

# stalling not sprinting

Australia is a prosperous country. We have a high standard of living, we have rich resources and we have a highly educated population. We have a reputation for being inventive and we have successfully overcome the problem of being a large isolated continent separated from many of our trading partners. It is clear that our national innovation system has been pivotal in delivering economic success in the past, but today it is being reshaped by the confluence of four powerful circumstances.

Firstly, the architecture of Australia's system is now a generation old and, in many respects, out of date.

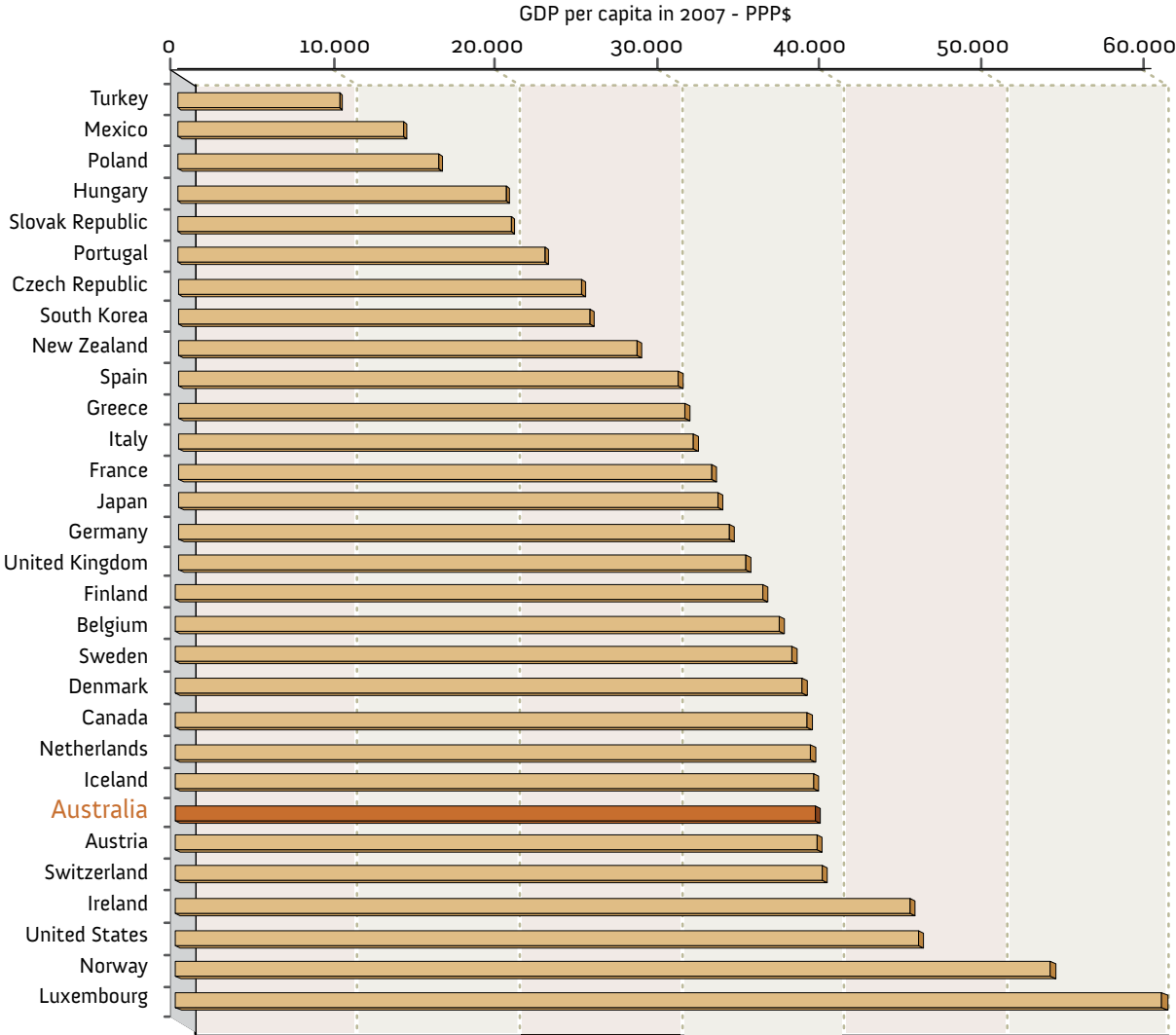
Secondly, the nature of innovation and our understanding of it are changing fast. In the 1980s, the policy framework was designed to accelerate the commercialisation of research, scientific discovery and technological advance. Less attention was paid to improving the capacity of firms to apply science and research to secure productivity benefits for the nation. Today, innovation is understood to involve much more than just the transmission of knowledge down a pipeline from research to development to application. In the age of the internet, with the opportunities for collaboration which it provides, open, collaborative innovation is increasingly important. The internet has meant distance is no longer such an impediment, and we need to take advantage of it in transforming ideas into clever goods and services at a faster rate, in having a population as skilled and knowledgeable as our competitors, and in enhancing our lifestyle and protecting our environment.

