Australian Government

AUSTRALIA'S CHIEF SCIENTIST

Future of Australian Science, Technology and Innovation

PMSEIC JULY 2012

OVERVIEW

This paper provides a foundation for the discussion by PMSEIC members of Australia's global position in science, technology and innovation. It builds on the Office of the Chief Scientist Occasional Paper 2 (see meeting papers). Charts on the following pages serve to position Australia with respect to two groups of countries:

1. some countries at similar stages of development and with similar governance systems and cultural attributes to Australia (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Great Britain, Ireland, Norway, Sweden, USA); and

2. the countries included in the Asian Century white paper (China, India, Indonesia, Japan, Malaysia, Philippines, Republic of Korea, Singapore, Thailand and Vietnam).

The first three figures present different aspects of the split of researchers between the higher education and business sectors, and indicate that Australia's current position is probably not optimal in this regard. Figures 4 to 6 present research performance in terms of publication impact (citations), and indicate that Australia's favourable position is reliant on ongoing collaborations with Group 1 countries. Anecdotal reports indicate that the step from R&D to innovation is an area where Australia needs to improve, and the final three figures suggest an approach to developing some solutions.

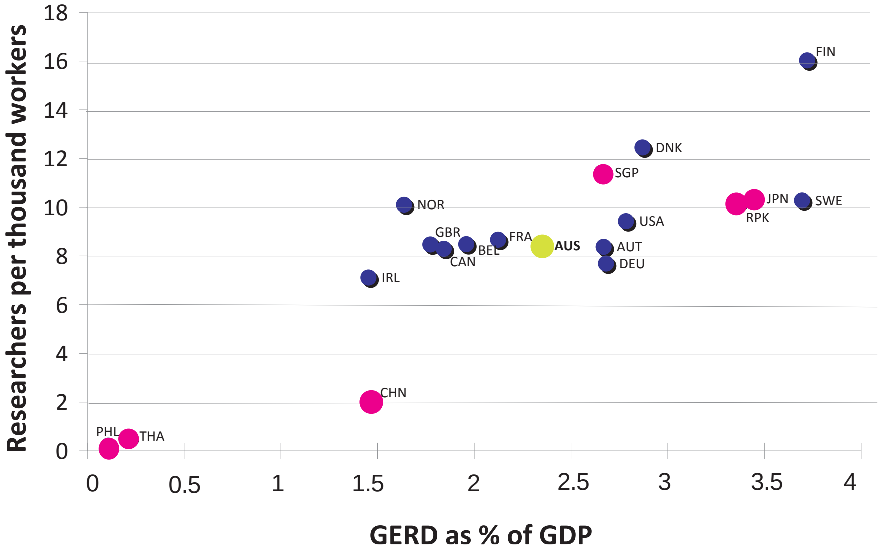
MESSAGES:

- Doctoral research programs in Australia could be modified to better prepare doctoral graduates for working as researchers either in the business sector or closely with the business sector.
- International research collaboration with the USA, UK and Europe is necessary to ensure Australia does not lose its current position of research impact, and ideally to significantly improve it. Collaboration could also be facilitated with Asian countries as a means of gaining commercial benefit from technology transfer.
- A project could be undertaken to explore the relationship between research funding, research impact, and innovation within key areas relevant to agriculture, manufacturing and technology development. This could be addressed through combined analysis of research bibliometrics and patent analytics.

