1	-0.1	0.2	0.0	0.0	-4.07
Wood & paper products	-0.2	0.3	0.3	0.0	-0.2	0.0	0.0	0.18
Printing, publishing & recorded media	0.5	0.2	0.4	-0.1	0.2	-0.3	0.1	0.88
Petroleum, coal, chemical & associated products	1.0	2.4	1.0	0.5	0.5	0.0	0.0	5.49
Non-metallic mineral products	-0.3	0.0	0.2	0.0	0.0	0.0	0.0	-0.03
Metal products	-2.8	-0.3	1.0	-0.3	0.4	0.0	0.0	-2.06
Machinery & equipment	-3.1	-2.7	1.0	0.0	0.2	0.1	0.1	-4.30
Other manufacturing	-0.4	-0.5	0.7	-0.1	0.4	0.0	0.0	0.01
Total manufacturing	**-6.6**	**-2.5**	**6.1**	**0.5**	**2.2**	**-0.1**	**0.3**	**0.00**

a The shares are calculated using the manufacturing total. For example, the share of the NSW Metal products subdivision in total manufacturing employment fell by 2.8 percentage points from 1979-80 to 2000-01. The ASIC and ANZSIC were matched at the two digit level only to obtain an approximate concordance. This is reasonably accurate, with the exception of other manufacturing.

Sources: ABS (*Manufacturing Industry, Australia* Cat No. 8221.0, 2003; *Manufacturing Establishments, Details of Operations by Industry Class, Australia 1979-80*, Cat. No. 8203.0, 1981, this has revised data for 1977-78).

Table C.2 **Change in share of Australian manufacturing value added**
1979-80 to 2000-01[a]

ANZSIC industry	*Share of total manufacturing value added*							
	NSW	VIC	QLD	SA	WA	TAS	NT & ACT	Aust-ralia
	%	%	%	%	%	%	%	%
Food, beverage & tobacco	0.9	1.1	0.3	0.7	0.2	0.1	-0.1	3.21
Textile, clothing, footwear & leather	-1.3	-2.2	0.0	-0.2	0.1	-0.1	0.0	-3.59
Wood & paper products	0.2	0.7	0.4	0.2	-0.1	0.1	0.0	1.52
Printing, publishing & recorded media	0.3	-0.2	0.4	-0.1	0.3	-0.4	0.1	0.39
Petroleum, coal, chemical & associated products	0.0	2.4	1.0	0.5	1.2	0.1	0.0	5.25
Non-metallic mineral products	-0.2	-0.1	0.0	0.0	0.1	0.1	0.0	-0.04
Metal products	-2.8	0.0	1.2	-0.5	1.1	-0.1	0.1	-1.11
Machinery & equipment	-2.1	-1.5	0.3	-0.5	0.0	0.1	0.1	-3.67
Other manufacturing	-0.9	-1.2	0.3	-0.3	0.1	0.0	0.0	-1.96
Total manufacturing	**-6.0**	**-0.9**	**3.8**	**-0.1**	**3.0**	**-0.1**	**0.2**	**0.00**

[a] Using current price value added. See **a** in table C.1 regarding concordances.

Source: See table C.1.

D Changed inventory management

Reflecting running down of excess stocks and more efficient inventory management processes (including subsequently the adoption of just-in-time approaches), inventory to sales ratios nearly halved in manufacturing from the mid 1970s to the mid 1990s (figure D.1).[1]

This has been a source of efficiency benefits in manufacturing, and can be conceptualised as an improvement in productivity when output is measured as sales rather than value added. Manufacturing firms were able to meet sales targets with less value added than before (and therefore with less labour and capital inputs), particularly during the transition to lower inventory ratios. This productivity dividend would have freed some resources for other sectors (any factor used to produce value added). It should be noted that, using traditional measures of productivity based on value added, the effect would not be apparent as a manufacturing productivity gain at all, but simply as a reduction in the gross product contribution of manufacturing.

The effects of this transition are not trivial in an absolute sense. Back-of-the-envelope calculations (box D.1) suggest that during the transition period (from 1977-78 to 1992-93), the manufacturing sector could meet sales demand with around $5 billion *less* value added (in constant 2000-01 prices) than if previous inventory ratios had been maintained.[2] This amounts to around 0.5 per cent of the total amount of value added actually observed during this period.

In the steady state, with sales growing at 1.5 per cent per annum in real terms and a shift from an inventory ratio of 0.213 to 0.13, then, for a given sales target, value added needed to be around 0.1 percentage points less than it would have to be had the inventory ratio stayed at its old level (box D.1).

During the transition to the new inventory ratio, the effect would contribute to a declining ratio of value added to sales. The value added to sales ratio is often taken

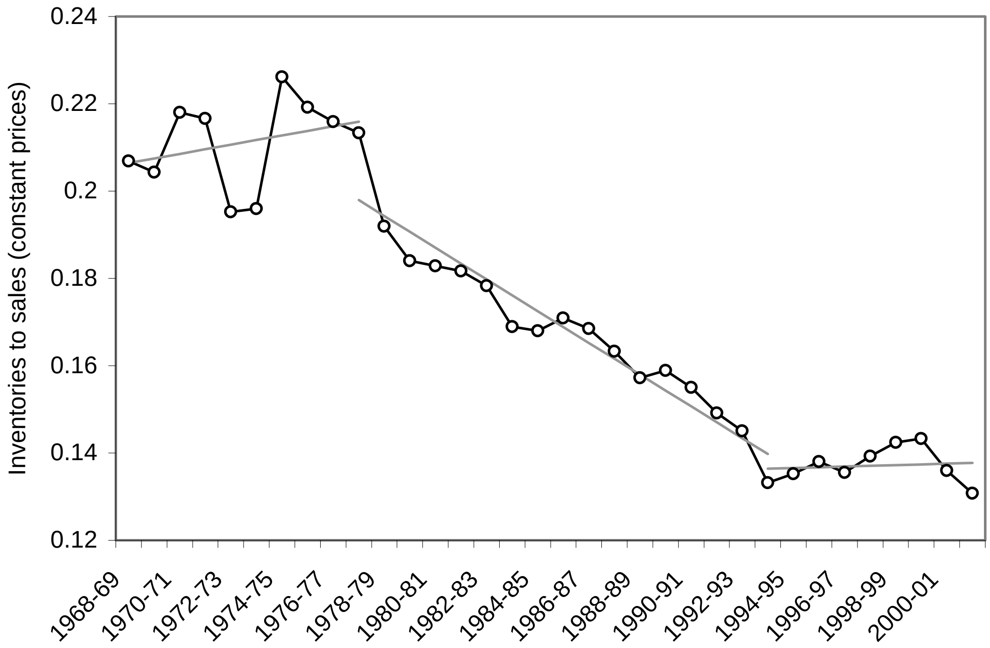
[1] Data on other sectors are incomplete, but some evidence (Johnston et al. 2000, p. 60-61) suggests that inventories to sales have also declined in wholesaling, at least from the later 1980s.

[2] A caveat is that the calculations depend on inferring the amount of materials used from ABS value added estimates. However, ABS value added estimates themselves make implicit assumptions about sales to value added ratios.

to indicate the extent of transformation undertaken in manufacturing, with the notion that less sophisticated manufacturing operations have lower ratios. However, where the decline reflects the winding down of high inventories, no inference about the fundamental nature of manufacturing can be made. That said, calculations comparing value added to sales ratios based on a fixed inventory ratio and those actually observed do not show significant differences in trends. Accordingly, the impact of declining inventory requirements do not explain the large reduction in value added to sales ratios (that mainly occurred from the late 1980s to the mid 1990s).

Nor do the effects of the transition to lower inventory requirements have any marked implications for findings about manufacturing productivity or value added trends.

Figure D.1 **Inventories to sales ratio**
Based on constant 2000-01 prices, Australia, 1968-69 to 2001-02[a]



a The trend lines are simple linear trends for the three periods. The series from 1985-86 was based on chain volume measures of closing inventories and income from sales of goods and services (from the ABS Business Indicators survey). The series from 1968-69 was based on the ratio of nominal closing inventories to nominal turnover, with inventories for 1970-71 interpolated (based on the Manufacturing Establishments survey). In theory, a constant price series should be used for the period prior to 1985-86. However, where nominal and real data are available (after 1985-86), the nominal and real ratios move very closely together anyway. In the absence of an appropriate price index for inventories, the nominal ratio was used for the pre-1985 period. The two series were spliced to form a continuous series.

Data sources: ABS (*Business Indicators, Australia,* Cat. No. 5676.0, for data from 1985-86 *Manufacturing Establishments, Details of Operations by Industry Class, Australia*, Cat. No. 8203.0, for prior data).

While the effect of adjustment of value added to changed inventory requirements is large in absolute terms, it does not make much difference to longer term trends. This is important because otherwise there might be a need to adjust or at least re-interpret the trends based on actual value added. For example, the trend growth rate in actual value added is 1.47 per cent per annum from 1977-78 to 1992-93 and only 0.02 per cent more if the counterfactual level of value added (associated with higher inventory ratios) is used. (In the steady state, there are no effects on value added trends.) Over shorter periods, the effect is bigger, but the key issue is the longer term trend, which is little affected by adjustment to a lower inventory ratio. Nevertheless, at least some of the apparently slow performance of manufacturing value added after 1977-78 can be traced to the fact that some of sales demand growth could be met by running down inventories.

The effects of changed inventory practices have the interesting implication that small gains in efficiency of resources can have relatively large benefits in absolute terms, as suggested by the resource saving of around $5 billion over the transition period (and a further estimated $2 billion gains since then).

Box D.1 **Estimating the effect of improved inventory management on manufacturing value added**

The method used for approximating the effect of higher inventory productivity on value added (or equally on the required inputs of composite labour and capital inputs) is as follows.

First, it is useful to describe the relationships between inventories (I), value added (VA), sales (S) and purchases (M) (all relationships being expressed in constant 2000-01 prices): $VA_t = S_t + \Delta I_t - M_t$

Material inputs are needed for both current sales and for accumulating inventories, so for ease these are expressed as: $M_t = \alpha_t (S_t + \Delta I_t)$ from which it follows that:

$$VA_t = (1 - \alpha_t)(S_t + \Delta I_t)$$

It was assumed that, in the absence of improved inventory management, inventories to sales would have stayed at around 0.213 (their level in 1977-78, which was typical of that period) and that sales (S) were unaffected (ie demand determined). This enables a new set of inventory data ($\tilde{I}$) to be calculated: $\tilde{I}_t = 0.65 S_t$ and $\Delta\tilde{I}_t = \tilde{I}_t - \tilde{I}_{t-1}$.

This implies a new level of VA were inventories to be at this higher counterfactual level: $\tilde{VA}_t = (1 - \alpha_t)(S_t + \Delta\tilde{I}_t)$ This implies that $\Delta VA_t = \tilde{VA}_t - VA_t$ is a measure of the reduced requirements for VA associated with more efficient inventory practices. Over the period from 1977-78 to 1992-93, the value of Σ(ΔVA) is $4.6 billion in constant 2000-01 prices and Σ(ΔVA)/ ΣVA is 0.55 per cent.

In the steady state, sales in manufacturing grow by some rate (g), so that $S_t = (1+g)\, S_{t-1}$. The material input requirement ratio (α) is fixed. The ratio of inventories to sales is stable at γ, so that $I_t = \gamma S_t$ and accordingly, $\Delta i_t = \gamma (1+g) S_{t-1} - \gamma S_{t-1} = \gamma g S_{t-1}$. This implies that value added $(VA_t) = S_{t-1} (1+g + \gamma g)(1-\alpha)$. In the steady state, the difference between value added at the current lower observed inventory ratio (γ) and its level ($\tilde{\gamma}$) had the older higher rate been maintained is:

$$\frac{VA_t}{\tilde{VA}_t} = \frac{(1 + g + \gamma g)}{(1 + g + \tilde{\gamma} g)}$$

With γ=0.13 and $\tilde{\gamma}$ =.213 and g=0.015, this implies that value added needs to be around 0.1 percentage points less than it would have to be had the inventory ratio stayed at its old level.

E Assessing vulnerability to structural change

A large body of empirical analysis of unemployment risk has identified traits that make some employees more vulnerable than others to continued unemployment once unemployed (summarised in Le and Miller 2000 and Borland 2000b). These include disability, Aboriginal and Torres Strait Islander background, poor proficiency in English, low educational attainment, older age and previous episodes of unemployment. There is another set of characteristics — sometimes overlapping with those above — that are associated with lower labour mobility by the unemployed. These include older age, being married and being female (Dockery 2000). Low mobility, all other things being equal, reduces the chance of successful job search.[1]

Given that the incidence of these traits varies considerably across industries, they may be an indicator of where the most serious adjustment issues could arise from structural change. Ideally, a single index of vulnerability that combined the different dimensions of labour market disadvantage would be useful. However, some variables are not readily available by industry (for example, past unemployment episodes) or have a sufficiently low incidence that they are unlikely to be useful for predictive purposes (for example, Aboriginal and Torres Strait Islander background). In other cases, the effects are ambiguous. Thus, while marriage status and gender can affect mobility, the effects are small, while their impact on unemployment risk is, if anything, negative. Accordingly, a measure of vulnerability was constructed from three variables only: the share of employees aged 45 years and over (Aged45+); the share of employees who were not monolingual English speakers and who indicated that they could not speak English well or not at all (Poor_English); and the share of employees who had no post-school qualifications (No_post_school).

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[1] It should be noted that lower mobility among some subgroups may sometimes reflect a reduced need to move because they have reasonable re-employment prospects where they are. Therefore, low mobility need not predispose a person to higher long-term unemployment risk. For example, married people have lower mobility, but better re-employment prospects. Similarly, people in a metropolitan area have lower mobility but reasonable re-employment opportunities because of good job diversity and availability in such areas (Dockery 2000).

Vulnerability was measured using a logit specification, where:

$P = e^M/(1+e^M)$ and

$M = a_0 + a_1$ Poor_English $+ a_2$ Aged45$^+$ $+ a_3$ No_post_school

where a_0 = -2.94, a_1 = 2.097, $a_2 = a_3$ = 1.21. The coefficients could not be estimated on the basis of some identified hazard (such as unemployment or low mobility) because of the absence of appropriate data at the three digit level. However, studies such as Dockery (2000) and Le and Miller (2000) provide an indication of the relative importance of these variables for unemployment risk and low job mobility. a_0 was selected to give a level of vulnerability of five per cent when the three variables above were set to zero. a_1 was selected so that the level of vulnerability was 30 per cent if a person had low English proficiency (measured as not speaking English well or not at all). a_2 and a_3 were selected so that the level of vulnerability was 15 per cent if a person was aged over 45 years or had no post-school qualifications. Given the functional form adopted, combinations of factors that make a person vulnerable to structural change reinforce each other. The indexes of vulnerability at the three digit ANZSIC level were then compared with the level for manufacturing as a whole to give a relative vulnerability measure for 1991 and 2001 (table E.1). The measure was robust to different choices of a_1 to a_3.

Table E.1 **Assessing vulnerability of the workforce[a]**

By industry, 1991 and 2001

ANZSIC code and description	*1991 aged 45+*	*2001 aged 45+*	*1991 not speaking English well or not at all*	*2001 not speaking English well or not at all*	*1991 no post school qualifications*	*2001 no post school qualifications*	*1991 Relative vulnerability*	*2001 Relative vulnerability*
	%	%	%	%	%	%	%	%
211 Meat & meat Products	23.6	28.1	3.0	3.5	78.2	76.6	16.9	24.0
212 Dairy products	30.8	33.4	2.6	1.4	76.8	60.8	23.0	7.2
213 Fruit & vegetable processing	29.0	35.8	3.4	3.6	75.9	57.7	21.7	10.8
214 Oil & fat	33.2	41.6	2.6	2.8	70.2	58.7	18.2	17.2
215 Flour mill & cereal foods	28.4	34.3	4.0	3.9	71.7	52.5	17.0	3.9
216 Bakery products	24.9	32.5	4.7	4.5	61.1	56.0	2.5	6.9
217 Other foods	28.3	35.5	3.6	2.7	57.5	48.9	0.3	-0.7
218 Beverages & malts	28.0	32.4	2.1	1.0	63.3	40.8	3.5	-14.6
219 Tobacco products	32.3	32.2	1.0	0.8	53.1	39.0	-4.7	-16.6
221 Textile fibres, yarns etc	30.8	39.3	7.3	6.0	69.5	66.4	24.1	30.7
222 Textile products	30.3	40.9	6.5	6.5	65.1	63.0	16.6	29.5
223 Knitting mills	33.8	47.5	18.0	17.7	80.2	57.8	69.8	58.7
224 Clothing	28.8	43.2	16.4	19.5	76.2	67.8	51.8	72.4
225 Footwear	30.9	38.9	12.4	9.9	68.8	74.5	35.0	50.7
226 Leather & leather product	30.1	36.6	7.3	5.4	90.1	55.2	51.1	12.4
231/232 Log sawmilling etc	25.6	29.0	1.5	1.3	57.4	59.5	-6.2	1.1
233 Paper & paper products	29.3	35.9	4.2	4.2	61.2	48.0	6.6	1.4
241/242 Printing, publishing etc	27.9	35.3	1.1	1.1	50.7	43.3	-11.1	-9.4

Table E.1 **continued**

ANZSIC code and description	*1991 aged 45+*	*2001 aged 45+*	*1991 not speaking English well or not at all*	*2001 not speaking English well or not at all*	*1991 no post school qualifications*	*2001 no post school qualifications*	*1991 Relative vulnerability*	*2001 Relative vulnerability*
	%	%	%	%	%	%	%	%
251 Petroleum refining	29.5	40.5	0.3	0.3	34.9	24.8	-24.8	-22.7
252 Petroleum & coal products nec	33.2	39.7	1.7	0.6	..	22.0	..	-25.2
253 Basic chemicals	30.3	38.4	1.2	1.2	39.6	46.4	-18.9	-3.1
254 Other chemical products	29.2	33.7	1.6	1.3	50.6	36.2	-9.2	-17.2
255 Rubber products	29.4	35.7	7.5	4.3	65.8	58.9	18.5	13.5
256 Plastic products	28.6	35.9	6.9	5.7	53.5	62.8	2.4	21.4
261 Glass & glass products	29.7	33.5	5.7	2.3	77.4	66.4	29.5	15.6
262 Ceramic products	32.3	39.2	3.5	2.0	54.7	57.5	1.4	11.2
263 Cement, lime, plaster etc.	32.7	38.7	2.1	1.2	64.0	51.6	9.3	2.7
264 Non-metallic mineral products nec	29.8	33.6	3.5	2.7	69.8	56.2	15.3	5.0
271 Iron & steel	31.4	36.1	4.3	2.8	49.8	34.6	-3.1	-14.0
272 Basic non-ferrous metals	26.9	34.4	0.7	1.3	45.5	46.8	-17.4	-6.5
273 Non-ferrous basic metal products	34.9	38.4	5.2	2.5	26.8	42.3	-19.9	-4.9
274/291 Structural metal products & prefabricated buildings	25.7	33.2	3.2	1.8	54.7	50.4	-5.9	-3.3
275 Sheet metal products	29.0	35.0	4.6	2.7	45.0	57.2	-9.7	7.5
276 Fabricated metal products	32.0	36.1	4.7	3.1	47.9	48.1	-3.8	-0.2
281 Motor vehicle & parts	28.6	32.7	8.4	2.3	52.3	44.2	4.1	-9.1
282 Other transport equipment	28.9	32.6	1.7	3.9	39.5	48.1	-19.5	-2.4
283 Photographic & scientific equipment	22.3	35.0	2.0	0.6	42.7	44.2	-21.9	-9.7
284/285/243 Electronic equipment, electrical equipment & appliance & recorded media & publishing	28.1	32.9	5.4	3.2	45.7	42.2	-8.6	-9.2
286 Industrial machinery & equipment	30.6	35.8	2.4	1.3	41.4	36.0	-15.2	-15.5
292 Furniture	25.1	30.2	4.3	4.0	55.1	51.5	-4.1	-1.2
294 Other manufacturing	25.3	37.8	2.5	2.8	60.8	49.7	-1.3	2.6
C: Manufacturing	**28.3**	**34.5**	**4.6**	**3.3**	**55.5**	**49.7**	**0.0**	**0.0**
A Agriculture, forestry & fishing	44.3	50.1	1.0	1.0	70.0	63.6	28.1	29.9
B Mining	24.4	33.4	0.3	0.2	49.8	38.7	-16.4	-16.8
D Electricity, gas & water supply	31.2	40.2	0.9	0.3	35.9	30.4	-21.7	-18.0
E Construction	26.4	32.9	1.7	1.3	42.9	41.0	-18.6	-13.5
F/G Wholesale & retail trade	23.3	27.2	1.2	1.1	59.9	54.7	-6.5	-6.2
I Transport & storage	31.5	39.8	0.9	0.6	63.0	59.3	4.6	11.3
J Communication services	27.5	32.1	0.9	0.4	56.5	51.3	-6.3	-5.8
K/L Finance, insurance, property & business services	23.7	32.2	0.8	0.7	47.8	39.7	-18.2	-16.3
M Government administration & defence	24.8	36.2	0.4	0.4	46.9	36.7	-18.4	-15.8
N/O Education, health & community services	29.2	42.7	0.6	0.3	30.9	23.4	-27.8	-21.9
P/Q/H Cultural & recreational services, personal & other services & accommodation, cafes & restaurants	22.1	27.9	2.2	1.6	57.8	50.2	-8.1	-9.1
R Non-classifiable economic units	31.1	37.1	3.6	2.8	..	..	-44.5	-40.4
Not stated	31.1	38.6	3.9	4.0	..	..	-44.2	-38.1
Total all industries	**27.3**	**34.3**	**1.7**	**1.2**	**50.4**	**44.3**	**-10.9**	**-9.2**

a The 1991 data are based on ASIC, while the 2001 data are based on ANZSIC. Although it is sometimes imperfect, a concordance between ASIC and ANZSIC has been applied,

Sources: Unpublished ABS data from the 1991 and 2001 Population Censuses and unpublished ABS data on educational attainment of the workforce.