Thirdly, Australia's focus on innovation policy intensified in the 1980s after a prolonged decline in our innovation performance, and a commensurate decline in our relative prosperity. This focus bore fruit in sharply rising levels of R&D and other forms of innovation. That rate of improvement has stalled over the last decade and some indicators suggest that there has been an absolute decline recently. As a share of GDP, public support for research and development (whether private or public) has fallen by nearly a quarter and public expenditure on education has slipped below the OECD average.

Lastly, the two most populous countries in our region, India and China, are transforming themselves into economic giants. They are doing so by embracing openness and trade, as we did in the 1980s, and through a strong commitment to innovation. In fact, innovation is central to their self-transformation. This is more than economic 'catch-up'; these countries are becoming leaders in innovation in many fields. Many developed nations, like Finland, Singapore and Korea, have responded by increasing their innovation effort. Australia must do so too or see our relative prosperity decline.

Despite, these concerns, Australia remains one of the world's most prosperous industrial economies, as can be seen in Figure 4 which displays real GDP per capita for 30 countries in the OECD.

**Figure 4: GDP per capita in 30 OECD countries, 2007**



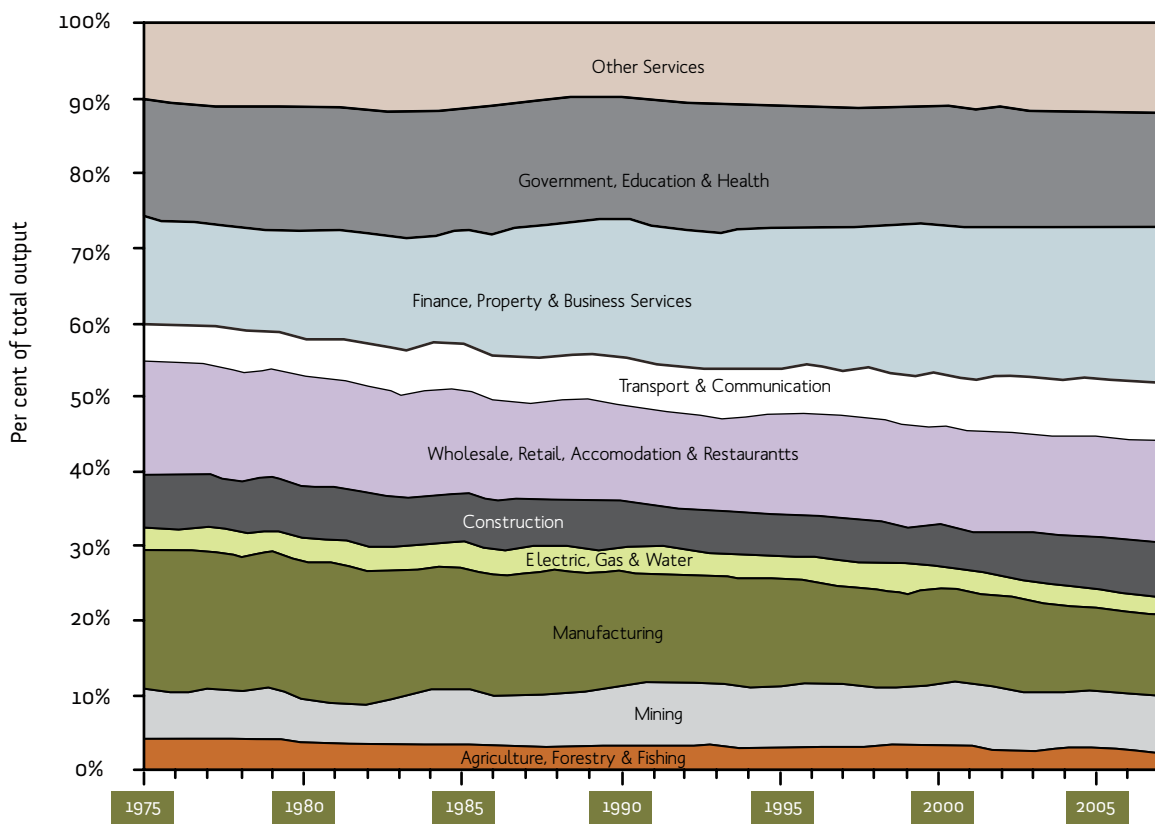
Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2008, [www.conference-board.org/economics/](http://www.conference-board.org/economics/), via Steve Dowrick.

Australia has the 7th highest average income per person and this was attained through strong innovative performance, initiated in the 1980s and consolidated in the 1990s, in parallel with key policy innovations that resulted in the liberalisation of trade, deregulation and privatisation. Australia became one of the fastest growing OECD economies in terms of productivity and, even when productivity growth slowed, the economy was buoyed by strong growth in the terms of trade between 2003 and 2008. It is an enviable record and regarded by some overseas as a ‘miracle’ after the difficult economic circumstances of the 1980s.

## Composition of the Australian Economy

The structure of Australia's economy has changed markedly in the last three decades. Our productivity growth has been very concentrated in particular sectors. Service sector industries have come to dominate, with a higher share of output than in some other advanced economies, while the manufacturing sector has been in decline. Finance, property and business services have increased their share from 14 to 21 percent while the manufacturing sector share of output has declined from 19 to 11 percent of output between 1975 and 2007 (see Figure 5).