DATA SOURCES

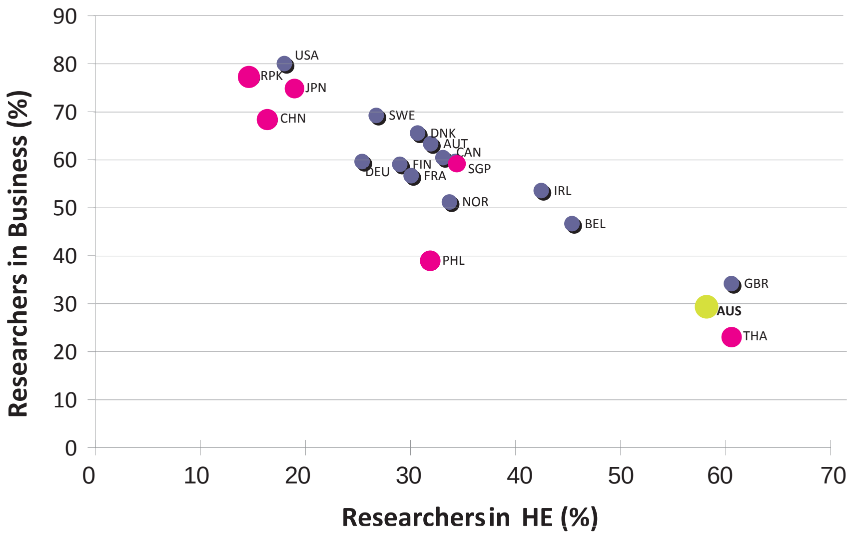
Data sources for this analysis are: the UNESCO Institute for Statistics (R&D spending, researchers in the workforce); the OECD 2011 Scoreboard and the European Commission (sectoral distribution of R&D spending); the US National Science Foundation (sectoral distribution of US researchers); the Population Division of the UN Department of Economic and Social Affairs (population); Thomson-Reuters and Elsevier-Scopus bibliometric databases (research publication volume, impact, and collaboration); and IP Australia for patent filing data.

FIGURE 1: Researchers per 1000 workers versus Gross Expenditure on R&D (GERD) as a percentage of GDP in 2008.



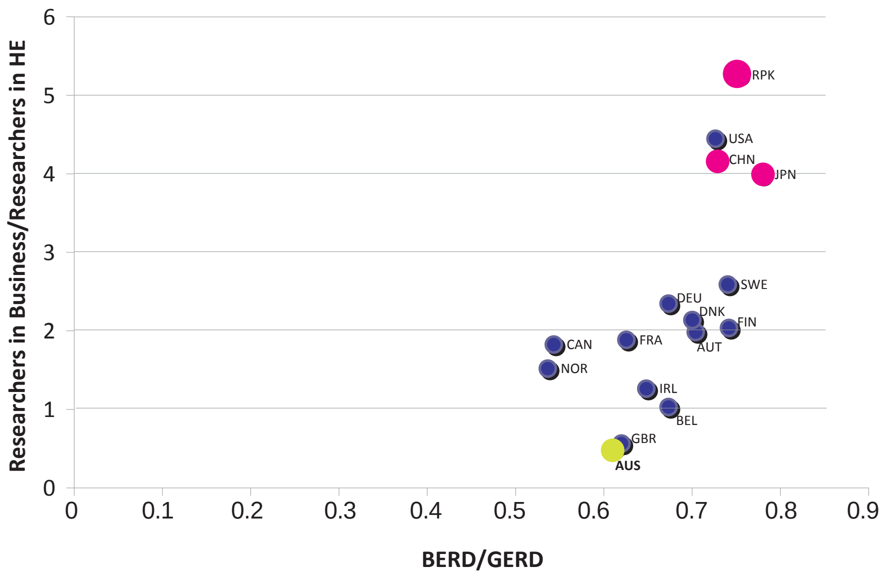
Generally, countries with high levels of GERD as a percentage of GDP ("R&D intensity") also have relatively large numbers of researchers in the workforce. Australia is positioned in the mid-lower space occupied by Group 1 countries. The more developed Group 2 countries also sit above Australia with respect to researchers in the workforce and R&D intensity.

FIGURE 2: Percentages of researchers in the Business sector versus the Higher Education (HE) sector in 2008.