F Sensitivity to GDP shocks

In order to examine one of the sources of structural change in manufacturing, a simple test of the contemporaneous sensitivity of employment to GDP shocks was undertaken for 96 industry classes (the derivation of this grouping being explained in appendix A). Data on employment growth were available for the ASIC-based data from 1969-70 to 1991-92 and for ANZSIC-based data from 1990-91 to 1999-2000. The two data sets were combined into an overlapping data set, but with scope for there to be a difference in trend employment growth by including a dummy variable (ASIC), which is one for observations based on ASIC data and 0 otherwise.

The regression was estimated as:[1]

$$\Delta \log E_t = \alpha + \beta \, ASIC_t + \phi_1 \, POS_t + \phi_2 \, NEG_t$$

for each of the classes, where $POS_t = \Delta \log GDP_t$ if $\Delta \log GDP_t > 0$ and $NEG_t = \Delta \log GDP_t$ if $\Delta \log GDP_t <= 0$. GDP shocks were decomposed into negative and positive components since it is widely supposed that the effects on employment are different. A test of symmetric effects was undertaken.

The results (table F.1) suggest that some industry classes were very much more responsive than others to contemporaneous GDP shocks. In around two-thirds of cases, industries had greater sensitivity to contemporaneous negative shocks than positive ones and in around one-third of cases, the difference between negative and positive GDP shocks was statistically significant (at the five per cent level).

1 Data for the overlapping period were not eliminated. Rather, for the years 1990-91 and 1991-92, there are two lots of two observations, one based on $\Delta \log E$ from ASIC-based data and another based on $\Delta \log E$ from ANZSIC based data.

Table F.1 **Sensitivity of manufacturing industry employment to GDP shocks**[a]

1969-70 to 1999-2000

Industry description	*+S*	*t stat*	*-S*	*t stat*	*Sym*	R^2
Agricultural machinery	1.32	(1.26)	11.41	(7.40)	0.00	0.40
Transport equipment nec	2.13	(1.39)	10.18	(4.74)	0.01	0.12
Other non-metallic products	-0.25	(-0.24)	9.63	(13.86)	0.00	0.21
Hand tool & general hardware	0.93	(1.36)	9.56	(8.71)	0.00	0.30
Mining & construction machinery	-0.11	(-0.08)	9.26	(5.13)	0.00	0.14
Toys & sporting goods	0.96	(0.76)	7.90	(4.27)	0.02	0.19
Non-ferrous metal castings	0.85	(0.62)	7.70	(3.56)	0.05	0.10
Leather tanning & fur dressings	-1.71	(-2.18)	6.84	(4.82)	0.00	0.19
Basic iron & steel	0.20	(0.37)	6.50	(7.95)	0.00	0.38
Batteries	-1.26	(-1.45)	6.43	(5.23)	0.00	0.14
Non-ferrous metal rolling nec	3.35	(2.53)	6.40	(3.34)	0.33	0.40
Rubber tyre & rubber products nec	0.92	(1.31)	6.08	(5.66)	0.00	0.16
Commercial space heating & cooling equipment	0.05	(0.03)	5.42	(2.28)	0.16	0.03
Ceramic products nec	1.25	(1.83)	5.16	(5.02)	0.02	0.26
Boatbuilding	2.36	(1.68)	5.16	(2.92)	0.35	0.22
Leather & leather substitute products	0.51	(0.44)	5.12	(3.39)	0.07	0.07
Other industrial machinery	0.39	(0.88)	4.86	(8.25)	0.00	0.28
Lifting & material handling equipment	0.76	(0.85)	4.82	(4.81)	0.02	0.11
Household appliances	1.02	(2.19)	4.72	(8.18)	0.00	0.23
Plywood, veneers & fabricated woods	2.68	(2.79)	4.66	(3.35)	0.39	0.41
Non-ferrous pipe fitting	1.32	(1.47)	4.49	(3.54)	0.14	0.15
Wines & spirits	1.14	(3.14)	4.29	(8.52)	0.00	0.45
Ceramic tiles & pipes	0.66	(1.02)	4.15	(5.21)	0.01	0.13
Motor vehicle bodies	2.63	(3.40)	3.88	(3.65)	0.47	0.40
Architectural aluminium products	2.59	(3.99)	3.70	(3.88)	0.47	0.53
Ropes, cordage & twines	0.47	(0.22)	3.68	(1.13)	0.54	0.06
Metal containers	-1.25	(-0.97)	3.67	(2.08)	0.09	0.05
Clay bricks	1.67	(3.29)	3.59	(4.94)	0.11	0.44
Iron & steel casting & forging	1.13	(2.41)	3.53	(6.57)	0.01	0.24
Structural steel fabrication, prefab metal buildings & architectural metal products nec	1.95	(2.56)	3.19	(2.61)	0.51	0.27
Aluminium rolling, drawing, extruding	0.98	(2.01)	3.16	(3.56)	0.09	0.24
Wooden furniture & other furniture	1.96	(3.85)	3.06	(4.26)	0.36	0.54
Margarine & oils & fats nec	-0.42	(-0.52)	3.03	(2.76)	0.06	0.05
All other wood products	0.90	(1.87)	3.03	(5.35)	0.03	0.25
Paints	0.03	(0.06)	2.82	(4.87)	0.01	0.08
Photographic & optical goods	0.97	(1.16)	2.79	(2.13)	0.35	0.07
Pumps & compressors	2.07	(3.09)	2.79	(2.85)	0.64	0.31
Aircraft	0.17	(0.62)	2.78	(6.15)	0.00	0.27
Nuts, bolts, screws & rivets	1.18	(1.63)	2.70	(2.37)	0.39	0.18
Lights, signs & electrical equipment nec	0.58	(1.02)	2.69	(4.12)	0.07	0.14
Medicinal & pharmaceutical products	-0.42	(-0.67)	2.60	(3.09)	0.03	0.10

Table F.1 **Continued**

Industry description	*+S*	*t stat*	*-S*	*t stat*	*Sym*	R^2
Other textile products	1.31	(2.22)	2.51	(2.98)	0.38	0.25
Mattress	1.47	(0.80)	2.43	(1.09)	0.81	0.08
Steel pipe & tubing	0.50	(0.62)	2.42	(2.09)	0.29	0.09
Soft drinks, cordials & syrups	-0.85	(-1.10)	2.40	(2.31)	0.06	0.09
Food processing machinery	1.95	(1.79)	2.29	(1.46)	0.89	0.16
Prepared animal & bird feed	0.37	(0.80)	2.07	(3.76)	0.07	0.06
Miscellaneous metal products	1.18	(2.45)	2.00	(3.72)	0.38	0.25
Petroleum & coal products nec	1.48	(1.01)	1.97	(0.90)	0.89	0.16
Metal coating & finishing	1.59	(2.23)	1.94	(1.88)	0.84	0.18
Paper products nec	1.18	(2.52)	1.80	(2.20)	0.62	0.24
Confectionary	-0.11	(-0.25)	1.69	(2.96)	0.05	0.02
Petroleum refining	-0.83	(-1.46)	1.61	(1.90)	0.07	0.10
Plastic & related products	1.74	(4.34)	1.57	(2.32)	0.87	0.50
Medical, surgical, prof. & scientific eq.	2.38	(3.32)	1.46	(1.83)	0.53	0.40
Beers & malts	-0.03	(-0.03)	1.25	(1.06)	0.50	0.23
Glass & glass products	0.86	(1.63)	1.18	(1.57)	0.79	0.12
Cereal foods & baking mixes	-0.45	(-0.34)	1.11	(0.53)	0.64	0.01
Bread	0.08	(0.12)	1.02	(0.90)	0.59	0.06
Industrial gases & chemicals	1.28	(2.09)	1.00	(0.97)	0.86	0.14
Paper bags & paperboard	-0.08	(-0.15)	0.87	(1.30)	0.40	0.05
Cement & lime	0.97	(1.39)	0.49	(0.46)	0.78	0.11
Tobacco products	-0.87	(-1.42)	0.47	(0.59)	0.30	0.25
Basic non-ferrous metals	0.34	(0.79)	0.36	(0.52)	0.99	0.26
Electric cable & wire	0.49	(0.35)	0.35	(0.16)	0.97	0.03
Jewellery & silverware	1.22	(1.00)	0.30	(0.16)	0.77	0.05
Biscuits	1.53	(2.55)	0.28	(0.28)	0.43	0.20
Hosiery	2.67	(4.48)	0.24	(0.28)	0.08	0.33
Manufacturing nec	0.05	(0.06)	0.21	(0.20)	0.93	0.05
Milk products	0.26	(0.54)	0.15	(0.21)	0.92	0.09
Other chemical products	0.83	(1.11)	-0.06	(-0.05)	0.66	0.06
Footwear	2.23	(2.40)	-0.08	(-0.06)	0.32	0.25
Flour mill	-0.40	(-0.24)	-0.09	(-0.05)	0.93	0.01
Pulp, paper & paperboard	1.15	(1.53)	-0.10	(-0.09)	0.48	0.16
Motor vehicle parts & other	3.02	(6.43)	-0.21	(-0.34)	0.00	0.58
Other clothing & knitted goods	2.56	(4.10)	-0.22	(-0.23)	0.08	0.49
Chemical fertilisers	0.49	(0.33)	-0.30	(-0.13)	0.83	0.01
Poultry processing & bacon, ham & small good	0.52	(0.99)	-0.43	(-0.50)	0.47	0.05
Ink	0.68	(0.82)	-0.46	(-0.36)	0.58	0.02
Publishing & printing	0.81	(2.73)	-0.51	(-0.95)	0.10	0.17
Recorded media, electronic equipment nec, computers & business machines, telecommunications equipment	2.10	(2.39)	-0.55	(-0.43)	0.20	0.17
Synthetic resins & rubber	0.04	(0.08)	-0.60	(-0.81)	0.58	0.08
Textile fibres, yarns & woven fabric	1.72	(2.25)	-0.72	(-0.49)	0.27	0.21
Paper stationary	1.28	(2.03)	-0.74	(-0.92)	0.14	0.06

Table F.1 **Continued**

Industry description	*+S*	*t stat*	*-S*	*t stat*	*Sym*	R^2
Seafood processing	-0.37	(-0.39)	-0.87	(-0.58)	0.83	0.05
Ready-mix, pipes & box culverts, prods nec	1.19	(3.18)	-0.88	(-1.21)	0.05	0.19
Pesticides	0.28	(0.19)	-0.93	(-0.43)	0.72	0.01
Sugars & foods nec	0.60	(1.34)	-1.05	(-1.60)	0.12	0.05
Fruit & vegetable processing	1.94	(6.38)	-1.08	(-2.29)	0.00	0.40
Meat products	0.94	(1.06)	-1.39	(-1.15)	0.24	0.05
Cakes & pastries	1.52	(3.10)	-2.29	(-3.07)	0.00	0.20
Shipbuilding	0.96	(1.29)	-2.29	(-2.33)	0.04	0.16
Automotive electrical & instrument	5.99	(5.74)	-3.00	(-1.84)	0.00	0.54
Soaps, detergents, cosmetics & toiletries	1.00	(1.60)	-3.85	(-4.28)	0.00	0.13
Cardigans & pullovers	3.71	(2.15)	-7.51	(-2.86)	0.01	0.16
Railway equipment	5.31	(1.23)	-10.11	(-1.58)	0.14	0.10

a +S is the sensitivity of employment to positive GDP shocks while –S is the sensitivity to negative GDP shocks. Since a negative GDP shock was recorded as a negative number (rather than its absolute sign), the sign on –S is expected to be positive. T statistics for the sensitivity estimates are in parentheses and are corrected using White's heteroscedasticity adjustment to the covariance matrix. Sym is the significance level of a Chi Square test of the restriction that +S = -S, to see if apparent asymmetric effects are likely to be real.

Sources: ABS (*Manufacturing Establishments, Details of Operations by Industry Class, Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and the Industry Commission (1995) using the 96 industry concordance described in appendix A.

While few generalisations appear to be valid, industries with high sensitivity to positive GDP shocks tended to produce investment goods and consumer durables (with roughly twice the sensitivity of the average), while those with low sensitivity to positive shocks tended to produce food and beverages.[2] Food and beverages and other consumer non-durables also tended to have statistically weaker sensitivity to negative GDP shocks than other industry classes. In most cases, GDP fluctuations played a relatively minor role in yearly variations of industry employment (the average explanatory power being around 19 per cent).

2 To identify patterns of this kind, the industries were placed into several (sometimes non-exclusive) categories: investment-good producing industries, construction-related, other input related, consumer durables, food and non-food non-durable consumer goods. Then regressions of the 96 sensitivity coefficients were run against dummies for these categories (the data being used in the regressions are the outputs of other regressions).

G Determining productivity peaks

Short-term movements in productivity make it difficult to identify underlying trends in productivity. In order to make a meaningful comparison of productivity over time, it is necessary to remove these random and cyclical factors. The ABS recommends comparing average growth rates between productivity peaks.[1]

Peak years are defined as peak deviations of the multifactor productivity (MFP) index from its long run trend. The trend series is constructed using an 11 term Henderson moving average (with an IC ratio of 0.4). Deviations (D) are determined as the percentage difference between the original MFP index (MFPA) and the trend series (MFPT); that is:

$$D_t = (MFPA_t / MFPT_t - 1) \times 100 \qquad \{1\}$$

The peak years are determined by the local maxima of this series.

The ABS has estimated peak years for market sector MFP using this approach.[2] However, estimating productivity trends for manufacturing across market sector peak years may not adequately control for cyclical factors unique to manufacturing. For example, demand shocks do not affect all sectors with the same speed. To overcome this, the ABS used the Henderson smoothing algorithm to generate a D series {1} from manufacturing MFP estimates supplied by the Commission. The productivity peaks for manufacturing were then determined by the Commission using a decision rule that identified local maxima. The rule used in this report to identify the major peaks was:

$$PEAK_t = \text{IF}\,(D_t > \lambda) \text{ and } (D_{t+1} < D_t) \text{ and } (D_{t-1} < D_t) = 1 \qquad \{2\}$$

where λ is the key threshold value, set at 1.0 in this case (notably, the standard deviation of D_t was just above unity for manufacturing and around 1.3 for the market sector, so the choice of λ can be seen as roughly picking points that are at least one standard deviation above the actual MFP index). Smaller MFP peaks were identified for the purposes of calculating trends across some shorter periods (by using $\lambda = 0.66$). These decision rules, when applied to the market sector, produce

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1 Although others have argued for a different basis for determining starting and ending dates for trend analysis (Quiggin 2001).

2 *Australian System of National Accounts*, Cat. No. 5204.0, November 2002

results close to that found by the ABS, suggesting that they are likely to be apt for manufacturing. Using the decision rule with $\lambda = 0.66$ for the market sector picked up the same peaks identified by the ABS for this sector, while using $\lambda = 1.0$ for the market sector picked up every peak bar one identified by the ABS for this sector.

It is notable that while some peaks coincide for manufacturing and the market sector, there are five peaks in productivity in manufacturing that are not peaks for the market sector (1969-70, 1976-77, 1979-80, 1996-97 and 2001-02). This suggests the potential importance of estimating different peak-to-peak periods for different sectors.

That said, peaks in the market sector might still be appropriate if they better pick up pure demand effects — such as recessions. Indeed, percentage changes in MFP were much more closely correlated with contemporaneous changes in unemployment for the market sector than manufacturing.[3] However, percentage changes in MFP for the market sector and manufacturing had about the same correlation with another measure of aggregate demand change.[4] It was also found that *lagged* values of Δ (unemployment rate) were more correlated with MFP change for manufacturing than the market sector, suggesting that cyclical effects may just have different timing for different sectors. Overall, this suggests that peak-to-peak periods are probably best constructed on a sector by sector basis.

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3 The correlation coefficients were –0.05 for manufacturing and –0.32 for the market sector.

4 This was $\Delta\Delta$ ln(credit) where credit denotes the value of loans, advances and banks bills outstanding from all financial institutions.

H Budgetary assistance to industry

H.1 Commonwealth budgetary assistance

Besides border protection measures, the Federal Government also provides direct assistance to manufacturing, including: support for research and development (R&D) and export marketing; various tax concessions; assistance in the financing of projects; investment incentives for major projects and some sector specific support programs. Such measures are not necessarily reflective of a desire to protect local industry. For example, the R&D-related measures are designed to overcome sub-optimal under-investment in private R&D which results from lower private than social rates of return. Nevertheless, they shift resources between industries and activities. Understanding their magnitude and their targets can explain patterns in industry development. For example, as noted by the Productivity Commission (2003b), assistance to the pharmaceutical industry has had a major effect on its R&D and output levels.

