Measuring innovative performance — essential for effective innovation policy and economic growth

Despite a compelling economic case for innovation as a policy priority, innovative performance is not assessed regularly as a barometer of economic performance like unemployment or inflation. Without a good measure of innovative performance, innovation will continue to languish as an item on the economic policy agenda.

The measurement problem

Economists have long known that a country's innovative performance was a key driver of its economic growth and prosperity, and that the market system alone cannot generate all socially desirable technological improvements.

Innovation is the primary textbook example of a positive externality: an activity with social benefits that substantially exceed an innovator's private benefits.

Given its importance in generating economic growth and the failure of markets to deliver it at an optimal rate, why doesn't innovation policy rank more highly on any economic policy agenda?

Compared with the mainstays of macroeconomic stability and competition policy — handled by the Reserve Bank (RBA) and the Australian Competition and Consumer Commission (ACCC) respectively — innovation policy has no permanent presence at a policy institution.

One key reason for this is that innovation policy lacks an objective. Whilst appropriate, the goal of achieving 'more innovation' does not readily translate into a measure of performance. Policymakers need a measurable objective to indicate if a policy direction is succeeding or failing.

Measurements of macroeconomic stability are available in the form of movements in unemployment and prices, and measures of concentration and entry into our industries also provide good indicators for competition policy. For innovation, however, there is no agreed measure and without this there is no key policy achievement indicator. [1]

The main hurdle in establishing a measure of innovative performance useful for policy analysis is the incredibly long periods of time between the push of a particular policy lever and its impact on the rate of innovation. Compared with

monetary policy, which can have an impact on inflation, unemployment or the exchange rate in a matter of months, innovation policy can take many years for the full effects to be realised. This is well outside the necessary timeframe for a mechanism that would signal policymakers that policy is off course and needs to change direction.

This also immediately poses a problem for measuring innovative performance in terms of innovative output.

Consider an indicator like the number of patents being generated by Australians in a given year. This is potentially a good measure of the current level of Australia's innovativeness. But it is not a worthwhile indicator of the effectiveness of current government policy.

It might be an indicator of how well policy was undertaken a decade ago, but even that is problematic given the sheer number of shocks — including world events and changes in the economic cycle — that have occurred over that time. And these issues also affect other measures of innovative output viz. patents, trademarks, designs and indeed, citations of scientific publications.

So if measures of output won't do the trick, what about innovative inputs? The 2004 study *Mapping Australian Science & Innovatio*n documented statistical information on many such inputs including: the level of R&D expenditures; the number of scientists employed; university–industry collaborations; and the level of venture capital funding. In each case, the general view was that more of these inputs will mean more output in terms of innovation.

But beyond the policy recommendation that 'more is better' there is a problem in benchmarking performance in this way. Even in per capita terms there are few of these inputs where Australia appears to be doing more than other countries. And then, there is the question of which countries we might compare ourselves with.

All of this points towards a balanced scorecard that allows us to identify where we are doing more and where we are doing less. It does not indicate, however, whether the mix is right for us and our economic base. After all, to point out that we graduate more biologists but fewer engineers than other countries might be good news for our medical industries and bad news for information technology but what does it mean for the country as a whole? As it stands, the scorecards based on inputs do not lend themselves to good judgment and the establishment of sound policy criteria.

The Innovation Index

A more rigorous and objective approach has been pioneered by Professors Michael Porter of Harvard and Scott Stern of Northwestern.[2] In a project wholly funded by the Intellectual Property Research Institute of Australia (IPRIA), we

have been involved in updating their basic approach for specific use in Australian policy making.[3]

The approach is based on a simple idea: if we use information from a wide variety of countries, we can establish clear relationships between past innovative inputs and more recent innovative output and thereby develop a measure of a country's current capacity to innovate. Consequently, the resulting measure will indicate how effective the mix and level of current inputs will be in generating future innovation; providing the feedback necessary for effective innovation policy.

To this end, we have undertaken the following steps. First, we needed to pick a measure of innovative output that would be comparable across countries. As almost all innovations with substantial commercial application are filed in the United States, we chose to use the total quantity of patents granted (per capita) in a given year to individuals or firms from a country by the US Patent Office as our measure of international patent output.[4]

To use this measure it must be lagged because the innovation environment pertinent for the patent grant is the environment that prevailed at the time of application. This lag reflects the difference between innovative capacity (innovation inputs) and the innovation index (predicted innovation outputs). Recent advice from the US Patent Office indicates that the average lag between patent application and patent grant is two years and this is the lag used here.