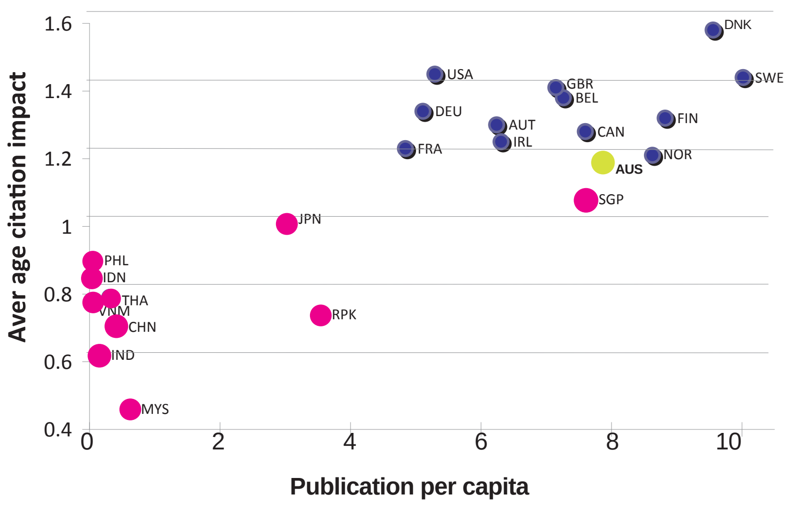
Only 30 per cent of Australian researchers are employed in the Business sector. Great Britain (Group 1) and Thailand (Group 2) are the only countries in this comparison that occupy a similar position to Australia. Most other countries have more than 50 per cent of researchers employed in the Business sector. The USA, Republic of Korea, Japan, Sweden and China have approximately 70–80 per cent of researchers working in that sector.

FIGURE 3: Ratio of researchers in the Business sector to those in the Higher Education (HE) sector versus ratio of Business Expenditure on R&D (BERD) to Gross Expenditure on R&D (GERD) in 2008 (Japan data for 2007).



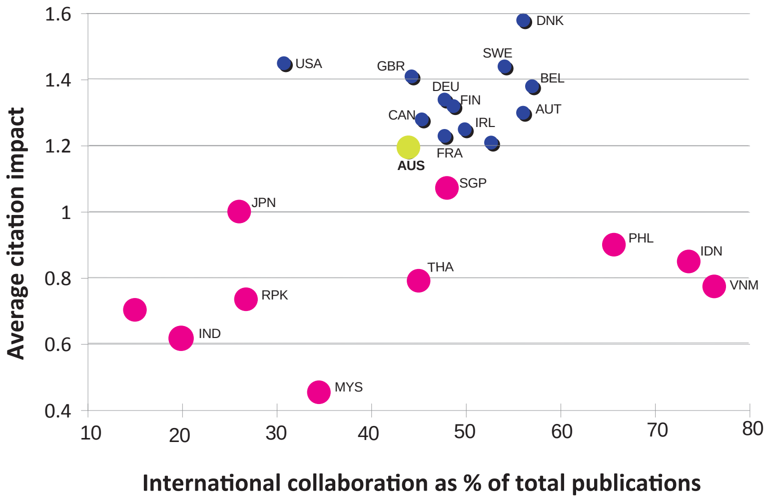
High proportions of researchers in business tend to be associated with high proportions of business R&D spending (BERD) as a proportion of gross R&D expenditure (GERD). Australia's position is almost outside the space occupied by Group 1 countries with both fewer researchers in the Business sector and smaller BERD than most. Of the Group 2 countries available, all three are strong in these metrics.

FIGURE 4: Average publication citation impact versus per capita publication rate during 2006-10.