In aggregate, the Trade & Assistance Review 2001-02 (TAR) (Productivity Commission 2002a) estimated total Commonwealth budgetary assistance to industry to be $3.9 billion in 2001-02, comprising a range of budgetary outlays and tax concessions. Following a steep rise up to 1994-95, nominal assistance levels fell again before rising slowly (figure H.1). However, there was no strong trend overall. In real terms, Commonwealth budgetary assistance has remained relatively unchanged since 1991-92.

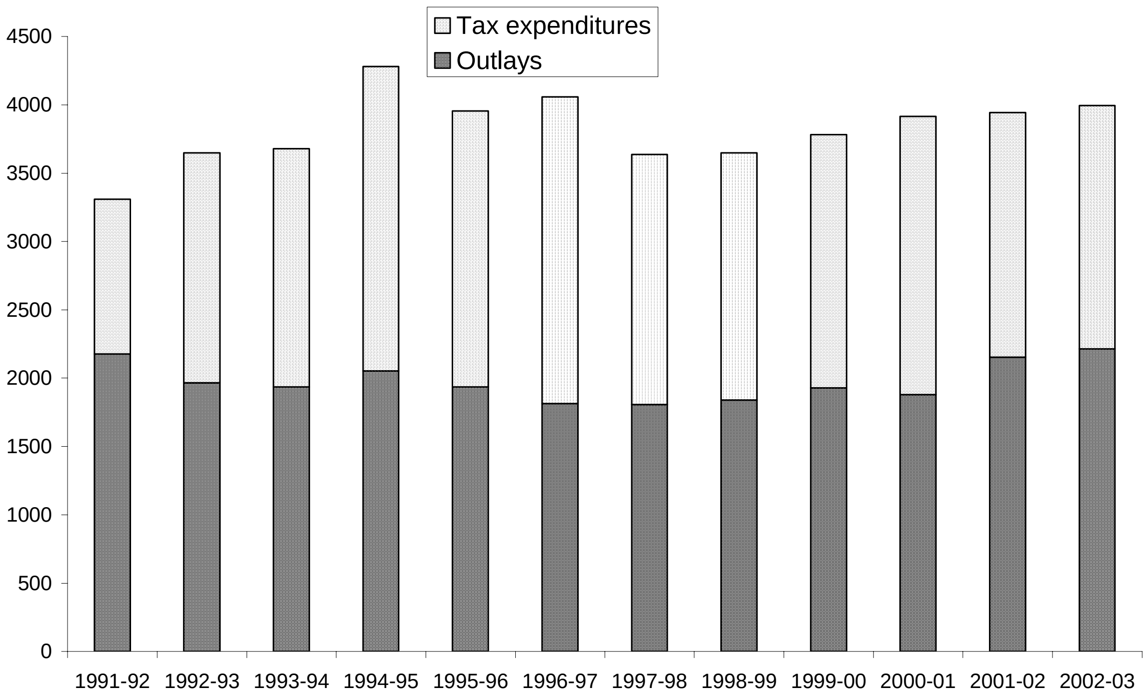
Tax concessions comprised a variety of programs. In 2001-02, the bulk of concessions were administered through the Automotive Competitiveness Investment Scheme (31 per cent of total tax concessions), the R&D tax concession (23 per cent), the Development allowance (11 per cent) and TRADEX (9 per cent).

Budgetary outlays can be divided into two broad categories. Those that fund government institutions for their industry related activities and those that directly fund industry.

Just over half (52 per cent) of the budgetary outlays in 2001-02 took the form of funding to government institutions. For example, CSIRO received about 17 per cent of total Commonwealth budgetary outlays, Austrade 8 per cent and the Australian Tourist Commission 5 per cent.

Figure H.1 **Commonwealth budgetary assistance to industry, 1991-92 to 2002-03[a]**

$ million



a Budgetary assistance for 2002-03 is a projection.

Source: PC 2002a.

The other half (48 per cent) of budgetary outlays went in the form of direct financial assistance. For example, R&D Start accounted for 11 per cent and the TCF Strategic Investment Program for 7 per cent of total budgetary outlays.

The TAR also classified Commonwealth budgetary assistance according to the activity that the measures are designed to assist. The main target activities were identified as: R&D (37 per cent), other industry specific assistance (27 per cent), exports (17 per cent), investment (9 per cent), sectoral assistance (6 per cent) and general assistance (4 per cent).

The TAR estimated that nearly half of the budgetary assistance (tax concessions and budgetary outlays combined) disbursed in 2001-02 went to the manufacturing industry (table H.1).

Table H.1 **Budgetary assistance by industry grouping, 2001-02**

Industry grouping	*Budgetary outlays*	*Tax concessions*	*Total*	*Share of total*	*Share of manufactuting*	*Share of turnover*[a]
	$ m	$ m	$ m	%	%	%
Primary production	529	133	663	16.8	..	..
Mining	76	136	212	5.4	..	..
Services	525	369	893	22.6	..	..
Manufacturing	764	1099	1863	47.2	100	0.8
Food, beverages and tobacco	55	27	82		4.4	0.1
Textiles, clothing, footwear and leather	189	27	216		11.6	2.4
Wood and paper products	32	8	40		2.1	0.3
Printing, publishing and recorded media	22	2	24		1.3	0.1
Petroleum, coal, chemicals etc.	158	28	185		9.9	0.5
Non-metallic mineral products	12	8	19		1.0	0.2
Metal product manufacturing	48	73	121		6.5	0.3
Motor vehicles and parts	19	689	707		38.0	4.1
Other transport equipment	28	76	105		5.6	2.1
Other machinery and equipment	126	51	178		9.5	0.8
Other manufacturing	28	24	52		2.8	0.8
Unallocated manufacturing[b]	46	88	134		7.2	n.a.
TOTAL	**2155**	**1790**	**3944**	**100**		

[a] Turnover figures used are for the year 1999-2000 (unpublished ABS data). [b] Includes general programs where details of claimants and/or beneficiaries are unknown.

Source: PC 2002a.

Motor vehicle and parts and TCF accounted for about half (49 per cent) of the budgetary assistance received by the manufacturing industry. This represented around two to four per cent of turnover for these industries.

Commonwealth budgetary assistance to manufacturing did not exhibit any strong trend over the period beginning 1995-96 (table H.2).[1]

H.2 Other assistance

State and Territory governments also provide considerable assistance to firms and industries in the form of grants and loans, tax concessions, various subsidies and industry adjustment programs. Local firms may also benefit from subsidised infrastructure or services provided by State, Territory and Local Governments.

[1] The Commission (PC 2002a) estimated that manufacturing accounted for about 47 per cent of Commonwealth budgetary assistance to industry. However, these latest estimates are not directly comparable with earlier ones due to a change in methodology.

Table H.2 **Commonwealth budgetary assistance, 1995-96 to 2001-02[a]**

$ million, current prices

Year	Commonwealth budgetary assistance to manufacturing	Total Commonwealth budgetary assistance	Share of manufacturing in total assistance
	$m	$m	%
1995-96	1680	3689	46
1996-97	1639	3808	43
1997-98	1442	3365	43
1998-99	1495	3442	43
1999-00	1502	3539	42
2000-01	1552	3700	42
2001-02	1701	3856	44

a Due to data revisions, the estimates vary somewhat across publication years and are not fully comparable. However, these variations were small enough not to be of much concern. The estimates reported here are averages across the values reported in the various issues of the TAR (1997-98 to 2001-02).

Sources: PC 1998b, PC 1999b, PC 2000a and PC 2001a.

State and Territory budgetary outlays on industry assistance to manufacturing were estimated at approximately $1 billion in 1994-95 (Industry Commission 1996a). In an updated estimate, the TAR (PC 2002a) found State and Territory Government outlays to manufacturing to be much smaller (table H.3), even when the fraction (between half and three-quarters) of unallocated government outlays that is estimated to go to manufacturing is included in manufacturing outlays. Part of the reason for the discrepancy is that the Industry Commission (1996a) estimate included the provision of land, electricity, access roads, water and sewerage at below market prices, whereas the TAR (PC 2002a) estimate excluded such forms of assistance.

Table H.3 **State and Territory budgetary outlays, 2000-01 and 2001-02**

$ million, current prices

Industry sector	*2000-01*	*2001-02*
Primary production	918	971
Mining	121	136
Services	1 360	1 438
Manufacturing[a]	58	93
Unallocated[a]	529	673

a The unallocated category includes programs with limited information about the beneficiaries of assistance. However, the TAR (PC 2002a) deems it likely that they predominantly assist businesses and industries in the manufacturing sector. Thus, the TAR estimates that between half and three-quarters of the unallocated category are likely to assist manufacturers, raising the estimated assistance to Manufacturing for 2000-01 to between $320 million and $450 million and the estimate for 2001-02 to between $430 million and $600 million.

Source: PC 2002a.

In addition, TAR (PC 2002a) estimated the payroll revenue forgone by State and Territory governments for industry assistance purposes to have been approximately $5 billion in 2001-02.[2] This represents a nominal increase of more than 60 per cent over the IC (1996a) estimate of State and Territory tax exemptions and concessions for 1993-94. Both publications stressed the approximate nature of their estimates and, due to data limitations, neither provided an industry sector breakdown.

Based on survey results, the Industry Commission (IC 1996a) also provided a rough estimate of local government assistance to industry in general. It was estimated that local governments provided $220 million of financial assistance (direct or revenue forgone) to businesses in 1994-95.

Further, some indirect government assistance to the manufacturing sector is provided through rules and regulations and is not accounted for in the various estimates in this section. For example, governments at all levels have procurement preferences, both in civilian and defence procurements. Procurement preferences either give preference to local suppliers, or they impose certain local industry development obligations on foreign suppliers. It is difficult to estimate the value of support provided through these channels.

In recent years, the largest civilian procurement program has been the Partnership for Development Program, which encouraged transnational corporations in the telecommunications equipment and information technology industries to site production activities in Australia. A BIE (1994) evaluation of the program estimated the cost of the scheme (in terms of higher prices) at around $26 million.

Other procurement preferences can have a strong influence on the economic development of manufacturing sectors where the agencies purchase a significant share of the market. For example, defence procurement preferences have an impact on the development of shipbuilding, aircraft components and electronics. The domestic medical and scientific instruments industry has also benefited from government procurement preferences in the past, as have locally made passenger cars.

[2] To obtain this figure, the TAR compared the actual amount of payroll tax collected by States and Territories from the relevant industries with the revenue that they could have raised without the exemptions and concessions.

I Modelling productivity

This appendix presents two suites of modelling results based on different data sets, discusses the role of data errors in estimating productivity growth and provides some aggregate data.

The first (section I.1) is based on labour productivity estimates derived from manufacturing data at the three and four digit ANZSIC level over the period from 1989-90 to 1999-2000. The models based on three digit data are more sophisticated because data on hours allow the computation of an hours-adjusted labour productivity measure, and because there are data on trade and research and development (R&D) measures at this level that were not available at the four digit level.

The second (section I.2) applies varying econometric tools to the analysis of a long time series of productivity for aggregate manufacturing up to 2001-02.

Finally, possible errors in the data (section I.3) and the key aggregate data (section I.4) are presented.

I.1 Modelling industry-specific labour productivity differences

The main aim of this modelling was to discover industry characteristics that were associated with low or high labour productivity changes over the 1990s between industry classes within manufacturing (chapter 7). It should be emphasised that the modelling was largely descriptive in purpose — aiming to summarise certain stylised facts about the *nature* of industries experiencing different productivity changes over this period. It should not be assumed that any associations are necessarily causal. In particular, the analysis is not a growth accounting one, in which the changes in various inputs and their combinations explain output (this is done at a more aggregate level in section I.2). In that context, an obvious drawback in the analysis is the absence of capital data. Chapter 7 established that a major source of productivity gain is capital intensity. Some of the parameters in the modelling that follows may be picking up the unobserved correlation between an industry characteristic and changes in capital intensity.

In most cases, the modelling considered whether various industry characteristics at the start of the data series were significant in explaining subsequent labour productivity growth.[1] However, in the case of R&D intensity, consistent data were only available on a three digit ANZSIC basis from 1992-93. Given the variability of R&D from year to year, the R&D intensity of an industry was measured as the average intensity from 1992-93 to 1996-97.[2]

A range of variables were considered in the analysis:

- the wage share of value added in 1989-90, which will be a proxy for the labour intensity of an industry. Highly labour intensive industries producing tradeable manufactures have come increasingly under pressure from imported goods from developing countries. Such pressure might have prompted increased capital investment or managerial efforts to improve productivity;
- the materials share of turnover in 1989-90, which is a measure of the degree of transformation undertaken by an industry (it is one minus the value added share of turnover). It is sometimes claimed that high value added industries (or lower materials share industries) have greater potential for performance. The inclusion of this variable allows assessment of whether this is true. It is conceivable, for example, that technological change that more efficiently manages large throughput of materials in production processes is complementary to labour productivity gains;
- the R&D intensity of an industry, which is an (imperfect) proxy for the extent to which new knowledge generation is important to output or processes. The 1990s was a period of rapid diffusion of information and communication technologies (Parham, Roberts and Sun 2001). These might be especially complementary to industries in which knowledge generation is an important function (such as Electronic and communication equipment industries and Pharmaceuticals). Alternatively, the variable may pick up those industries where output quality has risen most from technical change, this being reflected in declining price indexes used to construct real value added;[3]

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1 This avoids potential endogeneity bias.

2 In some industries where R&D amounts were small, the ABS did not publish R&D data for each year. In that case, the intensity was estimated as $A/B*I_B$ where A is the average R&D intensity for *any* years where data were available from 1992-93 to 1999-2000 for the industry with incomplete data, B is the corresponding average intensity for the nearest ANZSIC class where data were complete) over the *same* years available for A, and I_B is the R&D intensity for 1992-93 to 1996-97 for the industry associated with B.

3 R&D intensities tend to pick up the nature of the outputs, not the nature of the inputs. Higher R&D is associated with high technology output industries where quality adjustment of outputs is

- dummy variables that distinguished high, medium and low technology industries (defined in chapter 1). These (and other similar dummy variables that rated industries by whether they were high, medium or low R&D intensity) were used for four digit data where discrete measures of R&D intensity were not available;
- the degree of import penetration and export propensity in 1989-90, which proxies trade exposure of industries. Levels of (and changes in) trade exposure might be linked to productivity growth in several ways. For example, industries with greater trade exposure have greater incentives and means for acquiring and using new knowledge, with benefits for labour productivity growth; and
- the educational composition of the workforce. Data were available at the 3 digit level for 1994. Three educational categories were considered: the share of employees with no post-school qualifications, the share of employees with university education and the remainder. In level form, the educational composition of the workforce may not have a direct effect on labour productivity *change*, but like a high R&D intensity, greater educational capabilities of a workforce may make it more receptive to new technologies and knowledge.[4]

most likely (this is separate from the issue of quality adjustment of capital inputs discussed in chapter 7, which is not specific to high technology industries).

4 Recent evidence has found that changes in skill levels have not had large effects on productivity in recent times. Barnes and Kennard (2002) incorporated changing skill levels into labour inputs for the Australian market sector (not manufacturing). They estimated that, between 1988-89 and 1993-94, growth in skills contributed 0.2 of a percentage point to the 0.7 per cent a year growth in multifactor productivity in the market sector. But the growth in skills contributed only around 0.05 of a percentage point to the 1.7 per cent a year growth in multifactor productivity from 1993-94 to 1997-98.

Table I.1 **Bivariate regression results of labour productivity growth against various indicator variables**[a]

Variable	*3 digit ANZSIC data*			*4 digit ANZSIC data*		
	Coeff.	t stat	ρ	Coeff.	t stat	ρ
Materials share	0.127	2.7	0.38	0.137	4.4	0.34
R&D Intensity	0.301	4.0	0.52	..	..	..
Post-school but not university	-0.000	0.0	-0.00	..	..	..
University	0.106	2.1	0.30	..	..	..
No post school qualifications	-0.015	0.7	-0.11	..	..	..
Wages share	0.038	1.4	0.21	0.037	2.2	0.18
Import penetration	0.014	0.7	0.10	..	..	..
Export propensity	0.023	1.1	0.16	..	..	..
High technology	..	..	..	6.65	5.8	0.43
High R&D intensity	..	..	..	6.32	5.9	0.44

a High R&D and high technology industries are the same with the exception of the Aircraft industry, which is rated high technology, but not in the highest R&D intensity category. ρ is the correlation coefficient.

Simple regressions of labour productivity growth against each of the above variables singly (table I.1) suggested the potential importance of the materials share, R&D intensity (or the technology status of an industry), the share of the workforce with university qualifications and the wages share. Of course, other variables may be significant in a multivariate context.

A more complex model was then constructed from the variables in table I.1 (avoiding collinear combinations) for the two data sets, and then simplified after tests of significance. The final models were:

3 digit ANZSIC:

$$\Delta \ln(\text{labour productivity}) = \underset{(2.4)}{-6.37} + \underset{(2.8)}{0.111}\ \text{Material\_share} + \underset{(3.6)}{0.257}\ \text{R\&D\_intensity} + \underset{(1.5)}{0.064}\ \text{University}$$

$R^2 = 0.41$, N = 46

4 digit ANZSIC:

$$\Delta \ln(\text{labour productivity}) = \underset{(4.1)}{-8.46} + \underset{(5.2)}{0.144}\ \text{Material\_share} + \underset{(1.3)}{0.019}\ \text{Wage\_share} + \underset{(5.9)}{6.06}\ \text{High\_tech}$$

$R^2 = 0.32$, N = 153

The models suggest that industries with higher labour shares of value added in 1988-89 (which, for given wages, implies higher labour intensity) tended to experience faster subsequent productivity growth — though the statistical significance of the result varied among different model specifications. For every 10 percentage points of additional labour share, labour productivity growth from 1989-90 to 1999-2000 was around 0.19 percentage points greater — a small effect.

Industries with higher material inputs to turnover in 1988-89 also experienced faster subsequent productivity growth. For every 10 percentage points of additional materials share in turnover, labour productivity growth from 1989-90 to 1999-2000 was around 1.1 to 1.4 percentage points greater, which is a significant effect. This is why labour productivity growth was higher among simply transformed manufactures (which have a higher materials to turnover ratio). As noted above, it is possible that such industries are more amenable to automation and improved handling of large throughput of materials, which would tend to also elevate value added per employee. A better data set — preferably at the firm level — might be able to corroborate this effect.

While strong initial trade exposure might spur labour productivity, either through the effects of competition or through learning in new markets, trade orientation, measured by export propensity or import penetration in 1989-90 (or their change over time in some other unreported models) had no statistically significant impacts on labour productivity growth. This may reflect the fact that, by 1989-90, the Australian economy was already relatively open, so that the biggest trade-mediated effects on productivity may have already been achieved in previous years.

