Australian Government

OFFICE OF THE CHIEF SCIENTIST

International Science and Innovation Systems

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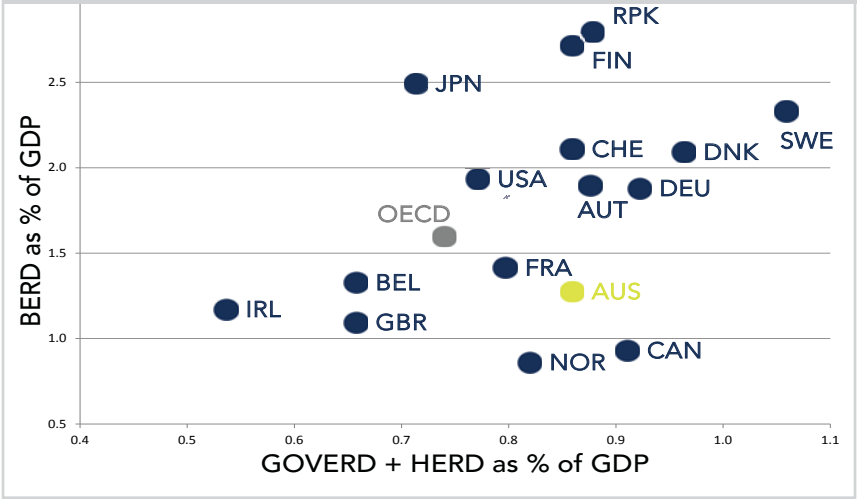
This paper presents a comparison of the science and innovation systems of a group of research-intensive countries with whom Australia partners and competes. It includes summary figures comparing: research expenditure, publishing performance and national science and innovation performance.

1. RESEARCH EXPENDITURE

Research and development (R&D) expenditure is a key enabler of research outputs. The Organisation for Economic Co-operation and Development (OECD) provides national R&D investment profiles using R&D expenditure by sector as a share of Gross Domestic Product (GDP). Gross Expenditure on R&D (GERD) is composed of three constituents: R&D financed by the Government (GOVERD), by the business sector (BERD), and by the higher education sector (HERD).

FIGURE 1: Government and Higher Education Expenditure on R&D as a percentage of GDP plotted against Business R&D as a percentage of GDP in 2010 (2008 for Switzerland).



BOX 1: Comparison Countries

Europe: Austria (AUT), Belgium (BEL), Denmark (DNK), France (FRA), Finland (FIN), Germany (DEU), Great Britain (GBR), Ireland (IRL), Norway (NOR), Sweden (SWE), Switzerland (CHE).

Americas: Canada (CAN), United States (USA).

Asia: Republic of Korea (RPK), Japan (JPN).

The division of GERD across the government, higher education and business sectors illustrates the emphasis placed on different types of R&D investments within a country. Figure 1 shows that government and higher education sector investment in R&D in Australia is greater than the OECD average, as well as several much larger economies including Britain, the United States and Japan, but less than the high performing Nordic nations, Germany, and Canada. In contrast, the intensity of R&D investment by Australian businesses is below the OECD average, the US and most of the European countries that we aspire to match in R&D and innovation performance.

Common measures used to assess the returns on research investment include citation metrics to assess academic performance and several indicators of innovation performance.

2. RESEARCH PUBLISHING PERFORMANCE - CITATIONS

In February 2013, the Office of the Chief Scientist released an Occasional Paper which showed that although Australian science has an overall citation rate above the world average; it performs below an average for selected European countries (Fig. 2). While the data presented in that paper are based on a single measure (citation rate) they raise the question about the choice of an appropriate benchmark to measure our research performance and excellence. Many of the countries with which we collaborate and compete with perform above the European average.