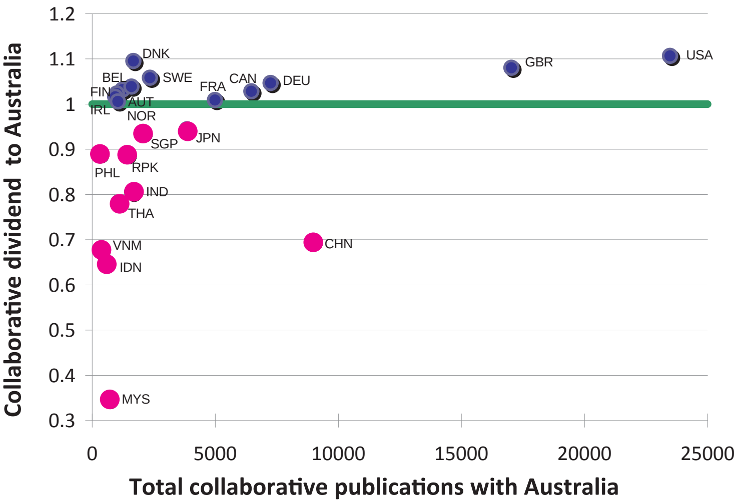
Group 1 countries produce more publications and with higher impact than Group 2 countries. Australia's position is in the cluster of Group 1 countries, but in the lower ranks. Australia has a larger publication rate than most of the countries in that cluster, but the average citation impact is the lowest of the countries representing that group.

FIGURE 5: Average citation impact factor relative to the world versus degree of international collaboration during 2006-10.



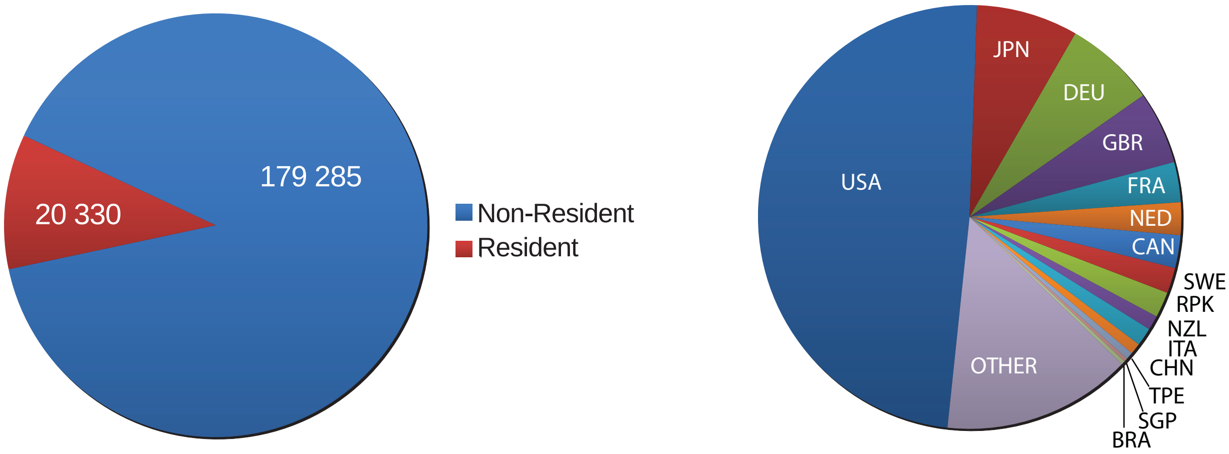
International research collaboration is an important part of advanced R&D systems. Australia's position is consistent with Group 1 countries in that it has a relatively large proportion of internationally co-authored publications. The average citation impact of Australian publications, as previously noted, is ranked the lowest of the Group 1 countries analysed. This raises the question of who benefits most from collaboration between Australia and Group 1 countries.

FIGURE 6: Research impact benefit from collaboration between Australia and other countries during 2006-10.