While many innovations are not patented — for example, intangible innovations within organisations or product innovations in service industries —– the level of patenting is positively correlated with other measures of innovation. Remember our purpose was not to focus on this output measure but to understand it.

Second, we needed to sort out from the list of potential drivers of international patenting what were the significant drivers. R&D investments, the number of scientists and engineers, overall productivity, and education expenditures may all theoretically generate more innovativeness but they are also related to one another. So, when coming up with an index of how current inputs would drive future innovation, we needed to consider the mix of drivers that could explain most of the variation in international patenting across countries. To do this, we ran a series of regressions of potential drivers in each country against the level of international patenting. This allowed us to use both country differences as well as changes over time to quantify the relationship between the most significant drivers and international patenting.

We found that R&D activity, the numbers of scientists and GDP per capita were all important. But higher levels of international patenting were driven by the total expenditure on secondary and tertiary education, the amount of R&D performed by universities (whether funded by government or not), the amount of R&D

funded by industry, the strength of intellectual property protection and the general level of openness to international forces. Examining each driver across the OECD, we quantified econometrically its impact on international patenting. The aim was to use these quantified relationships to build an index of a country's overall innovative capacity.

Innovative capacity today

[Note for designers: Insert Table 1 near here]
Table 1 illustrates our findings. First, let's compare trends in the drivers of innovative capacity to see how countries are faring relative to other countries over time. Australia looks to be at a relative standstill. Second, by comparing the rankings on the number of international patent grants with the innovative capacity index, it is clear that the measure of output provides a poor indicator of future performance. Take, for example, Denmark. What it is doing today means that it will be a world leader in innovation on a per capita basis in the not too distant future.

Australia's innovative potential

[Note for designers: Insert Figure 1 near here]
Finally, if we look just at Australia (see Figure 1), we can see that, until recently, our innovative capacity has improved over the past two decades. We have moved from a classical imitator economy to a second tier innovator, due to the microeconomic reforms and macroeconomic stability of the 1980s and 1990s, but we are still a long way from being a first tier innovator. Put simply, we do not spend as much on education or perform as much R&D (especially in our universities) as countries we consider our economic equals.

To understand this, it is useful to look at the drivers of innovative capacity for Australia. We found that they key factors contributing to the recent decline in our innovative capacity were: stagnating R&D expenditure; a decline in IP protection; and a continuing decline in education funding.

Australia's Innovation Index recorded a small decline in 2004. This decline, together with Austria's improved index, saw Australia's OECD innovative capacity ranking fall from 14th in 2003 to 15th in 2004.

This fall in innovative capacity was not associated with the most direct drivers of innovative capacity: R&D spending and R&D personnel. In these areas Australia's most recent growth rate has been slightly higher than the average growth rate for the OECD. These factors do, however, remain a cause for concern. Looking back beyond the most recent years, Figure 2 shows that Australia's real R&D spending has stagnated since 1996 and employment of R&D personnel relative to the OECD average has also declined over this period.
[Note for designers: Insert Figure 2 near here]

Some more subtle drivers of innovation rates appear to be behind the 2004 decline in the index. While Australia has made impressive strides in intellectual property protection, recent declines in the perception of intellectual property protection have contributed to a decline in the innovation index. If the IP protection perception levels of 2001 had been maintained, Australia's overall Index value would have recorded a slight increase, all other things being equal.

The reasons for the decline in the perception of Australia's IP protection may be related to controversy surrounding copyright issues, music copying and more recently IP issues highlighted by the US–Australia free trade agreement. Across the OECD a general decline has occurred in the perception of the strength of IP protection, no doubt fuelled by worldwide controversy over piracy, copyright and digital IP issues.

Yet Australia's decline has been greater than the OECD average. More recent surveys indicate that this has continued, which will feed into future innovation index calculations.

[Note for designers: Insert Figure 3 near here]
A further feature of the 2004 downturn in the index is the continued decline in public spending on secondary and tertiary education as a proportion of GDP. Figure 3 shows that this has been an area of long-term relative decline for Australia compared with the rest of the developed world. Although demographic shifts play some part in this decrease this is unlikely to explain the relative decline for Australia compared with the OECD average. Instead, policy choices appear to have shifted public funding away from these sectors in Australia, comparing unfavourably with the persistent increases in public funding of education for the OECD as a whole.