The most statistically robust result of the modelling was that industries that were categorised as having high R&D intensities or characterised as 'high technology' had labour productivity growth rates that were significantly higher than other firms (for a given material and wage share). This result was the most statistically robust of the findings. In the case of three digit data, where a measure of average R&D intensity was available, the effect was an additional 0.26 percentage points of productivity growth for every percentage point of greater R&D intensity. Thus, an industry with an R&D intensity of 10 per cent was (all other things being equal) found to have a productivity growth rate about 2.5 percentage points higher than an industry that undertook zero R&D. In the case of the four digit data, industries identified as being either high technology (defined in chapter 1 — and closely associated with R&D intensities) or high R&D intensity were found to, on average, have a labour productivity growth rate of over six percentage points above the mean.

It should be emphasised that *changes* in R&D intensity between 1992-93 and 1999-2000 (or similar periods around these dates that may capture lags in responses from R&D to output) were not significant in explaining labour productivity growth. A similar result was found by Revesz and Lattimore (2001, pp. 58-59) using firm-level data from the Business Longitudinal Survey. This suggests that the R&D

result above may not be causal, but rather, is picking up some common feature of high technology industries.

One contender is the price deflator for output. Industries with high R&D intensities tend to be subject to rapid technological change (both as a result of that R&D, but in Australia particularly from knowledge flows from abroad). The ABS often adjusts the price indexes for such high technology industries for the improved quality of their outputs using various approaches (such as hedonic regressions). The association between (initial) R&D intensity and labour productivity may reflect the fact that quality adjustment of output prices is most likely for industries producing sophisticated goods where R&D payoffs are greater. There is a (highly statistically significant) negative correlation between average R&D intensities and price trends from 1989-90 to 1999-2000. However, when the residual from a regression of average R&D intensity on price growth was used in a regression of labour productivity instead of the raw intensity, a similar significance and coefficient was found. This suggests that price effects are not the source of the R&D effect on labour productivity outcomes.

The other major possible interpretation of the results is that high technology industries may particularly have increased their intensity of use of information technologies. The use of such technologies has been an important source of productivity growth (Parham, Roberts and Sun 2001). Average R&D intensities in manufacturing may proxy their uptake. This would also be consistent with the finding that greater shares of university-trained employees in an industry is associated with increased productivity growth.

I.2 A time-series model of productivity in Australian manufacturing

Explicit modelling of the behaviour of manufacturing productivity over time provides useful insights about the major contributors to labour productivity improvement. Modelling also enables assessment of whether productivity growth has been higher or lower over some periods in an economic and statistically significant way. Otherwise, high (or low) productivity growth rates shown up by simple analysis of MFP trends for some periods may actually be a product of noisy data, signifying little. Moreover, econometric models do not embrace as strong a set of assumptions about weights for combining capital and labour productivity as the standard non-parametric growth accounting approach.

The model developed in this section builds on previous studies (Lattimore 1990 and Dowrick 1990) which sought to put the large number of explanations for manufacturing productivity into a systematic framework.[5] However, there are potential problems with the framework — particularly its handling of cyclical factors and the long-term — which new approaches (for example, Dowrick 1998) have sought to remedy.

Dowrick (1998) and Lowe (1997) estimated an Error Correction Model (ECM) to deal with the potentially spurious regression results in Dowrick (1990). Although Dowrick only estimated the model for the market sector, Karunaratne (2001) estimated a similar ECM for Australian manufacturing, using data from Gretton and Fisher (1997). This section applies the ECM specification to aggregate manufacturing data using a longer and revised set of data. The model can then be used to examine the contribution of the capital-labour ratio, cyclical factors and MFP to growth of labour productivity in manufacturing.

The ECM has two parts, combined in one model:

$$\Delta y_t = a + \gamma \Delta k_t - \xi y_{t-1} + \xi\, [\alpha k_{t-1} + \eta_1 T1_{t-1} + \eta_2 T2_{t-1} + \ldots + \eta_N TN_{t-1}] + \varepsilon_t \qquad \{1\}$$

where y is log labour productivity, a is a constant and k is the log capital-labour ratio. The model allows for shifting trends in productivity over time (due to shifts in exogenous technical progress or efficiency gains as a result of reform). This was tested by including different trends corresponding to the major peaks identified by the ABS in their trend-cycle analysis. These are the time trends T1 to TN. For manufacturing, the initial specification included six trends corresponding to the major peaks (T1954, T1964, T1973, T1984, T1993 and T1996).[6] In the case of the market sector, four peaks were included (T1964, T1984, T1988 and T1998). Statistical testing reduced the number of trend periods. These trend terms can be interpreted as trend MFP independent of cyclical factors.

The (once-lagged) predicted *long-run* level of labour productivity (LR) is represented by the terms LR = $[\alpha k_{t-1} + \eta_1 T1_{t-1} + \eta_2 T2_{t-1} + \ldots + \eta_N TN_{t-1}]$. The ECM is therefore $ECM_{t-1} = y_{t-1} - LR_{t-1}$ so that the full model can be reformulated as:

$$\Delta y_t = a + \gamma \Delta k_t - \xi\, ECM_{t-1} + \varepsilon_t \qquad \{2\}$$

[5] This was based on a Cobb-Douglas model that decomposed labour productivity into contributions from the capital/labour ratio, cyclical factors and trend MFP.

[6] For example, T1954 is a simple trend variable starting in 1954-55 with the value one and adding one for each subsequent year. T1964 has the value of zero until 1964-65, when it takes the value of one and then also accumulates by one each year. The other trend variables adopt a similar form.

The model is an ECM because if labour productivity moves above (below) the level predicted by the capital-labour ratio and yearly changes in technical progress, then in subsequent periods it falls (rises) to restore long-run equilibrium.

The term Δk is the cyclical variable, picking up changes in the capital-labour ratio resulting from the economic cycle. It is notable that for both manufacturing and the market sector, Δk is strongly correlated with changes in the unemployment rate — a common measure of the business cycle.[7] So the LR terms represent the long run, while growth in the capital-labour ratio and feedback from deviations from the long run model (the ECM) drive short run changes.

While the long run component can be separately estimated in level form and then the residual included in the differenced equation, this two-step ECM has some drawbacks, hence the use of a one-step procedure. (The long-run was also separately estimated for comparative purposes, and the results are shown in table I.2.)

In Dowrick's specification, additional terms representing the change in the trends were also included in {1}.[8] In difference form, these variables act as dummy variables — shifting the constant up or down. Since the dependent variable is Δy, this implies shifts up or down in productivity growth. However, such long run shifts are already captured by the ECM, making interpretation of these dummies unclear. They have been omitted from this specification. (In any case, when they were included we found them to be jointly and individually insignificant.)

The model is estimated using unpublished ABS (and spliced BIE) data for total manufacturing for the period 1954-55 to 2001-02.[9] The results are reported below, along with updated estimates for the market sector (for the period 1964-65 to 2001-02), which are included for comparison.

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[7] The correlations are 0.60 and 0.71 for manufacturing and the market sector respectively.

[8] That is, variables of the form: $\theta_1 \Delta T1_t + \theta_2 \Delta T2_t + \quad + \theta_N \Delta TN_t$.

[9] The data are from the same source as figure 7.1.

Table I.2 **Error Correction Model**

Manufacturing and the market sector[a]

Explanators	*Market sector*		*Manufacturing*	
	ECM	Simple long run	ECM	Simple long run
y_{-1}	-0.822 (5.9)	..	-0.694 (5.6)	..
k_{-1}	0.328 (3.2)	0.469 (4.1)	0.251 (4.0)	0.240 (5.0)
$T54_{-1}$	..	..	0.0208 (3.4)	0.0381 (13.4)
$T64_{-1}$	0.0170 (3.5)	0.0183 (3.3)	-0.0094 (3.7)	-0.0165 (11.3)
$T74_{-1}$	-0.0139 (5.6)	-0.0157 (5.1)	..	..
$T88_{-1}$	0.0076 (4.9)	0.0072 (5.6)	..	..
Δk	0.178 (0.8)	..	0.152 (2.2)	..
constant	-0.320 (2.5)	-0.334 (2.3)	-0.592 (3.0)	-1.166 (11.6)
N	37	38	47	48
DW	..	1.45	..	1.09
$RBar^2$	0.49	0.994	0.48	0.999
Normality	OK	..	OK	..
RESET tests	OK	..	OK	..
Het tests	OK	..	OK	..
Serial Corr. tests	OK	..	OK	..
Stability tests	OK	..	OK	..

a The simple long run results use contemporaneous trends, not lagged ones and use y_t as the dependent variable. t statistics are in parentheses. Normality was tested using the Jarque-Bera test. RESET2 and RESET3 specification tests (RESET), a suite of heteroscedasticity tests (HET), LM tests for serial correlation up to five lags and a suite of stability tests (Hansen stability tests, one step residuals; and one step, breakpoint and forecast Chow tests) were conducted. Since the long run form is misspecified (if the ECM is the 'correct' form of the model), no diagnostics are reported, except for the Durbin-Watson test, which will tend to reveal spurious regression if it is very low.

Interpreting the results

The long run model embedded in the ECM model for manufacturing is:

$$y_t = constant + 0.362\ k_t + 0.03\ T54_t - 0.0135\ T64_t \qquad \{3\}$$

The coefficient on the capital-labour ratio in the long run model should approximate the average capital share in manufacturing income over the time period. While data on this share are not available for the full period, the capital share was 0.35 between 1974-75 and 2001-02, which is very close to the estimated coefficient. The model suggests that, from 1964-65, manufacturing MFP was growing by a constant 1.65 per cent per annum, down from the high growth period in the 1950s. While the growth rate fluctuates from year to year, no systematic shifts in trend growth are apparent after the mid-1960s. In particular, there was no post-oil shock decline in manufacturing productivity[10] and no apparent resurgence in the early 1990s. This is

10 In line with past findings presented in Lattimore 1990 and Dowrick 1990.

unlike the market sector, in which there are two apparent shifts in productivity trends after the mid 1960s: a trend growth of 2.1 per cent from 1964-65 to 1974-75; then only 0.4 per cent per annum from 1974-75 to 1988-89; and 1.3 per cent per annum from 1988-89 to 2001-02.

While most of the differences between labour productivity growth in manufacturing and the market sector can be attributed to differences in MFP growth, some can also be attributed to different rates of capital deepening. The capital-labour ratio in manufacturing grew by a trend rate of 4.1 per cent from 1964-65 to 2001-02, whilst it grew by only 3.2 per cent in the market sector. To assess the extent to which the greater capital deepening in manufacturing explains the difference between market sector and manufacturing labour productivity, a counter factual scenario was conducted using the ECM. Forecast labour productivity levels associated with the observed manufacturing capital-labour ratio increased by a trend rate of 3.1 per cent per annum from 1964-65 to 2001-02. Had the manufacturing capital-labour ratio only increased at the market sector rate, the trend would have been 2.8 per cent per annum. Thus, 0.4 percentage points of the difference between the trend rates of labour productivity in manufacturing and the market sector can be attributed to differences in capital deepening.[11]

An interesting question is whether there may be different productivity outcomes associated with changing compositions of the capital stock. The ABS now breaks capital into a variety of components — buildings and structures; equipment; software and various other categories (eg livestock, artistic output). Preliminary empirical investigation did not reveal statistically significant differences in the impacts on labour productivity of these different capital sub-components.[12]

Structural time series approaches

One possible drawback with the use of Dowrick’s (1998) approach, and its implementation above, is that it assumes that there are distinct structural breaks in productivity growth and that the breaks are identified after inspecting the data. Some data series — such as a random walk with drift — will appear to have variable trends, when none are actually present. Good model fit achieved by

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[11] The trend rate of labour productivity over the relevant period for the market sector was 2.2 per cent.

[12] In testing these issues, it should be noted that $\alpha \log(K1/L) + \beta \log(K2/L) + \phi \log(K3/L) = (\alpha+\beta+\phi) \log(\Sigma K/L) + \alpha \log(K1/K) + \beta \log(K2/K) + \phi \log(K3/K)$. Each single capital share is not so likely to be correlated with $\log(\Sigma K/L)$, unlike the individual capital-labour ratios. However, in an estimated model, clearly one share must be left out to avoid collinearity. Taking this approach, a variety of models were tested for the market sector and manufacturing — using the ECM approach and various structural time series models along the lines of Harvey (1991).

including deterministic trends for any apparent shifts in growth patterns may be quite illusory, and the forecasting potential of the models may be quite poor.

Moreover, to the extent that the shifting productivity trends reflect economic factors, such as microeconomic reform or new technologies, they are often likely to change gradually, rather than rapidly (the oil shock might be an exception for the market sector). In this case, productivity trends or levels may slowly evolve over time.

There are several possible approaches in response to these limitations:

- First, where distinct structural breaks are suspected, the t statistics used to detect structural breaks can be modified to take account of pre-testing (ie a larger t is required to reject the null of no break).
- Second, where productivity is a stochastic trend, structural time series modelling can be applied (Harvey 1991). It is then also possible to test whether trends would best be represented as deterministic (with structural breaks) or as stochastic.

The second approach — based on a local linear trend model — was adopted in this report. Ignoring capital-intensity, a univariate representation of the local linear trend is:

$$y_t = \mu_t + \varepsilon_t$$
$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t$$
$$\beta_t = \beta_{t-1} + \xi_t$$

η_t allows the level of the trend to shift up or down over time, while ξ_t allows the slope to shift. The larger are the variances of η_t and ξ_t, the greater are the stochastic components of shifting productivity. If, on the other hand, $\sigma_\eta^2 = \sigma_\xi^2 = 0$, then the model collapses to a deterministic trend, which, other than allowing for several deterministic trends, is the form of equation {1}. The results are in table I.3.

Table I.3 **Structural time series model of labour productivity growth[a]**
Manufacturing and the market sector

	Market sector	*Manufacturing*
Explanatory variables' coefficients		
y_{-1}	-0.953 (6.1)	-0.772 (5.0)
k_{-1}	0.313 (1.9)	0.293 (3.5)
Δk	0.161 (0.9)	0.151 (1.9)
Coefficients of the final state vector		
Level	0.036 (2.8)	0.044 (4.9)
Slope	0.0131 (1.6)	0.0131 (2.1)
Estimated variances		
σ_{ε}^{2} (irregular component)	2.15 E-4	1.12 E-04
σ_{η}^{2} (level component)	1.44 E-5	8.07 E-05
σ_{ξ}^{2} (slope component)	1.076 E-5	8.15 E-07
Diagnostics		
R_D^2	0.66	0.60
Normality	OK	OK
Serial correlation	OK	OK

a The time periods for estimation are as in the previous table. Diagnostics and derivation of the reported statistics are described in Harvey (1991) and from the STAMP package (Koopman et al. 2000).

As in the case of the previous model, the structural time series model can be represented as an ECM.

$$\Delta y_t = 0.151\ \Delta k_t - 0.772\ (y_{t-1} - \text{stochastic\_trend}_{t-1} - 0.379\ k_{t-1}) \qquad \{4\}$$

so that the long run is: $y_t = \text{stochastic\_trend}_t + 0.379\ k_t$, which reveals a similar relationship to capital deepening as the non-stochastic model.

The distinctive feature of this model is its stochastic trend. Changes in the trend represent the growth rate of productivity, which can be decomposed into shifts in the level and the slope (figure I.1). In the case of manufacturing, most shifts are in the level, rather than the slope.[13] The model implies that productivity growth has been highly erratic, but that it declined in the mid 1960s, with a slight upturn in the late 1990s.

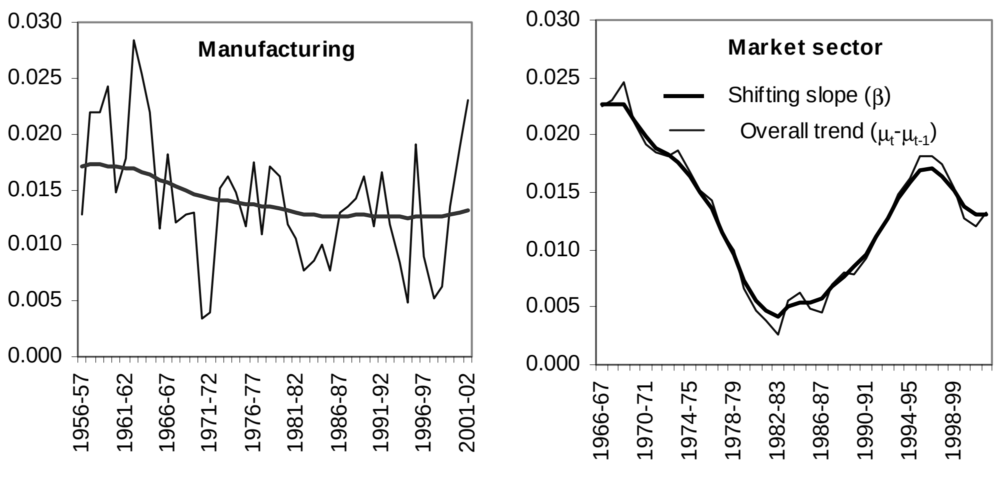
In contrast, the market sector model shows very distinct changing trends in productivity growth rates, with strong upward growth in the 1990s from its nadir in the mid-1980s. A structural time series model makes no assumptions about the

13 This is also revealed by the relative variances of the slope and level error terms, with the slope variance around 1/100th of the level variance. Indeed, probably a superior specification is to set a fixed slope and just have a stochastic level.

selection of starting points for trend analysis (as does the OLS model) and is not therefore subject to the critique that the selection of starting points is central to the productivity growth findings (Quiggin 2001). The results therefore reinforce the view that MFP accelerated in the 1990s for the market sector.

While the model diagnostics (table I.3) are generally acceptable for both sectors, in the case of manufacturing, analysis of the auxiliary residuals[14] suggests a possible structural break around 1964-65. The shift in the slope was sufficiently large that it might be better modelled by including an 'intervention' variable — in this case a slope shift. When such a variable is included in the model, the estimated variance of the slope and level error terms becomes zero, and the model reverts to {3}. Thus, for manufacturing, the ECM based on two deterministic trends appears to be a reasonable summary of productivity trends.

Figure I.1 **Stochastic trends in manufacturing and the market sector labour productivity growth, 1956-57 to 2001-02**



Disaggregated MFP modelling

The updated Gretton and Fisher (1997) database was used to model the nature of productivity trends for eight groups of manufacturing industries. The database, while encompassing a different period and based on different underlying data than that used in table I.3, also suggested that there was no stochastic slope in aggregate manufacturing MFP (table I.4). However, there was evidence of shifting slopes for several industry groups, such as Textiles, clothing and footwear, Printing,

[14] The standardised smoothing errors are the test statistics used for identifying outliers and structural breaks in levels and slopes. They are an optional diagnostic in STAMP (Koopman et al. 2000).

publishing and recorded media, Petroleum and coal products and Transport equipment (figure I.2).