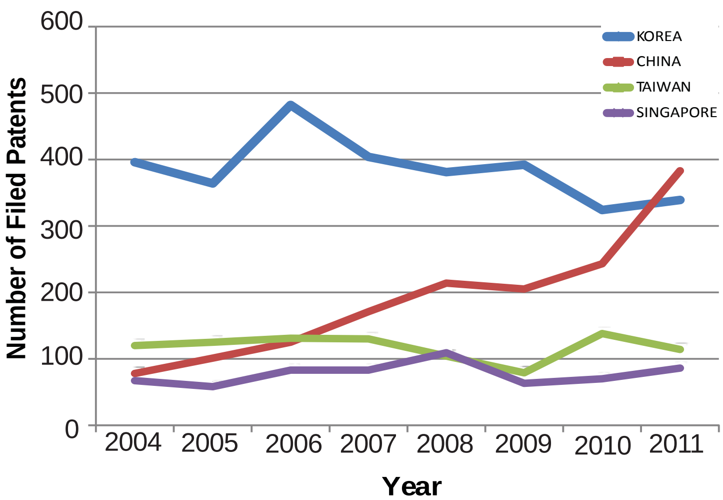
Collaboration dividend (vertical axis) is with respect to Australia, thus a dividend of greater than 1 means Australia benefits more from the collaboration than the partner country and a dividend of less than 1 means that the partner country benefits more than Australia. Collaboration with any of the Group 1 countries results in a net benefit to Australia, and it is sensible that our largest collaboration effort (horizontal axis) is with the USA and Great Britain, as they provide us with largest increases in research impact.

FIGURE 7: Proportion of resident and non-resident patents filed in Australia during 2004-11 (left chart), and proportion by country of non-resident patents over the same period (right chart).



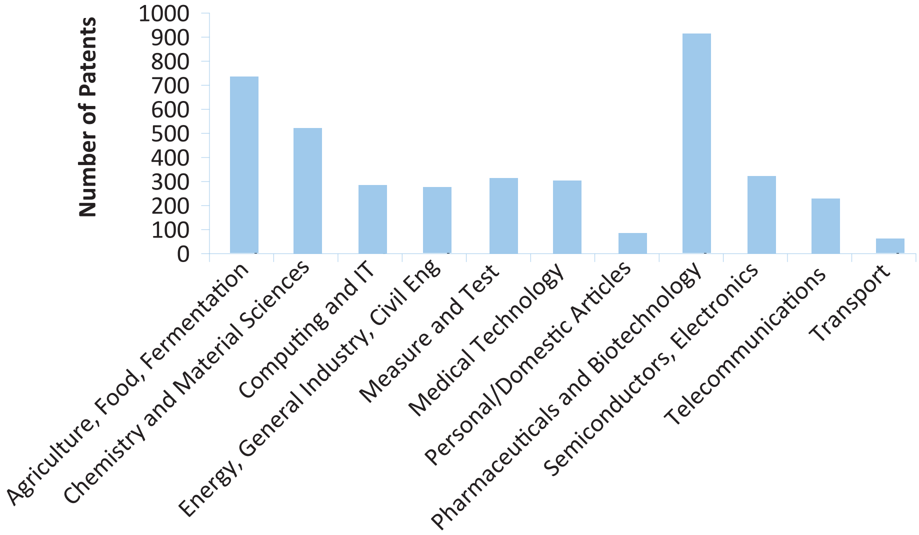
Resident patents (originating within Australia) represent only 10 per cent of all patents filed during the period. Nearly half of non-resident patents filed in Australia are of US origin, with the next largest numbers filed originating from Japan, Germany, and Great Britain. The countries with which Australia has most patent activity are similar to those with which we have strongest ties in research collaboration.

FIGURE 8: Trends in patents filed in Australia from selected Asian countries.



There has been strong growth in the number of patents filed from China, in contrast to relatively flat trends for the other Asian countries shown and most of the Group 1 countries (not shown).

FIGURE 9: Patents originating from the Higher Education sector filed during 1999-2009, by technology field.



The total number of patents filed by 15 Australian universities (including the Group of Eight) during the decade was approximately 4,100. Of these, around 1800 were filed in Australia. This represents less than 8 per cent of resident patents filed over the same period. The focus areas for patent activity by these universities was pharmaceuticals and biotechnology, agriculture and food production, and chemical and material sciences.