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# Innovation Checkpoint 1999: Innovation in Australian Businesses

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## The Australian Expert Group in Industry Studies (AEGIS)

AEGIS research focuses on elucidating the dynamics of industrial growth and development, mapping product systems so as to reveal and analyse the drivers of innovation in different industries. AEGIS focuses on exploration and analyses of innovative capacity in industry, including both technological bases and organisational arrangements, and the relationships between such capacity and economic growth.

The aim is to provide a more effective basis for public policy development so as to assist with Australia's shift to the knowledge-intensive economy the nation needs in the twentyfirst century.

AEGIS has expertise in the analysis of the dynamics of innovation in many industries, including building and construction, heavy engineering, furnishings, textiles, clothing, footwear and leather, toolmaking, medical devices and health industry products and services. The group is also involved in international work on clusters and collaboration in innovation in a national sample of industries. The present report represents further AEGIS work on the state of innovation in Australia as a whole.

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# Preface

This report was commissioned by the Australian Business Foundation to check on Australia's innovation performance, particularly since the publication of the Foundation's inaugural report *The High Road or the Low Road? Alternatives for Australia's Future* in 1997.

The Australian Business Foundation is an independent, private sector think-tank. Its mission is to strengthen Australian enterprise through research and policy innovation. It does this by conducting ground-breaking research, which it uses to foster informed and well-argued debates and imaginative policy solutions and initiatives.

The Australian Business Foundation was created at arm's length from its founder and sponsor, the eminent business services organisation, Australian Business Limited. The end goal is to advance the store of knowledge about how best to generate future growth, prosperity and jobs for the widest reach of the Australian community.

This is what prompted the Australian Business Foundation to commission *The High Road or the Low Road?*. The report proved to be a pioneering influence in introducing to Australia's public debates the critical importance of innovation to economic growth, business performance and living standards.

This new work, *Innovation Checkpoint 1999: Innovation in Australian Businesses*, was commissioned in order to maintain this momentum and to assess progress on some of the key measures of innovation discussed in the original study.

The principal finding of this report is that, despite a number of continuing positive trends and some positive developments over recent years, serious problems remain.

Such problems need to be resolved if Australia is to maximise its innovation potential.

Finally, the authors wish to thank the Australian Business Foundation, for support for this project, especially its Chair, Dr Ian Pollard, and Chief Executive, Ms Narelle Kennedy. It is hoped that this study will prove to be a useful guide to Australia's innovation performance and challenges for the future.

# Executive Summary

Recognising that economic development increasingly relies on innovation, the Australian Business Foundation commissioned the present study to monitor further Australia's innovation performance, building on the findings of the Foundation's inaugural report, *The High Road or the Low Road: Alternatives for Australia's Future?*, published in 1997.

The current report provides a brief overview of key indicators of innovation, with particular emphasis on data that have emerged since the original study. A broad range of indicators is used in order to compensate for the limitations of individual indicators, to emphasise non-R&D measures of innovation and to examine performance in different aspects of the innovation process.

The indicators reviewed are:

- innovation propensities and expenditure;
- R&D expenditure and employment;
- training and skills;
- venture capital;
- machinery and equipment investment;
- industry structure; and
- trade patterns.

The innovation propensity and expenditure data provide a direct measure of innovation but only very limited data are available. The R&D and human resource statistics provide an insight into Australia's investment in key innovation inputs. Venture capital is a critical ingredient in the commercialisation of inventions. Machinery and equipment investment is a major agent in the diffusion of innovations and can be a major source of process innovation. Industry and trade statistics reflect the success of our innovation efforts, and also our innovation potential.

The focus in innovation data internationally and within Australia is on manufacturing and that focus is reflected in this report. The service sector has been growing fast but the manufacturing sector still contributes most of Australia's R&D and it has one of the highest propensities to innovate compared to other sectors, both in Australia and other OECD countries. Much service activity is also linked to manufacturing and so some innovation there is captured in manufacturing data.

Innovation depends on a series of different investments and activities undertaken by businesses and occurs within a framework of institutions and organisations which lie partly in the private and partly in the public sector. These include knowledge-generating and diffusion organisations and regulatory frameworks which together form what has become known as a country's National System of Innovation.

This report focuses only on innovation investments made within the private sector. The spotlight is on Australian businesses, although this in part relies on a public policy environment conducive to private sector innovation.

There are four key areas where Australia has performed relatively well over recent years:

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<b><i>Knowledge-Based Service Industries</i></b>	Continued strong growth in knowledge-based service industries, albeit from a low base, suggests that Australia is improving her capability to meet the forecast explosion in international trade in high-value services and suggests that reliance on competition based on knowledge, innovation and productivity (rather than on wages and exchange rates) may be spreading among Australian businesses.
<b><i>Machinery and Equipment Investment</i></b>	Since 1990 there has been a strong increase in machinery and equipment investment, reflecting an improving stock of embodied knowledge and potentially rapid diffusion of innovations. This may indicate only a return to earlier levels, however.
<b><i>Venture Capital Investment</i></b>	Australia's recent growth in venture capital investment and greater attention to early-stage finance, if continued, will provide greater scope to turn ideas into commercialised outcomes. Australia's growth rates in venture capital continue to rank very low compared to other OECD countries, however.
<b><i>High Skilled Jobs</i></b>	The somewhat faster growth of high-skilled jobs compared to low-skilled jobs since 1996 indicates a positive turnaround in the trend witnessed over the previous decade. Again, this may represent the beginnings of a shift toward competition based on knowledge within the Australian economy.

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These trends, if continued, will help generate an industry structure better equipped to capture value from Australia's knowledge-base. In respect of these indicators, Australia seems to be developing a more sustainable development path – one more likely to pay higher wages, in return for higher levels of innovation and productivity.

Other data, however, suggest that many areas of serious concern remain.

This report finds that Australia's innovation performance over the 1990s has been mixed. On the one hand, several indicators show continued growth and others show a positive turnaround in activity in recent years. On the other hand, many negative trends remain and new problems have recently arisen.

The report uncovered five particularly concerning negative trends in the following areas:

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***Innovation Rates***

The recently falling proportion of manufacturing businesses which claim to be involved in either product or process innovating cuts to the heart of Australia's innovation performance and, if continued, can be expected to seriously undermine our position as a knowledge-based economy. This problem has emerged since the Australian Business Foundation's last report on innovation in 1997.

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***R&D Personnel and Expenditure Levels***

The substantial falls in R&D expenditure and employment by Australian businesses recorded since 1995 pose a significant threat to Australian innovation performance – particularly as R&D is widely considered an essential input to the innovation process. This is another problem that has only emerged over the last few years.

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***Australian Management Skills***

A recent survey has again highlighted poor management skills in Australia, particularly in relation to capturing value from innovation. Australian management attitudes towards innovation have the potential to:

- constrain partnership opportunities available to Australian inventors;
  - limit the rewards reaped from Australian ideas; and
  - fail to maximise the opportunities available for sustainable business growth.
- 

***Size of the Manufacturing Sector***

With a manufacturing sector that both continues to account for an extremely low proportion of GDP compared to many other OECD countries and is shrinking, Australia has limited manufacturing-related complementary assets (marketing, production) to support:

- the commercialisation phase of innovation activity; and
  - service sector growth.
- 

***Training Commitment***

The low and falling commitment of employers to staff training since 1990 was confirmed in new data released since the publication of *The High Road or the Low Road?*. Given the importance of skills in transforming information into knowledge and knowledge into innovations, this trend will seriously undermine Australia's innovation efforts.

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On balance, therefore, Australia's innovation performance has not been up to world class standards over the past few years.

The five problems noted above significantly constrain Australia's innovation performance. Appropriate action, taken by both the private and public sectors, is required if Australia is to maximise its innovation potential.

## *Summary of Findings*

The sections below provide a detailed summary of the report's main findings. Data unless otherwise stated is the latest available.

### *Innovation Propensities and Expenditure*

- The proportion of manufacturing businesses undertaking technological innovation fell 6 percentage points, from 32 per cent to 26 per cent, between the periods July 1991 to June 1994 and July 1994 to June 1997.
- The proportion of Australian manufacturing business undertaking technological innovation between 1994 and 1997 was low compared to that seen in other OECD countries.
- Technological innovation expenditure by Australian manufacturing business in 1996, as a percentage of total sales, was very low compared to that seen in other OECD countries.

### *Business Research and Development Expenditure (BERD)*

- Manufacturing BERD, as a percentage of value-added, dropped 9.6 per cent between 1995/96 and 1996/97 and 18 per cent between 1996/97 and 1997/98.
- Service sector BERD, as a percentage of value-added, fell 13 per cent between 1995/96 and 1996/97.
- The fall in total BERD between 1995/96 and 1996/97 was the first decrease in BERD recorded by the ABS since they started measuring R&D expenditure in the mid 1970s.
- This poor BERD performance in 1996/97 and 1997/98 contrasts with very strong growth rates over the 1990s, by international standards.
- Strong BERD growth over the 1990s means that in the service sector, Australian BERD as a percentage of value-added is very close to the OECD average. Australia still ranks very low compared to other OECD countries in terms of manufacturing performance, however.

### *Business Employment in Research and Development*

- The number of business personnel working on R&D showed strong growth in Australia between 1984 and 1995 but since then a downward trend has emerged, with the number of personnel falling 9.5 per cent between 1995/96 and 1997/98.
- The contribution of Australian business enterprise R&D personnel to the total number of R&D personnel in Australia was 29 per cent in 1996. This was very low compared to the average of 47 per cent found in 24 OECD countries.

### *Training and Skills*

- In Australia, training hours per employee fell approximately 17 per cent between 1990 and 1996.
- The trend rate of employment growth in high-skilled jobs over the past four years has been slightly higher than that for lower-skilled jobs.
- A recent investigation of the quality of management skills in Australia concluded that Australian managers failed to appreciate the value of innovation to the same extent as their

international counterparts and that they overestimated their own competencies and achievements.

- A recent government report noted a shortage of venture capital management skills in Australia.

### *Venture Capital*

- Enterprise investment by the combined Australian and New Zealand venture capital markets increased 76 per cent between 1997/98 and 1998/99.
- Industry sources suggest that the Australian venture capital industry has 're-emerged' over the 1990s, partly in response to government programs.
- Despite recent growth, Australia ranked second last in a group of 16 OECD countries in terms of average annual growth in venture capital investment between 1995 and 1997.

### *Machinery and Equipment Investment*

- Over the past 38 years, Australia has experienced a downward trend in machinery and equipment investment but the 1990s have seen strong growth overall.
- In the international context, Australia ranked higher than the OECD average in terms of machinery and equipment investment as a proportion of GDP for 1995 (latest year available).

### *Industry Structure*

- Australia's manufacturing sector contracted at a faster rate than the OECD average between 1980 and 1997.
- In 1997 the share of GDP contributed by manufacturing in Australia was the third lowest of 19 OECD countries.
- Across OECD countries between 1980 and 1996, the high-technology manufacturing sector was the only group of manufacturing industries growing as a proportion of GDP, while in Australia this sector was shrinking as a proportion of GDP.
- Nevertheless, in terms of the average annual growth of value-added by *knowledge-based* industries (defined to include service industries) between 1985 and 1996, Australia ranked third highest among a group of 21 OECD countries.

### *Trade Structure*

- Between 1990 and 1995, Australia's high and medium-high technology manufacturing exports showed strong growth, with slower growth evident to 1996.
- In terms of high and medium-high technology exports as a share of production, however, Australian performance in the international context is poor, ranking fourth last and second last respectively in a group of 18 OECD countries in 1996.
- In the high and medium-high technology sectors, Australian has shown an increasing reliance on imports over the 1990s.

# Introduction

This report presents an updated picture of Australia's business innovation potential, building on a major investigation undertaken by the University of Western Sydney Macarthur, for the Australian Business Foundation in 1997. That report, *The High Road or the Low Road?*, received significant attention nationally and appears to have played a valuable role in assisting public policy makers to understand the importance and operation of Australia's innovation and production systems.

The present report focuses on the private sector, examining the innovation performance of Australian businesses according to a number of important indicators, namely: innovation propensities and expenditure; R&D expenditure and employment; training and skills; venture capital; machinery and equipment investment; industry structure; and trade patterns. These indicators have been developed by OECD countries to enable international comparisons of performance to be made and because they include all major elements of investment which contribute significantly to innovation.

**Table 1: Innovation Indicators**

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<i>Indicator Type</i>	<i>Value of Indicator</i>
Innovation Propensities and Expenditure	Direct measure of innovation activity (based on OECD designed innovation surveys, only limited data available).
R&D Expenditure	The most widely available and extensively used proxy for measuring the level of innovation activity.
R&D Employment	Provides an important human resource perspective on firms' commitment to innovation.
Training and Skills	Considered by the OECD to be among the 'root sources' of innovation. The quality of human resources impacts on the ability to manage innovation processes.
Venture Capital	Facilitates the commercialisation of R&D outputs and hence the capturing of economic value from new knowledge.
Machinery and Equipment Investment	An indirect measure of knowledge-intensity because it represents R&D embodied in physical capital. Can be a source of process innovation and linked organisational innovation.
Industry Structure	Changes in industry structure reflect movements in the R&D intensity of economic activity. A move towards a more R&D-intensive industry structure increases innovation opportunities and hence growth.
Trade Patterns	Particularly important in relation to the trade balance for R&D-intensive goods and services. The balance reflects our success in transforming R&D and other innovation inputs into commercialised outputs that satisfy international markets.

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Together these indicators measure our ability to transform information into economically useful knowledge and knowledge into new products, processes and services (see discussion in the next section). Further, although some emphasis is placed on the performance of high technology industrial sectors, the report also focuses on other measures of innovation because innovation is not necessarily tied only to the use of advanced technology.

A broad range of innovation indicators is needed because innovation performance is a difficult concept to measure, making consideration of a range of indicators necessary to present a comprehensive picture.

Indeed, a recent review of innovation measures concluded that ‘each measure has some validity, but none can act as a stand alone measure of innovation’ (Rogers 1998: 21). Despite calls for the development of a composite innovation indicator (ISR 1999: viii; Rogers 1998: 21), and some progress towards this goal by a few analysts (eg. US Council on Competitiveness 1999; Melbourne Institute of Applied Economic Research in IR&D Board 1998: 57), current best practice calls for consideration of a range of indicators, as presented in this report.<sup>1,2</sup>

Each specific indicator presented in this report was selected on three criteria:

1. the extent to which it relates to the activity of businesses (rather than to the government or higher education sectors);
2. the extent to which it is considered central in the literature or the extent to which it would usefully expand the scope of analysis; and
3. the extent to which comparable and recent data were available.

The present report provides a stand-alone summary of Australia’s recent progress in improving innovation performance. It does not aim to provide the kind of comprehensive analysis of Australia’s national innovation system we presented in 1997. Readers interested in pursuing a more thorough understanding of the issues are encouraged to refer to *The High Road or the Low Road?*.

The following eight sections present key charts revealing trends in Australia’s business innovation performance and critical international comparisons.<sup>3</sup> Readers will note an emphasis on the manufacturing sector. This is related to the wealth of both international and Australian data available on this sector, which in turn is related to the historical and continuing importance of manufacturing in most advanced OECD countries.

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<sup>1</sup> Although the reports cited produce innovation indexes, in both cases the index is discussed in the context of the range of indicators contributing to the index.

