Chief Scientist for Australia

Submission to Senate inquiry into the Australian innovation system

Key points

- Nations at all levels of development are prioritising the capabilities required for innovation. At the core of almost every national innovation agenda is a reliance on STEM: science, technology, engineering and mathematics.
- Innovation is central to building jobs, increasing productivity and generating wealth, but Australia's innovative capacity remains limited by structural and cultural barriers.
- Innovation performance and national competitiveness can be enhanced through a forward-looking, long-term and whole-of-government strategy.

Introduction

Innovation is recognised internationally as the key to boosting productivity, creating more and better jobs, enhancing competitiveness and growing an economy.[1] It is estimated, for example, that scientific innovation has produced roughly half of all US economic growth in the last 50 years.[2] In Australia, the Productivity Commission has found that 65 per cent of economic growth per capita from 1964 to 2005 can be ascribed to improvements in our use of capital and labour, made possible by innovation.[3]

Just as the imperative for innovation is widely understood, so too is the need for forward-looking, long-term and strategic innovation policy. Innovation is fundamentally about market experimentation by business, which involves the acceptance, or at least tolerance, of the risk of failure[4] - in addition to the human skills to tackle the problems intelligently.

Nations at all levels of development have therefore put a premium on boosting innovation potential, through the quality of their knowledge infrastructure and the health of their investment climate. Many have strategies that target public investment to identified areas of priority and comparative advantage. Linking up effort from school to higher education and into work is also a growing focus.

Innovation thrives in a workplace with diverse skills. At its core, however, are science, technology, engineering and mathematics (STEM), the source of lucrative ideas as well as the capabilities to execute them. A STEM education equips future workers to grasp technical problems, manage complex systems and cope in a technology-rich environment. Securing STEM talent has become in consequence an 'almost universal preoccupation' of government,[5] widely shared in industry.[6,7]

For a nation like Australia, the prospects for knowledge-powered growth are great. So too are the risks of being left behind. A national focus on innovation and the capabilities it requires will position Australians for the future.

Australia's innovation performance in an international context

Australia enjoys many advantages as a destination for innovation investment. The evidence nevertheless suggests that Australia is not realising the value that these assets might be expected to create. Australia is falling behind its overseas competitors on key innovation measures.[8] While Australia was ranked 17th of 143 countries overall in the Global Innovation Index 2014,[9] we were 81st in Innovation Efficiency, a measure of innovation output relative to input, demonstrating that we are performing below our potential.

Australia's capacity for turning ideas into new products, services or processes remains limited by structural and cultural barriers that inhibit both risk taking behaviour, and the flow of people, ideas and funding between the private and public sectors.

- **Falling participation rates and performance in critical STEM disciplines**
  Australian schools show a decline in the rates of participation in 'science' subjects to the lowest level in 20 years.[10] This has consequences for the general level of science literacy in the community, as well as industry's capacity to lead or adjust to change. Science enrolments in higher education have increased by close to 30 per cent since 2007, although study beyond first year in key disciplines such as physics and chemistry is of concern.[11]

- **Gaps in the skills pipeline**
  Australian industry has reported difficulty in recruiting high-quality, work-ready STEM-skilled employees.[12] At the same time, very few businesses offer positions to research-trained staff. Less than one in three (30 per cent) Australian researchers work in industry; half the OECD average (60 per cent) and substantially less than the US, where four of every five researchers are in the business sector.[13,14] The restricted pathways for workers with higher skills, particularly at early career stage, create a significant risk of brain-drain.

- **Inward-focus, siloed thinking**
  Collaborative innovation between businesses and research organisations more than triples the likelihood of business productivity growth.[15] Across the OECD, Australia ranks 15th on business-to-research collaboration for small to medium enterprises; and 21st for large firms. Just 4 per cent of our large firms collaborated and only slightly more of our SMEs.[16]

- **Unconducive climate for innovators**
  Less than one in two Australian firms identify themselves as 'innovators'.[17] Just 1.5 per cent of Australian companies developed new to the world innovations in 2011, compared to between 10 to 40 per cent in other OECD countries. More than 60 per cent of Australian innovators kept innovations within the company.[18] Those who try to carve a new direction are often stymied by a lack of support from financial markets;[19] limited skills in business management;[20] difficulty in accessing global supply chains[21] or poor intellectual property strategy.[22]

Setting a strategic course

Australia currently has many industry investment and incentive programmes to support an array of R&D activities at national and regional levels.[23] We are one of only three (of 33) nations in data published by the OECD to invest in such programs without the benefit of an overarching strategy.