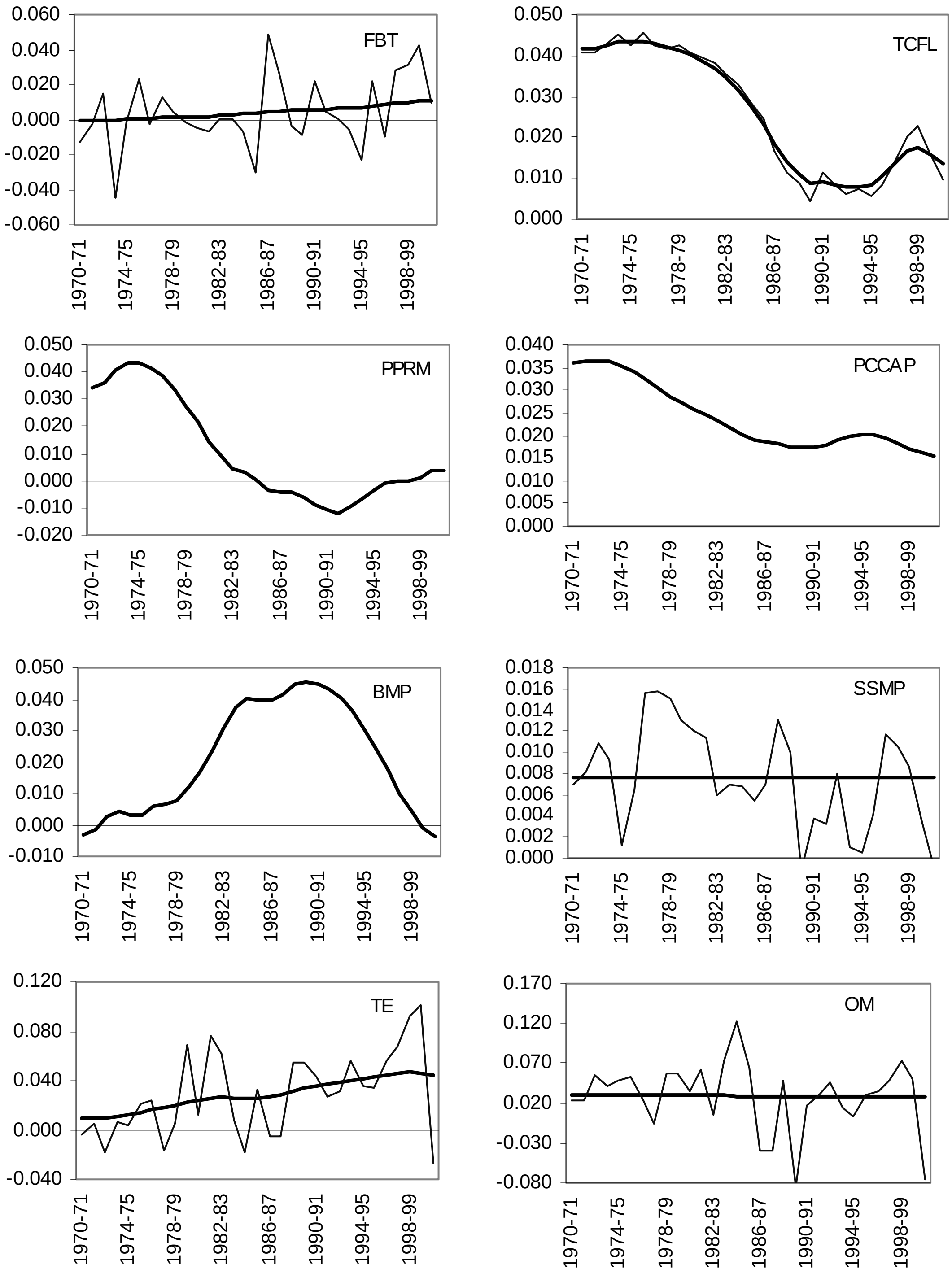
Table I.4 **Structural time series models of disaggregated manufacturing productivity**

1969-70 to 2000-01[a]

Industry	*Coefficient estimates*					*Estimated variance*		
	Explanatory variables			Final state vector				
	y_{-1}	k_{-1}	Δk	Level	Slope	σ_{ε}^{2}	σ_{η}^{2}	σ_{ξ}^{2}
FBT	-1.049	0.581	0.753	4.95	0.011	0.0	4.20E-04	5.50E-06
TCFL	-1.135	0.173	0.212	5.43	0.014	8.90E-04	8.40E-05	4.20E-05
PPRM	-0.956	0.179	0.164	4.37	0.0037	8.00E-04	0.0	6.80E-05
PCCAP[b]	-0.777	-0.021	0.27	3.77	0.016	6.70E-04	0.0	1.19E-05
BMP	-0.831	0.218	0.07	4.09	-0.004	1.30E-03	0.0	1.10E+04
SSMP	-0.866	0.105	0.155	4.06	0.0076	6.00E-04	1.40E+04	0.0
TE	-1.285	0.281	0.348	6.41	0.044	2.20E-04	1.30E-03	4.00E-05
OM[b]	-1.2	-0.049	0.268	5.82	0.029	0	2.10E-03	4.30E-07
All	-1.5	0.286	0.27	7.18	0.0275	9.50E-05	3.40E-04	0.0

[a] The explanation for the variables and features of these structural time series models is in table I.3 and the previous sub-section. Derivation of the reported statistics is described in Harvey (1991) and from the STAMP package (Koopman et al. 2000). The industry mnemonics are in table I.7 below. [b] The coefficients on these (unrealistic) parameter values for the capital-labour ratio were not significant (and in the case of OM, the estimation routine only had weak convergence).

Figure I.2 **Stochastic trends in productivity in manufacturing industry groups, 1970-71 to 2000-01**[a]



[a] The bold line is the slope (and where not identical) the overall trend (m_t-m_{t-1}) is the lighter line.

I.3 Data errors and measurement issues

Data problems in productivity estimation are well established (Diewert 2000). Productivity estimates are effectively residuals, and so will usually amplify any noise to signal ratio. As an illustration, suppose that the relative standard errors on levels of manufacturing output, labour, capital and the capital share are one, two, five and five per cent respectively and that the errors are distributed normally and independently over time (arising from sampling and non-sampling errors).[15] These are not large RSEs by the standards of statistical collections, bearing in mind problems with deflators, survey biases, sampling errors, National Accounts balancing and the methodological assumptions underlying the construction of capital stocks.

The 95 per cent confidence interval associated purely with data errors for the trend MFP growth rate from 1974-75 to 2001-02 and from 1993-94 to 2001-02 can then be calculated using simulation techniques (and compared with the actual observed values). The results (based on 1000 simulations) reveal that long run estimates of MFP growth in manufacturing are likely to be quite robust (table I.5). However, for shorter periods, such as the relevant peak-to-peak period during the 1990s for manufacturing, small data errors have important impacts. There is a five per cent chance that manufacturing MFP in the 1990s was over 1.69 per cent per annum (greater than its long run average) and a five per cent chance that it was 0.9 per cent or less. Thus, it is conceivable that manufacturing has in fact experienced significantly more rapid MFP growth in the 1990s than the published figures reveal (or indeed less growth).

Table I.5 **Effects of errors on manufacturing MFP trend estimates**

RSEs (output, labour, capital, capital share) %	*1974-75 to 2001-02*			*1993-94 to 2001-02*		
	5% lower	Actual	95% upper	5% lower	Actual	95% upper
	%	%	%	%	%	%
(1, 2, 5, 5)	1.59	1.64	1.69	0.89	1.18	1.69
(2, 4, 10, 10)	1.52	1.64	1.76	0.60	1.18	1.73

Source: Commission calculations.

15 Actual sampling errors from the Manufacturing Survey are relatively low. For example, in 1997-98, the standard errors were 0.4, 0.2 and 4.9 per cent for employment, industry value added and acquisition of plant and equipment, respectively. However, this ignores other sources of errors, which are often quite large (as partly indicated by the magnitude of revisions to the series).

The illustration in table I.5 is based on the assumption that errors are distributed normally and independently over time and that they are additive around the non-logged level of the variable. Other assumptions are possible and would have different implications. For example, it is possible that errors in levels might be very large indeed, but that errors in log differences are smaller because errors are correlated over time. Serial correlation almost certainly applies to capital stock errors, given that they represent accumulated investment series (so errors in the past stocks are also reflected in current stocks). However, despite serial correlation, errors in log differences are likely to be still large for capital (due to the influence of errors in the current price deflator and the latest investment flow into capital). There is scope for much more sophisticated research into the likely effects of data errors in MFP estimates that takes into account their likely form and magnitude.

A window into the impact of data errors is given by a comparison of MFP estimates for manufacturing based on alternative labour input data. There are two main information sources for employment in manufacturing: the ABS *Labour Force Survey* (LFS) and the *Manufacturing Census* (MC).[16] The LFS is used for labour input data for the MFP calculations in chapter 7 for all market sector industries, bar manufacturing, which uses the MC as the basis for the employment numbers.[17] Had MFP estimates for manufacturing been, like other industries, based on the LFS instead of the MC, then a rather different picture emerges for some periods (table I.6). For example, over the period from 1979-80 to 2001-02, the trend growth rate based on the MC is about 70 per cent higher than that derived from the LFS (and the implied overall improvement in output levels over the period is different by more than 80 per cent).[18]

The ABS argues that the employment measures from the MC are more reliable (have lower RSEs) and have the benefit of coming from the same source as the value added data. However, it comes at the cost of comparability to other industries, where data on employment come from the LFS and data on value added from employer-based surveys. If the employment estimates from the MC are superior in accuracy and precision to the labour survey estimates, then this gives an indication of the scope of possible measurement problems for MFP estimates for other industries.

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[16] Data on manufacturing have actually been collected sometimes from a census and sometimes (more lately) from a survey. For ease of description, these manufacturing collections are referred to as the MC.

[17] This is, for all years except 1985-86 when LFS data are used. Hours worked per week still comes from the LFS for all years.

[18] That is, [(1.0153^23)-1]/[(1.0091^23)-1]= 0.802.

Table I.6 **Growth rates in MFP using two different labour input sources**

Trend annual growth rates

	Manufacturing industry (Labour Force Survey)	*Manufacturing industry (Manufacturing Census)*
	%	%
1979-80 to 1981-82	1.40	1.41
1981-82 to 1984-85	2.07	2.10
1984-85 to 1988-89	1.43	1.55
1988-89 to 1993-94	0.60	2.04
1993-94 to 1996-97	0.02	1.09
1996-97 to 2001-02	1.49	1.52
1979-80 to 2001-02	0.91	1.53

Source: Both estimates use the same unpublished ABS data for output, capital and factor shares. However, the MFP in column one uses labour estimates from the Labour Force Survey and the MFP in column two uses labour estimates from the manufacturing census.

Quite apart from data errors in series, there are many methodological issues affecting measures of inputs and output in manufacturing. For example:

- in 1994-95, the ABS changed the methodology used to estimate industry value added from an income-only approach to an input-output approach to balance with expenditure. It is possible that differences in value added before and after 1994-95 reflect changes in the methodology. However, it is not possible to estimate the effect of changing the methodology because there is no overlapping year(s) in which estimates were calculated using both methodologies;
- capital series are not measured directly, but are derived from investment inflows using assumptions about asset lives, economic depreciation and weights for different asset lives. These assumptions are reasonable, but will sometimes be wrong. For example, effective asset lives are assumed to be exogenous, yet factor price changes, such as the oil shock in the 1970s, or technological shifts, such as the ICT revolution in the 1990s, may accelerate the obsolescence of existing capital stocks. This can bias MFP estimates considerably over the period of adjustment;
- the extent to which outputs and inputs are quality adjusted varies. Considerable adjustment for quality increases have been applied to ICT goods, where quality differences have been dramatic, but hedonic methods have not been applied to all goods and services in the economy. Moreover, the methods that have been used for quality adjustment could understate or overstate quality changes, depending on a range of methodological issues. Biases in price indexes will cause biases in measures of productivity growth;

- in 2002, the ABS made changes to the manufacturing survey which could have introduced a time bias. The registration of businesses in the survey was changed to base registration on the ABN. This represents a break in the series and comparisons of years either side of 2002 will be affected by this change;
- another bias may arise if the ratio of intermediate inputs to output changes over time. The ABS uses a reference year to accurately estimate the proportion of intermediate inputs used by an industry. This allows the ABS to construct a value added measure using the intermediate input data. However, the years outside the reference year require assumptions to be made about the proportion of intermediate inputs each industry uses. The productivity estimates will be biased over time if the actual ratio of intermediate inputs to gross output differs from that predicted by the ABS;
- ABS research (Zheng et al. 2002) indicates the theoretical superiority of a KLEMS (taking account of capital, labour, energy, material inputs and services) approach to MFP measurement instead of the current ABS approach of using just capital and labour. Provisional calculations suggest that taking account of inputs in a more sophisticated way can be important, particularly for individual sectors. Even for the market sector as a whole, the research finds provisionally that, taking account of imports and non-market sector inputs, MFP is overestimated by an average of 0.1 to 0.3 per cent each year. It finds that overestimation is larger in periods of productivity improvement;
- the ABS's classification of industries could introduce a bias in productivity measurement between industries. A firm is classified by its primary activity (the theoretical ideal would be for each subset to be allocated to the appropriate classification). So a firm that has manufacturing as its primary activity may also have 25 per cent of the business devoted to freight distribution. Existing measures of manufacturing productivity take account of both primary and secondary activities, vitiating the 'true' measure of manufacturing productivity. As the share of primary and secondary activities shifts, this can bias estimates of productivity growth over time and between industries. Wolff and ten Raa (2001) argued that part of the increase in manufacturing productivity in the US over the 1980s and 1990s was the result of manufacturing firms contracting out less productive parts of their business to the services sector; and
- measures of productive capital are subject to greater measurement problems than other variables in MFP estimates. The degree to which these errors matter depend on the factor shares. These tend to be higher in manufacturing — particularly for machinery and equipment (compared with buildings) than other industries. The measurement of machinery and equipment capital stocks involves strong assumptions about the life and depreciation rate of very

heterogeneous assets with very differing asset lives and changing qualities. (These problems are likely to be less severe for buildings.)

On the other hand, while there are obviously many problems and data limitations affecting productivity estimation in manufacturing, in fact, the data are more likely to be more accurate and precise than in many other industries. For example, the core data on employment and value added for earlier years are from censuses of businesses, rather than surveys, as for many other industries. Output is more easily measured than many services.

I.4 Productivity data

This section presents detailed productivity data, since these are often useful for other research purposes as well as replication of results. The first part presents new ABS estimates for manufacturing MFP and inputs — which have been spliced to BIE data to generate a longer time series. The second part presents updated estimates using the approach of Gretton and Fisher (1997) for some key manufacturing subdivisions. In presenting the data, the following mnemonics are used (table I.7).

Table I.7 **Mnemonics**

FBT	Food, beverages and tobacco
TCFL	Textiles, clothing, footwear and leather
PPRM	Printing, publishing and recorded media
PCCAP	Petroleum, coal, chemicals and associated products
BMP	Basic metal products
SSMP	Structural and sheet metal products
TE	Transport equipment
OM	Other manufacturing
M	Manufacturing

Table I.8 Aggregate manufacturing input and output data

1954-55 to 2001-02

	Output index	*Capital index*	*Labour index*	*Capital - labour ratio*	*Total inputs*	*Value added 2000-01 prices*
	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	$m
1954-55	24.12	15.15	119.72	12.65	51.90	17 690
1955-56	25.81	16.66	122.12	13.64	54.95	18 928
1956-57	26.53	18.02	122.12	14.76	56.81	19 459
1957-58	28.46	19.24	123.31	15.60	58.66	20 874
1958-59	30.15	20.45	124.51	16.42	60.77	22 113
1959-60	33.53	21.51	130.50	16.48	63.67	24 589
1960-61	34.49	22.87	131.69	17.37	65.74	25 297
1961-62	34.73	24.69	128.10	19.27	67.10	25 474
1962-63	38.59	26.66	131.69	20.24	70.86	28 304
1963-64	42.21	28.32	136.48	20.75	74.11	30 958
1964-65	46.31	29.99	142.47	21.05	78.25	33 965
1965-66	47.52	32.11	144.87	22.17	81.37	34 852
1966-67	50.65	34.69	146.06	23.75	85.23	37 148
1967-68	53.55	37.11	149.66	24.80	88.86	39 275
1968-69	56.20	39.08	152.05	25.70	91.91	41 218
1969-70	59.82	41.81	154.44	27.07	95.53	43 873
1970-71	60.78	44.23	154.44	28.64	98.38	44 578
1971-72	61.75	46.66	155.64	29.98	100.85	45 289
1972-73	64.16	49.08	154.44	31.78	102.70	47 057
1973-74	69.22	50.75	160.43	31.63	106.67	50 768
1974-75	65.61	51.20	146.06	35.05	101.57	48 120
1975-76	64.90	50.98	140.44	36.30	98.57	47 606
1976-77	66.50	52.08	136.35	38.19	97.05	48 782
1977-78	66.22	52.08	133.68	38.96	95.67	48 571
1978-79	68.95	53.15	134.27	39.58	96.52	50 571
1979-80	71.92	54.41	135.46	40.17	97.79	52 751
1980-81	73.39	56.11	135.21	41.50	98.57	53 832
1981-82	75.21	58.60	134.43	43.59	99.43	55 166

(continued next page)

Table I.8 Continued

	Output index	*Capital index*	*Labour index*	*Capital - labour ratio*	*Total inputs*	*Value added 2000-01 prices*
	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	$m
1982-83	69.02	59.28	118.95	49.84	91.41	50 629
1983-84	70.07	60.01	115.95	51.76	90.15	51 397
1984-85	73.65	60.68	118.41	51.24	91.75	54 023
1985-86	74.12	61.87	118.54	52.19	92.46	54 367
1986-87	76.15	63.39	118.55	53.47	93.29	55 854
1987-88	81.23	65.85	123.69	53.24	97.17	59 579
1988-89	85.90	68.45	128.60	53.23	101.02	63 011
1989-90	84.90	71.41	121.73	58.66	99.13	62 269
1990-91	83.03	72.00	115.30	62.45	96.03	60 898
1991-92	80.56	72.39	105.29	68.75	90.74	59 091
1992-93	82.28	73.66	102.96	71.54	90.03	60 353
1993-94	85.95	74.63	105.07	71.03	91.62	63 046
1994-95	87.78	77.16	109.10	70.72	94.97	64 385
1995-96	89.76	80.41	104.98	76.60	94.27	65 834
1996-97	91.59	84.08	103.53	81.21	95.12	67 182
1997-98	94.58	89.33	104.53	85.46	98.06	69 374
1998-99	96.46	93.68	104.80	89.39	100.15	70 749
1999-00	97.38	98.24	101.92	96.39	100.41	71 429
2000-01	100.00	100.00	100.00	100.00	100.00	73 354
2001-02	103.03	101.45	96.52	105.11	98.49	75 573

Sources: PC(2003a) for the years from 1974-75 to 2001-02 and spliced from BIE (1985) for previous years.