<sup>2</sup> Despite the breadth of indicators touched-on here, it has not been possible to present all available measures. Among those not shown are measures related to knowledge diffusion, scientific publications, patents, designs and trademarks.

<sup>3</sup> The selection of OECD countries use as comparisons is heavily affected by the availability of data. In a number of cases, the most recent data available is several years old.

The focus in innovation data internationally and within Australia is on manufacturing and that focus is reflected in this report. The service sector has been growing fast but the manufacturing sector still contributes most of Australia's R&D and it has one of the highest propensities to innovate compared to other sectors, both in Australia and other OECD countries. Much service activity is also linked to manufacturing and so some innovation there is captured in manufacturing data.<sup>4</sup>

The report is designed to present as current a picture as possible. The limited availability of very recent data, however, especially international data, mean that there is always something of a time lag.

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<sup>4</sup> Section 7 discusses the importance of the manufacturing sector in more detail.

# Background

There is overwhelming evidence that innovation and knowledge-intensity are key factors promoting growth in modern economies. The OECD is the leading international authority on the empirical evidence, drawing together work by several international academic centres as well as government statistical agencies (eg. OECD 1999a; 1999b; 1999c; 1996a), which has been supported by developments in traditional economic theory (see summary in EPAC 1995).

## *Knowledge Economies*

Since the early 1990s, OECD analysts have focussed increasingly on the growing knowledge-intensity of modern economies and the strong links between knowledge-intensity and economic growth such that knowledge-intensive economies have become known as 'knowledge economies'. These economies are 'directly based on the production, distribution and use of knowledge and information' (OECD 1996a: 7).

The 'knowledge' of the knowledge-economy involves:

...something more than information. Information corresponds to the specific elements of knowledge which can be broken down into bits and sent long distances by means of information infrastructures'. (Lundvall 1996: 3)

Rather, economically-useful 'knowledge' corresponds to bits of information that have been transformed by human skills (Lundvall 1996: 3). In turn, innovation involves 'the transformation of knowledge into new products, processes and services' (US Council on Competitiveness 1999: 12).

Innovation becomes more important in the context of a knowledge-based economy. As the new economies develop, high level skills and competencies are needed to turn information into usable knowledge and knowledge into innovations.

Innovation has been shown in turn to flourish most successfully in the context of knowledge-intensive industrial structures (eg. OECD 1999a; 1996a). This is a positive upward spiral. Innovation improves the knowledge-intensity of the industrial structure by encouraging the emergence of new innovative businesses and industries while, at the same time, the knowledge-intensity of the industrial structure will feed the innovation process since new innovative businesses interact with other businesses influencing their capabilities and aspirations.

## *Innovation in all Sectors*

There is a common misconception that only areas such as information and communication technologies (ICT) are the hallmark of a knowledge-intensive economy. It should be understood, however, that while knowledge-intensive industries are likely to grow more rapidly than other industries in a knowledge economy, this trend 'does not signal a science-based economy dominated by high-tech firms' (Lundvall 1996: 3). Innovation in traditional

raw-material based industries, for example, has been critical to economic growth in some European countries (Smith 1998). Indeed, a major new report has concluded that:

Innovation can drive productivity improvement across all industrial sectors. In this sense, there are not 'low tech' industries – only low technology companies that fail to incorporate new ideas and methods into their products and processes. Innovation opportunities are present today in virtually any industry. Although industries producing enabling technologies such as computers, software, and communications have received much attention, opportunities to apply advanced technology are present in fields as disparate as textiles, machinery, and financial services. (US Council on Competitiveness 1999: 12)

Nor is innovation tied only to the use of 'advanced physical technologies'. Changes in the way businesses organise themselves may also be highly innovative and yield rapid growth. R&D statistics capture these organisational innovations only to a limited extent. OECD research suggests that some low R&D-intensive industries may enjoy strong growth due to high levels of innovation based on non-R&D inputs. This research found that:

...the knowledge bases of apparently low and medium technology industries...are in fact deep, complex, science-based and above all systemic (in the sense of involving complex and sustained institutional interactions) (Smith 1998: 1).

This shows that, although R&D statistics tell a large part of the innovation story, they cannot tell the whole story. As far as possible, therefore, the present report considers both R&D and non-R&D indicators.

The notion of a knowledge-economy implies that there has been a change in the basis of competition across *all* sectors. Information, knowledge and ideas, incorporated in innovation processes, now constitute critical competitive competencies in all areas. The success of individuals, firms, regions and national economies depends on their innovation capabilities.

### *A new awareness*

Many OECD countries are now implementing policies explicitly aimed at increasing the knowledge-intensity of their economic systems and promoting innovation (eg. OECD 1999a; 1996a). In the private sector, international business consultants are increasingly stressing the importance of knowledge and innovation to their clients (eg. Arthur D. Little 1998).

Key stakeholders in Australia also acknowledge that Australia's future prosperity relies critically on our innovation potential. For instance, the Prime Minister's Science, Engineering and Innovation Council has stated that:

As we move into the next millennium, Australia must be at the leading edge of innovation to capture the opportunities offered to knowledge-based economies. (PMSEIC 1999: 14)

The Prime Minister endorses these views, suggesting that 'science and innovation play a vital role in our social and economic development' (Howard 1998). Business and union leaders similarly support the development of an innovative Australia (eg. BCA 1999; ABF 1997; AMWU 1997). This report checks our progress towards our goals.

# Section 1: Innovation Propensities and Expenditure

Since 1992, when the OECD established guidelines for collecting and interpreting technological innovation data, a number of OECD countries have undertaken innovation surveys. In Australia, the ABS has conducted two innovation surveys of manufacturing businesses.<sup>5</sup> The first survey covered the period 1991 to 1994 and the second survey covered the period 1994 to 1997.

These surveys were based on concepts and standard questions developed jointly by the OECD and Eurostat. The surveys focused on technological innovation which is defined as ‘new products and processes and significant changes of products and processes’ (ABS 8116.0). The key results are summarised below.

**Table 2: Change in Proportion of Manufacturing Businesses Undertaking Technological Innovation, 1991 – 1994 to 1994 – 1997**

<i>Total Manufacturing Sector</i>	<i>Small Firms (less than 10 employees)</i>	<i>Large Firms (10 or more employees)</i>
<ul style="list-style-type: none"> <li>• fell 6 percentage points</li> <li>• from 32 to 26 per cent</li> </ul>	<ul style="list-style-type: none"> <li>• fell 8 percentage points</li> <li>• from 27 to 19 per cent</li> </ul>	<ul style="list-style-type: none"> <li>• fell 3 percentage points</li> <li>• from 50 to 47 per cent</li> </ul>

Source: ABS 8116.0

Overall, the ABS innovation surveys reveal a drop in the rate of technological innovation in the manufacturing sector between the two periods, from 32 per cent to 26 per cent. This fall was most pronounced among smaller businesses. The ABS suggests that the rate of technological innovation in the manufacturing sector is directly related to business size, measured by employment levels.

The survey results suggest that innovating businesses are more productive. The 1996-97 survey showed that turnover-per-employee was over 50 per cent higher for technologically innovating businesses than for businesses which did not undertake technological innovation.

Both surveys found that product innovation was more commonly undertaken than process innovation. In the first survey the innovation rates were 30 and 23 per cent respectively, compared to 23 and 18 per cent respectively in the second survey.

In terms of specific industries, the petroleum, coal, chemical and associated product industry recorded the highest rate of technological innovation in both surveys. The textiles clothing and footwear industry had the lowest rate of technological innovation in the 1996-97 survey, very closely followed by the wood and paper product industry. These two industries also had the lowest rates of technological innovation in the 1993-94 survey.

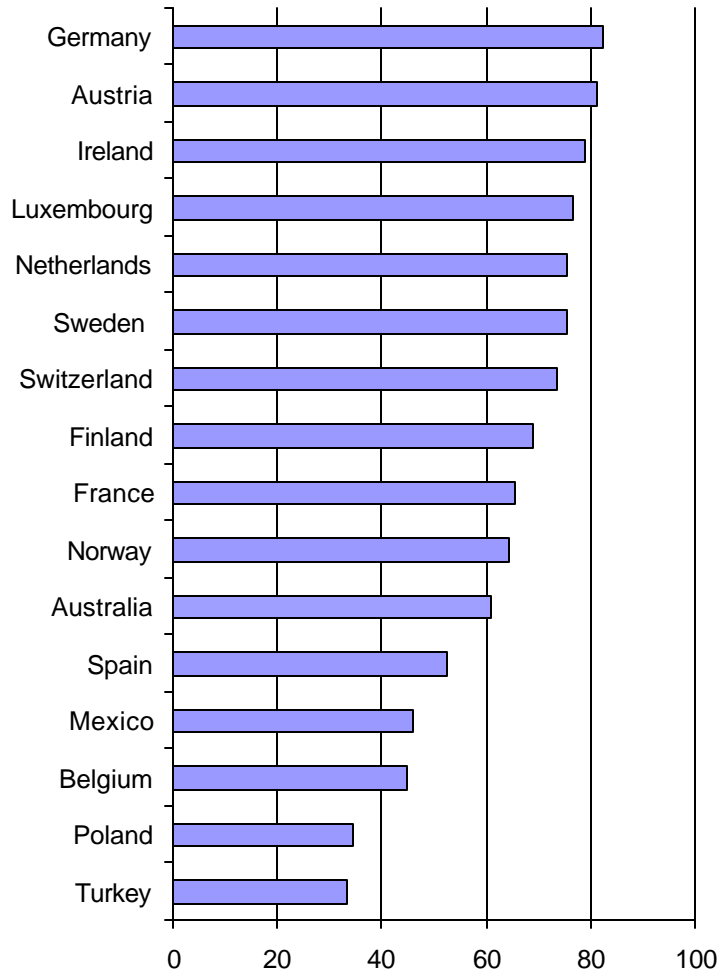
The overall decline in innovation activity shown in Table 2 has been widely attributed to changes in government programs to support innovation activity, most notably the reduction in

<sup>5</sup> Although other sectors have been surveyed, comparable time series data were only available for the manufacturing sector at the time of writing.

the maximum rate of assistance available under the R&D tax concession from 150 per cent of eligible expenditure to 125 per cent in August 1996. If this claimed connection is correct it suggests that businesses in Australia have not fully accepted the need for investment in R&D as a normal business expense as might be expected in a knowledge-intensive economy.

The following charts review Australia's innovation performance in the international context. The results show cause for concern.

**Figure 1: Proportion of Manufacturing Firms with 20 or More Employees Undertaking Technological Innovation, 1994-96, Various OECD Countries**



Note 1: Differs from ABS rate of technological innovation because figures relate to the activities of firms with 20 or more employees. Note 2: Australia: 1994-1997; Turkey: 1995-1997

Source OECD 1999a: 170

Australia is ranked sixth last in this table of 16 countries.<sup>6</sup> Australia's industrial structure is likely to have contributed to our relatively low ranking. This is in part because, as ABS data reveal, the propensity to innovate is higher among larger firms and, compared with the leading countries shown, Australia's manufacturing sector contains a much higher proportion of smaller firms. This pushes our overall rate of innovation downwards. Hence, when

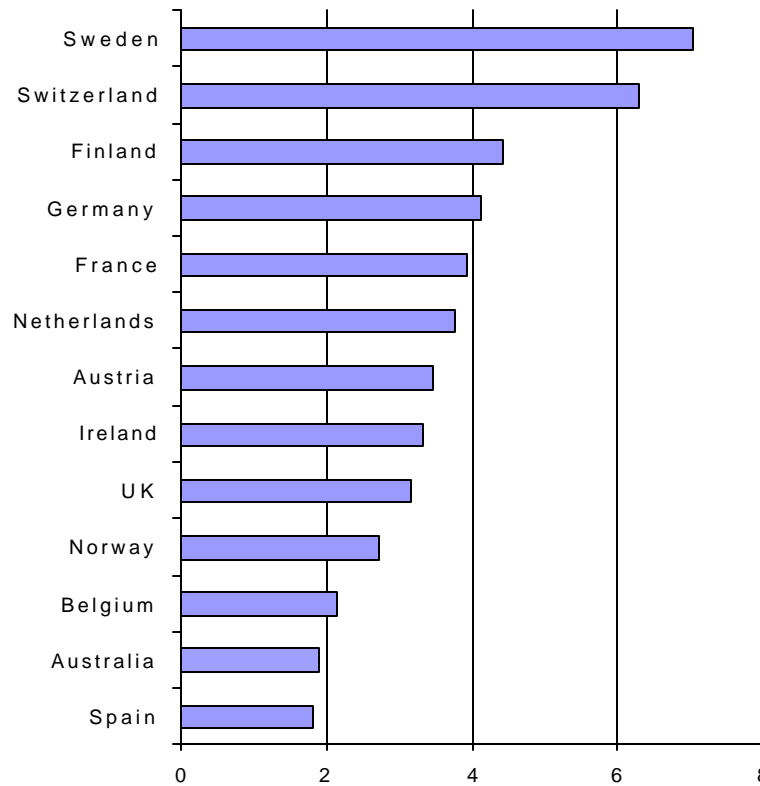
<sup>6</sup> The ABS advises that our relative performance, though still poor, may be better than indicated due to differences in survey design and survey response rates between countries.

international technological innovation rates are compared for firms with between 20 and 49 employees (ie. excluding larger firms), we move up to rank sixth highest out of the 16 countries (OECD 1999a: 170).

Negative influences on Australia’s ranking might also include poor management attitudes toward innovation (discussed in Section 4); and inadequate venture capital availability (discussed in Section 5).

Not only is the proportion of manufacturing firms undertaking technological innovation relatively low in Australia but expenditure as a proportion of sales is also low by OECD standards. Australian technological innovation expenditure as a proportion of sales is compared internationally below.

**Figure 2: Expenditure on Technological Innovation as a Percentage of Total Sales, Manufacturing Sector, 1996, Various OECD Countries**



Source: OECD 1999a: 146

Australia’s performance is very poor in this context. Again, our industrial structure may provide a partial explanation. Australia is home to very few head offices of multinational businesses. Research shows that most of the R&D conducted by such businesses is still likely to be centred close to the head office (Marceau in press). In this way, Australia’s industrial structure is likely to have a negative impact on innovation intensity measures.

Other possible explanations for our low ranking here too include poor management attitudes toward innovation (Arthur D. Little 1998) and limited venture capital availability for high-risk, innovation-intensive start-up enterprises (ISR/Howard Partners advice 1999).