An important note is that the index only rose for eight of the 29 OECD countries in 2004 despite widespread increases in resource and policy commitments to innovation across the OECD. Part of the explanation for this lies in a 'raising the bar' trend for new-to-the-world technology, where increasing resource and policy commitments are needed merely to maintain innovation rates.

Where to go from here?

Our index is one potential measure of innovative performance that can be useful in setting policy. For instance, in a couple of years it will provide a good indication of the importance of the US Free Trade Agreement (and other policy changes such as recent reforms to increase tertiary education spending) for our innovative capacity. Gaining general acceptance of these issues as a matter of national priority is, however, another matter. We can help in providing the tools but the will has to come from elsewhere.

Nonetheless, for three years we have been conducting this study and the results have been robust and point in the same direction every year. Thus, the 2003 conclusions of Gans and Stern continue to gain credence and are worth reiterating here.

In a global economy, innovation-based competitiveness provides a more stable foundation for productivity growth than the traditional emphasis on low-cost production. Having secured a position as a leading user of global technology and creating an environment of political stability and regional leadership, Australia has an historic opportunity to pursue policies and investments to establish itself as a leading innovative nation.

Australia must build upon a foundation of openness to international competition and the protection of intellectual property rights. However, we also need to focus on certain areas that appear to have become neglected over the past two decades. In particular, Australia should significantly increase its investment in order to:

- Ensure a world-class pool of trained innovators by maintaining a high level of university excellence and providing incentives for students to pursue science and engineering careers.
- Provide incentives and opportunities for the deployment of risk capital.
- Facilitate innovation as a cumulative step-by-step process.
- Continue to open up Australia to international competition and investment and upgrading the effectiveness of intellectual property protection.
- Maintain a vigorous yet sophisticated approach to anti-trust enforcement.
- Reduce barriers to entry and excessive regulation that hinder effective cluster development.
- Build innovation-driven dynamic clusters based on unique strengths and capabilities.
- Enhance the university system so that it is responsive to the science and technology requirements of emerging cluster areas.
- Encourage the establishment and growth of institutions for collaboration within and across industrial areas.

Australia's innovation policy must be cohesive in order to create a favourable environment for private sector innovation. Rather than micro-management of individual projects or short-term schemes that do not necessarily fit within the overall plan, innovation policy must be consistent and allow markets and investors to ultimately choose where to deploy resources and capital for global innovation.

Indeed, in the Australian context, high-technology investments may not be in what are conventionally regarded as high-technology industries, as Australia's key strengths build on historical advantages in primary industries.

Ultimately, policy should not be judged on whether a particular company or industry flourishes but on whether, taken as a whole, Australian firms are increasingly able to develop and commercialise innovation for global competitive advantage and as a source of prosperity for Australia going forward.

TABLE 1

Country	2003 Rank	2003 Innovation Index
USA	1	277.4
Finland	2	198.8
Sweden	3	180.8
Japan	4	173.3
Switzerland	5	155.8
Denmark	6	139.7
Canada	7	118.5
Germany	8	108.6
Norway	9	96.8
Iceland	10	83.7
France	11	80.9
Netherlands	12	80.7
Belgium	13	75.1
Australia	**14**	**57.2**
Austria	15	53.2
UK	16	51.3
Ireland	17	48.9
New Zealand	18	28.2
S Korea	19	28.2
Italy	20	21.3
Spain	21	20.0
Greece	22	10.5
Portugal	23	8.1
Hungary	24	4.3
Poland	25	3.7
Turkey	26	0.7
Mexico	27	0.7

Country	2004 Rank	2004 Innovation Index	Number of Patents Granted per Capita (2004)
USA	1	255.9	251.7
Finland	2	206.7	176.0
Sweden	3	176.7	143.6
Switzerland	4	156.9	173.0
Denmark	5	156.9	76.7
Japan	6	142.2	276.7
Canada	7	116.3	105.8
Germany	8	104.1	130.5
Norway	9	101.3	53.0
France	10	74.0	56.3
Belgium	11	72.8	58.8
Iceland	12	71.2	69.0
Netherlands	13	71.0	78.3
Austria	14	58.0	66.5
Australia	**15**	**54.7**	**47.4**
UK	16	50.7	58.1
Ireland	17	44.1	46.3
S Korea	18	28.8	92.0
New Zealand	19	27.8	35.0
Spain	20	21.1	6.4
Italy	21	20.8	27.5
Greece	22	10.9	1.4
Portugal	23	8.0	1.6
Hungary	24	4.1	4.8
Poland	25	3.3	0.4
Turkey	26	0.7	0.2
Mexico	27	0.6	0.8