**Figure 5: Sectoral composition of Australia's output, 1975 to 2007**



Source: Victorian Innovation Economy Advisory Board, 2006

Australian productivity growth has been much more concentrated than other countries over the past decade and has come principally from service sector industries.<sup>1</sup>

<sup>1</sup> Alan Hughes and Vadim Grinevich, The Contribution of Services and Other Sectors to Australian Productivity Growth, 1980-2004, report prepared for the Australian Business Foundation, 2007

## Investment in human capital

The most fundamental drivers of innovation are the skills, knowledge and attitudes of the workforce – collectively referred to as the human capital of the nation.

A major shift in educational attainment levels occurred in Australia over the decades of the 1970s and 1980s – particularly for Australian girls. The proportion of boys staying on at school to Year 12 roughly doubled in the twenty years from 1970, from 35 percent to around 70 percent, whilst the proportion of girls staying to Year 12 more than trebled over the same period – from 25 percent to over 80 percent. Retention rates have largely stabilised since 1990.

Rising school retention rates were matched by rapidly rising rates of achievement of tertiary qualifications. By 2003, 40 percent of young women and 34 percent of young men aged 25-34 had achieved tertiary qualifications. This level of attainment is slightly below that of the USA and slightly ahead of attainment in the UK.<sup>1</sup> This is an achievement we can be proud of.

The OECD Program for International Student Assessment (PISA)<sup>2</sup> is an internationally standardised assessment that was jointly developed by participating countries and administered to 15-year-olds in schools. In terms of reading proficiency, the 2006 survey ranked Australian 15-year-olds at 9th out of 30 in terms of high levels of proficiency, with 35 percent of students achieving Levels 4 and 5. Unfortunately, we seem to have stalled here as this result represents a deterioration in performance since 2000 when 43 percent achieved these levels of proficiency and Australia was ranked 3rd.

A somewhat similar picture of high but declining levels of relative proficiency<sup>3</sup> is given by the PISA results on mathematical proficiency. Australian 15-year-olds rank 9th out of 30 in 2006 with an average score of 520, down from 5th position in 2000 when the average score was 533. This is worrying given the importance of mathematics to building strong engineering and other important skill bases for future innovation.

When it comes to interest in learning science, surveys of Australia's 15-year-olds paint a dismal picture. The PISA 2006 survey<sup>4</sup> records an average interest score of just 465, ranking Australians 24th out of the 30 OECD countries. Not having scientifically literate leaders may stall our capacity to solve major technical problems which are affecting Australia and the rest of the world.

1 Gene Tunny, Educational attainment in Australia, Economic Roundup Autumn 2006, Canberra: Commonwealth Treasury.

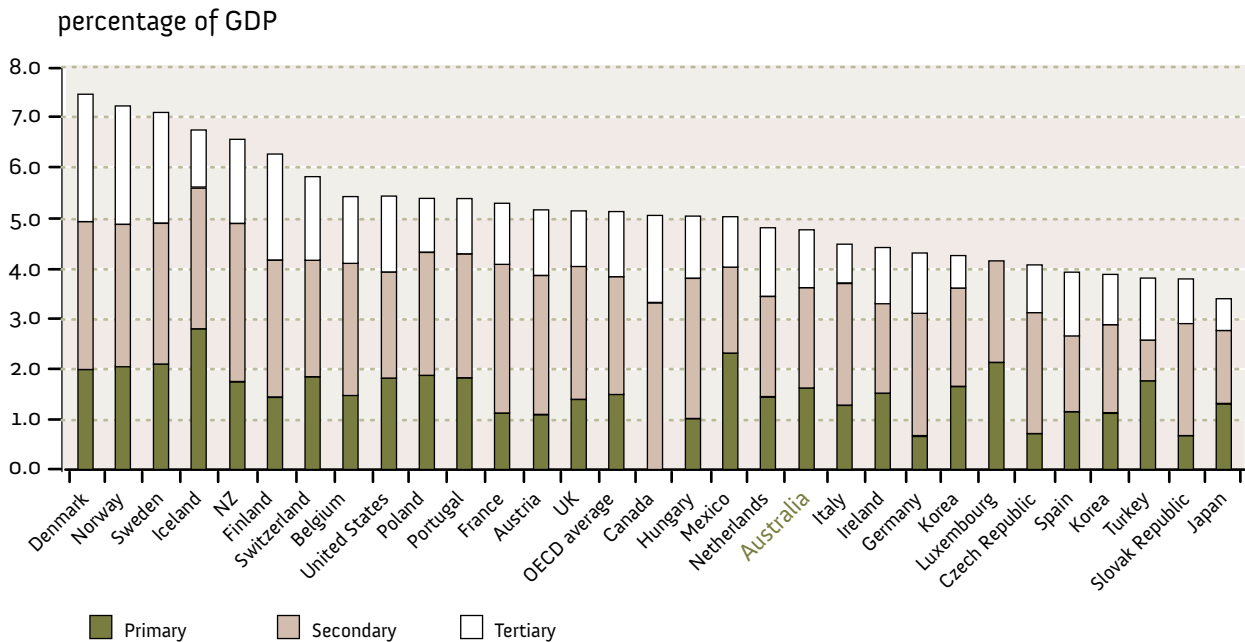
2 OECD Programme for International Student Assessment (PISA), [http://www.pisa.oecd.org/pages/0,2987,en\\_32252351\\_32235731\\_1\\_1\\_1\\_1\\_1\\_1,00.html](http://www.pisa.oecd.org/pages/0,2987,en_32252351_32235731_1_1_1_1_1_1,00.html)