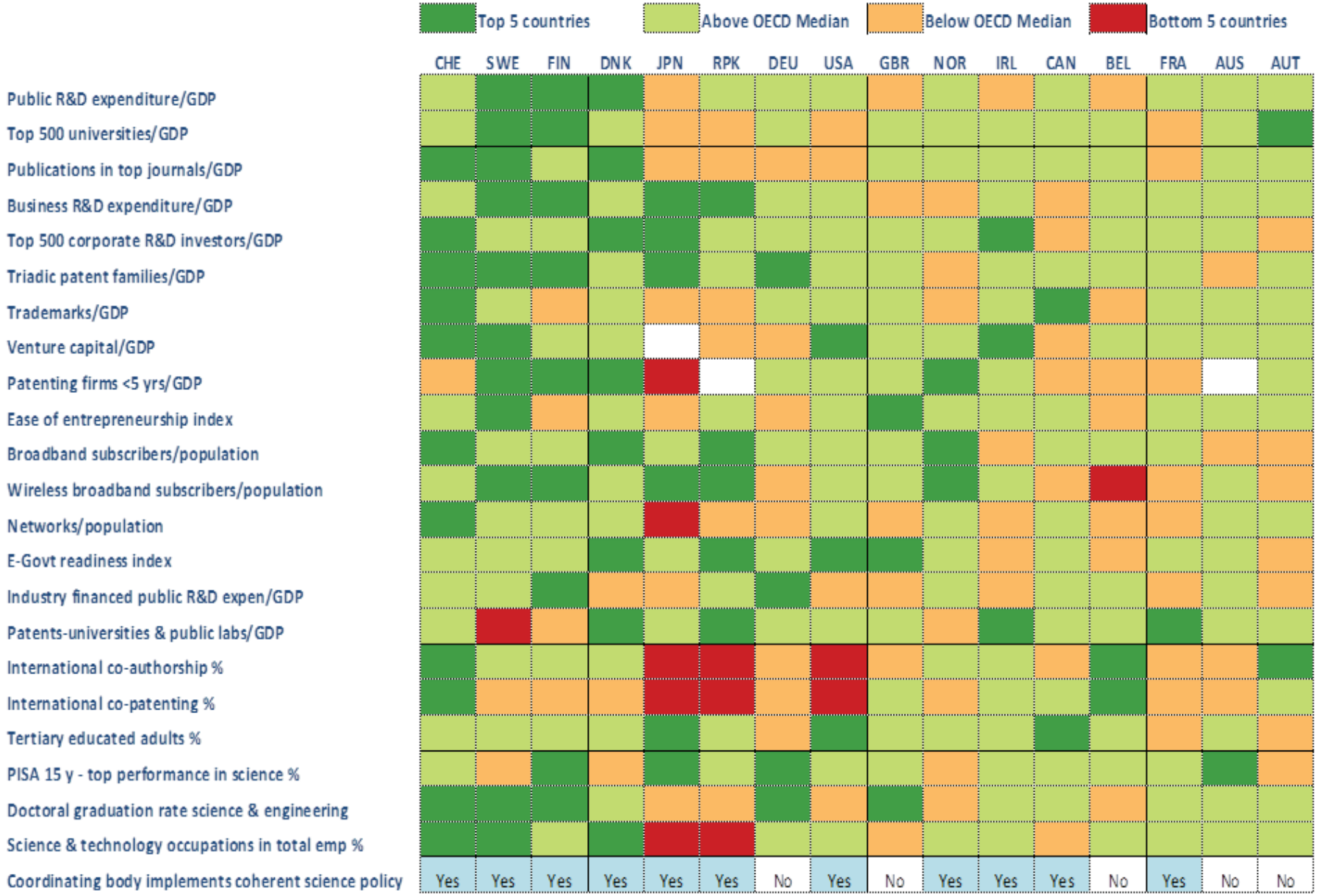
FIGURE 2: Countries are grouped by average citations per paper over the period 1996 to 2010: countries in the green box had an aggregated average citation rate above the European average, amber between European and world averages; and red below both.

ABOVE EUROPEAN AVERAGE	ABOVE WORLD AVERAGE	BELOW WORLD AVERAGE
• USA	• NOR	• SGP
• CHE	• DEU	• IDN
• DNK	• AUSTRALIA	• VNM
• SWE	• FRA	• THA
• GBR	• AUT	• RPK
• FIN	• IRL	• IND
• CAN	• PHL	• MYS
• BEL	• JPN	• CHN

3. NATIONAL SCIENCE AND INNOVATION PERFORMANCE

A comparison of national science and innovation performance indicators from the OECD (Fig. 3) indicates that although Australia performs above the OECD average in the majority of areas, there are a few areas such as triadic patent generation, broadband subscribers per population and international co-authorship and co-patent generation where we fall below the OECD average. In addition, while Australia is a top five performer (dark green boxes) in the Programme for International Student Assessment (PISA) rankings, many other research-intensive countries are in the top five across a wider range of categories (Switzerland and the Nordic countries in particular).