Table I.9 Aggregate manufacturing factors share and productivity measures

1954-55 to 2001-02

	Capital share of income	*Labour share of income*	*Multifactor productivity index (accurate)*	*Labour productivity index*
	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0
1954-55	..	..	46.48	20.15
1955-56	..	..	46.97	21.13
1956-57	..	..	46.71	21.73
1957-58	..	..	48.52	23.08
1958-59	..	..	49.62	24.21
1959-60	..	..	52.66	25.69
1960-61	..	..	52.47	26.19
1961-62	..	..	51.76	27.11
1962-63	..	..	54.47	29.30

(continued next page)

Table I.9 **Continued**

	Capital share of income	*Labour share of income*	*Multifactor productivity index (accurate)*	*Labour productivity index*
	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0	2000-01 = 100.0
1963-64	..	..	56.96	30.93
1964-65	..	..	59.19	32.50
1965-66	..	..	58.41	32.80
1966-67	..	..	59.43	34.68
1967-68	..	..	60.27	35.78
1968-69	..	..	61.15	36.96
1969-70	..	..	62.62	38.73
1970-71	..	..	61.79	39.35
1971-72	..	..	61.23	39.67
1972-73	..	..	62.47	41.54
1973-74	..	..	64.90	43.15
1974-75	26.00	74.00	64.60	44.92
1975-76	27.00	73.00	65.80	46.21
1976-77	28.00	72.00	68.50	48.77
1977-78	28.00	72.00	69.20	49.54
1978-79	28.00	72.00	71.40	51.35
1979-80	30.00	70.00	73.50	53.09
1980-81	30.00	70.00	74.40	54.28
1981-82	29.00	71.00	75.60	55.95
1982-83	28.00	72.00	75.50	58.03
1983-84	34.00	66.00	77.70	60.44
1984-85	35.00	65.00	80.30	62.20
1985-86	37.00	63.00	80.20	62.52
1986-87	36.00	64.00	81.60	64.24
1987-88	38.00	62.00	83.60	65.67
1988-89	37.00	63.00	85.00	66.80
1989-90	37.00	63.00	85.60	69.74
1990-91	35.00	65.00	86.50	72.01
1991-92	36.00	64.00	88.80	76.52
1992-93	37.00	63.00	91.40	79.91
1993-94	40.00	60.00	93.80	81.80
1994-95	40.00	60.00	92.40	80.46
1995-96	38.00	62.00	95.20	85.50
1996-97	40.00	60.00	96.30	88.46
1997-98	42.00	58.00	96.40	90.48
1998-99	40.00	60.00	96.30	92.04
1999-00	41.00	59.00	97.00	95.55
2000-01	40.00	60.00	100.00	100.00
2001-02	41.00	59.00	104.60	106.74

Source: As in table I.8.

Table I.10 **Output (value added) by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	66.4	90.8	45.7	52.1	50.5	80.0	74.3	69.5	64.9
1969-70	67.6	94.9	49.4	56.9	53.9	85.7	79.9	74.4	69.0
1970-71	69.7	97.2	49.7	59.0	54.5	87.1	80.9	75.0	70.2
1971-72	72.5	96.5	49.9	61.6	53.3	88.5	83.1	76.0	71.5
1972-73	77.1	97.9	53.7	66.7	57.6	88.3	82.1	79.2	74.5
1973-74	75.9	105.5	59.1	75.3	64.3	94.6	87.6	86.1	80.0
1974-75	77.1	87.8	57.4	71.9	63.2	84.4	83.5	82.6	76.3
1975-76	79.4	92.9	56.1	71.5	58.7	80.8	81.9	81.9	75.7
1976-77	81.7	88.5	59.4	75.9	62.6	82.3	84.4	83.4	77.9
1977-78	83.8	87.3	61.3	77.4	61.6	82.1	78.6	81.0	77.2
1978-79	85.0	92.6	64.7	82.3	65.7	87.2	79.9	84.1	80.5
1979-80	85.8	94.8	70.0	84.4	71.7	92.2	87.0	87.2	84.1
1980-81	86.8	96.1	72.2	84.9	75.1	96.2	82.4	90.9	85.7
1981-82	87.1	96.8	74.7	88.3	75.1	99.8	87.4	93.5	87.9
1982-83	86.8	90.2	70.7	83.8	65.0	85.2	83.1	80.9	80.7
1983-84	86.5	95.6	74.6	86.3	72.0	82.9	81.6	80.4	82.0
1984-85	87.5	101.1	81.7	88.7	81.7	85.0	84.5	91.6	87.8
1985-86	86.0	107.9	81.9	89.4	81.5	84.8	83.2	95.3	88.8
1986-87	91.3	106.7	84.9	92.8	84.9	88.3	85.1	93.9	90.8
1987-88	96.7	109.4	93.4	99.9	87.6	99.7	89.1	99.2	96.5
1988-89	99.3	111.4	97.5	102.9	93.7	108.1	95.9	108.4	102.2
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	103.0	97.7	97.6	102.6	100.7	94.6	90.5	94.8	97.9
1991-92	102.8	92.1	91.1	99.1	103.4	89.5	83.7	92.1	95.1
1992-93	103.8	88.4	96.9	100.6	101.9	94.4	84.2	95.8	96.9
1993-94	107.6	89.6	98.9	105.5	107.3	97.6	90.7	100.9	101.3
1994-95	108.8	87.5	104.1	108.8	103.6	98.3	95.9	104.4	103.3
1995-96	112.8	83.0	105.3	115.0	110.8	96.3	99.3	105.1	105.9
1996-97	114.3	82.4	111.6	117.4	109.5	102.5	103.5	106.0	107.9
1997-98	123.6	83.9	110.4	120.5	107.1	106.5	110.9	108.6	111.4
1998-99	131.4	85.0	112.4	128.0	112.5	106.3	114.4	112.4	116.0
1999-00	139.6	79.6	119.2	127.5	105.8	102.4	130.7	115.4	119.0
2000-01	148.7	74.7	109.3	133.6	106.2	102.8	127.4	111.0	118.9

Source: Updated estimates from Gretton and Fisher (1997).

Table I.11 **Hours worked by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	107.5	180.4	79.0	109.7	116.8	107.2	126.9	117.5	118.0
1969-70	111.7	181.2	82.9	113.2	120.5	112.8	130.1	118.8	121.0
1970-71	114.5	176.0	82.8	114.7	121.7	113.6	131.7	118.6	121.3
1971-72	117.2	170.8	82.7	116.1	122.9	114.3	133.3	118.5	121.6
1972-73	118.2	164.6	83.0	124.7	125.2	109.4	134.1	117.9	121.6
1973-74	118.9	163.7	85.9	123.8	129.1	112.1	139.5	125.2	125.0
1974-75	114.6	133.0	80.3	115.0	129.6	103.7	129.4	118.0	116.1
1975-76	115.3	129.0	74.5	108.8	126.0	100.9	124.2	110.8	111.6
1976-77	112.4	120.6	74.7	108.1	122.0	96.6	125.4	106.8	108.5
1977-78	106.9	116.2	73.9	108.2	116.7	93.3	115.4	106.8	105.4
1978-79	107.3	116.5	77.9	111.3	121.2	97.1	121.2	103.3	106.4
1979-80	104.3	115.8	79.6	111.7	127.1	101.7	116.8	104.1	106.6
1980-81	104.5	113.3	81.3	108.2	131.0	104.7	113.2	105.0	106.7
1981-82	98.0	108.7	81.8	107.9	125.5	104.7	111.5	101.7	103.7
1982-83	94.3	96.8	80.3	98.3	103.4	88.5	96.8	86.7	91.8
1983-84	93.1	99.6	79.2	96.2	99.8	85.2	98.1	84.0	90.4
1984-85	93.2	104.4	81.6	99.7	99.7	86.2	104.9	86.0	92.8
1985-86	93.7	105.0	85.7	107.1	99.9	86.1	92.6	84.3	92.1
1986-87	93.4	104.4	90.7	99.5	97.7	91.8	98.1	89.2	94.2
1987-88	100.6	106.6	90.8	103.9	104.6	99.3	98.3	95.9	99.2
1988-89	99.5	102.6	95.3	104.0	96.3	101.9	101.0	97.5	99.4
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	95.7	84.2	92.6	98.1	93.9	91.7	81.6	89.7	90.8
1991-92	95.2	81.2	94.6	98.0	90.4	88.1	75.2	88.9	89.1
1992-93	94.5	79.3	96.8	96.4	83.6	88.1	74.1	88.4	88.0
1993-94	97.1	76.2	98.8	98.0	79.3	93.8	75.6	93.6	90.5
1994-95	96.3	76.8	104.3	97.9	77.6	96.6	79.5	94.8	91.7
1995-96	93.4	72.5	99.1	99.0	76.5	95.7	78.9	92.0	89.5
1996-97	94.0	71.6	104.2	98.8	72.4	97.6	77.0	91.0	89.3
1997-98	97.9	69.8	105.2	99.1	71.1	99.3	78.3	89.8	89.7
1998-99	99.0	63.9	109.3	102.6	71.1	96.3	73.3	87.8	88.5
1999-00	94.3	60.1	107.5	101.2	66.8	91.7	78.4	87.1	86.7
2000-01	115.0	61.3	98.8	110.6	70.3	99.0	84.5	93.3	93.8

Source: Updated estimates from Gretton and Fisher (1997).

Table I.12 **Employment by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	107.6	180.7	77.8	111.5	121.4	109.3	131.8	118.9	119.5
1969-70	111.8	181.5	81.7	115.1	125.2	115.0	135.2	120.2	122.4
1970-71	114.6	176.3	81.6	116.6	126.4	115.7	136.9	120.0	122.8
1971-72	117.4	171.1	81.5	118.0	127.7	116.5	138.5	119.8	123.1
1972-73	118.3	164.9	81.7	126.7	130.1	111.5	139.4	119.3	123.1
1973-74	119.1	164.0	84.6	125.8	134.1	114.2	144.9	126.6	126.5
1974-75	114.8	133.2	79.0	116.9	134.6	105.7	134.5	119.3	117.5
1975-76	114.7	132.5	76.2	111.9	128.5	100.4	129.7	112.5	113.3
1976-77	114.1	122.6	75.3	111.6	128.4	98.3	130.6	108.9	110.9
1977-78	113.2	117.6	75.8	111.7	124.8	96.8	123.2	105.1	108.1
1978-79	109.9	116.6	77.8	112.9	126.7	99.1	124.9	104.4	108.0
1979-80	108.0	116.6	81.7	113.0	132.5	102.2	125.0	105.2	109.0
1980-81	106.5	114.6	83.4	111.2	135.8	106.2	117.2	105.9	108.6
1981-82	103.6	112.9	84.6	113.4	135.3	109.3	120.0	106.8	109.1
1982-83	101.2	101.7	83.7	105.6	116.8	95.9	110.5	93.8	99.4
1983-84	98.2	102.7	83.4	101.7	108.4	88.6	106.6	88.0	95.3
1984-85	96.7	106.8	85.3	102.1	107.8	87.4	109.2	89.3	96.2
1985-86	98.0	109.0	87.2	110.6	106.8	87.9	97.4	86.4	95.4
1986-87	97.8	107.5	92.5	101.2	103.5	91.8	101.9	90.9	96.8
1987-88	101.7	109.5	94.2	105.2	105.2	98.7	101.6	96.3	100.5
1988-89	102.2	104.2	97.0	105.4	99.5	101.4	106.2	98.5	101.3
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	98.1	86.9	95.6	98.3	96.3	92.2	84.9	91.1	92.7
1991-92	95.5	81.8	96.4	96.7	92.0	87.4	77.2	90.0	89.8
1992-93	95.6	78.9	98.4	95.4	87.1	87.9	75.8	89.2	88.9
1993-94	96.8	76.3	99.7	95.5	79.7	91.6	75.0	91.4	89.4
1994-95	96.6	76.4	103.6	96.5	76.7	92.7	76.2	93.2	90.4
1995-96	94.3	73.7	99.2	98.5	74.6	93.4	76.8	91.0	88.9
1996-97	94.7	72.1	103.4	97.0	72.1	94.5	76.5	89.7	88.6
1997-98	97.7	72.3	107.9	96.4	72.0	95.9	78.1	88.8	89.4
1998-99	97.0	64.6	107.4	100.0	71.8	93.1	73.2	85.4	87.1
1999-00	95.5	60.7	106.7	99.0	67.5	90.9	76.6	85.0	86.0
2000-01	113.1	62.9	100.2	107.8	71.3	96.0	84.3	92.7	93.1

Source: Updated estimates from Gretton and Fisher (1997).

Table I.13 **Capital capacity by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	43.22	68.72	32.93	75.76	29.14	52.19	49.19	52.31	39.21
1969-70	45.74	72.59	33.78	80.48	31.74	57.10	51.79	56.53	41.90
1970-71	48.21	77.17	33.77	83.31	36.41	61.34	56.02	60.42	44.87
1971-72	50.93	80.04	35.71	84.89	40.69	65.45	58.13	63.64	47.40
1972-73	54.45	82.14	35.78	84.03	42.58	68.82	61.04	65.75	48.93
1973-74	57.52	84.35	34.57	79.21	44.05	73.09	65.46	71.16	54.06
1974-75	60.03	85.49	33.26	77.81	47.24	75.29	67.36	62.29	60.90
1975-76	61.73	83.58	32.89	77.39	48.76	75.50	67.34	54.52	61.91
1976-77	65.36	81.34	33.56	77.04	49.59	77.16	67.65	56.54	63.79
1977-78	69.16	79.38	33.42	79.20	63.74	78.88	70.50	58.82	65.78
1978-79	72.01	78.17	34.23	82.61	67.90	80.66	70.18	61.03	67.77
1979-80	74.39	78.31	36.50	84.01	69.88	82.93	71.87	63.20	69.71
1980-81	77.19	78.72	38.26	86.31	77.44	85.88	74.31	66.64	73.59
1981-82	80.65	79.50	41.37	89.48	89.02	87.23	69.50	69.31	78.20
1982-83	83.63	78.99	45.45	91.24	94.90	88.68	67.93	69.53	80.91
1983-84	85.15	79.75	49.00	90.80	95.74	88.78	68.57	69.18	81.60
1984-85	87.80	81.15	54.42	89.49	94.63	91.22	71.09	69.81	82.58
1985-86	89.88	81.75	62.22	89.20	96.11	93.52	72.48	72.02	84.71
1986-87	91.62	83.91	70.66	89.49	98.27	94.73	80.69	75.04	87.55
1987-88	93.88	88.46	85.25	90.35	98.71	95.31	94.08	81.55	91.22
1988-89	96.92	94.58	92.22	93.95	98.51	98.50	98.16	90.53	95.40
1989-90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1990-91	103.05	99.73	102.81	104.93	101.80	100.48	101.52	104.54	102.93
1991-92	104.57	98.47	105.83	109.77	105.60	99.26	100.50	107.18	105.13
1992-93	106.55	97.34	113.53	112.58	105.83	97.59	99.08	108.80	106.34
1993-94	112.47	97.34	121.77	115.53	104.42	96.71	100.30	113.21	109.00
1994-95	118.82	100.39	146.38	122.12	103.79	97.80	101.50	120.14	113.96
1995-96	124.25	100.13	155.49	125.98	108.47	99.02	104.10	128.37	118.91
1996-97	130.69	99.40	162.75	129.62	109.82	98.25	108.85	137.72	123.68
1997-98	139.35	98.95	175.12	132.93	110.76	99.96	113.50	146.11	128.96
1998-99	145.62	98.07	189.33	136.05	114.88	98.61	112.51	150.33	132.61
1999-00	153.09	95.12	202.07	141.80	114.12	99.08	111.98	155.53	136.33
2000-01	158.64	93.55	197.91	143.18	110.88	97.12	111.58	158.80	137.56

Source: Updated estimates from Gretton and Fisher (1997).

Table I.14 **Labour productivity based on persons employed by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	61.7	50.3	58.8	46.8	41.6	73.3	56.4	58.5	54.3
1969-70	60.4	52.3	60.5	49.5	43.1	74.6	59.1	61.9	56.3
1970-71	60.8	55.1	61.0	50.6	43.1	75.3	59.1	62.5	57.2
1971-72	61.8	56.4	61.3	52.1	41.8	76.0	60.0	63.4	58.0
1972-73	65.1	59.4	65.8	52.7	44.3	79.2	58.9	66.3	60.6
1973-74	63.8	64.3	69.8	59.8	47.9	82.9	60.4	68.0	63.2
1974-75	67.1	65.9	72.6	61.5	47.0	79.9	62.1	69.2	65.0
1975-76	69.2	70.2	73.6	64.0	45.7	80.5	63.2	72.8	66.8
1976-77	71.6	72.2	78.8	68.0	48.8	83.7	64.6	76.6	70.3
1977-78	74.0	74.2	80.8	69.3	49.4	84.8	63.8	77.1	71.5
1978-79	77.4	79.4	83.2	72.9	51.9	88.0	64.0	80.6	74.5
1979-80	79.4	81.3	85.7	74.7	54.1	90.2	69.6	82.9	77.1
1980-81	81.5	83.8	86.5	76.4	55.3	90.5	70.2	85.8	78.9
1981-82	84.1	85.7	88.3	77.9	55.5	91.3	72.8	87.5	80.6
1982-83	85.8	88.6	84.5	79.4	55.6	88.9	75.2	86.3	81.1
1983-84	88.1	93.0	89.5	84.9	66.4	93.6	76.6	91.4	86.0
1984-85	90.4	94.6	95.8	86.9	75.8	97.3	77.4	102.5	91.3
1985-86	87.8	99.0	94.0	80.9	76.3	96.5	85.4	110.4	93.0
1986-87	93.4	99.2	91.8	91.7	82.1	96.2	83.5	103.3	93.9
1987-88	95.1	100.0	99.2	94.9	83.3	101.0	87.7	103.0	96.1
1988-89	97.2	107.0	100.5	97.6	94.1	106.6	90.4	110.1	100.9
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	105.0	112.5	102.1	104.3	104.6	102.6	106.5	104.0	105.6
1991-92	107.6	112.6	94.5	102.4	112.4	102.4	108.5	102.4	105.9
1992-93	108.6	112.1	98.5	105.5	117.0	107.4	111.1	107.4	108.9
1993-94	111.2	117.4	99.2	110.5	134.6	106.5	120.9	110.4	113.3
1994-95	112.7	114.5	100.5	112.8	135.1	106.1	125.8	112.1	114.3
1995-96	119.6	112.6	106.2	116.8	148.5	103.1	129.3	115.5	119.2
1996-97	120.7	114.2	107.9	121.0	151.8	108.4	135.3	118.1	121.9
1997-98	126.5	116.0	102.3	125.0	148.7	111.1	141.9	122.3	124.6
1998-99	135.5	131.5	104.7	128.0	156.7	114.2	156.4	131.6	133.2
1999-00	146.2	131.1	111.7	128.8	156.8	112.6	170.6	135.7	138.3
2000-01	131.5	118.7	109.1	123.9	149.0	107.1	151.1	119.8	127.7

Source: Updated estimates from Gretton and Fisher (1997).