3 All scores in a given year are relative to the OECD mean which is set at 500.

4 PISA Science Competencies for Tomorrow's World, 2006 [http://www.pisa.oecd.org/document/2/0,3343,en\\_32252351\\_32236191\\_39718850\\_1\\_1\\_1\\_1,00.html](http://www.pisa.oecd.org/document/2/0,3343,en_32252351_32236191_39718850_1_1_1_1,00.html)

Cross-country differences in educational attainment and performance are driven in part by differences in national levels of expenditure. Comparisons of public expenditure at primary, secondary and tertiary levels are shown in Figure 6 for 30 OECD countries.

**Figure 6: Public expenditure on education by level, percent of GDP, 2003**



Source: OECD Family Database [www.oecd.org/els/social/family/database](http://www.oecd.org/els/social/family/database); OECD - Social Policy Division - Directorate of Employment, Labour and Social Affairs

On these comparisons Australia's public expenditure ranks 19th out of 30 and is slightly below the OECD average in terms of total public expenditure on education as a proportion of GDP. Only in primary education is Australia above average in its rate of public investment. Moreover Australia shows a decline over time in public resources devoted to education, the share declining from 5 percent in 1995 to 4.8 percent by 2004.<sup>1</sup>

The decline in public investment since 1995 has been offset to some extent by rising private expenditure on education. Nevertheless, the sum of public and private educational expenditures in Australia, amounting to 5.8 percent of GDP in 2004, still lags the OECD weighted average of 6.2 percent.

In summary, our investment in human capital has stalled. Our investment in the educational revolution of the 1970s and 1980s saw a massive increase in the proportion of young people, particularly young women, staying on at school to complete Year 12, and a matching increase in tertiary enrolments. By the mid 1990s Australia was a world leader in educational standards.

<sup>1</sup> OECD, Education at a Glance, Table B4.1. 2007

Since that time, however, public investment in education has declined as a share of GDP, leaving Australia below the OECD average. Over the past decade there has been evidence of declining educational proficiency relative to other OECD economies in both the literacy and numeracy of 15-year-olds.

### **Investment in R&D**

The Productivity Commission<sup>1</sup> observed that Australia lags behind leading OECD countries in terms of the resources devoted to research and development (R&D), both in business expenditure and government expenditure, with business expenditure as a proportion of GDP just half of the OECD average. It argues that the performance on business R&D can be explained, at least in part, by the sectoral bias in Australia towards relatively low-tech industries. This observation could, however, be turned the other way around to argue that the sectoral composition of Australian industry is influenced by the low level of R&D expenditure. We think our innovation system should encourage the growth of world's best knowledge-intensive industries to emulate our achievement in the area of mining technology services.

Whilst R&D is only one input into the innovation process, it is found in many studies to be a significant contributor to productivity growth. The evidence is summarised in Annex 4. This evidence is backed up in the Australian context by the Productivity Commission<sup>2</sup>.

### **Non-R&D innovation investment**

The Productivity Commission<sup>3</sup> points out that care must be taken in relying on measurable R&D expenditure as a proxy for total national innovation, given that organisational innovation is very important in the service sector but weakly reflected in R&D expenditure, as well as in patents data.

Surveys by the ABS show that non-technological innovation is undertaken by a significantly large number of firms across all industries. This evidence suggests that normal R&D measures significantly understate the amount of innovation occurring, particularly in SMEs. Formal R&D spending accounts for only one third of total business expenditure on innovation. Smith and O'Brien<sup>4</sup> however, in their census of Tasmanian firms, found that more than 40 percent of all firms are performing R&D, a figure much higher than indicated in ABS figures.

<sup>1</sup> Productivity Commission Research Report, Public Support for Science and Innovation, March 2007.

<sup>2</sup> Ibid, p628

<sup>3</sup> Ibid

<sup>4</sup> Keith Smith and Kieran O'Brien, Innovation in Tasmania: An innovation census in an Australian state. Australian Innovation research Centre. 2008.

Australian Government support for science and innovation is broader than pure R&D funding, encompassing various government portfolio programs, CSIRO and National Health and Medical Research Council (NHMRC) funding, ARC funding of research, research tax concessions and university research funding. Australia has highly unique assets in its research armoury such as the CSIRO, which is a massive interdisciplinary organisation with tentacles across the continent and the world. But our broad-based support for science and innovation has declined over the past fifteen years, from a high of 0.76 percent of GDP in 1993 to a low of 0.58 percent in 2007 (Figure 1).