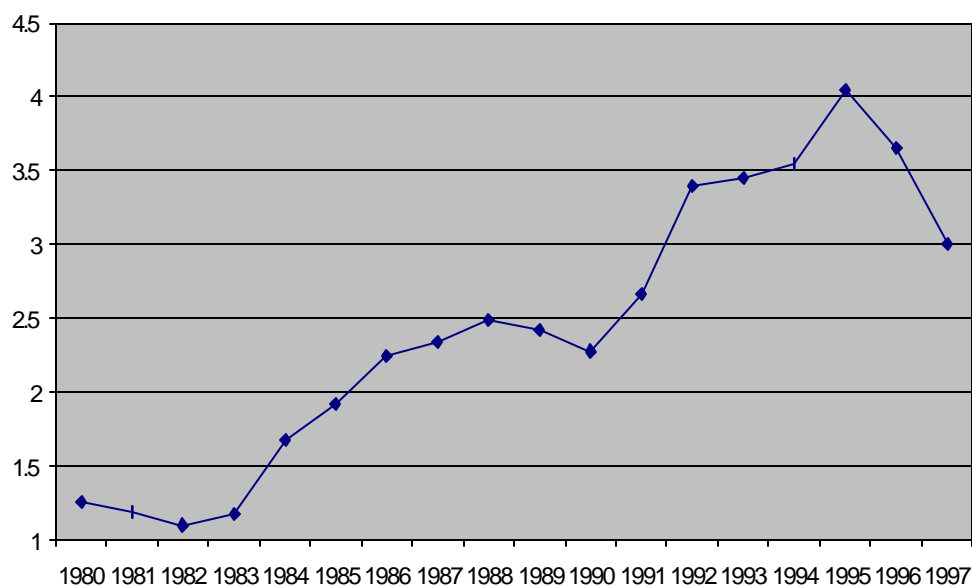
## Section 2: Business Research and Development Expenditure

R&D expenditure is a common and valuable proxy measure for innovation because R&D is a key input to innovation processes. Although R&D data does not allow investigation of all elements of innovation,<sup>7</sup> it does provide a reasonable and widely accepted indication of the level of investigative activity being undertaken to produce new economically-useful knowledge.

This section overviews business expenditure on research and development (BERD) in the manufacturing and service sectors. These sectors have been selected because they contain the core knowledge-based industries in OECD economies – those shown to be key elements of national innovation systems (OECD 1999a, 1999b, 1999c).

The figure below shows Australian business expenditure on research and development in the manufacturing sector.

**Figure 3: Australian Manufacturing Business Expenditure on R&D as a percentage of Value-Added, 1980-1997**



Note 1: Figure for 1997 is based on ABS 8104.0 for 1997/98 and OECD 1999, Stan Database. The ABS advise that an unknown proportion of the reduction in business expenditure on R&D in 1997 may be attributable to ABS activity in reviewing the classification of businesses assigned to the manufacturing sector which resulted in a fall in the number of businesses in the sector. Note 2: Value-added is considered the best denominator for R&D intensity measures (see Sheehan 1995: 87). Note 3: The ABS introduced more comprehensive survey techniques in 1985, so that prior to that date ABS, and therefore OECD, R&D expenditures may have been understated. Note 4: The ABS advise that OECD data for, say, 1997, is actually the ABS data for 1997-98. Hence, the impact of the reduction in the R&D Tax Concession is likely to be reflected in the OECD's 1996 data.

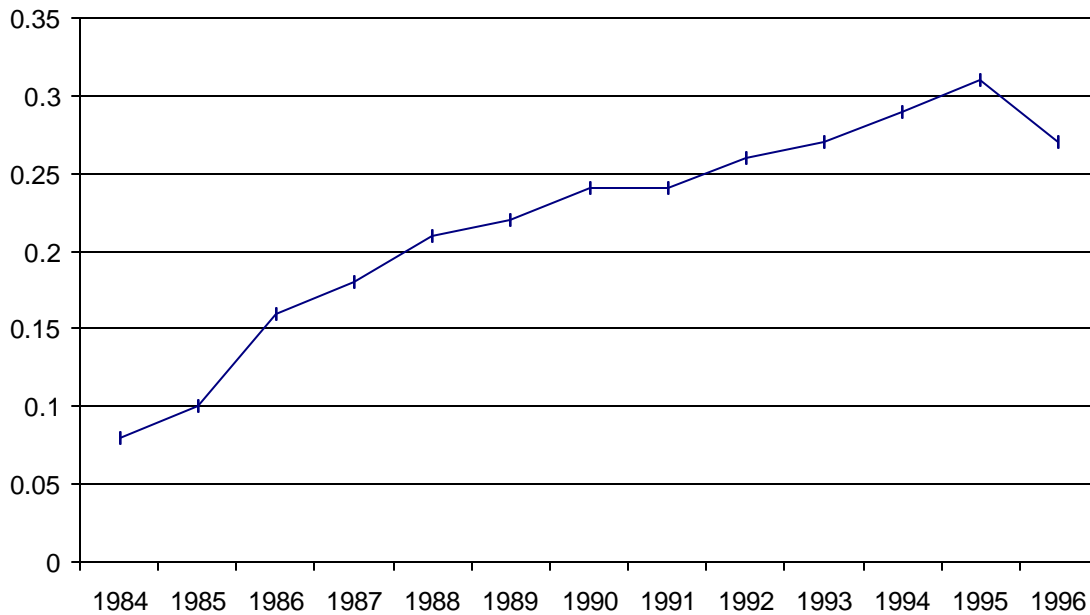
Source OECD 1999 Main Industrial Indicators Database; OECD 1999 ANBERD Database; OECD 1999 STAN Database; ABS 8104.0

<sup>7</sup> Such as: knowledge bases; knowledge diffusion; low-risk innovation; commercialisation of ideas; and diffusion of innovations.

Manufacturing BERD as a proportion of value-added showed consistent and rapid growth over the early to mid-1990s, reaching a high point in 1995. Since that time, the proportion has been falling – dropping 9.6 per cent between 1995 and 1996 (with the OECD figures being based on ABS figures for 1995/96 and 1996/97 respectively) and 18 per cent between 1996 and 1997 (based on ABS figures for 1996/97 and 1997/98).<sup>8</sup>

The pattern of early 1990s growth in service sector R&D intensity is reported below.

**Figure 4: Australian Business Expenditure on Research and Development, Service Sector, as a Percentage of Value-Added, 1980-1996**



Note: In the time available, it has not been possible to estimate a comparable figure for 1997.

Source OECD 1999 Main Industrial Indicators Database

As with the manufacturing sector, the service sector has seen rapid growth in the proportion of value-added devoted to R&D over the 1990s, reaching a high point in 1995. This was followed by a 13 per cent fall in 1996 (based on ABS 1996/97 figures). In contrast to the situation in manufacturing, however, ABS data suggest that service sector BERD shifted back and *increased* between 1996/97 and 1997/98 (although it should be noted that a comparable ratio is not yet available for 1997 and, if value-added increased faster, the ratio may fall again).

In absolute expenditure terms, the falls in BERD have been less pronounced. Manufacturing and service sector BERD fell in 1996/97, compared to the previous year, by only 1.4 per cent and 8.4 per cent respectively. In the following year, the rate of decline increased in the manufacturing sector to 5.3 per cent while the service sector recovered, with 6.7 per cent growth. Overall, total BERD fell 3.3 per cent in 1996/97 compared to the previous year, and 3.7 per cent in 1997/98 compared to 1996/97 (ABS 8104.0). These reductions in activity,

<sup>8</sup> It is possible that ABS changes to classification of manufacturing businesses have exacerbated the manufacturing sector fall in BERD recorded to 1997/98.

though relatively small compared to the proportional figures, are significant.<sup>9</sup> The fall in total BERD between 1995/96 and 1996/97 is especially striking because it represents the first decrease in BERD recorded by the ABS since starting to measure R&D expenditure in the mid-1970s (House of Representatives Standing Committee on Industry, Science and Resources 1999: 23).

Other data sources similarly reveal reduced R&D activity by Australian businesses in recent years. For example, there was:

- a 32 per cent fall in businesses using the R&D tax concession from 1996 to 1998 (Tabakoff and Featherstone 1999: 54); and
- a drop in R&D expenditure (as a percentage of turnover) by 33 of Australia's top 50 R&D performing businesses between 1997 and 1998 (Walker 1998: 3).

A number of factors could explain the drop in R&D activity witnessed in Australia over the last few years. These include increasing pressure on multinationals to reduce costs as a result of competitive pressures arising from rapid globalisation of economic activity; accompanied in some cases by a shift to undertaking R&D in cheaper areas of the world. There may also have been a shift to more informal methods of innovation that are not reflected in R&D statistics (eg. low-risk, customer-initiated innovations). However, the abrupt nature of the turnaround in R&D activity and the timing of the change suggest that the decline is likely to be related to policy announcements made in 1996, involving:

- a reduction in the rate of the tax concession for R&D from 150 per cent to 125 per cent;
- reduced scope to claim the concession because of changes to key definitions and lodgement provisions; and
- termination of the R&D syndication scheme.

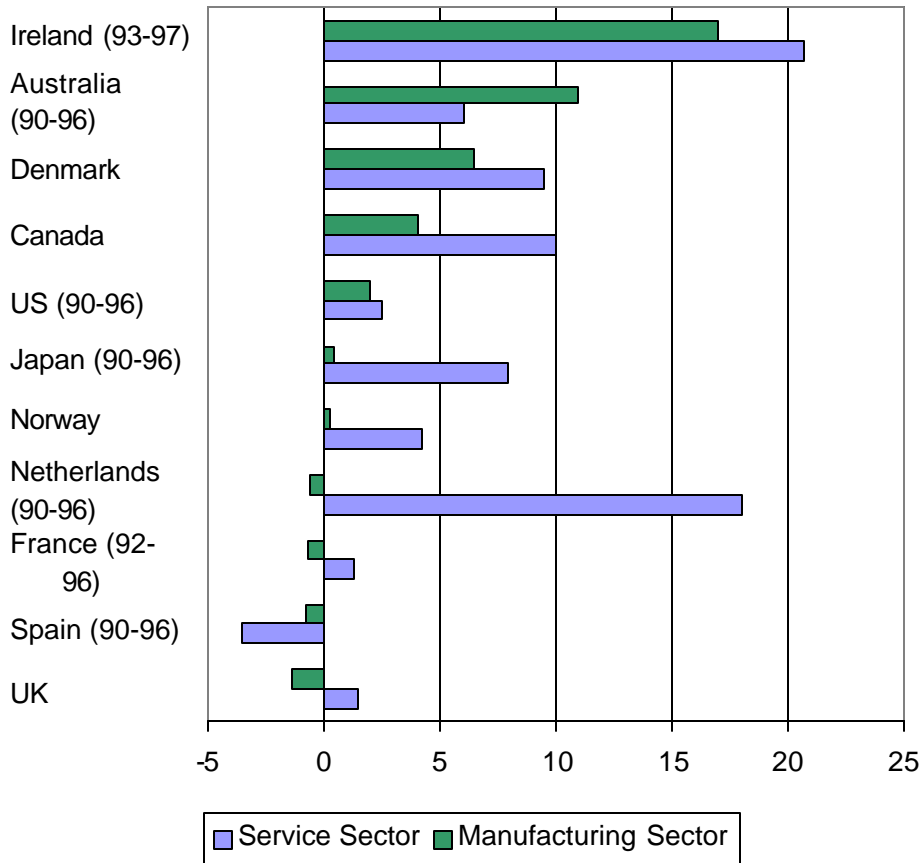
Australia's negative R&D trends are of great concern given that the innovation literature invariably stresses the importance of a 'vibrant research base' in the new competitive circumstances, and particularly business involvement in that research base. The significance of a robust R&D effort was emphasised in the Australian context as recently as August 1999, with the House of Representatives Standing Committee on Industry, Science and Resources 'stress[ing] the importance of maintaining an indigenous R&D capacity' (1999: 31).

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<sup>9</sup> In any case, changes in absolute expenditure are probably of less interest than changes in expenditure *as a proportion of value-added* – as the latter indicator captures firms' commitment in the context of the size of their operations.

The figure below compares our manufacturing and service sector BERD performance during the 1990s with that of other OECD nations.

**Figure 5: Business Expenditure on Research and Development, Average Annual Growth, Manufacturing and Service Sectors, Selected OECD Countries, 1990-1997, %**

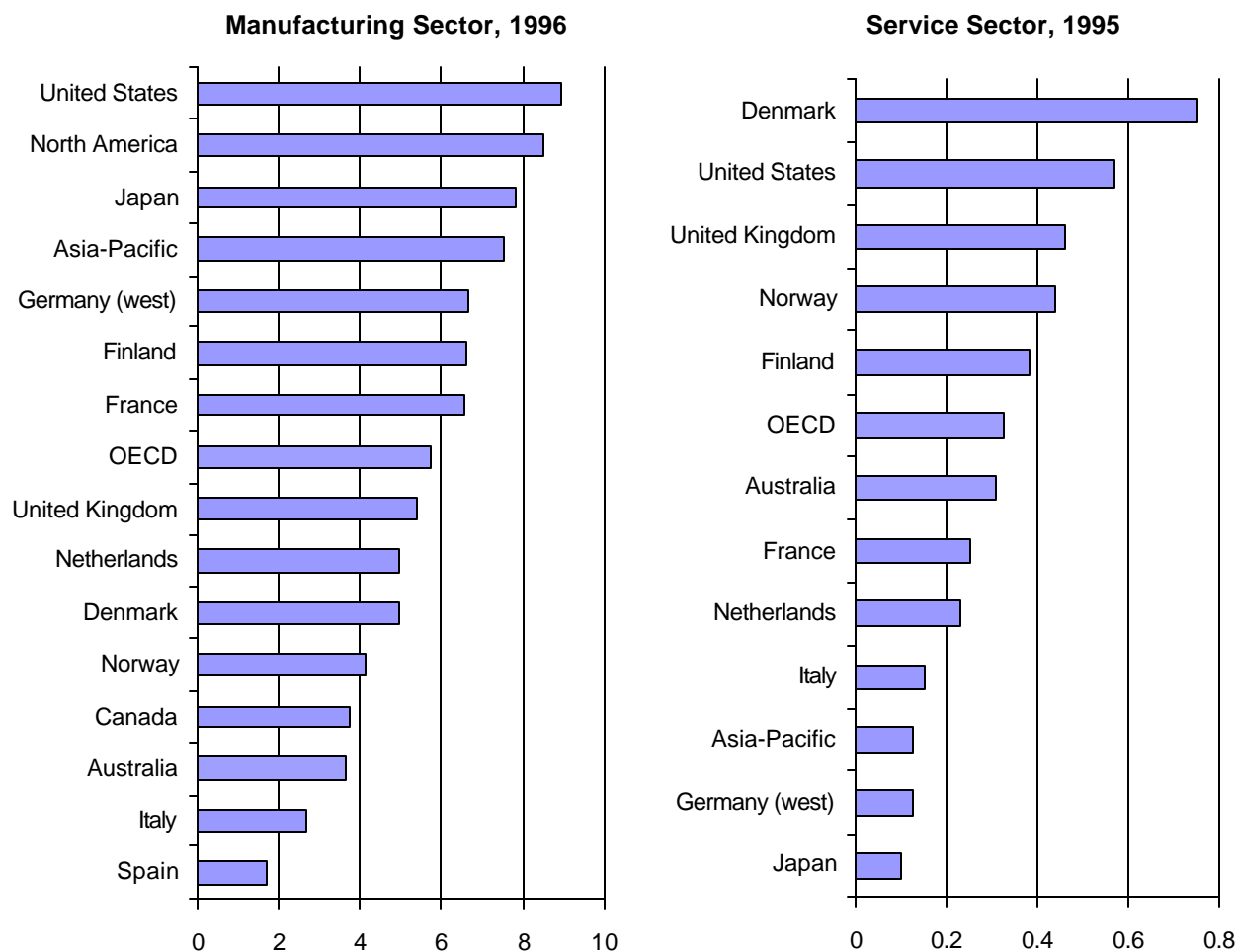


Source: OECD 1999a: 47

Figure 5 shows that of the eleven countries ranked by manufacturing sector R&D growth over the period 1990-1997, Australia is in second place. Ranked by service sector R&D growth over the same period, Australia is placed sixth. Even when placed in international context, therefore, Australian R&D intensities thus showed very strong growth over the period. It should be noted, however, that this growth was from a very low base.