FIGURE 3: Comparative performance of national science & innovation systems 2011. The matrix is derived from the OECD Science, Technology & Industry Outlook, 2012 (p. 234). The dark green squares represent those countries that scored in the top 5 out of all the OECD countries for that performance indicator; light green is in the middle range above the OECD median; orange is in the middle range below the OECD median; & red denotes that the country was in the bottom 5 OECD performers. Light blue squares, at the bottom of the matrix, indicate that the country has a current science policy & coordinating body.



4. NATIONAL SCIENCE POLICY ATTRIBUTES

The countries that rate highly in research performance (average citations) and innovation performance (OECD indicators) on the whole have a coherent national science policy (blue squares, Fig. 3). The US presents an anomalous picture due largely to the scale of its research endeavour and market. It is by far the highest performer in terms of citations, but with regard to the innovation indicators it only appears in the top five performers in venture capital, e-government readiness and the proportion of tertiary educated adults.

The majority of the national science policies that were reviewed set research priorities and guide funding (Figure 4 and Table 1). Two-thirds of these countries prioritise education and/or scientific literacy and over half contain guidelines for increasing international engagement. The US, Swiss and Swedish policies are enshrined in legislation.

FIGURE 4: Comparison of national science policies.

	USA	CHE	DNK	SWE	FIN	CAN	NOR	FRA	IRL	JPN	RPK
Implementation year	2009	2013	2008	2012	2010	2007	2010	2009	2006	2011	2000
Research Funding	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Research Priorities set	Yes	No*	Yes	Yes	Yes	Yes	No*	Yes	Yes	Yes	Yes
Includes innovation	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Education/Sci. literacy	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No	Yes
Int. engagement	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No
Human Resources	No	No	Yes	Yes	Yes	No	No	Yes	No	No	No
In legislation	Yes	Yes	No	Yes	No	No	No	No	No	No	No
GERD as % GDP, 2010	2.8	2.9	3.1	3.4	3.9	1.9	1.7	2.2	1.7	3.3	3.7
Target for GERD	3%	3%	3%	4%	4%	3%	3%	3%	2.5%	4%	5%
Target year	undefined	2020	2020	2020	2020	2010	2020	2020	2020	2020	2014

** Research priorities set via separate mechanism*

TABLE 1: The focus and stand-out attributes of a selection of national science policies.

	POLICY NAME	MAIN FOCUS	STAND-OUT ATTRIBUTES
USA	The President's Plan for Science and Innovation	Funding	Integrated policy across Federal R&D portfolio
CHE	Education, Research and Innovation Message	International standing	General principle of sustainable development, social cohesion, education and training
DNK	Denmark – A Nation of Solutions	International standing	International centres of Innovation - Silicon Valley, Shanghai, Munich, Hong Kong, Sao Paulo
SWE	Research and Innovation Bill 2012/13:30	High quality research & innovation	Policy specified in legislation, with explicit funding targets
FIN	Research and Innovation Policy Guidelines for 2011-2015	International standing	FinNodes - China, US, Russia, Japan & India
CAN	Mobilising Science and Technology to Canada's Advantage	Developing a S&T culture	Aim to establish an Industrial Research and Innovation Council
NOR	Science for the Future 2010-2014	Education	Internationalisation is an overall priority
FRA	National Strategy for Research and Innovation	Developing a S&T culture	Strong focus on generating enthusiasm across society for science and research
IRL	The Strategy for Science, Technology and Innovation	Developing a S&T culture	Structured PhDs - includes teaching of generic skills
JPN	4th Science & Technology Basic Plan	Addressing national challenges	Increased funding for basic research
RPK	The Second Basic Plan for Nurturing Human Resources in Science, Engineering & Technology 2011-2015	Quality R&D	Governance - National S&T Commission linked to the President's Office