### The rate of patenting

The establishment of patents on products and processes is an approximate measure of inventiveness. Some patents are taken up by innovators, so an increase in the supply of patents can be associated loosely with a rise in innovation. However, great care must be taken in inferring too much about innovation from patents data. Gans and Hayes<sup>1</sup> investigate the determinants of OECD countries' 'Innovation Output', which they define as the number of international patents per capita granted by the US Patent and Trademark Office. They find that 'innovation output', which is but one of a number of intermediate outputs produced by the innovation system, over the period 1973 to 2004 is associated with a range of variables. These include the primary inputs – R&D expenditures and educational expenditures – as well as variables they had constructed to identify the strength of protection for intellectual property, the clustering of innovation and the quality of linkages between the public and private sectors. Using their results to compute an 'innovation index', they report that Australia's innovative performance was weak in the 1970s in comparison with 23 other OECD countries, placing Australia as a third-tier or imitator economy. Innovative performance improved markedly in the 1980s and 1990s, moving Australia to the second tier of OECD economies alongside the Netherlands, Belgium and the UK. According to their measure, Australia's innovation performance has plateaued since 1998. They conclude that the sharp improvement in performance which started in the early 1980s was driven largely by increases in R&D expenditure and employment and by improvements in IP protection which outweighed the declining rate of public investment in education. Although a number of reservations can be expressed about such a study, it does concur with other indicators that innovation has slowed over the past decade.

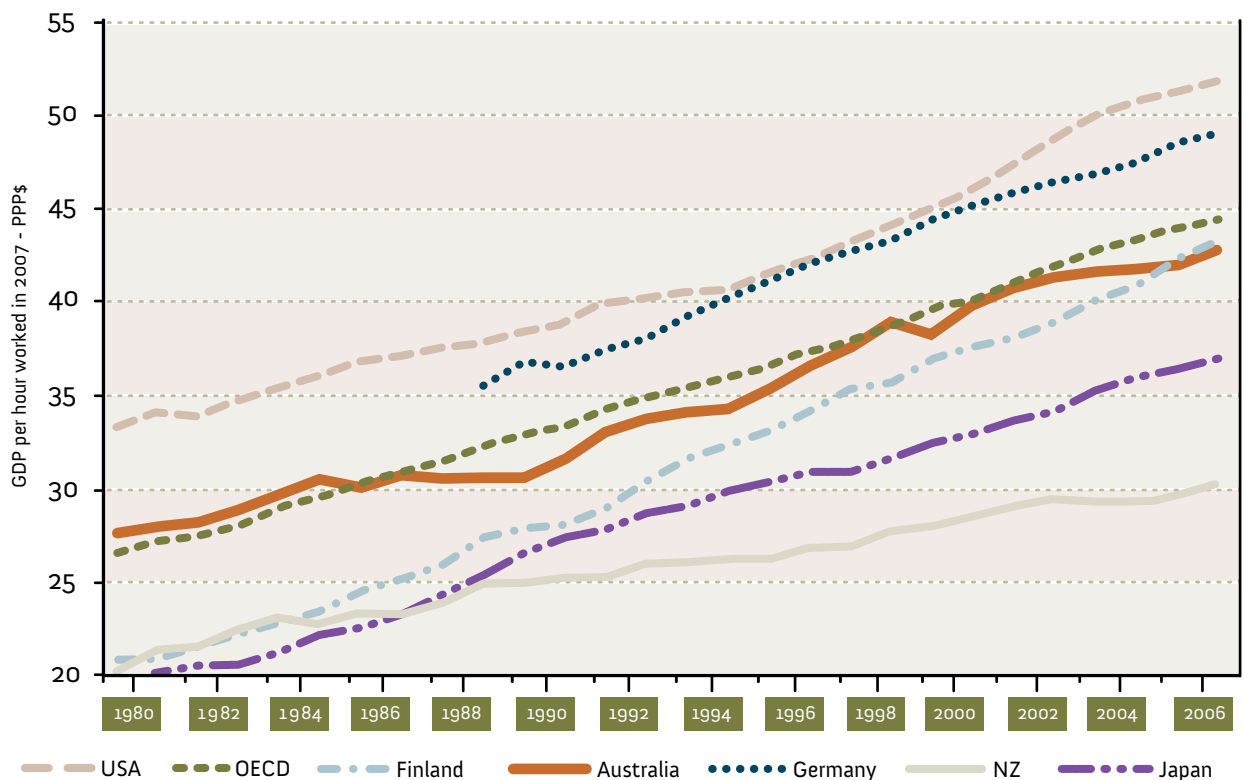
<sup>1</sup> Gans, Joshua and Richard Hayes, *Assessing Australia's Innovative Capacity: 2007 Update*, Centre for Ideas and the Economy, Melbourne Business School, 2008. [www.mbs.edu/jgans](http://www.mbs.edu/jgans)

## Assessing the final outputs of innovation: productivity and living standards

Ultimately we want to know whether the innovation system is delivering benefits to the sustainable living standards of Australians. The prime determinant of living standards is the productivity of labour, measured as the real value of output per hour worked.<sup>1</sup>

Figure 7 displays the path of real GDP per hour worked for 9 comparator economies and for the OECD as a whole. Australia experienced fairly rapid growth in the productivity of labour throughout the 1990s, when Australian productivity caught up with the OECD average. But OECD productivity has grown faster since 2002. In comparison with the USA, Australian labour productivity was 83 percent in 1980, rising to 88 percent in 1998, slipping to 82 percent by 2007.