The chart below ranks Australian manufacturing and service sector R&D investment as a percentage of value added in the context of various OECD countries' performance in the latest available year. Again it shows that services did very well.

**Figure 6: BERD as a Percentage of Value Added, Various OECD Countries**



Note 1: OECD figure for both sectors is the average for the countries shown in each chart (excluding Australia).  
 Note 2: BERD is shown as a percentage of value-added by the relevant sectors.

Source: OECD 1999 Main Industrial Database

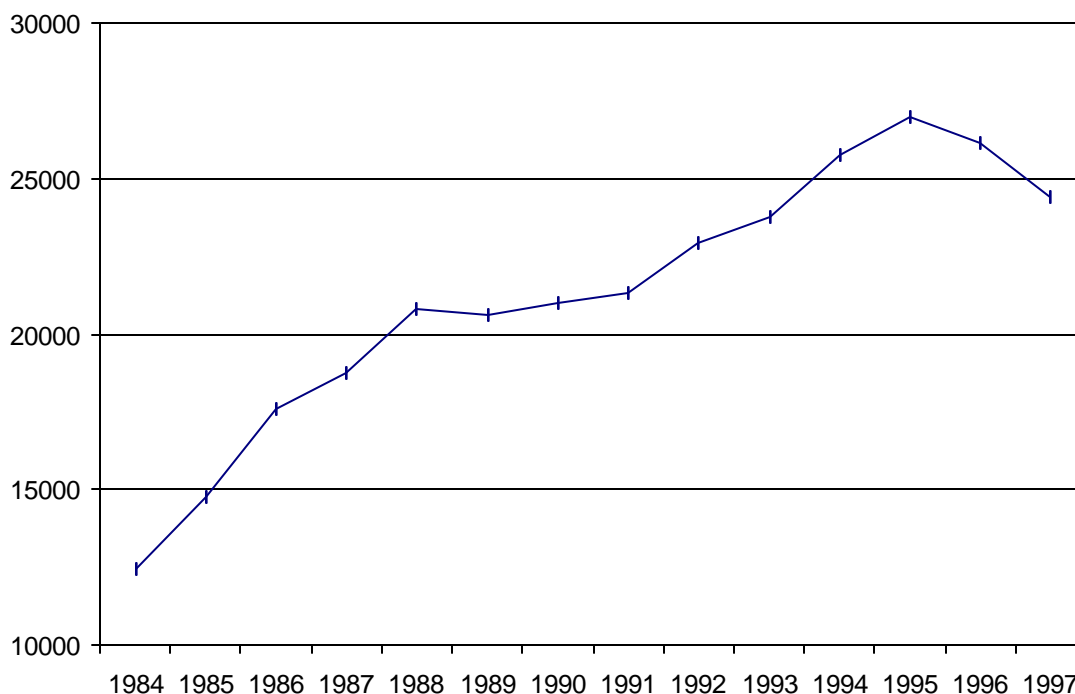
Australia is thus clearly closer to OECD averages in the services sector than in manufacturing.

In order to maintain strong growth rates, the negative trends which have emerged in recent years will need to be addressed. Legislation passed earlier this year to improve access to the R&D concession and reduce compliance costs (ISR 1999b and ISR 1999c) is a step in the right direction. The decline in private sector investment in R&D would be less serious if it were compensated by significant increased public sector investment. It is generally recognised that universities are critical in Australia's knowledge-generation system but Commonwealth expenditure on higher education research as a proportion of GDP has declined in recent years (see Appendix B).

## Section 3: Business Employment in Research and Development

Business research and development activity can also be usefully analysed by employment trends. The chart below shows Australian trends.

**Figure 7: Business Enterprise R&D Personnel, Australia, 1984-1997**



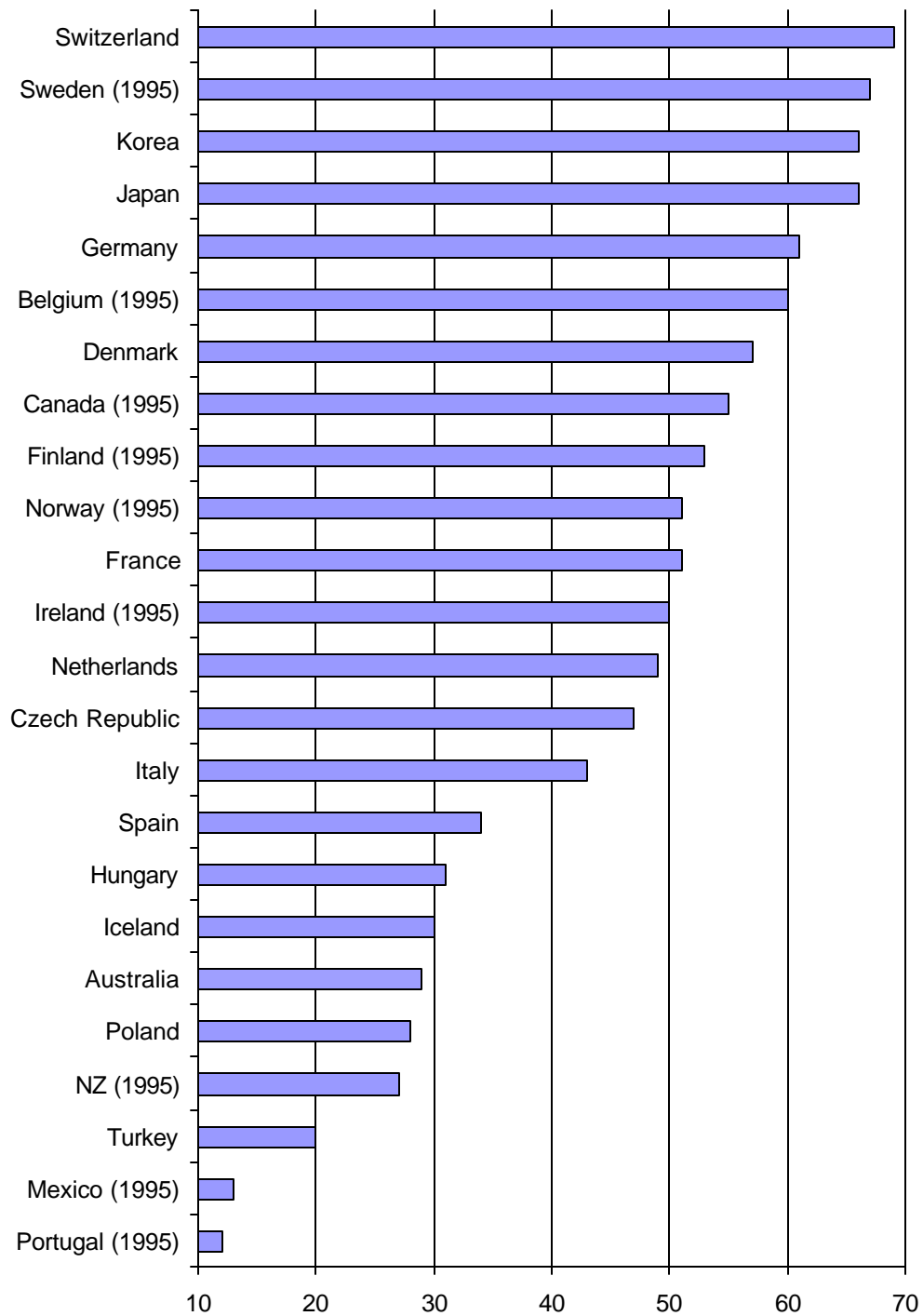
Note 1: Based on 'full-time equivalent' (FTE) measurement of human resource employment. Note 2: The 1997 ABS figure excludes businesses in the Agriculture, Forestry and Fishing industries and it is likely that the OECD figures for the previous years similarly exclude these industries.

Source: OECD 1999 MSTI Database; ABS 8104.0

The first decline in the number of R&D employees in 12 years was recorded in 1996. The fall may also be related to the drop in the rate of assistance provided by the R&D tax concession in 1996 and seems clearly an indication of reduced investment in R&D. This change is reflected in the OECD's 1996 data because it is based on ABS 1996/97 data (ABS advice). Between 1995 and 1997, the number of R&D personnel fell 9.5 per cent. While 1999 figures are not yet available, it is known that the top R&D performing corporation in Australia, BHP, shed more than 100 scientists during the year (industry advice).

The reversal of Australia's long-running upward trend is of serious concern, particularly given our poor international standing, as shown in the following figure.

**Figure 8: Business Enterprise R&D Personnel as a Percentage of Total R&D Personnel, Various OECD Countries, 1996**



Note 1: Countries shown are those for which data is available. Note 2: Total R&D personnel is made up of business, government and higher education R&D personnel.

Source: OECD 1999 MSTI Database

Of the 24 countries shown, Australia is ranked sixth last, appearing between Iceland and Poland. The contrasts with the top performers are striking. The situation in Australia relative to that of other smaller economies such as Finland, Norway, Ireland, the Netherlands or the Czech Republic is in some ways even more worrying because of both size and some structural similarities in the economies of these nations when compared to Australia. In particular, it should be noted that the Netherlands has almost exactly the same population and GDP as Australia and yet Netherlands enterprises employ proportionately almost twice the proportion of R&D personnel as do Australian businesses.

In the international context, Australian business involvement in employing R&D personnel, as a proportion of total R&D personnel employed (which includes government and higher education sector employment), is poor. The figures are somewhat affected by the presence in Australia of the CSIRO, a major public-sector research system. However, France has an equivalent public-sector system but still maintains a business R&D personnel proportion that is nearly twice that of Australia.

## Section 4: Training and Skills

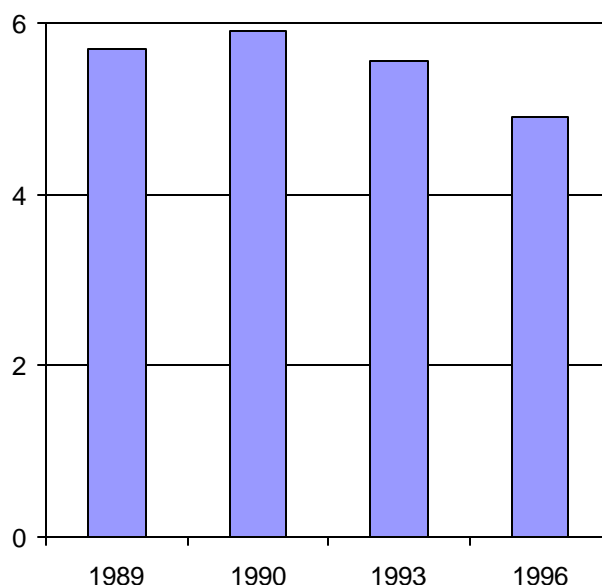
The OECD's work on innovation and knowledge economies emphasises the increasing importance of high-level training and skills in creating economic value through innovation. The following key points are made:

- Governments in OECD countries are ...reinforcing the basic framework conditions for industrial innovation, and in particular concentrating on the promotion of a highly skilled labour force and a vibrant research base (OECD 1999d: 1).
- [U]pskilling is clearly under way in OECD economies, as high-skilled workers take a larger share of total employment and the demand for low-skilled workers declines. ...Despite the different distribution of skills in manufacturing and services, upskilling is occurring in both sectors (OECD 1997: 4).

If Australia is going to be competitive in the global context, we also will need a good supply of well-trained and highly-skilled workers and managers. Investment in training and higher education, however, is often poor by international standards, and falling.

The chart below shows available Australian training data.

**Figure 9: Training Hours per Employee, Australia, Various Years**



Note 1: Covers employers in the private and public sectors but excludes employers in the agriculture, forestry and fishing industries. Note 2: No other years available. Note 3: Data covers a three month reference period – July to September.

Source: ABS: 6353.0

Figure 9 shows that the level of commitment by businesses in the private and public sectors to training has fallen approximately 17 per cent from the peak reached at the beginning of the decade. This reduced performance is likely to be related to the termination of the Training Guarantee Levy in 1994.

It is also possible to examine the skill level of Australia's labour force. A recent report by the Department of Industry, Science and Resources employs OECD data to examine shifts in employment based on the following four skill classes:

- white-collar, high-skill;
- white-collar, low-skill;
- blue-collar, high-skill; and
- blue-collar, low-skill.

The OECD highlights the importance of growth in white-collar, high-skill jobs to sustainable economic growth.

For the period 1986 to 1991, the OECD data shows that:

... [i]n Australia's manufacturing sector, the only category which registered growth in employment was white-collar, high-skilled. In the services sector, too, the highest rate of growth was registered for the high-skilled, white-collar workers.' (ISR 1999a: 5)

These are certainly good results. However, *The High Road or the Low Road?* analysed the same data set and concluded that the *ratio* of white-collar, high-skilled employment to white-collar, low-skilled employment fell slightly over the period 1986 to 1991 (Marceau et al 1997: 8.18). There thus appears to have been some falling-off in the growth trend between 1986 and 1991.

Australia's growth in white-collar, high-skilled jobs can also be reviewed in the international context. Australia's growth in higher skilled jobs in the service sector between 1986 and 1991 was good, ranking equal second highest of ten countries examined. However, in the manufacturing sector, Australia's growth in such jobs over the period was the equal fourth lowest of the ten countries examined (based on OECD data presented in ISR 1999a: 50-51).

Overall, these OECD data indicate mixed results. To assess our own recent trends, more recent Australian data are now reviewed. Such data is based on the Australian Standard Classification of Occupations (ASCO). The classification system assigns skill levels to occupations as shown in the chart below:

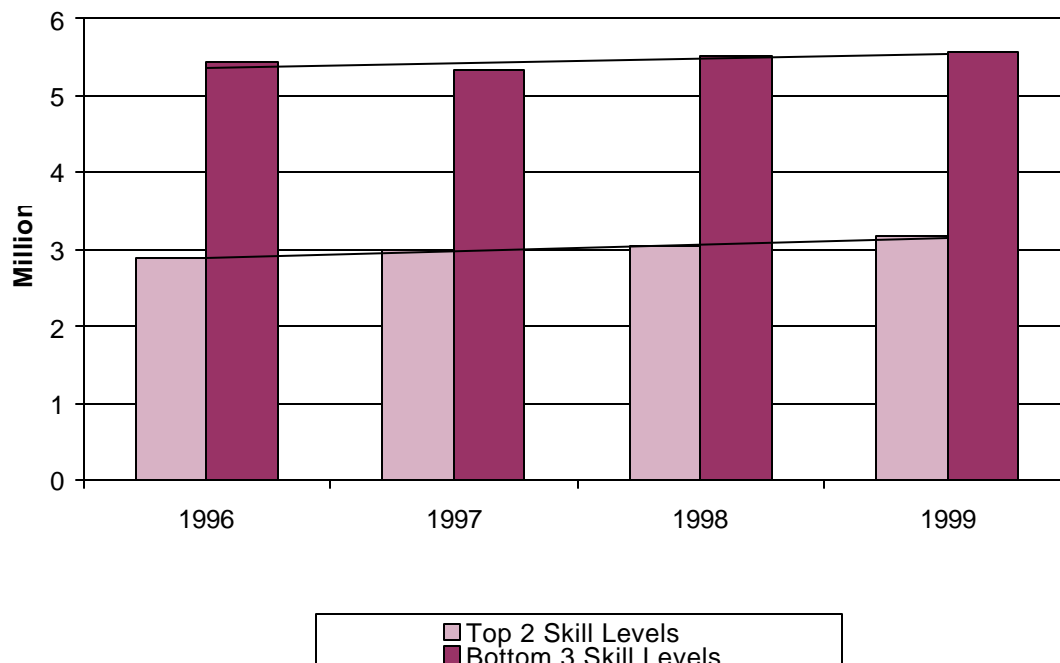
**Table 3: Australian Standard Classification of Occupations, Second Edition**

<i>Major Group</i>	<i>Skill Level</i>
1. Managers and administrators	1
2. Professionals	1
3. Associate Professionals	2
4. Tradespersons and related workers	3
5. Advanced clerical and service workers	3
6. Intermediate clerical sales and service workers	4
7. Intermediate production and transport workers	4
8. Elementary clerical sales and service workers	5
9. Labourers and related workers	5

Source: ABS 1220.0

This information can be used to chart Australia's progress in generating employment in higher-skilled and lower-skilled occupations. The chart below reviews growth in occupations classified to the top 2 skills levels, rather than growth in occupations classified to the bottom 3 skill levels.<sup>10</sup>

**Figure 10: Persons Employed by Skill Level, Australia, 1996-1999<sup>11</sup>**



Note 1: The data are revised August figures from ABS 6203.0 in view of the latest census information. Note 2: Full-time plus part-time.