Table I.15 **Labour productivity based on hours worked by major manufacturing subdivisions**

1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	61.8	50.4	57.9	47.5	43.2	74.6	58.6	59.1	55.0
1969-70	60.5	52.4	59.5	50.3	44.7	76.0	61.4	62.7	57.0
1970-71	60.9	55.2	60.0	51.4	44.8	76.7	61.4	63.2	57.9
1971-72	61.8	56.5	60.3	53.0	43.4	77.4	62.3	64.2	58.8
1972-73	65.2	59.5	64.8	53.5	46.0	80.7	61.2	67.1	61.3
1973-74	63.8	64.4	68.7	60.8	49.8	84.4	62.8	68.8	64.0
1974-75	67.2	66.1	71.5	62.5	48.8	81.4	64.5	70.1	65.7
1975-76	68.8	72.1	75.2	65.7	46.6	80.1	65.9	73.9	67.8
1976-77	72.7	73.4	79.4	70.2	51.3	85.1	67.3	78.1	71.8
1977-78	78.4	75.1	83.0	71.5	52.8	88.0	68.1	75.9	73.3
1978-79	79.2	79.4	83.1	73.9	54.2	89.8	65.9	81.4	75.7
1979-80	82.3	81.9	88.0	75.5	56.4	90.6	74.5	83.7	78.9
1980-81	83.0	84.8	88.8	78.5	57.3	91.9	72.7	86.6	80.3
1981-82	88.9	89.1	91.4	81.8	59.8	95.3	78.4	91.9	84.8
1982-83	92.0	93.1	88.1	85.2	62.8	96.3	85.8	93.3	87.8
1983-84	92.9	96.0	94.3	89.8	72.1	97.3	83.2	95.8	90.7
1984-85	93.9	96.8	100.1	89.0	82.0	98.6	80.6	106.4	94.6
1985-86	91.8	102.7	95.6	83.4	81.6	98.4	89.9	113.1	96.4
1986-87	97.8	102.1	93.6	93.3	86.9	96.3	86.7	105.2	96.5
1987-88	96.2	102.7	102.9	96.2	83.7	100.3	90.6	103.5	97.3
1988-89	99.9	108.6	102.3	99.0	97.3	106.1	94.9	111.2	102.8
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	107.7	116.0	105.4	104.6	107.2	103.2	110.9	105.6	107.9
1991-92	108.0	113.4	96.3	101.1	114.3	101.6	111.2	103.6	106.8
1992-93	109.9	111.5	100.1	104.4	122.0	107.1	113.7	108.4	110.0
1993-94	110.9	117.5	100.1	107.6	135.3	104.0	120.0	107.7	112.0
1994-95	112.9	114.0	99.8	111.2	133.5	101.8	120.6	110.2	112.6
1995-96	120.7	114.4	106.3	116.1	144.8	100.6	125.8	114.2	118.4
1996-97	121.6	115.1	107.1	118.8	151.3	105.0	134.5	116.4	120.9
1997-98	126.2	120.1	105.0	121.6	150.5	107.3	141.5	121.0	124.2
1998-99	132.7	133.1	102.9	124.7	158.3	110.4	156.0	128.0	131.0
1999-00	148.1	132.5	110.9	126.0	158.3	111.7	166.7	132.5	137.2
2000-01	129.3	121.9	110.6	120.8	151.0	103.8	150.7	118.9	126.8

Source: Updated estimates from Gretton and Fisher (1997).

Table I.16 **Capital productivity by major manufacturing subdivisions**
1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	153.6	132.2	138.9	68.8	173.2	153.4	151.1	132.9	165.6
1969-70	147.7	130.8	146.1	70.7	169.8	150.2	154.3	131.7	164.6
1970-71	144.5	126.0	147.3	70.8	149.7	142.0	144.4	124.1	156.4
1971-72	142.4	120.6	139.8	72.5	131.1	135.2	143.0	119.4	150.8
1972-73	141.5	119.2	150.2	79.4	135.3	128.3	134.6	120.4	152.3
1973-74	132.0	125.1	170.8	95.0	145.9	129.4	133.8	121.1	148.0
1974-75	128.4	102.8	172.5	92.3	133.8	112.2	123.9	132.7	125.3
1975-76	128.5	111.2	170.4	92.4	120.4	107.0	121.7	150.3	122.3
1976-77	124.9	108.8	176.9	98.5	126.3	106.6	124.7	147.5	122.2
1977-78	121.2	110.0	183.4	97.7	96.7	104.1	111.5	137.7	117.4
1978-79	118.1	118.4	189.1	99.6	96.8	108.1	113.9	137.8	118.8
1979-80	115.3	121.1	191.9	100.4	102.6	111.2	121.1	137.9	120.7
1980-81	112.4	122.0	188.6	98.4	97.0	112.0	110.8	136.4	116.5
1981-82	108.0	121.7	180.5	98.7	84.3	114.4	125.7	134.8	112.4
1982-83	103.8	114.1	155.6	91.9	68.5	96.1	122.3	116.4	99.7
1983-84	101.6	119.8	152.3	95.1	75.2	93.4	119.0	116.2	100.5
1984-85	99.6	124.6	150.2	99.2	86.4	93.2	118.9	131.2	106.3
1985-86	95.6	132.0	131.7	100.2	84.8	90.6	114.8	132.4	104.8
1986-87	99.7	127.1	120.2	103.7	86.4	93.2	105.4	125.1	103.8
1987-88	103.0	123.7	109.6	110.5	88.7	104.6	94.7	121.6	105.8
1988-89	102.5	117.8	105.7	109.5	95.1	109.7	97.7	119.8	107.1
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	100.0	98.0	94.9	97.8	99.0	94.2	89.1	90.7	95.1
1991-92	98.3	93.5	86.1	90.3	97.9	90.2	83.3	85.9	90.5
1992-93	97.4	90.8	85.3	89.4	96.3	96.8	85.0	88.1	91.1
1993-94	95.7	92.1	81.2	91.3	102.8	100.9	90.4	89.1	92.9
1994-95	91.6	87.2	71.1	89.1	99.8	100.6	94.5	86.9	90.6
1995-96	90.8	82.9	67.7	91.3	102.2	97.2	95.4	81.9	89.1
1996-97	87.5	82.9	68.6	90.6	99.7	104.3	95.1	77.0	87.3
1997-98	88.7	84.8	63.0	90.6	96.7	106.6	97.7	74.3	86.4
1998-99	90.2	86.7	59.4	94.1	97.9	107.8	101.7	74.8	87.5
1999-00	91.2	83.7	59.0	89.9	92.7	103.3	116.7	74.2	87.3
2000-01	93.7	79.9	55.2	93.3	95.8	105.8	114.2	69.9	86.5

Source: Updated estimates from Gretton and Fisher (1997).

Table I.17 Multifactor productivity by major manufacturing subdivisions

Based on hours worked, 1989-90 = 100

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*	*M*
	Index	Index	Index	Index	Index	Index	Index	Index	Index
1968-69	86.7	65.5	72.4	56.3	72.5	91.9	75.7	75.9	74.5
1969-70	84.3	67.2	74.7	58.7	73.2	92.5	78.6	78.7	76.0
1970-71	83.9	69.1	75.4	59.5	69.2	91.6	77.0	77.8	75.3
1971-72	84.3	69.5	75.2	61.1	64.5	90.9	77.6	77.9	75.2
1972-73	86.8	72.0	80.7	64.0	67.7	92.4	75.5	80.7	77.4
1973-74	83.5	77.3	86.6	74.5	73.2	95.6	77.0	82.3	80.6
1974-75	85.5	75.4	89.7	74.7	69.9	89.4	77.6	85.4	81.0
1975-76	86.8	82.2	93.6	77.1	65.3	87.1	78.6	91.6	83.2
1976-77	89.0	82.9	98.5	82.2	70.6	90.9	80.4	95.0	86.6
1977-78	92.4	84.6	102.8	82.9	64.8	92.3	79.1	91.3	86.0
1978-79	92.2	89.9	103.6	85.1	66.0	94.7	77.3	96.1	87.9
1979-80	93.6	92.4	108.6	86.4	69.2	96.2	86.2	98.0	90.9
1980-81	93.2	95.0	108.9	87.4	68.1	97.3	82.8	99.9	91.1
1981-82	96.1	98.4	110.2	89.6	66.3	100.4	90.3	103.7	93.9
1982-83	96.9	100.1	103.8	89.1	65.1	96.2	95.9	100.3	93.0
1983-84	96.7	103.7	108.9	93.1	73.7	96.1	93.1	102.2	95.5
1984-85	96.6	105.5	113.3	94.6	84.2	96.9	90.9	114.2	100.0
1985-86	93.8	111.9	105.4	91.9	83.3	95.9	97.6	119.2	100.6
1986-87	99.0	110.1	101.0	98.9	86.9	95.4	93.0	111.4	100.3
1987-88	99.5	109.6	105.0	103.7	86.4	101.9	92.5	109.2	101.2
1988-89	101.3	111.8	103.4	104.6	95.9	107.5	96.3	114.2	104.9
1989-90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	103.5	109.1	101.8	100.8	102.0	99.5	99.9	99.6	101.5
1991-92	102.7	105.7	92.8	94.9	104.4	96.8	97.2	96.3	98.6
1992-93	103.1	103.5	94.7	95.6	106.9	102.8	99.3	99.9	100.6
1993-94	102.6	107.5	92.9	98.0	116.2	102.6	105.0	100.0	102.6
1994-95	101.3	103.4	88.7	98.0	113.8	101.1	107.0	100.6	101.8
1995-96	104.5	102.0	91.3	101.3	119.6	99.2	110.3	101.3	104.0
1996-97	103.1	102.5	92.1	102.0	120.5	104.4	114.7	100.9	104.8
1997-98	106.0	106.5	89.1	103.3	118.3	106.6	119.6	103.1	106.3
1998-99	110.1	115.9	86.8	106.5	122.2	109.3	129.2	107.9	110.5
1999-00	118.6	114.7	92.5	105.4	119.5	109.3	140.6	110.6	114.0
2000-01	108.6	106.1	91.4	103.6	118.5	104.6	129.4	100.4	107.2

Source: Updated estimates from Gretton and Fisher (1997).

Table I.18 Multifactor productivity trend estimates for major manufacturing subdivisions

Compound growth rates, 1969-70 to 2000-01[a]

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*
1969-70 to 1973-74	0.1	2.6	3.3	5.0	-0.6	0.2	0.0	1.9
1973-74 to 1984-85	1.1	3.1	2.0	2.5	1.3	0.4	1.8	2.5
1984-85 to 1993-94	0.7	-0.1	-1.5	0.5	3.9	0.7	1.2	-1.0
1993-94 to 2000-01	1.2	0.8	-0.4	1.0	0.9	0.6	3.5	0.8
1969-70 to 2000-01	0.9	1.6	0.6	1.9	1.7	0.5	1.8	1.0

[a] This table shows compound growth rates for trend values of MFP. The trends are calculated by applying a smoothing algorithm (an Epanechnikov kernel) to the original MFP series. The use of trend values avoids the problems associated with varying peak periods for different subdivisions.

Source: Updated estimates from Gretton and Fisher (1997).

Table I.19 Labour productivity trend estimates for major manufacturing subdivisions

Compound growth rates, 1969-70 to 2000-01[a]

	FBT	*TCFL*	*PPRM*	*PCCAP*	*BMP*	*SSMP*	*TE*	*OM*
1969-70 to 1973-74	1.6	4.2	3.2	4.1	1.7	1.8	1.0	2.5
1973-74 to 1984-85	3.2	4.0	3.0	3.7	4.5	1.7	2.7	3.6
1984-85 to 1993-94	2.1	1.8	0.7	2.3	6.0	0.6	3.8	0.7
1993-94 to 2000-01	2.6	1.6	0.8	1.9	2.5	0.6	4.1	2.0
1969-70 to 2000-01	2.5	2.8	1.9	2.9	4.1	1.1	3.1	2.3

[a] This table shows compound growth rates for trend values of labour productivity. The trends are calculated by applying a smoothing algorithm (an Epanechnikov kernel) to the original labour productivity series. The use of trend values avoids the problems associated with varying peak periods for different subdivisions.

Source: Updated estimates from Gretton and Fisher (1997).

J Industry structure in OECD countries

Table J.1 **Share of individual sectors in total manufacturing value added**
selected OECD countries

Industry subdivision	*Australia* *1997-98*	*USA* *1998*	*Germany* *1998*	*Japan* *1997*	*Korea* *1998*	*France* *1998*
	%	%	%	%	%	%
Food, beverages and tobacco	20.0	9.9	9.0	11.0	11.4	14.4
Textiles, clothing, footwear & leather	4.8	3.9	2.6	3.3	5.0	5.1
Wood products	3.6	2.9	2.0	1.0	0.5	1.7
Paper, printing and publishing	11.9	10.4	7.8	7.9	3.8	8.5
Chemicals and petroleum product	14.2	17.9	15.9	13.9	26.7	18.4
Pharmaceuticals	2.2	8.1	na	2.7	2.8	3.7
Non-metallic minerals	4.2	2.7	4.0	3.5	3.6	4.6
Metal products	17.4	10.9	13.2	13.2	11.3	13.3
Basic metals	10.0	3.8	4.1	7.5	7.7	3.7
Simple metal fabrications	7.5	7.1	9.0	5.7	3.6	9.6
Total machinery and equipment	20.7	38.1	42.6	40.5	36.1	29.9
Motor vehicles	7.5	7.5	12.7	8.8	6.8	7.2
Other transport equipment	2.6	4.0	1.9	1.2	9.5	3.1
Scientific and medical eq.	1.0	4.0	3.3	1.6	1.0	3.5
Electronic equipment	2.4	10.6	3.0	11.3	13.8	4.1
Electrical equipment	3.2	2.7	6.9	5.2	1.3	3.9
Production machinery & eq.	4.2	9.2	14.8	12.5	3.8	8.0
Other manufacturing	3.2	3.5	3.0	5.8	1.6	4.1
Total manufacturing	100.0	100.0	100	100	100.0	100
Manufacturing in GDP	**13.6**	**16.5**	**22.5**	**23.5**	**30.5**	**18.5**

Sources: OECD (2001); for Australia: ABS (*National Income, Expenditure and Product*, Cat. No. 5206.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0).

K Sectoral contributions to Australian economic activity

Table K.1 indicates the sectoral contributions of manufacturing using several measures of inputs and outputs. Since incomplete data are available for some industries and sectors, the contributions have to be interpreted with care. For example, sales data are not available for the agricultural sector, some business services and the non-market sector generally. Similarly, R&D data are only collected for some segments of the business sector (for example, they exclude the agricultural sector).

It is also important to note that the ABS collects data on some measures from several surveys, and these may differ from each other. For example:

- estimated employment for manufacturing from the Labour Force Survey for manufacturing is different from the Manufacturing Survey/Census;
- measures of gross product for manufacturing differ between the National Accounts and the Manufacturing Census/Survey (appendix B); and
- investment in gross fixed capital expenditure from the ABS National Accounts differs from that recorded in the alternative ABS catalogue on investment (*Private New Capital Expenditure and Expected Expenditure*, Cat. No. 5625.0) because of different data sources, the treatment of speculative construction projects and the omission of acquisition of existing assets. For example, for 2001-02, investment in manufacturing from this publication was $9 179 million or 81 per cent of the National Accounts estimate.

Table K.1 uses those surveys that have the greatest sectoral scope.

Table K.1 **Sectoral contributions to Australian economic activity**

2001-02, current prices

		Sectors				
		Agriculture	Mining	Manufacturing	Services	Total
Value added[a]	$m	24 767	34 192	76 137	451 701	586 797
Sales[b]	$m	..	56 294	272 870	>858 082	..
Employment[c]	Persons '000	438	81	1 098	7 590	9 207
Hours[d]	Average weekly hours '000	18 546	3 592	42 243	258 017	322 397
Investment[e]	$m	7 316	13 188	11 275	74 892	106 671
Capital stock[f]	$m	53 808	125 953	99 651	881 926	1161 338
R&D[g]	$m	..	456	2 170	2 199	4 825

[a] Gross product from the ABS National Accounts. The Services sector is defined residually as all sectors apart from Manufacturing, Mining and Agriculture (but not including ownership of dwellings). The total shown is the sum of the sectors as defined above and is not equal to GDP, which includes ownership of dwellings, taxes less subsidies and the statistical discrepancy. [b] For selected market sector industries from the ABS Business Indicators Survey. [c] Derived from the ABS Labour Force Survey and includes wage and salary earners, employers, the self-employed and unpaid family workers. The data are derived as the average of employment over the four quarters of the financial year. [d] The average weekly hours in each sector from the ABS Labour Force survey. [e] Gross fixed capital expenditure from the ABS National Accounts. [f] The net capital stock (ie gross stock less depreciation) drawn from the National Accounts. [g] Business sector only and for 2000-01.

Sources: ABS (*Australian System of National Accounts*, Cat. No. 5204.0; *Research and Experimental Development, Businesses, Australia,* Cat. No. 8104.0; *Business Indicators, Australia*, Cat. No. 5676.0).

Table K.2 **Share of activity by sector[a]**

2001-02

Sector	*Value added*[b]	*Employment*	*Hours*	*Investment*	*Capital stock*	*R&D*
	%	%	%	%	%	%
Agriculture	4.2	4.8	5.8	6.9	4.6	na
Mining	5.8	0.9	1.1	12.4	10.8	9.5
Manufacturing	13.0	11.9	13.1	10.6	8.6	45.0
Services	77.0	82.4	80.0	70.2	75.9	45.6

[a] See table K.1 for notes relating to the individual activity and input measures. [b] The value added share is calculated as a share of the sectors and not as a share of GDP as a whole.

Sources: ABS, *Australian System of National Accounts* (Cat. No. 5204.0) and ABS, *Research and Experimental Development, Businesses, Australia* (Cat. No. 8104.0).

L Input-output links for manufacturing industries

Table L.1 **Manufacturing industries direct requirement coefficients**
1996-97

		These sectors provide inputs …						
		Agricul-ture	Mining	Manu-facturing	Services	Interm-ediate inputs	Value added	Imports
		%	%	%	%	%	%	%
… to the output of these indust-ries	Meat and dairy	44.1	0.1	**11.7**	20.9	76.8	19.7	1.8
	Other food	14.7	1.1	**23.4**	25.8	65.0	27.6	5.6
	Beverages and tobacco	14.1	0.2	**19.9**	27.2	61.4	32.3	4.3
	Textiles and leather	21.2	0.5	**16.9**	24.1	62.8	24.4	8.9
	Clothing and footwear	0.3	0.1	**25.0**	20.9	46.2	28.1	22.9
	Wood products	4.6	0.2	**25.0**	21.4	51.2	38.3	8.8
	Paper printing and publishing	0.8	0.2	**18.7**	23.7	43.3	39.6	14.0
	Petroleum and coal products	0.0	33.2	**2.8**	7.2	43.2	11.8	44.0
	Chemicals	0.6	2.2	**24.9**	26.5	54.2	27.5	17.1
	Rubber and plastics	0.4	0.2	**24.6**	19.7	44.9	35.2	17.6
	Non-metallic minerals	0.0	10.2	**18.4**	29.5	58.1	34.4	5.1
	Basic metals	0.0	18.7	**27.8**	19.0	65.6	25.8	7.1
	Fabricated metal products	0.0	0.4	**35.8**	18.2	54.3	35.2	8.5
	Transport equipment	0.0	0.1	**29.9**	14.8	44.8	30.9	22.3
	Other machinery and equipment	0.0	0.3	**26.0**	18.3	44.7	32.9	20.1
	Other manufacturing	0.5	0.7	**30.0**	19.0	50.2	36.8	11.3
	All manufacturing	**6.4**	**4.5**	**23.1**	**20.8**	**54.8**	**29.7**	**13.4**

Source: ABS (*Australian National Accounts: Input-output Tables (Product Details) 1996-97,* Cat. No. 5215.0).