**Figure 7: GDP per hour worked in selected OECD economies, 1980 to 2007**



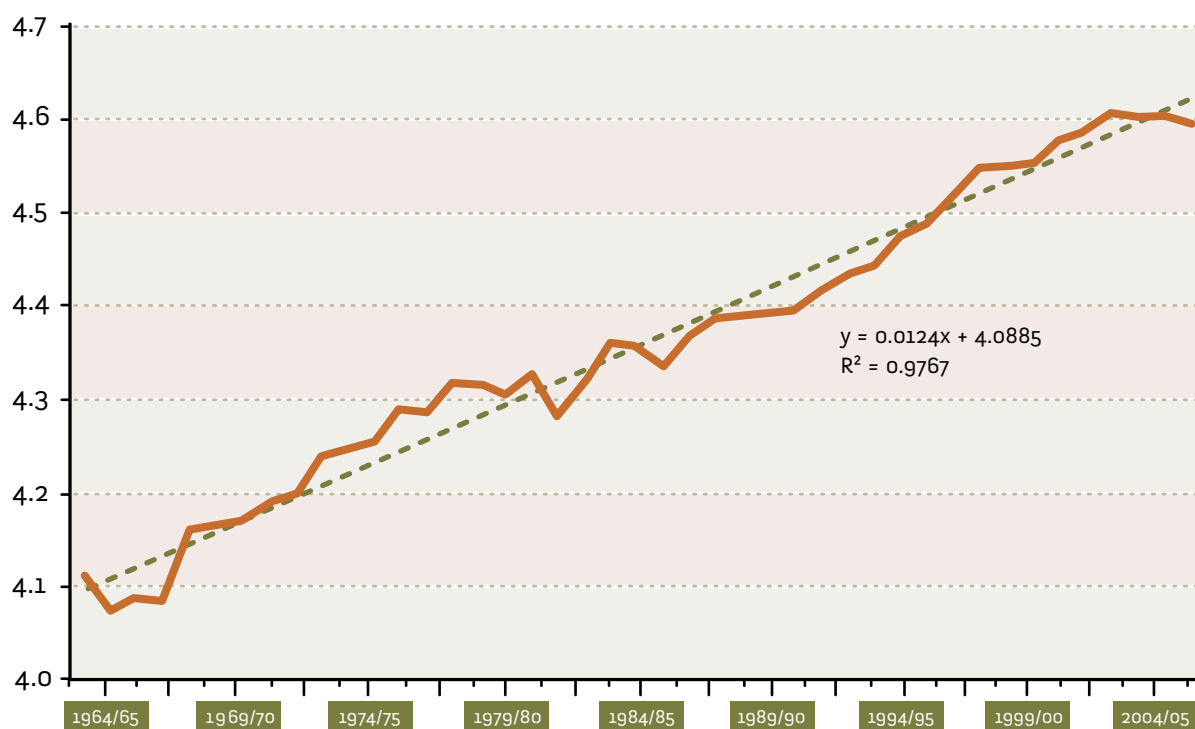
Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2008, [www.conference-board.org/economics/](http://www.conference-board.org/economics/), via Steve Dowrick.

<sup>1</sup> There are problems with this measure in that for many countries, including Australia, the value of non-marketed services such as public education and government is not measured; instead, the value of output is assumed to be the same as the value of the inputs which amounts to an assumption of no productivity growth. Since the public sector has experienced substantial innovation in work practices, particularly through the introduction of new computer and communication technologies, this means that the official figures probably understate the true rate of national productivity growth. A clear example of this problem is in the education sector which has become Australia's third largest exporter, after coal and iron ore (see: Australia's Export of Education Services, Reserve Bank Bulletin, June 2008, [www.rba.gov.au/PublicationsAndResearch/Bulletin/bu\\_jun08/aus\\_exports\\_education\\_services.html](http://www.rba.gov.au/PublicationsAndResearch/Bulletin/bu_jun08/aus_exports_education_services.html)). The way productivity is measured gives little clue that innovation has been taking place in this sector.

It is instructive to look at productivity growth in more detail by examining the performance of different sectors of the Australian economy. Hughes and Grinevich <sup>1</sup> highlight the importance of service sector industries for overall economic performance. The three sectors that contributed most to overall productivity growth between 1992 and 2004 are all in the service sector: wholesale trade, communications and finance. Agriculture, construction and transport were also amongst the top ten contributors. This confirms previous findings from the Productivity Commission that service sector innovation has been vital for growth in the whole economy over the past few decades. It also raised questions: Is our innovation system tuned in to services? Are we taking advantage of Australia's lead position in services in global trade?

So far we have examined the growth of the productivity of labour. This is not a direct measure of the contribution of innovation because it includes the contribution of capital investment whereby the workforce is enabled to produce more because they have more machinery and equipment to work with. If the contribution of capital is excluded, the resulting measure of 'multi-factor' productivity provides a better indication of the contribution of innovation. The most recent ABS estimates of this measure are illustrated in Figure 8 for the market sector of the Australian economy.