Source: ABS unpublished data

Figure 10 needs careful interpretation. Between 1996 and 1999, employment in the occupations assigned to the top 2 skill levels increased 10.2 per cent, while employment in the remaining occupations only increased 2.3 per cent. This is a very positive result given the importance of skills in sponsoring innovation. However, the *trend rates of growth* for the two broad occupational groupings over the period were very similar, with trend growth in high-skilled jobs being only slightly higher.

Given the international move towards developing knowledge-based economies as the basis of competition, it would be desirable for the top skill-level occupations to show a substantially *faster* trend rate of growth than the bottom skill-level occupations. There is thus room for considerable improvement in overall rates of growth in higher-skilled occupations.

<sup>10</sup> The results are not greatly affected by whether one, two or three skill levels are taken to represent the high skill class.

<sup>11</sup> Earlier data is based on ASCO First Edition. The ABS advises that the available method for achieving concordance is unlikely to produce a very satisfactory result, so a longer time series can not be presented.

Further, the similarity of trends between the two broad skill groups appears to have emerged only in recent years. Earlier Australian Bureau of Statistics data reported in *The High Road or the Low Road?* showed that employment in high-skilled occupations was growing more slowly than employment in low-skilled occupations.<sup>12</sup> It is likely that the improvement in growth of high-skilled jobs is related to the rapid growth of knowledge-based industries (shown in Figure 16 later in the report). There is a need to ensure that more recent trends continue and are enhanced.

Recent reports indicate that the *quality* of critical innovation skills evident within knowledge-intensive occupations is less than optimal. This is particularly so with respect to Australian managers. Indeed, this conclusion was reached in *The High Road or the Low Road?* (1997: 8.20), based largely on data reported in the Karpin report (1995).

A survey by Arthur D. Little in 1997 suggests that the situation did not improve much in the years after Karpin's study. Arthur D. Little investigated the skills of Australian managers in capturing value from innovation by comparing survey-based attitudinal data against actual performance and world trends. The key conclusions drawn in the report were that, compared to their overseas counterparts, Australian managers:

- Under-rated the importance of product and service innovation (although not process and business innovation)

This poor appreciation of the importance of product and service innovation was seen to reflect an emphasis on incremental innovation aimed at streamlining existing operations in order to lower costs rather than developing new ways of competing through market offerings. This approach may achieve cost reductions, but is unlikely to 'create new opportunities needed to fuel sustainable growth' (Arthur D. Little 1998: 2) and may contribute to reduced employment opportunities.

- Had relatively low expectations of capturing value from innovation

Australian managers tend to focus on innovations in managing the supply chain, (perhaps focussing on cost rather than quality and other aspects of increased competitiveness). Such an approach may only result in 'one-time cost reductions' but failed to deliver sustainable competitive advantage.

- Ranked their own innovation performance very highly

This self-perception was seen by Arthur D. Little to sit uneasily with the evidence. The report noted: 'Perceived 'parity performance level[s]' on the part of Australian companies [are] just not the case.' (1998: 3).

- Felt they were well prepared to maximise value from innovation

Again, this view was seen by Arthur D. Little to sit uneasily with the evidence. The report raised the concern that 'Australian managers are not aware of actual best practices being used elsewhere in the world' (1998: 15).

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<sup>12</sup> The data shown in *The High Road or the Low Road?* are based on a slightly different skill-classification of occupations. It was not possible to replicate that classification as the ASCO classification system changed in 1996.

- Tracked and measured innovation less frequently than any other country surveyed.

The report highlighted ‘the risk that Australian companies are running by neglecting to treat innovation as a measurable business process’ (1998: 20).

In summary, the report observed that:

Australian executives have lulled themselves into a false sense of security while competitors around the world are able to accelerate performance and further distance themselves from the average performance of Australian companies. (1998: 3)

The recent report of the House of Representatives Standing Committee on Industry, Science and Resources noted another area where Australian management skills were frustrating innovation performance. The report highlighted the paucity of venture capital management skills in Australia. Many finance managers lack ‘experience in assessing the risk context of a commercial activity that is highly R&D dependent.’ (1999: 123).

Given the importance of human resources in facilitating innovation, it is vital to improve skill levels (especially among managers), increase job growth in highly-skilled occupations and reverse the negative trends in training investment performance by firms.

## Section 5: Venture Capital

OECD work emphasises the importance of venture capital to innovation performance, noting that:

... the results of research and development must be effectively translated into commercial outcomes. Access to finance is seen as a key factor in this process of innovation. Venture capital, as a specific type of finance that has been developed to fund high-risk projects, has an important role to play in this connection. In knowledge-based economies, economic growth and job creation increasingly. (1996b: 5)

The results of a survey of venture capital in Australia and New Zealand are shown below.

**Table 4: Venture Capital Investment, Australia and New Zealand Venture Capital Sector, 1996/97 to 1998/99, A\$m**

<i>Year</i>	<i>A\$m</i>
1996/97	391.4
1997/98	386.5
1998/99	681.5

Source: Australian Venture Capital Journal/PriceWaterhouseCoopers Venture Capital Survey, Australian Venture Capital Journal, September Issue 1999 and 1997.

These data show rapid growth in the amount of venture capital invested by the sector in businesses over the past year. Overall investment increased 76 per cent between 1997/98 and 1998/99. Indeed, it appears that venture capital investment in Australia has shown an upward trend over the 1990s (ISR advice). This is particularly encouraging given the importance of venture capital to successful commercialisation of R&D and hence innovation we noted above.

Further, a recent survey by PriceWaterhouseCoopers shows that the proportion of early-stage companies that receiving venture funding has grown over recent years, albeit from a low base (1998: 4). This is encouraging as the early stage sector is of critical importance to economic growth. Significant levels of start-up funding have been received by firms in the health, medical, biotechnology and IT sectors (1998: 4).

Industry sources suggest that the Australian venture capital industry has re-emerged over the 1990s, following the stock market crash of 1987. Government programs are seen to have played a major role in providing appropriate incentives. Both the Pooled Development Funds (PDF) program and the Innovation Investment Fund (IIF) program seem to have been critical. The venture capital sector is now putting more emphasis on early-stage, high-technology firms through newly established funds that have been created under the IIF program. (ISR/Partners advice 1999)

Growth in the availability of funding for seed and start-up businesses is also seen to be reliant on growth in Australia's informal venture capital sector via, for example, so-called 'business angels'. Indeed, there are signs that this sector is growing strongly. (ISR/Howard Partners advice 1999).

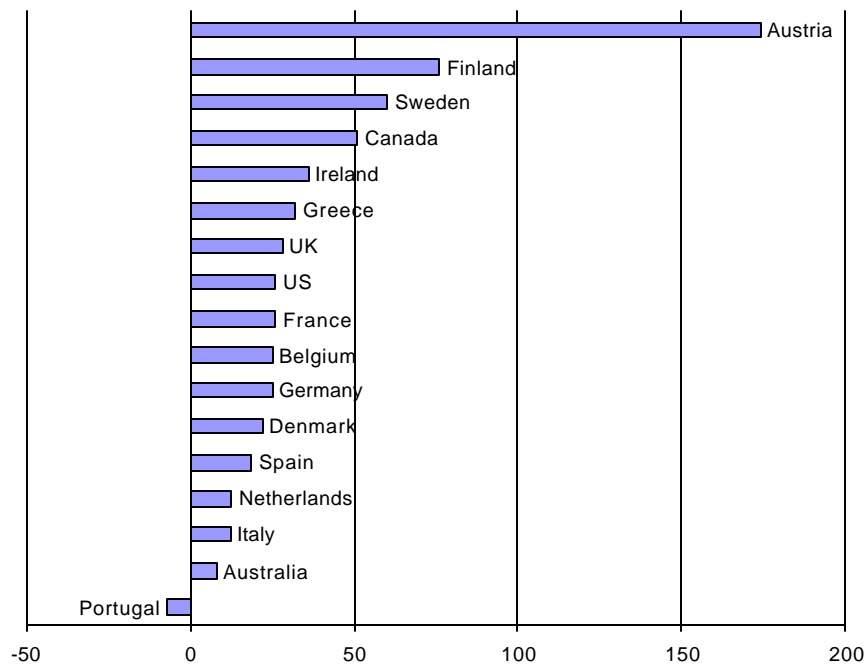
There is also scope for improvement in the adverse impact of the current taxation system on Australia's venture capital industry. The report of the Ralph Review of business taxation observed that 'Australia's relatively harsh capital gains tax (CGT) regime impacts adversely on venture capital investments...consequently the Review is recommending significant CGT relief for venture capital' (1999: 78). The Federal Government has supported most of the Review's recommendations regarding the CGT and the venture capital industry. It is likely that these changes and the continuation of programs such as the Innovation Investment Fund will mean that Australia's available pool of venture capital will continue to improve.

Improvement is also anticipated in terms of the structure of Australia's venture capital investments, which currently focus too heavily on short-term, late-stage opportunities (ISR/Howard Partners advice 1999). For instance, of the \$681.5m invested in 1998/99, only 19.1 per cent was directed towards early-stage sectors (seed, start-up and early expansion capital) where major capital shortages exist. This focus was confirmed by a survey undertaken by Arthur Anderson/AVCAL in 1998 which reveals that 'the predominant form of [venture capital] investment in Australia is in expansion opportunities' (AVCAL Website). The PriceWaterhouseCoopers Survey makes the same point (1998: 8).

Indeed, further growth in all sectors is required. The recent report of the House of Representatives Standing Committee on Industry, Science and Resources emphasised that limited access to venture capital remains a major problem for small innovative businesses in Australia (1999: 105-119).

It is also important that current positive trends are maintained and enhanced in order to improve Australia's performance in the international context.

**Figure 11: Investment in Venture Capital, Average Annual Growth, 1995-1997, Various OECD Countries, %**



Note: Figures do not include 'business angel' investments.  
 Source: OCED 1999a: 55

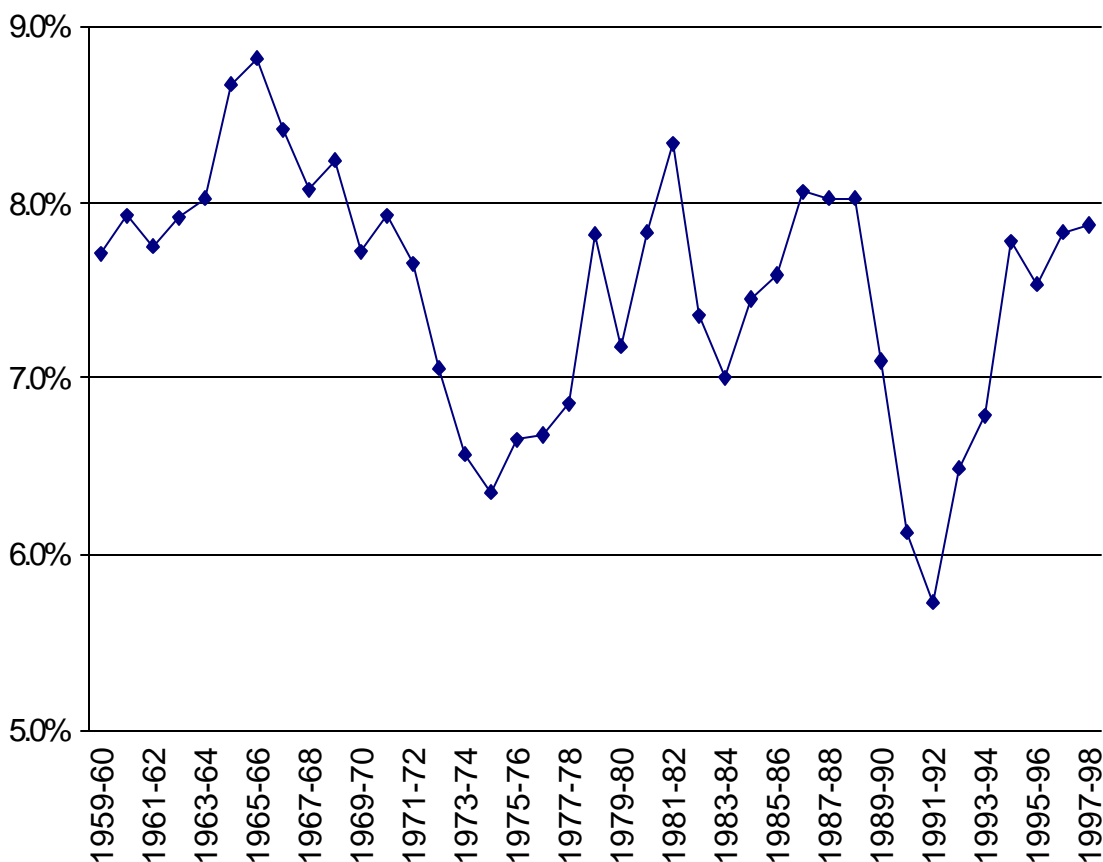
The figure above shows that over the period 1995 to 1997, Australian growth rates in venture capital investment have been very poor in the international context. Australia is ranked second last of the 17 comparable countries surveyed.

## Section 6: Machinery and Equipment Investment

Machinery and equipment investment patterns are a very useful indirect indicator of innovation activity. New machinery and equipment are a major source of innovation because they permit process innovations, including organisational ones. The OECD notes that machinery and equipment investment is a particularly important method of diffusing new technologies in the manufacturing sector (1999a: 16).

The chart below shows Australian trends over the long term.

**Figure 12: Australian Machinery and Equipment Investment as a Percentage of GDP, 1960-1998**



Source: PC Ausstats ABS 5204.0

This chart covers a period of close to 40 years. Over this time, Australia has witnessed a downward trend in machinery and equipment investment. In contrast, the 1990s have seen strong upward growth, although annual investment levels are yet to match the higher annual investments of the 1960s and 1980s. The new investment *may* reflect both considerable investment in information technology, the essential underpinning of much activity, and through this the impact of a slow but major shift in the nature of economic activity and its organisation through greater reliance on new technologies in many areas of manufacturing and service provision. The *kind* of investment, however needs further investigation.

Since the publication of machinery and equipment investment statistics in *The High Road or the Low Road?*, international data have become available and are shown in the following table.