FIGURE 1

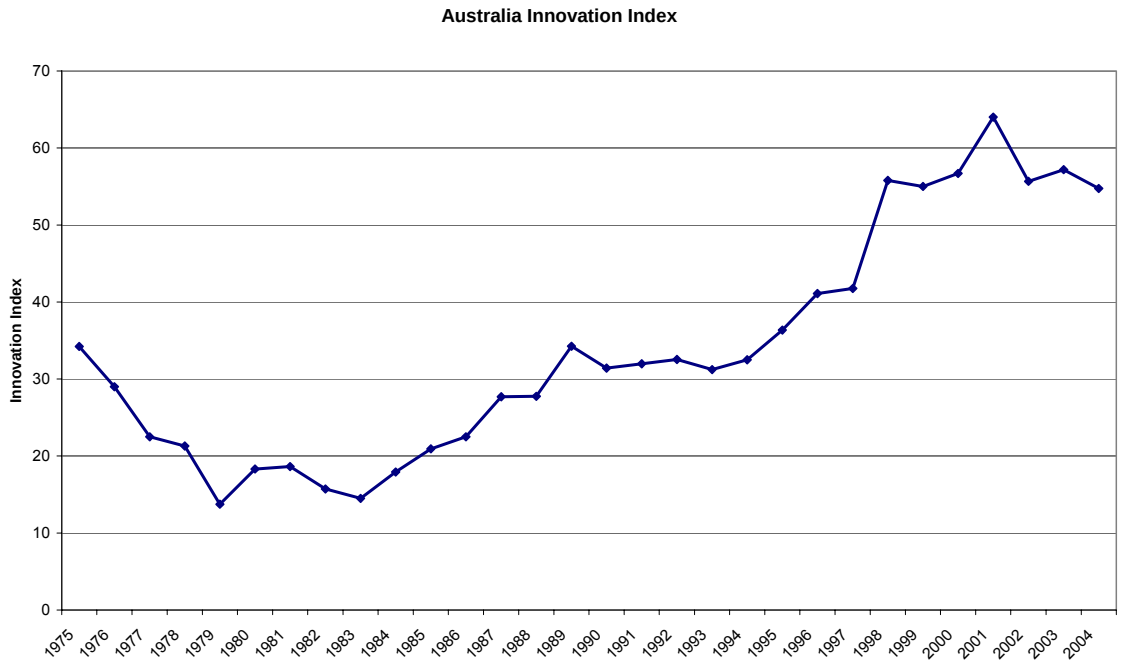


FIGURE 2

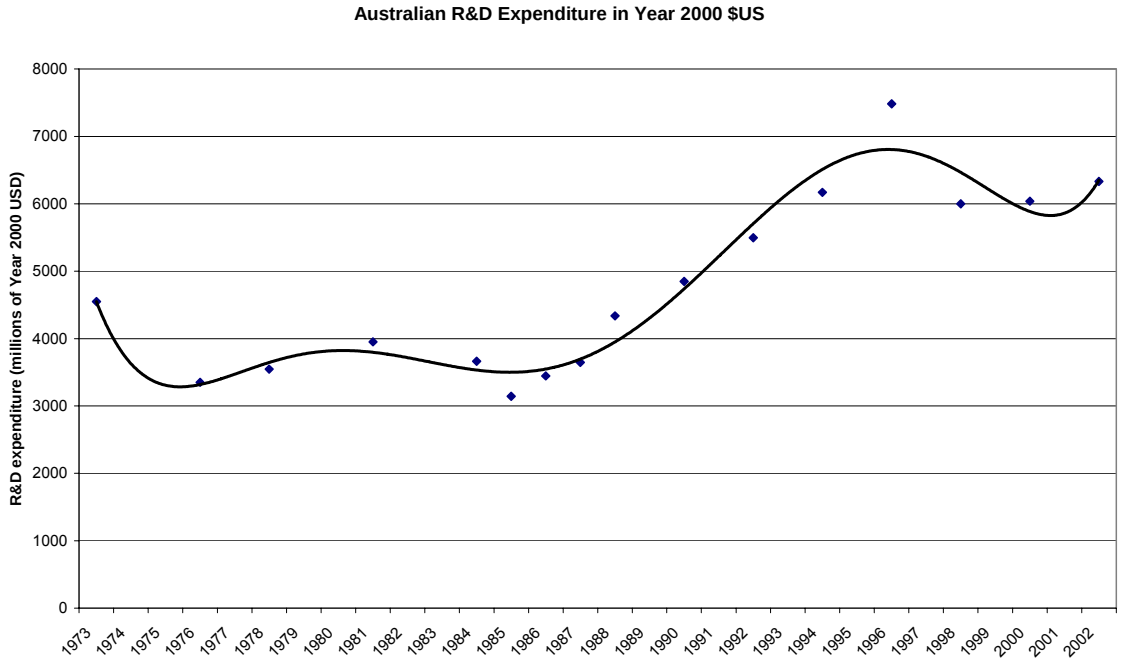
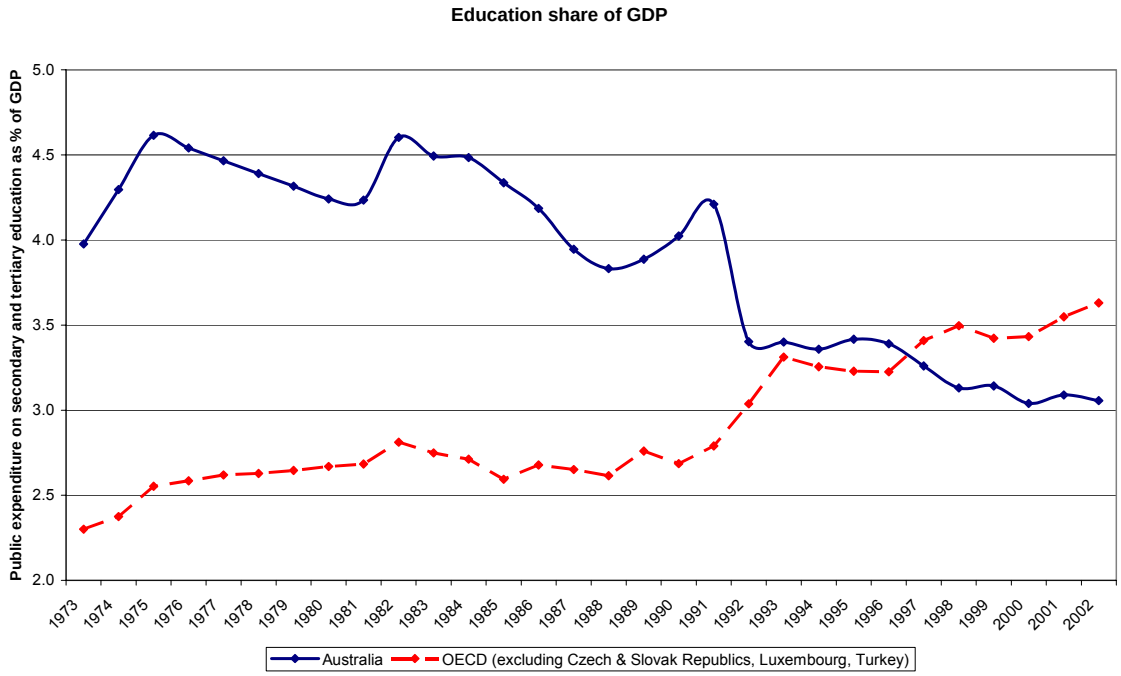


FIGURE 3



ENDNOTES

[1] This question was also asked earlier by Joshua Gans 2004, 'A measure of all things innovative,' *Australian Financial Review*, 17 May, and this article is an expansion and update of that earlier work.

[2] See Michael E. Porter 1999, Harvard Business School, Professor Scott Stern MIT Sloan School & NBER, Council on Competitiveness, *The New Challenge to America's Prosperity: Findings from the Innovation Index,* Washington DC.

[3] See J.S. Gans and S. Stern 2003, 'Assessing Australia's Innovative Capacity in the 21st Century', Intellectual Property Research Institute of Australia Working Paper.

[4] Gans and Stern (2003) used patents granted according to the date of the patent application, primarily to account for some missing data issues. This update returns to the use of patents granted in a given year.

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