**Figure 8: Multi-factor productivity in the market sector 1964/65 to 2006/07**



Note: The labour input is measured as hours worked in the market sector.  
Source: Australian System of National Accounts, ABS Cat. 5204.0, Canberra.

<sup>1</sup> Alan Hughes and Vadim Grinevich, The Contribution of Services and Other Sectors to Australian Productivity Growth 1980-2004 (Report prepared for the Australian Business Foundation), Cambridge, UK: Centre for Business Research, 2007.

The bold line in the figure traces the path of multi-factor productivity since 1964. The dashed straight line represents the long-run trend rate of growth, 1.24 percent per year.<sup>1</sup> There was a long period of sustained and rapid productivity growth, averaging 1.7 percent per year, between 1991-02 and 2002-03. This miracle growth has, however, stalled since 2003. No multi-factor productivity growth has occurred in the market sector since 2003.

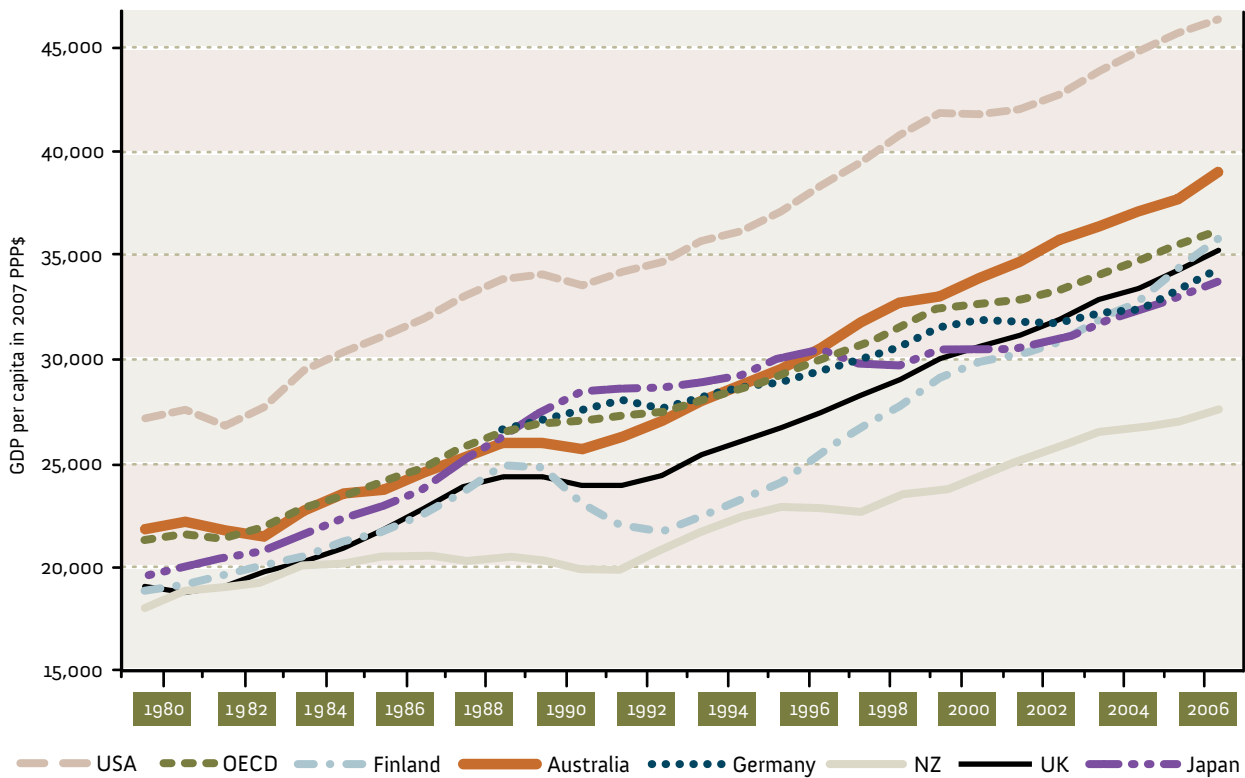
This collapse in productivity growth might be taken as an indication that innovative activity has ceased but an examination of sectoral trends reveals a more complex picture. Since 2003 there has been continued growth in multifactor productivity in several sectors, including communications, transport and finance. This growth has been offset by productivity decline in mining (since 2000), in agriculture (since 2005), and in electricity, gas & water (since 1997).

In the case of agriculture, the collapse in productivity can be attributed to drought rather than any lack of innovation capacity. The collapse in productivity in mining is more complex. This sector is the source of most of Australia's rising terms of trade. The huge rise in the world prices for minerals has led to sharp increases in both capital investment (the capital stock has risen by 34 percent since 2000-01) and employment of labour (hours worked have risen by 68 percent). Opening new mines involves a long delay, and in the short-term the exploitation of previously marginal mines inevitably involves decreasing returns. The 25 percent fall in mining productivity since 2000 is almost certainly due to these special factors which have nothing to do with the underlying rate of innovation in the industry. Consideration of these special sectoral factors leads to a conclusion that whilst the rate of innovation-led productivity growth has slowed since the miracle growth rates of the 1990s, innovation has not ceased.