**Table 5: Machinery and Equipment Investment as a Proportion of GDP, Various OECD Countries, 1995, %**

Korea	13.1
Turkey	10.8
Portugal	10.7
New Zealand	10.2
Japan	10.1
Denmark	9.5
Switzerland	9.3
Austria	9.1
Italy	9.0
<b>Australia</b>	<b>8.7</b>
Greece	8.4
UK	8.3
<b>OECD</b>	<b>8.3</b>
Canada	8.2
France	8.1
Netherlands	8.1
Sweden	7.7
Mexico	7.6
Germany	7.6
US	7.2
Belgium	7.1
Finland	7.0
Ireland	7.0
Spain	6.8
Iceland	4.6

Note 1: 1995 is the most recent international comparison available. Note 2: Australia's figure differs from that shown in Figure 12 due to the differences in the basis of the data series.

Source: OECD 1999a: 114

The most up-to-date international data indicate that Australia's performance in the international context is a little above the OECD average. Australia's very strong growth between 1991/92 and 1994/95 shown in Figure 12 has no doubt contributed to this good international ranking. However, we remain below other industrialised countries such as Japan, Denmark, Switzerland and Italy, and not greatly above Canada, the Netherlands and Sweden who may have started from a better base.

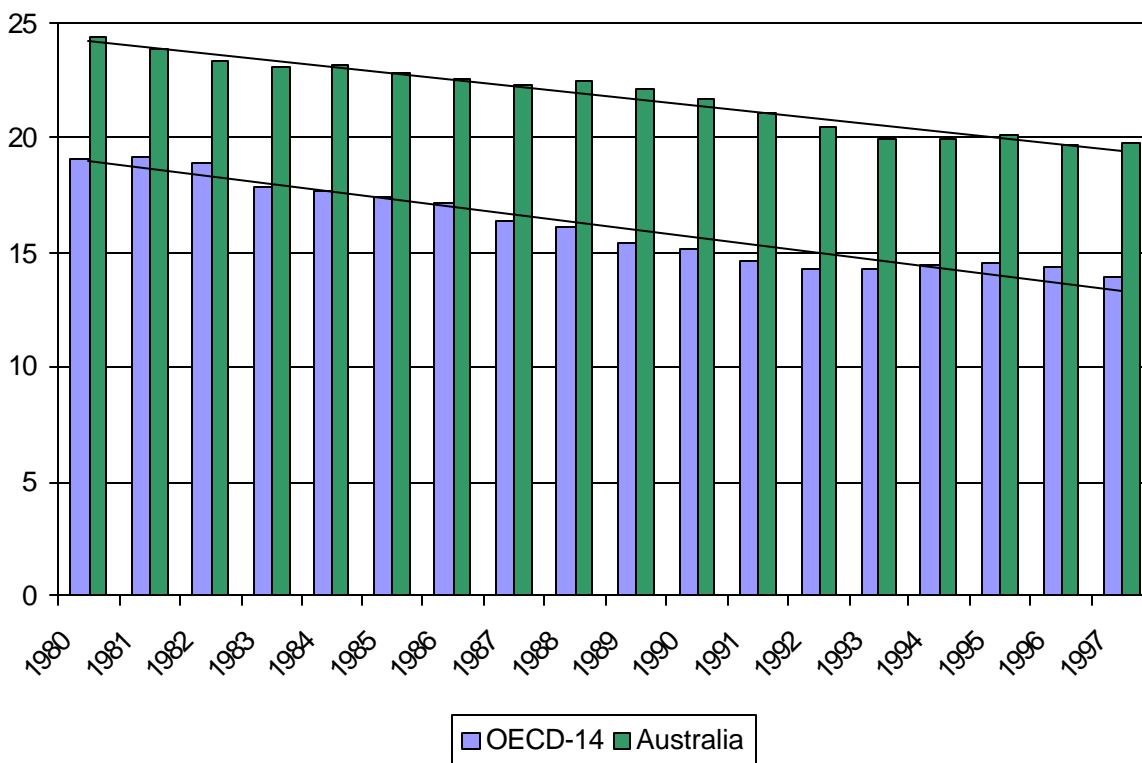
On the OECD's classifications related to this measure, Australia has relatively high recent rates of investment in embodied R&D and relatively rapid technology diffusion, increasing the knowledge-intensity of the economy. The longer term trend shown in Figure 12 suggests that this recent activity represents a good deal of 'catch-up', however, and perhaps the opening of the economy to greater external competition as well as the world-wide shift to IT core technologies.

## Section 7: Industry Structure

Industry structure is not a direct indicator of innovation performance but a country's industry structure reflects past innovation performance and constrains innovation potential.

The figure below shows the declining importance of the manufacturing sector across OECD countries.

**Figure 13: Share of GDP Contributed by Manufacturing, 1980-1997, Australia and OECD, %**



Note: The OECD average is based on the standard OECD-14 group which includes Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States.

Source: OECD 1999 Main Industrial Indicators Database

The falling share of GDP held by the manufacturing sector reflects the increasing service intensity of OECD economies. The relative size of the manufacturing sector is declining as knowledge-based service industries continue to grow. Nevertheless, for a number of reasons it is important to maintain a robust manufacturing sector in Australia, as elsewhere:

- the manufacturing sector continues to contribute most of Australia's R&D (ABS 8104);
- the manufacturing sector has one of the highest propensities to innovate compared to other sectors (ABS advice);

- recent Australian studies highlight the emergence of an *integrated* manufacturing-services sector (Pappas and Sheehan 1998) – high value jobs in knowledge-intensive service industries depend on a robust manufacturing sector;
- input-output analysis has revealed that the manufacturing sector is very strongly interlinked with other sectors, making it an important ‘complementary asset’ in the commercialisation of inventions developed in other sectors (Marceau et al. 1997);
- the innovation literature emphasises the role of demanding customers in the manufacturing sector driving innovation (Marceau et al. 1997);
- Teece (1987: 91) has found that a country with a ‘manufacturing disadvantage may find that an early advantage at the research and development stage has no commercial value... [therefore,] concern that the decline of manufacturing threatens the entire economy appears to be well founded’.

As Figure 13 shows, over the period 1980 to 1997 the trend rate of decline in the importance of Australia’s manufacturing sector exceeded that of the OECD. Further, the fall in manufacturing share of GDP over the period was 27 per cent for Australia, while for the OECD it was 19 per cent. Given the strong linkages between the manufacturing and service sectors, continued rapid service-sector growth in Australia (see Figure 16) may be threatened by further reductions in the size of the manufacturing sector.

Figure 14 ranks manufacturing share of GDP, by OECD country, for 1997. It shows that by 1997 the contribution of manufacturing to GDP in Australia placed us third last out of 19 OECD countries, ahead only of Norway — another resource-based economy — and Greece. Again, the Netherlands should be noted for its position five places above us. Denmark and Canada, two other countries often used as comparators for Australia, have also retained somewhat higher proportions of manufacturing in their economies. Two further resource intensive economies — Finland and Sweden — are also well ahead of us.

**Figure 14: Share of GDP Contributed by Manufacturing, Various OECD Countries, 1997, %**



Source: OECD 1999 Main Industrial Indicators Database

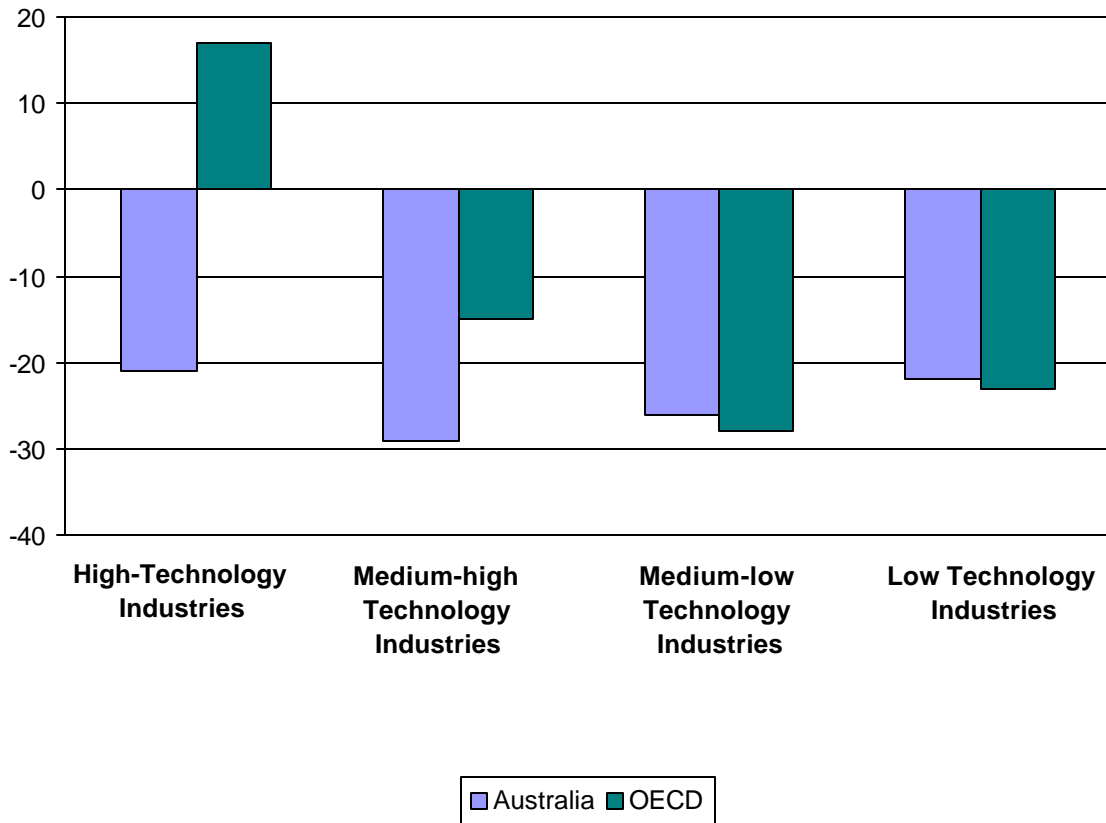
Innovation potential is also strongly influenced by the *composition* of the manufacturing sector. This is often interpreted according to the OECD's technology classification of industries.<sup>13</sup> The composition of Australia's manufacturing sector according to this classification is important because the innovation literature emphasises the desirability of maintaining and expanding the share of GDP contributed by 'high-tech' industries (keeping in mind that this sort of analysis reflects only part of a nation's innovation performance – see Background section above).

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<sup>13</sup> See Appendix A.

The chart below reveals the changing composition of OECD economies based on technology intensities.

**Figure 15: Percentage Change in Proportion of GDP Contributed by Manufacturing Industries Classified by Technology Intensity, 1980-1996, Australia and OECD**

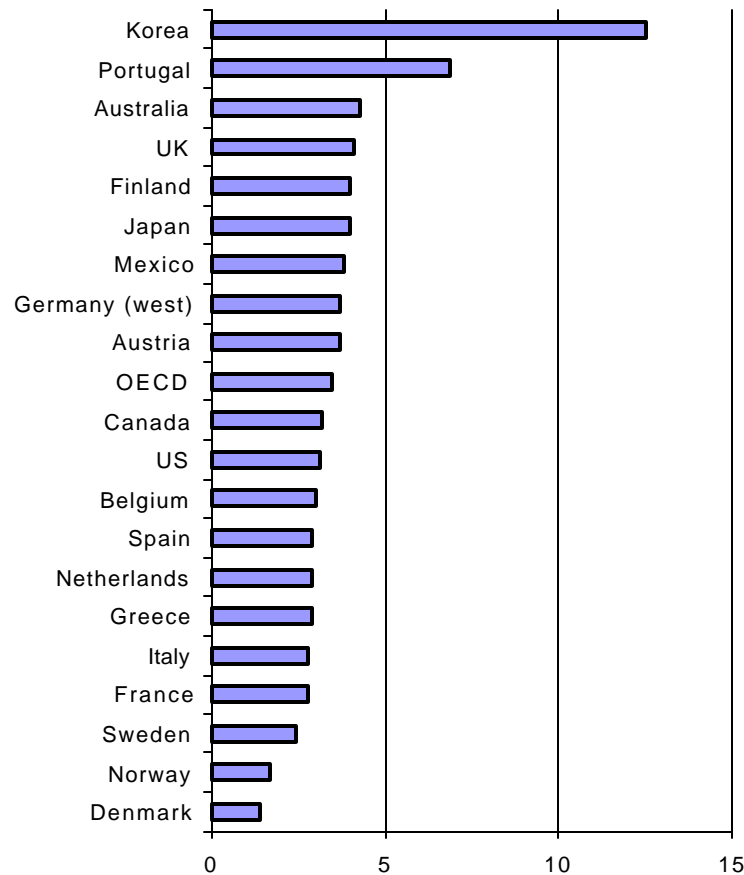


Source: OECD 1999 Main Industrial Indicators

Australia's manufacturing sector is shrinking as a proportion of GDP across all the technology-intensity classifications shown above. Average trends across OECD countries also show shrinking proportions across three of the four categories. However, across the OECD, *the share of GDP contributed by high technology manufacturing industries has increased 17 per cent over the period*. The lack of growth in the relative size of Australia's high-technology manufacturing sector is very concerning given the importance that the innovation literature attaches to this sector.

A broader perspective on structural change and the knowledge intensity of Australia's industrial structure is provided by a recent OECD publication which combines data related to the share of GDP contributed by high and medium-high technology manufacturing sectors with the share contributed by key knowledge-intensive service industries to arrive at a measure for 'total knowledge-based industries'. Growth in these industries across the OECD is shown below.

**Figure 16: Average Annual Growth, Knowledge-based Industries, Percentage of Business Sector Value-Added, 1985-1996, Various OECD Countries**



Note 1: Knowledge based industries include high and medium-high technology manufacturing sectors, together with the following service industries: communications, finance, insurance, other business, community, social and personal community, social and personal services depend considerably on public sector funding. Note 2: There are slight variations in the period over which the average is calculated between countries and slight variations in the industries covered between countries.

Source: OECD 1999a: 115

The chart shows that between 1985 and 1996 Australia did especially well, the average annual growth of Australia’s knowledge-based industries as a proportion of business sector value-added being the third highest of the 22 countries listed. While the growth rate across the OECD between 1986 and 1994 was only 3.5 per cent, the comparable figure for Australia (between 1985 and 1996) was a strong 4.3 per cent. This result supports the conclusion of Sheehan et al (1995: iv-vi) that Australia has strong growth opportunities in these industries in the global context.

Given the absence of strong growth in high-technology manufacturing sectors shown in Figure 15, it is likely that the growth shown in Figure 16 relates primarily to service industries.

Australia’s very strong growth in knowledge-based services reinforces the view that we are ‘competitively placed to participate in the export of service activities, especially to the Asian region, across a wide range of sectors’ (Sheehan et al 1995: ix).