Table L.2 **Direct requirement coefficients by degree of input transformation in manufacturing**

1996-97[a]

		These sectors provide inputs …								
		Agric.	Mining	STMs	ETMs	**Manuf.**	Services	Inter. usage	Value added	Imports
		%	%	%	%	**%**	%	%	%	%
… to the output of these indust-ries	STMs	12.1	8.4	15.2	4.2	**19.4**	21.7	61.7	26.0	10.5
	Pharmaceuticals	1.0	0.1	3.9	22.3	**26.2**	32.3	59.6	27.6	13.9
	Motor vehicles	0.0	0.1	10.3	19.7	**30.1**	15.6	45.8	29.2	23.1
	Other transport equipment	0.0	0.1	9.1	20.0	**29.2**	12.2	41.5	36.5	19.9
	Photographic, scientific and medical equipment	0.0	0.3	7.3	8.9	**16.3**	21.4	37.9	43.0	16.4
	Electronic equipment	0.0	0.2	2.8	10.5	**13.2**	18.5	32.0	37.5	28.4
	Electrical equipment	0.1	0.6	15.3	17.4	**32.6**	17.8	51.1	27.5	19.3
	Production machinery	0.0	0.2	14.1	15.2	**29.3**	18.1	47.5	33.5	16.5
	ETMs	0.2	0.2	12.8	14.3	**27.2**	19.7	47.3	33.8	16.7
	All manufacturing	**6.4**	**4.5**	**14.1**	**9.0**	**23.1**	**20.8**	**54.8**	**29.7**	**13.4**

a STMs and ETMs are defined on an industry basis in this table (appendix A).

Source: ABS (*Australian National Accounts: Input-output Tables (Product Details) 1996-97,* Cat. No. 5215.0).

M Trade effects on manufacturing employment

Gaston (1998) estimated an econometric model of the factors that affected employment outcomes in Australian manufacturing for the period from 1973-74 to 1991-92. Table M.1 uses the parameters from Gaston's estimated model to give an indication of trade effects on manufacturing employment over a longer time period (from 1969-70 to 2001-02), holding all other influences constant (such as changing consumption patterns, real wages and interest rates).[1]

To apply Gaston's model, estimates of real exports, imports and the effective rate of assistance were required:

- Current price export[2] and import series from 1988-89 to 2001-02 on an ANZSIC basis were obtained from the ABS. These were spliced with series on an ASIC basis from the Industry Commission's *Australian manufacturing and trade database* (commencing in 1968-69).
- These trade series were converted to real values by deflating by price indexes. The import price index for manufacturing was obtained for manufacturing on an ANZSIC basis from Econdata (ABS, *International Trade Price Index, Australia*, Cat. No. 6457.0) from 1983-84 to 2001-02 (and was annualised by taking the average of the quarters) and re-calibrated to 2000-01=100.0). A longer time series was formed by splicing the import price series from Foster and Stewart (1991, p. 26).
- The effective rates of assistance (ERAs) for manufacturing were obtained from Productivity Commission (2000) *Trade & Assistance Review* (pp. 114-116), with data for 1997-98, 1998-99 and 2001-02 estimated on the basis of surrounding trends. There are several breaks in the ERA series, reflecting methodological differences. This means that the datum for 1969-70 is on a

[1] In using Gaston's model, it is assumed that the model can forecast reasonably well out of sample; and that the factors held constant in the simulation are not correlated with the trade variables to any substantial degree.

[2] Exports include re-exports.

somewhat different basis to that for 2001-02. However, the results are broadly indicative of the declining level of assistance to manufacturing.

The overall trade effect on log employment is the sum of the individual effects from export growth (0.30), import growth (-0.52) and reductions in the effective rate of assistance (-0.03). The overall effects of trade changes was a reduction in log employment of –0.25 — or in percentage terms a reduction of about 20 per cent in manufacturing employment.

Table M.1 **Trade effects on manufacturing employment**

1969-70 to 2001-02[a]

	Exports (X)	*Imports (M)*	*Effective rate of assistance (ERA)*	*Overall trade effects*	*Employment (E)*
	$m 2000-01 constant prices	$m 2000-01 constant prices	ratio		'000
1969-70	13,343	32,039	0.349	..	1342.0
2001-02	68,959	111,473	0.047	..	1098.2
Change measure	Δ ln X= 1.64	Δ ln M = 1.25	Δ ERA =-0.30	..	Δ ln E=-0.20
Employment effects (Δlog E)	0.30	-0.52	-0.03	-0.25	..
Employment effects (%)[b]	35.1	-40.8	-2.8	-22.3	..

a The coefficients used for calculating the employment effect are from model 2 in Gaston (1998). **b** While log changes have the desirable property that the sum of the log changes for the three separate trade effects adds up to the aggregate employment effect, they are less interpretable than percentage changes. Log changes were converted to percentage changes, noting that if α is the log change, the corresponding percentage change is $(e^{\alpha}-1)*100$. The percentage changes are shown in chapter 3.

N The Salter mechanism

Salter (1966) examined the link between productivity change and output change in the UK and US. Data for Australian manufacturing over the period from 1989-90 to 1999-2000 were used to investigate the extent to which productivity changes flowed on to price, output, employment and wages.

Data on gross product, employment, labour productivity, nominal wages per employee and the real product wage (the average wage per employee divided by the price index for the output of the industry of the employees) were obtained for the 153 industries comprising the ABS four digit ANZSIC for the period from 1989-90 to 1999-2000.

An estimate of the trend rate of growth of each variable for each industry was obtained by undertaking a linear regression of the logged value of each of the above variables against a time trend.

Then a series of regressions were undertaken of the trend productivity rates across the 153 industries against other trend estimates (table N.1). For example, the trend growth in output for 153 industries was regressed against the trend rate of growth of labour productivity for 153 industries to give the elasticity of output with respect to labour productivity.

As noted by Harris (1988), there is scope for outliers in trends of productivity or other variables to affect the ordinary least squares (OLS) estimates. This is especially true when using unweighted OLS on a highly disaggregated data set in which errors may be significant. Initial examination of the data revealed some outliers. Eliminating observations where the absolute value of the standardised residuals are greater than 2.5 or some other threshold is one remedy, but as noted by Rousseeuw and Leroy (1987), the OLS residuals themselves can be sufficiently contaminated to invalidate this approach.

Another approach is to use an estimation procedure that is better able to identify outliers, and then to apply OLS — this is the approach of Least Trimmed Squares (Rousseeuw and Leroy 1987). The results using this approach are significantly different for the 2^{nd} and 3^{rd} parameters in magnitudes, but do not alter the interpretation of the results (table N.1).

Table N.1 **The Salter mechanism**
1989-90 to 1999-2000[a]

	Elasticity	*t stat*	R^2
Ordinary least squares results			
Elasticity of price with respect to labour productivity	-0.31	8.1	0.30
Elasticity of output with respect to price	-0.97	5.6	0.17
Elasticity of employment with respect to labour productivity	-0.41	4.3	0.11
Elasticity of nominal wage rate with respect to labour productivity	0.16	4.6	0.15
Least trimmed squares results			
Elasticity of price with respect to labour productivity	-0.30	9.5	0.40
Elasticity of output with respect to price	-0.71	4.7	0.14
Elasticity of employment with respect to labour productivity	-0.40	5.0	0.16
Elasticity of nominal wage rate with respect to labour productivity	0.23	7.8	0.30

a The t statistics shown are corrected for possible heteroscedasticity.

Sources: Commission calculations, ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and unpublished data on prices from the ABS.

O Trends in employment and activity

This appendix examines some data on long-term trends within manufacturing (section O.1). It also considers the extent to which industries in different parts of manufacturing follow similar trends (section O.2)

O.1 Trends in employment and activity

Long run trends in employment and turnover indicate the varying extent of change within manufacturing. While changes in the classification of manufacturing from ASIC to ANZSIC impede analysis of these trends, it is still possible to gain a perspective on long-term structural change within manufacturing.

Table O.1 is based on two employment series for industries within manufacturing, matched to a common hybrid classification (appendix A):

- One series, based on the ASIC-only data, is from 1968-69 to 1991-92, with 1970-71 and 1985-86 missing as there was no census in these years.
- The second, based on the ANZSIC-only data, is from 1989-90 to 1999-2000.

For 1968-69 to 1999-2000, the annual trend growth rates were calculated by regressing the logarithm of the employment share against a time trend and a ‘dummy’ for ANZSIC data. This approach was used because it enabled a trend to be estimated that took account of missing years, overlapping data and the shifts in values that accompanied the change in the ASIC to ANZSIC. The growth rates for 1968-69 to 1991-92 and for 1989-90 to 1999-2000 are based on ASIC and ANZSIC data series respectively.

Table O.2 was constructed in a comparable manner, but using turnover data.

Table O.1 **Employment trends within manufacturing**

1968-69 to 1999-2000

	Employment shares				*Trend growth rates in employment levels*		
Industry description	*68-69*	*78-79*	*89-90*	*99-00*	*68-69 to 99-00*	*68-69 to 91-92*	*88-89 to 99-00*
	%	%	%	%	%	%	%
Food, beverages and tobacco	14.7	16.6	16.3	18.1	-0.8*	-0.9*	-0.2
Textiles, clothing and footwear	15.0	10.7	9.9	7.0	-3.3*	-3.2*	-3.9*
Clothing & footwear	9.7	7.1	6.7	4.1	-3.3*	-3.1*	-4.7*
Textiles & leather	5.3	3.6	3.2	2.9	-3.3*	-3.4*	-2.4*
Wood and paper products	7.1	6.5	6.6	7.0	-1.5*	-1.6*	-0.6
Printing and publishing	5.7	6.3	8.6	10.6	0.8*	0.8*	0.9*
Petroleum, coal, chemicals	8.4	9.5	9.0	10.4	-0.8*	-0.9*	0.1
Simply transformed chemicals	2.1	2.2	2.0	1.9	-1.6*	-1.5*	-2.1*
Elaborately transformed chemicals	5.6	6.3	6.1	7.1	-0.7*	-0.8*	0.3
Medicinal and pharmaceutical products	0.7	1.0	0.9	1.4	0.4	0.1	2.5*
Non-metallic mineral products	4.0	3.9	4.2	3.8	-1.6*	-1.5*	-2.3*
Metal products	15.8	16.9	16.8	15.8	-1.3*	-1.3*	-1.5*
Iron and steel	5.1	5.7	3.9	2.9	-3.0*	-2.9*	-4.4*
Non-ferrous metals	1.7	2.2	2.8	2.4	0.7*	1.1*	-3.3*
Simple metal fabrications	8.9	9.0	10.1	10.5	-1.0*	-1.1*	-0.1
Machinery and equipment	26.5	26.2	23.1	21.7	-2.2*	-2.3*	-1.1*
Motor vehicles	6.4	7.5	7.3	6.0	-1.7*	-1.6*	-2.6*
Other transport equipment	5.1	4.5	3.0	3.2	-3*	-3.4*	0.2
Photographic, medical and scientific eq.[a]	0.5	0.7	1.4	1.3	-0.3	-0.1	-2.0*
Electronic equipment[a]	2.4	1.9	2.2	2.5	-2.1*	-2.5*	1.4
Electrical equipment[a]	5.9	5.6	3.8	3.4	-2.5*	-2.5*	-2.2*
Production equipment	6.2	6.1	5.3	5.3	-2.2*	-2.4*	-0.2
Other manufacturing[a]	2.9	3.4	5.5	5.5	0.5*	0.7*	-0.7
Simply transformed manufactures	40.0	40.8	39.0	39.0	-1.5*	-1.5*	-1.3*
Elaborately transformed manufactures	60.0	59.2	61.0	61.0	-1.4*	-1.5*	-0.7
Total manufacturing	100	100	100	100	-1.4*	-1.5*	-0.9*

a The concordance between ANZSIC and ASIC was imperfect. The results for these industries are less reliable than others (although use of the ANZSIC 'dummy' should reduce the effects of measurement problems on estimates of the long-term trend). * Indicates statistical significance at least at the 5 per cent level.

Sources: ABS Censuses of Manufacturing (*Manufacturing Establishments, Details of Operations by Industry Class Australia*, Cat. No. 8203.0; *Manufacturing Industry, Australia,* Cat. No. 8221.0) and the Industry Commission (1995).

Table O.2 **Turnover trends in manufacturing**

Current prices, 1968-69 to 1999-2000

	Turnover shares				*Trend growth rates in turnover shares*		
Industry description	*68-69*	*78-79*	*89-90*	*99-00*	*68-69 to 99-00*	*68-69 to 91-92*	*88-89 to 99-00*
	%	%	%	%	%	%	%
Food, beverages and tobacco	21.7	22.8	19.6	22.4	-0.1	-0.3*	1.2*
Textiles, clothing and footwear	9.3	7.3	5.8	4.0	-2.0*	-1.9*	-3.4*
Clothing & footwear	5.0	4.0	3.2	1.9	-2.2*	-2.0*	-4.0*
Textiles & leather	4.3	3.3	2.6	2.1	-1.8*	-1.7*	-2.7*
Wood and paper products	6.2	6.0	5.7	6.0	-0.2	-0.2	-0.1
Printing and publishing	3.9	4.4	5.9	7.2	2.3*	2.3*	1.7*
Petroleum, coal, chemicals	11.4	12.5	15.4	15.7	1.0*	1.2*	-0.4
Simply transformed chemicals	4.6	4.9	7.8	6.5	0.9*	1.3*	-2.8*
Elaborately transformed chemicals	6.0	6.6	6.6	6.9	0.9*	1.0*	0.3
Medicinal and pharmaceutical products	0.9	1.1	1.1	2.3	2.3*	1.8*	6.7*
Non-metallic mineral products	3.9	4.4	4.8	4.6	0.6*	0.7*	-0.8
Metal products	18.8	19.9	20.4	17.9	0.1	0.3*	-1.1*
Iron and steel	6.5	6.9	5.6	4.8	-0.7*	-0.6*	-1.7*
Non-ferrous metals	4.8	5.6	7.3	6.2	1.3*	1.6*	-1.5*
Simple metal fabrications	7.5	7.4	7.5	6.9	-0.1	0.0	-0.3
Machinery and equipment	22.7	20.4	19.4	19.4	-0.6*	-0.8*	0.6*
Motor vehicles	8.2	7.6	7.5	7.6	-0.4*	-0.6*	0.9
Other transport equipment	2.6	2.2	2.4	2.2	-0.3	-0.4	-0.1
Photographic, medical and scientific eq.	0.3	0.5	0.8	1.0	2.3*	2.4*	1.3
Electronic equipment	1.5	1.3	1.9	2.6	1.0*	0.7	3.6*
Electrical equipment	5.1	4.3	3.0	2.6	-1.5*	-1.5*	-1.4*
Production equipment	5.0	4.5	3.7	3.4	-1.4*	-1.6*	0.3
Other manufacturing	2.1	2.3	2.9	2.8	0.8*	0.9*	-0.2
Simply transformed manufactures	52.1	53.9	53.4	52.5	0.0	0.0	-0.4*
Elaborately transformed manufactures	47.9	46.1	46.6	47.5	0.0	-0.1	0.5*
Total manufacturing	100	100	100	100	..	..	..

Source and notes: Table O.1.

O.2 Links between industry classes

As noted in chapter 4, output in industry classes *within* a manufacturing subdivision might be expected to move more closely together than output in industry classes in *different* subdivisions.

This can be tested by examining correlations between yearly growth rates in value added of the 153 four-digit ANZSIC industry classes (table O.3). In table O.3, the average correlation of (four-digit) industry classes *within* each (two-digit) industry subdivision is compared with the average correlation of (four-digit) classes *between* (two-digit) industry subdivisions. The derivation is complex. The underlying calculations in matrix notation are:

$$L = W \odot (A(\Omega - I)A')$$

where A is a 9×153 matrix that indicates which of the nine subdivisions each of the 153 four digit ANZSIC classes belongs to, Ω is the correlation matrix (153×153) of each industry class with each other, I is an (conformable) identity matrix, and W is a weighting matrix (9×9) that provides the denominator for calculating the average correlation (with $\odot$ being the Hadamard product). Note that for any non-diagonal element of W, the a_{ij} th element is $1/(n_i \times n_j)$ where n is the number of four digit industry classes in the respective two digit subdivisions. For diagonal elements of W, the a_{ii} th element is $1/([n_i - 1] \times n_i)$. W takes account of the fact that each element in $(A(\Omega - I)A')$ is an addition of many correlations and has to be normalised by the number of relevant individual correlations that make up each sum. L is a symmetric matrix, which is why only the top half is shown in the table.

Table O.3 **Short run links within and between manufacturing industry subdivisions[a]**

Based on annual growth rates in real value added 1990-91 to 1999-2000

	Correlation coefficients								
Codes	FBT	TCFL	WPP	PPRM	PCC	NMMP	MP	ME	OM
FBT	**-0.02**	0.01	-0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02
TCFL	..	**-0.03**	-0.02	-0.02	0.01	-0.01	0.01	0.01	0.00
WPP	..	..	**0.08**	0.12	0.03	0.19	0.06	0.07	0.11
PPRM	..	..	..	**-0.04**	0.02	0.17	0.02	0.03	0.06
PCC	..	..	..	..	**0.01**	0.01	0.03	0.05	0.01
NMMP	..	..	..	..	..	**0.26**	0.09	0.05	0.15
MP	..	..	..	..	..	..	**0.04**	0.06	0.10
ME	..	..	..	..	..	..	..	**0.06**	0.08
OM	..	..	..	..	..	..	..	..	**0.07**

a The industry codes stand for Food, beverages and tobacco, Textiles, clothing, footwear and leather, Wood and paper products, Printing, publishing and recorded media, Petroleum, coal, chemicals & associated products, Non-metallic mineral products, Metal products, Machinery and equipment and Other manufacturing respectively.

Source: Based on unpublished chain value added data from 1989-90 to 1999-2000 for 153 industry classes provided by the ABS.

Of course, it is possible that industries may not move together closely in terms of yearly growth rates, but may move together over the longer term. This is assessed in table O.4. Table O.4 is similar to table O.3, except that the matrix Ω contains only ones or zeros, based on the result of cointegration tests (with the assumption that individual industry value added series are integrated of order one). The log of value added of each industry class was regressed against the log of value added of every other class. The residuals were saved from each regression and a Dickey-Fuller test used to establish whether they were stationary or not. Using the 10 per cent significance critical value of this test, a one was recorded when two industry classes were cointegrated and a zero otherwise. Any figure in table O.4 is the proportion of classes within or between the relevant subdivisions that are cointegrated — or share a common trend. For example, of the possible links between industries making up food, beverages and tobacco, around 34 per cent appear to be cointegrated.

Table O.4 **Long run links within and between manufacturing industry subdivisions**

Based on regressions of log real value added 1989-90 to 1999-2000

	Correlation coefficients								
Codes	FBT	TCFL	WPP	PPRM	PCC	NMMP	MP	ME	OM
FBT	**0.34**	0.43	0.34	0.26	0.29	0.26	0.46	0.37	0.55
TCFL	..	**0.31**	0.23	0.17	0.20	0.16	0.33	0.25	0.37
WPP	..	..	**0.40**	0.32	0.30	0.30	0.48	0.39	0.49
PPRM	..	..	..	**0.20**	0.20	0.21	0.41	0.31	0.50
PCC	..	..	..	..	**0.22**	0.25	0.43	0.33	0.54
NMMP	..	..	..	..	..	**0.11**	0.38	0.28	0.40
MP	..	..	..	..	..	..	**0.40**	0.34	0.41
ME	..	..	..	..	..	..	..	**0.37**	0.49
OM	..	..	..	..	..	..	..	..	**0.29**

Source: As in table O.3.

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