<sup>1</sup> The vertical scale is in logarithmic units. This means that a straight line represents a constant proportional rate of growth and that the steeper the upward slope of the productivity line, the faster is the rate of productivity growth.

We turn next to Australian performance in living standards and well-being. A common measure of living standards is GDP per capita. It is far from a perfect measure because it excludes the value of leisure and household production, but data is available for most countries for long periods so it provides a consistent, if imperfect, measuring stick. Figure 9 displays these data for selected OECD countries.

**Figure 9: GDP per capita in selected OECD Economies, 1980 to 2007.**



Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2008, [www.conference-board.org/economics/](http://www.conference-board.org/economics/). Via Steve Dowrick (2008).

In terms of real income per person, Australia has risen substantially above the OECD average since the mid-1980s. Starting in 1980 at 81 percent of US levels, Australia had improved by 2007 to 84 percent. The continuing rise in Australia’s real income over the past few years, at a time when productivity growth has stalled, is due to the massive 40 percent improvement in the terms of trade over the past five years – a phenomenon that cannot be taken for granted to continue in the longer term.

The final measure of well-being discussed in this section is environmental quality and sustainability. Here the picture is rather bleaker. The State of the Environment Report 2006<sup>1</sup> covers many areas of environment concern affecting Australia. The report explains that salinity is

<sup>1</sup> Australian State of the Environment Committee, Australian State of the Environment - Independent report to the Australian Government Minister for the Environment and Heritage, 2006

occurring in about one-third of catchments assessed, particularly in south-western Australia, and in the southern Murray-Darling Basin. These are all areas with a long history of land clearing and intensive agricultural use. Reductions in the area of perennial native vegetation in these catchments have altered the surface and groundwater hydrology, increased groundwater recharge, and increased salt ingress to rivers and streams. Approximately 5.7 million hectares are within regions mapped to be at risk of or affected by dry-land salinity. At the same time, Australia has eminent research organisations which have developed and continue to provide innovative solutions to environmental problems, such as CSIRO and 11 environmental Cooperative Research Centres. These bodies turn Australia's science into successful new products, services and technologies.

### **Overall assessment of Australia's innovation record**

Australian innovation seems to have slowed or even stalled in the new millennium. Strong productivity growth in the decade of the 1990s has given way to significantly slower growth since 2003. Strong growth in average real income over the past five years appears to have been driven more by a massive improvement in the terms of trade rather than by innovation.

The productivity success of the 1990s was built on successful innovations occurring in agriculture and throughout the service industries, particularly in wholesale trade, communications and finance. The success appears to have been based on the adoption and adaptation of new computer and communication technologies by service oriented industries. The successful adoption of new technology and new processes was made possible by the strong rise in educational achievement that had occurred over the previous decades.

The cause of the productivity slowdown is uncertain. However, our analysis of the primary and intermediate inputs into the Australian national innovation system points to several factors.

- The education revolution of the 1970s and 1980s saw a massive influx of young Australians, particularly girls, into Year 12 education and then on to tertiary education. These well-educated young people entered the workforce in the 1990s, quickly became computer literate and were instrumental in implementing the innovation surge of that decade.
- A declining rate of public investment in education over the past decade has stalled the rate of increase in educational attainment. Relative proficiency in literacy and mathematics amongst our 15-year-olds is in decline and interest in science is alarmingly low.
- Public investment in research has declined since 1995 with university funding for research falling further behind the full-cost

of conducting that research and government research agencies such as the CSIRO suffering successive funding cutbacks.

- The vastly improved terms of trade, although a strong contributor to rising GDP per person, has been associated with a significant strengthening of the Australian dollar. This has made it difficult for non-resource sector exporters, with adverse effects on investments in imported capital goods that embody technological improvements and facilitate both process and product innovations. The 'Resource Curse' (or 'Dutch Disease') may have become relevant since 2003 with attendant effects on innovation and productivity growth.

Slowdown in productivity growth over the past five years is of major concern because rising terms of trade cannot be relied on to continue sustaining real income growth indefinitely. Although there is little prospect that the demand for Australia's natural resources will decline in the foreseeable future, the prices of natural resources could fall back significantly, reversing the terms of trade position. This would, most likely, be followed by a devaluation of the Australian dollar. However, exporting industries would not be able to take advantage of this unless there was a capacity to do so. Such a capacity can only come from a stock of human capital and through cumulative innovations in the provision of new processes and products. However, it can take decades, rather than years to build such capacity. Falling behind because of a lack innovation presents problems for our economy and its capacity to export. Our industries now compete in a world where innovation is taking place more widely, even in what are perceived to be underdeveloped countries. So we cannot afford to allow the resource boom to remove our competitiveness in non-resource industries. We must create conditions where our capacity to absorb overseas innovations and to develop our own innovations, in appropriate niche areas, is promoted vigorously.

The challenge now is to re-invigorate innovative activity, leading to renewed growth in productivity and living standards and an enhanced Australian capacity to deal effectively with major environmental and climactic challenges. These great challenges cannot be met unless our economy is strong and stable. Australia has proven in the past that it can be innovative and productive enough to solve major problems. Fortunately, we have both the resources and the necessary capability to meet these new challenges. All we need is the collective will to enact an ambitious and effective innovation strategy to prepare us for the future.