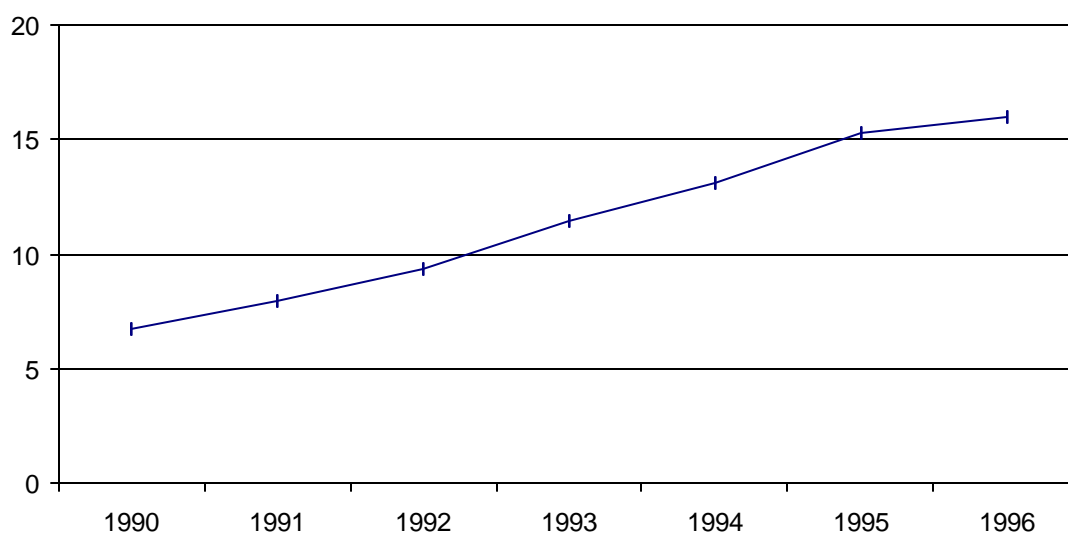
## Section 8: Trade Patterns

The nature of Australia's trade performance reflects the state of our national innovation system and its contribution to our competitive success globally. Knowledge-intensive exports (defined by R&D intensities) reflect our success in transforming R&D and other innovation inputs into commercialised outputs that satisfy international markets.

This section focuses on data pertaining to the high and medium-high technology manufacturing sectors. These sectors constitute an important arena of knowledge-intensive trade activity (although innovative, trade-oriented firms will also be present in other sectors – see Background section above). Although global trade in knowledge-intensive services is growing rapidly, trade in goods still dominates and is likely to do so for quite some time (OECD 1999a: 58-59).

The chart below shows Australia's recent export performance in R&D-intensive manufacturing sectors.

**Figure 17: Exports, High and Medium-high Technology Manufacturing Sectors, Australia, A\$ Billions, Current Prices**



Source: derived from OECD 1999 STAN Database

Australian high and medium-high technology exports show strong growth between 1990 and 1995, although this surge was followed by slower growth to 1996.

The high and medium-high technology sectors also remain a very small proportion of Australia's total exports.

In terms of promoting innovation and economic growth, it is important that exports in these sectors constitute a relatively high proportion of production because our participation in global markets acts to 'push' innovativeness. Unfortunately, the chart below indicates that Australian firms in these sectors have relatively little involvement in global markets.

**Table 6: Export Shares of Production, Various OECD Countries, 1996, %**

<i>High Technology Exports</i>		<i>Medium-high Technology Exports</i>	
<i>Proportion</i>	<i>Country</i>	<i>Proportion</i>	<i>Country</i>
130.8	Denmark	117.12	Nether'ds
129.25	Nether'ds	68.67	Canada
75.12	UK	68.33	Denmark
72.05	Sweden	66.33	Portugal
70.09	Mexico	64.61	Mexico
65.08	Finland	64.23	Sweden
60.24	Canada	55.54	Finland
51.44	Italy	50.65	UK
50.16	Norway	49.31	France
48.55	Korea	46.77	Germany (west)
46.72	France	44.35	Spain
46.56	Portugal	42.47	Italy
45.64	Germany (west)	41.12	Norway
41.5	Spain	32.56	Greece
<b>37.2</b>	<b>Australia</b>	30.94	Korea
29.41	US	23.26	Japan
21.82	Japan	<b>22.8</b>	<b>Australia</b>
16.3	Greece	20.32	US

Note: Exports can exceed production, primarily due to re-export activity.

Source: OECD 1999 Main Industrial Indicators Database

Of the 18 countries shown, Australia ranks fourth last in the high technology sector and second last in the medium-high technology sector. With very low export intensity in these sectors compared to other OECD countries, Australia's incentive to innovate, provided by outward looking competitive strategies, is lower than that of all other countries except the US, Japan and Greece.<sup>14</sup> Note also that outward looking strategies in these sectors are much more important for Australia than, say, the US and Japan, because of the relative absence of technologically demanding customers in Australia as well as our small domestic market.<sup>15</sup> Overseas customers may act as a spur to innovation in manufacturing firms and in turn manufacturing firms may become technologically demanding customers themselves in relation to Australian suppliers.

Further, it is important to note that low export intensity within these sectors reduces the scope for small innovative firms in the sectors to find export-oriented local partners to assist in providing global distribution channels and related help with commercialisation strategies.

As noted in *The High Road or the Low Road?* (1997: 10.40-41):

This, *ceteris paribus*, predisposes Australian innovators to sell, or in some cases license, their intellectual property to transnational firms. In this process much of the

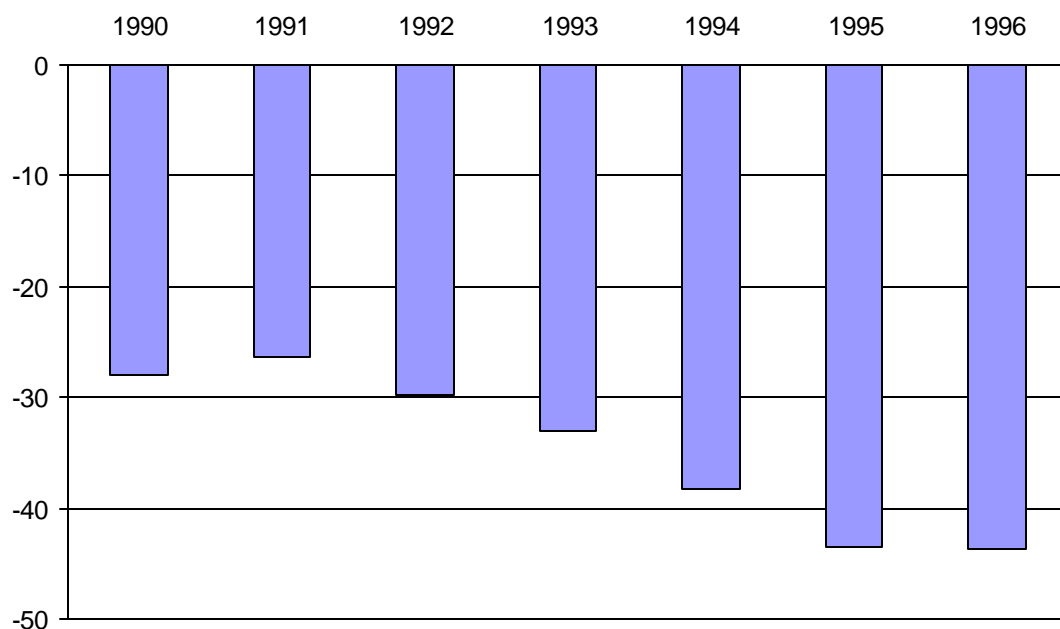
<sup>14</sup> The US and Japan are ranked near the bottom of this chart probably because of their very large domestic markets in the high and medium-high technology sectors.

<sup>15</sup> Of course this argument does not hold for all areas, especially some areas of information technology, where Australia has demanding customers.

export income, knowledge-intensive job creation, advanced manufacturing technology and follow-on R&D associated with these products goes offshore.

In a similar vein, innovation potential is eroded by Australia's reliance on imports in high and medium-high technology sectors. The chart below shows recent trends.

**Figure 18: Trade Balance, High and Medium-high Technology Manufacturing Sectors, Australia, 1990-1996, A\$ Billions**



Source: derived from OECD 1999 STAN Database

Australia shows an increasing reliance on imports over the 1990s. This is of concern, in part because of the effects on the trade balance but also because international analysts emphasise the need to maintain local innovation capabilities. Importing goods embodying high levels of R&D, as opposed to producing them in Australia, is a sub-optimal strategy because competitiveness remains to a large extent reliant on 'localised concentrations of skilled people and technology' (Tegart 1995: 4). Also, there are few possibilities for close user-producer relations to develop. Indeed, as mentioned above the recent report of the House of Representatives Standing Committee on Industry, Science and Resources stressed 'the importance of maintaining an indigenous R&D capacity' (1999: 31).

# Conclusions

*Innovation Checkpoint 1999*, the present report, has covered data on the key activities involved in business innovation and indicated strengths, progress and areas that need further action. It showed that Australia has made progress on four key areas but retreated further from internationally recognised good practice in five others.

The results are disturbing and suggest an urgent need for sophisticated policy developments and further commitment and investment by both public and private sectors if Australia is to realise her potential as a knowledge economy. The shift from where we are now to where international practices tell us we must move in the field of innovation is still a big one to make.

## *Shifting Policy Directions*

International work on different aspects of innovation and policies for its encouragement has established a framework for action through the focus on national, regional and local systems of innovation. Implementing improvements to the functioning of different elements of this framework has gradually shown that several re-orientations are necessary.

Internationally, a good deal of policy re-thinking is taking place (Lundvall 1999). Technology policy is becoming the central element of packages of industry support strategies, including through encouragement of access to international leading edge technology developments. Governments are moving away from sector-specific support towards measures recognising the importance of grouping clusters of firms, whether to assist them to upgrade their collective capabilities or to enable them to become the drivers of growth and 'development blocs', as Dahmen once called them (1988). That several OECD countries have moved in this direction can be seen in its publications on clusters, *Boosting Innovation* (OECD 1999). In particular, too, governments are recognising the increasing need for investment in human resources to support the full use of the new organisational forms and physical technologies developed. Innovation requires skill levels to rise and new skills to be developed at all levels of enterprises.

The new focus is thus on the cooperative, on building 'collective infrastructure' and on support for groupings of firms and industries and investment in new technologies.

In addition, it is increasingly clear that the focus of policy attention needs to shift somewhat to include the cross-sectoral as well as the sectoral. In particular, this may mean focusing on support for better linkages between the service activities which support manufacturing and into which manufacturing industries are increasingly shifting.

Companies themselves seem to be thinking cross-sectorally, both in the sense of their principal business activities and the links, not the separation, between services and manufacturing. Recent studies in Australia have shown the degree to which, for example, companies have moved into areas which are traditionally portrayed as the domain of other industries in official statistics (AEGIS 1999a and 1999b). Public policies must re-think

similarly. This may mean changes both in the ways in which nations collect relevant information and the development strategies they put in place.

*The High Road or the Low Road?* suggested ten policies and pathways for improving industry strategies in Australia. In particular, we suggested that a shift in policies towards improving cooperation and linkages was needed and that detailed audits of the functioning of clusters should be carried out. We underlined that recommendation by suggesting that governments should get to know and work cooperatively with players in key sectors and firms in the joint development of policy.

This shift requires considerable investment in the knowledge levels of both the public officials and the industry partners concerned so as to build policy capabilities within both sectors as the underpinnings of success in the new environment. Very considerable sophistication will be required if the new, more deft, smart and complex policy approaches necessary can be appropriately designed and implemented.

Linked to this, in its concluding remarks *The High Road or the Low Road?* pointed out that success in the new knowledge economy policy arena will involve much more sophisticated understandings of the workings of the economy than was then the case. That message needs reinforcement here. The basis for good policy is good information. Major innovation investments of the kind covered in *Innovation Checkpoint 1999* need continuous monitoring.

### *System Dynamics and Policy Coherence*

Equally important, we need better understanding of the relations *between* the indicators we use so we can see the dynamics of the system. More detailed research on the processes of innovation within specific industries and, increasingly important, *across* sectors is necessary. The major players in the innovation system – firms, government and knowledge-generating research, education and scientific institutions – need to work together to develop the appropriate data sets, to monitor progress and to resolve problems, building at the same time on emerging strengths. Ideally, the next Innovation Checkpoint should report on progress in the new policies and practices that underpin innovation and better the understanding of the mechanisms of innovation improvement.

The Commonwealth Government's Action Agendas process which has been in operation for the last twelve to eighteen months is a step in the right direction. Through that process the leaders of industry and public officials are beginning to undertake the joint analysis and stocktaking needed. The extent of the lack of communication between different players, even major ones in the private sectors concerned, and the lack of detailed knowledge on the part of some on the public sector side have become evident in the process in many areas, although some are considerably better than others. The Action Agendas seem to be starting a new dialogue and a new level of interaction and willingness to collaborate between government and industry is evident.

Some of these activities, however, continue to be hampered by a lack of research data on the dynamics of the areas concerned. In addition, in many fields sensible policies can only be developed on a cross-sectoral basis whereas the Action Agendas as currently framed are essentially sector-specific.

Despite these limitations, the Action Agendas are an important step forward on the path of joint learning by companies and policy-makers. Such activities must not be 'one-off' or stop with the end of the first program. The Agendas are just scratching the surface of the learning that needs to be done now and continues into the foreseeable future. Such joint public-private activities of the collaborative kind and the cluster-focused policies coming into play internationally must be continued if Australia's innovation potential is to be realised. The very nature of the 'learning economy' means that there is no end in sight to the learning, no single solution or solutions will suffice. Long term program coherence and continuity should be central tenets of future innovation policy.

### *Critical Investments*

Recognising that continual learning is critical also means that by definition there must be continual investment in education, training and the frameworks for user-producer learning suggested by Lundvall (1999) and others. As Soete, writing in a recent OECD publication, reminds us, 'the workforce is ageing and the technology is getting younger'; knowledge obsolescence is high. (1999:136)

Similarly, research, whether conducted in the private or public sectors, is a critical input to all aspects of economic development and is a major contributor to continuous learning. More imaginative policies will be needed to support knowledge generation, whether it takes place within specialist research organisations or via the transient research teams brought together to generate and apply new knowledge in close interaction with users. (Gibbons et al. 1994). This latter mode of research is especially important where issues cross traditional disciplinary boundaries. Ensuring the diffusion of knowledge generated by transient teams will be especially challenging since it is produced outside organised and permanent research frameworks.

*Innovation Checkpoint 1999* has not been able to cover all aspects of the complex interactions between different factors contributing to industrial growth in an economy undergoing a significant technological paradigm shift and moving to embrace the principles of innovation and the generation and application of usable knowledge as the core elements of future prosperity. For practical reasons of resources, time and space, the Checkpoint focussed only on fairly discrete and selected elements of business innovation investments and the financial support available. And not all of those.

In reality, however, we should not forget that there are many further factors in the innovation equation. These include infrastructure investments, both in the physical sense of roads, rail and ports and in the sense of 'technology infrastructure'. Investment in the former may not have kept up with international best practice, as was indicated in *The High Road or the Low Road?*, and may not have changed sufficiently since. The latter include the telecommunications and IT infrastructures available to businesses, such as reliable and secure access to the Internet for e-commerce as well as for increasing knowledge diffusion. Progress in parts of the technology infrastructure has been addressed by the creation of special bureaux, such as that for the Information Economy. This is a welcome development.

## *Innovative Policies*

Among the challenges for Australia is the need to be innovative in our policy development and coordination mechanisms. It is evident that in Australia, as in other countries too, policy orientations and development mechanisms have not been focussed in a coordinated manner on what affects industry development in the emerging economy.

Thus, critical areas of policy are being developed with different and sometimes conflicting goals in mind. These conflicts can be seen at both Commonwealth and State levels where policies developed by one area may conflict with those needed by departments with a focus on a particular industry such as health, or telecommunications or transport or, alternatively, those holding sector-wide responsibilities such as Agriculture or Tourism.

In the context of encouraging innovation via investment in embodied knowledge, for example, some current taxation change proposals, such as those curtailing accelerated depreciation on machinery and equipment, may be counterproductive. Others, however, such as changes to capital gains tax arrangements may serve the nation well by encouraging an increase in venture capital. Similarly, to assist with building innovation-related capability, policy makers may need to shift governments' own emphasis from cost minimisation towards innovation and technology development strategies.

Several analysts have started to focus on this problem of policy incoherence. Lundvall (1999), for example, has suggested that one aspect of the issue derives from the special characteristics of the key resource of a learning economy (knowledge) and the need to refocus understandings inhering within the frameworks used for policies.

Knowledge is not a scarce resource in the same manner as raw materials, even when supply falls short of demand. Moreover, knowledge is different in that the more industries use their knowledge, the more they acquire. Focus on the allocation of scarce resources which has been at the core of mainstream economies for a long time may be less appropriate to the new paradigm. Rather, uncertainty, dynamic economies of scale, and other issues long considered by economists as of relatively marginal importance are becoming the rule rather than the exception in knowledge-intensive fields. Now policy paradigms must allow for this.

## *Innovation and the Social Dimension*

Finally, it is important to recognize that 'innovation' is not something that happens just inside our public or private administrative and productive organisations. Proper understanding of the nature of innovation and the knowledge-intensive society it generates and supports extends to recognising the social dimension of innovation. This aspect relates directly to the social framework which supports trust.

There is increasing international evidence that the spread of knowledge generation and its rapid implementation and transformation into productive action owe a great deal to a framework of social cohesion in which different social partners trust others to consider their interests in the broad processes of change undertaken.

Change is, after all, the essential co-partner of innovation, and it is important to put in place mechanisms of social protection which enable employees, other businesses and stakeholders to embrace change rather than fear and resist it. The importance of such social protection in supporting innovation and change has been suggested in relation to the Nordic countries (Lundvall 1999: 24).

### *Innovation in Australia: Some Progress but a Long Way to Go*

The data gathered together in this report show that there are many aspects to innovation and the creation of a knowledge economy. Going successfully down the knowledge-generation path is demanding in many ways. It requires, say innovation analysts, both learning and forgetting. Australia has made some progress but is making only hesitant steps along the high road to future prosperity. The danger of going down the low road is not past.

# Appendix A: OECD Technology Classification of Manufacturing Industries

## *High Technology*

- Aircraft
- Office & computing equipment
- Drugs and medicines
- Radio, TV & communication equipment

## *Medium-high Technology*

- Professional goods (scientific instruments)
- Motor vehicles
- Electrical machines, excl. commun. equip.
- Chemicals, excl. drugs
- Other transport equipment
- Non-electrical machinery

## *Medium-low Technology*

- Rubber and plastic products
- Shipbuilding & repairing
- Other manufacturing
- Non-ferrous metals
- Non-metallic mineral products
- Metal products
- Petroleum refineries & products
- Ferrous metals

## *Low Technology*

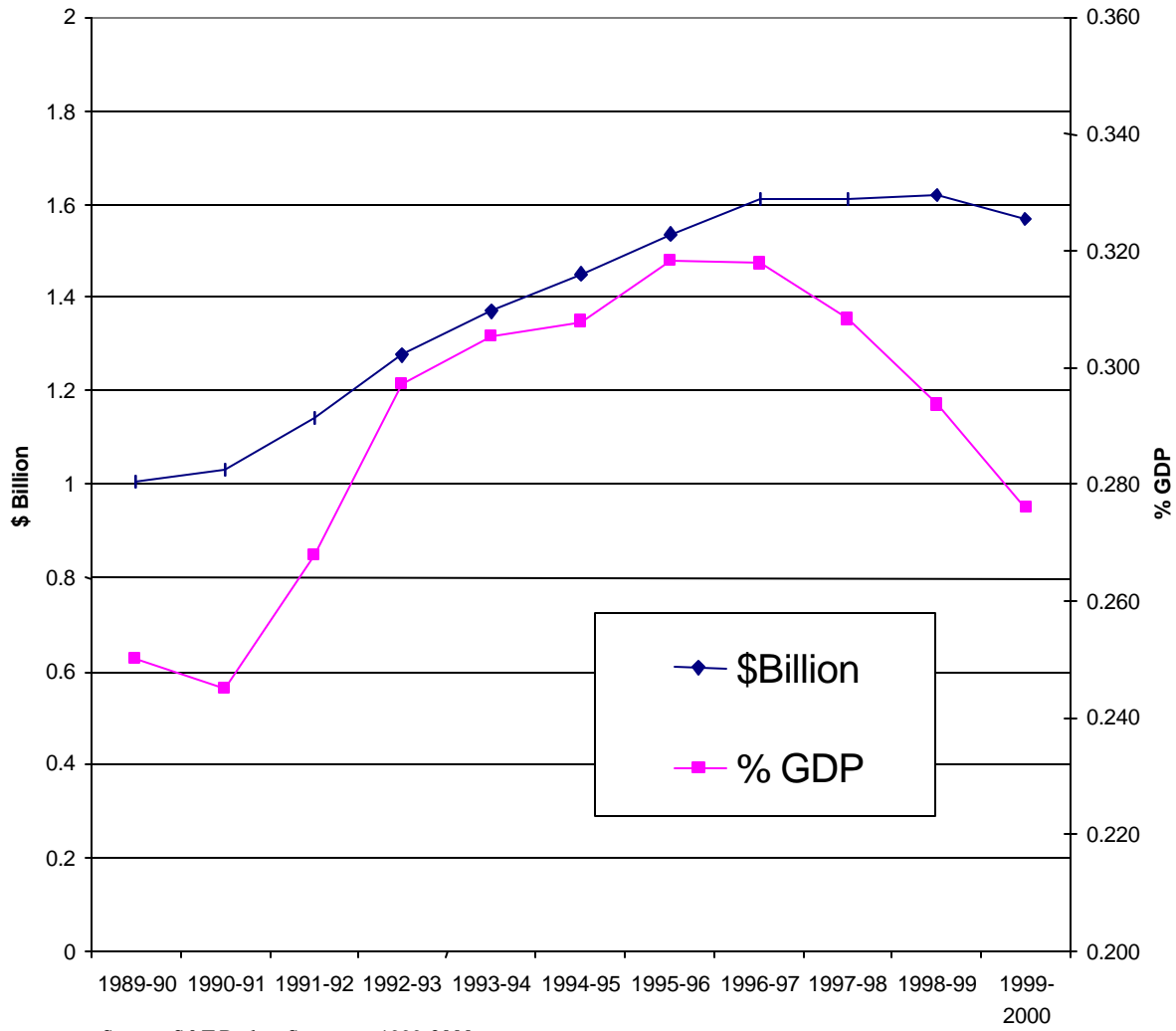
- Paper, paper products & printing
- Textiles, apparel & leather
- Food, beverages & tobacco
- Wood products & furniture

Source<sup>16</sup>: OECD 1999a: 106.

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<sup>16</sup> Note 1: Industries based on ISIC Revision 2. Note 2: Classification based on measures of R&D divided by production and value added, and R&D and acquired technology divided by production.

# Appendix B: Commonwealth Government Support for Higher Education Research



# Bibliography

ABF (Australian Business Foundation) (1997) 'Australia in Danger of Taking the Low-Skill, Low-Technology, Low-Wage Road'. *Media Release*. 4<sup>th</sup> September.

ABS (Australian Bureau of Statistics) 1220.0: *Australian Standard Classification of Occupations, 2ND ED*. Canberra: AusInfo

ABS 5204.0: *Australian System of National Accounts – Australia – Annual*. Canberra: AusInfo.

ABS 6203.0: *Labour Force*. Canberra: AusInfo.

ABS 6353.0: *Employer Training Expenditure*. Canberra: AusInfo.

ABS 8104.0: *Research and Development, Business*. Canberra: AusInfo.

ABS 8116.0: *Innovation in Manufacturing*. Canberra: AusInfo.

AEGIS (Australian Expert Group in Industry Studies) 1999a *The Emergence of Innovative New Businesses in the Building and Construction product System*. Project 3 of a series of five commissioned by the Department of Industry, Science and Resources, Canberra.

AEGIS 1999b *Service-Enhanced Manufacturing in the Building and Construction Product System*. Project 4 in the same series.

AMWU (Australian Manufacturing Workers' Union) (1997) *Rebuilding Australia: Industry Development for More Jobs*. Sydney: AMWU

Arthur D. Little (1998) *Arthur D. Little Global Survey on Innovation: The Australian Perspective*. Sydney: Arthur D. Little.

Asian Venture Capital Journal (1999) *The Guide to Venture Capital in Asia*. Asian Venture Capital Journal.

Australian Venture Capital Journal (1999) 'Australian Venture Capital Journal/PriceWaterhouseCoopers Venture Capital Survey'. *Australian Venture Capital Journal*, 8(80): 6-8.

Avcal (Website) (Australian Venture Capital Association)  
<http://www.avcal.com.au/index.htm>

BIE (1993) *R&D, Innovation and Competitiveness, An Evaluation of the Research and Development Tax Concession*. Research Report 50. Canberra: AGPS.

Business Council of Australia (1999) *BCA Papers*, 1(2).

California Management Review (1998) 'Special Issue of Knowledge and the Firm', *California Management Review*, 40(3).

Cohen, S. S. and J. Zysman (1987) 'Why Manufacturing Matters: The Myth of the Post-Industrial Economy'. *California Management Review*, xxix (3): 9-26.

Dahmen, E. (1988) 'Development Blocks in Industrial Economics', *Scandinavian Economist History Review*, 1, pp. 3-14.

EPAC (Economic Planning and Advisory Council) (1995) *Investment and Economic Growth*. Canberra: AGPS.

House of Representatives Standing Committee on Industry, Science and Resources (1999) *The Effect of Certain Public Policy Changes on Australia's R&D*. Canberra: AusInfo.

Howard, J. (1998) Prime Ministerial Media Release. 'Beyond the Clever Country'. 29 May 1998.

Industry Commission (1995) *Research and Development*. Report No. 44. Canberra: AGPS.

ISR (Commonwealth Department of Industry, Science and Resources) (1999) *Measuring the Knowledge-Based Economy*. Canberra: AusInfo

ISR (1999b) 'Passage of Bill to Improve Access to the R&D Tax Concession'. *Media Release*. 25 March.

ISR (1999c) 'R&D Tax Concession Lodgement Form Goes Online'. *Media Release*. 29 June.

ISR/Howard Partners advice (1999) Department of Industry, Science and Resources/Howard Partners advice.

Karpin, D. S. (1995) *Enterprising Nation: Renewing Australia's Managers to Meet the Challenges of the Asia-Pacific Century*. Report of the Industry Task Force on Leadership and Management Skills. Canberra: AGPS

Lester, R. (1998) *The Productive Edge: How American Industries are pointing the Way to a New Era of Economic Growth*. New York: W. W. Norton.

Liu, J. (1999) 'Knowledge Economy Affects the Globe'. *Beijing Review*, 42(5): 6-7.

Lundvall, B-A (1996) 'The Social Dimension of The Learning Economy'. *Working Paper 96-1*, Department of Business Studies, Aalborg University, Denmark.

- Lundvall, B-A (1999) 'Technology policy in the learning economy' in A. Archibugi, J. Howells and J. Miclise (eds) *Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press.
- Marceau, J., K. Manley and D. Sicklen (1997) *The High Road or the Low Road?: Alternatives for Australia's Future*. Sydney: Australian Business Foundation Limited.
- Marceau, J. (in press) 'The internationalisation of R&D: Opportunities and threats for the developing world'. In D. Lamberton (ed) *Globalization, Employment and Quality of Life*. London: IP Taurus
- Masood, E. (1998) 'Britain Embraces 'Knowledge Economy''. *Nature*, Dec 24: 714-716.
- OECD (1996a) (Organisation for Economic Development and Cooperation) *The Knowledge-Based Economy*. Paris: OECD.
- OECD (1996b) *Venture Capital and Innovation*. Paris: OECD.
- OECD (1997) *New Directions for Industrial Policy*. OECD Policy Brief No. 3. Paris: OECD.
- OECD (1997a) *Globalisation and Small and Medium Enterprises (SMES) Vol. 1. Synthesises Report*. Paris: OECD.
- OECD (1999) *The Knowledge-Based Economy: A Set of Facts and Figures*. Paris: OECD
- OECD (1999a) *OECD Science, Technology and Industry Scoreboard 1999. Benchmarking Knowledge-based Economies*. Paris: OECD.
- OECD (1999b) *Managing National Innovation Systems*. Paris: OECD.
- OECD (1999c) *Boosting Innovation: The Cluster Approach..* Paris: OECD.
- OECD (1999d) *Globalisation of Industrial R&D: Policy Issues*. Paris: OECD.
- Pappas, N. and P. Sheehan (1998) 'The New Manufacturing: Linkages between Production and Service Activities'. In P. Sheehan and G. Tegart (eds) *Working for the Future*. Melbourne: Victoria University Press.
- Phillips, R. (1997) *Innovation and Firm Performance in Australian Manufacturing*. Staff Research Paper, Industry Commission. Canberra: AGPS.
- PMSEIC (1999) Prime Minister's Science, Engineering and Innovation Council, Third Meeting – Agenda Item 4: 'Strengthening the Nexus Between Science and its Applications'. 25 June 1999.

PriceWaterhouseCoopers (1998) *The PriceWaterhouseCoopers Economic Impact of Venture Capital Survey*. Sydney: PriceWaterhouseCoopers.

Rogers, M. (1998) *The Definition and Measurement of Innovation*. Working Paper No. 10/98. Melbourne: Melbourne Institute of Applied Economic and Social Research.

SciTech (1998) 'Growing uncertainty about R and D'. *SciTech*, 18(35): 3.

Sheehan, P., N. Pappas, G. Tikhomirova and P. Sinclair (1995) *Australia and the Knowledge Economy*. Melbourne: Victoria University of Technology, Centre for Strategic Economic Studies.

Smith, K. (1998) 'Specialization, Innovation and Growth Across Heterogeneous Economies: Issues for Policy'. OECD Conference on *Innovation Systems: Growth Engines for the 21<sup>st</sup> Century*. Sydney, November 19<sup>th</sup> –20<sup>th</sup>.

Soete, L. (1997) 'Macroeconomic and structural policy in the knowledge-based economy: national policy challengers' in OECD *Industrial Competitiveness in the Knowledge-based Economy: The New Role of Governments*. Paris: OECD

Tabakoff, N. and T. Featherstone (1999) 'The Dumbing of Australia'. *Business Review Weekly*, 21(25): 52-57.

Taxation Institute of Australia (1998) *Industry Research and Development in Australia*. Victoria: Taxation Institute of Australia.

Teece, D. J. (1987) 'Capturing Value from Technological Innovation: Integration, Strategic Partnering, and Licensing Decisions'. In B. Guile and H. Brooks (eds) *Technology and Global Industry*. U.S: National Academy Press.

Tegart, G. (1995) *Matching Science and Technology to Future Needs*. Discussion Paper. University of Canberra

US Council on Competitiveness (1999) *The New Challenge to America's Prosperity: Findings from the Innovation Index*. Washington DC: US Council on Competitiveness.

Walker, D. (1998) 'Innovation hits crisis skids'. *The Age* 11 August: 3.