Like every other nation, Australia's capabilities and challenges are unique. There are nonetheless useful lessons to be drawn from the nations which capitalise most effectively on innovation.

The evidence shows that these innovation-led economies are characterised by:[24,25]

- Articulated science and technologies strategies linked to economic aspirations
- A reliable pipeline of STEM graduates, maintained through collaboration between government and industry.
- A STEM-literate population that seeks out new technologies and employs them creatively.
- Rich and deep connections to global science and export markets.
- A culture of risk-taking, entrepreneurialism and an openness to new ideas.
- Career pathways from academia to industry, and vice versa.
- A strong basic or 'blue-sky' research enterprise, providing a wellspring of technical know-how and step-change ideas.

Australia too has the opportunity to learn from success and take a long-term strategic view of innovation, underpinned by STEM.

Experience confirms that governments cannot create or mandate business innovation. Many actions are required – only some of which fall within the Australian Government's remit. Creative solutions should be encouraged. Business leadership should be welcomed.

Business, however, can only make the best of the parameters government policy creates. Australia's record confirms that the upfront costs and uncertain outcomes can too easily deter business support for basic research, ideas perceived to be risky and the large scale research infrastructure for growth.[26] Government action is required to address such market failure and supply the 'patient' capital for fundamental, curiosity-led, research; and to open viable pathways to commercialisation.[27,28]

Action in the public sector can both incentivise and coordinate the effort, securing for Australia the prospect of sustainable growth.

A successful innovation strategy will encompass the many interdependent parts of the ecosystem. It will be a whole-of-government agenda, linking the needs in different sectors of the economy to the capabilities in which the government invests. The importance of STEM in the workplace, for example, should be reflected in the school curriculum. Our strategy for international engagement should capitalise on our strengths in research. Our national priorities should be supported by the research we fund in the public sector.

Concluding Remarks

A widespread cultural change is required, and the Australian Government has the opportunity to lead it.

These considerations led the Office of the Chief Scientist to call for a national STEM strategy in a position paper released in July 2013. The paper has since received the endorsement of the Business Council of Australia, senior leaders of the research community and Australian educators.

The Chief Scientist welcomes the opportunity to share the Office's research in this field; including work commissioned from the Australian Council of Learned Academies.

[1] European Commission, Directorate-General for Research and Innovation The Grand Challenge: The Design and Societal Impact of Horizon 2020. 2012, European Commission: Brussels, Belgium.
[2] Jobs for the Future prepared for the U.S. Department of Labor and Employment and Training Administration, The STEM Workforce Challenge: The Role of the Public Workforce System in a National Solution for a Competitive Science, Technology, Engineering and Mathematics (STEM) Workforce. 2007.
[3] Productivity Commission, Public Support for Science and Innovation. 2007, Commonwealth of Australia. p.xxxi.
[4] Department of Industry, Australian Innovation System Report - 2013. 2013, Commonwealth of Australia: Canberra, Australian Capital Territory, Australia.
[5] Russell Tytler, Simon Marginson, Brigid Freeman, Kelly Roberts, STEM: Country Comparisons. 2013: Melbourne, Victoria.
[6] The Australian Industry Group, Lifting our Science, Technology, Engineering and Maths (STEM) Skills. 2013.
[7] Business Council of Australia, Action Plan for Enduing Prosperity. 2013.
[8] Organisation for Economic Cooperation and Development (OECD), Main Science and Technology Indicators, Technology and Industry Directorate for Science. 2012.
[9] Cornell University, INSEAD, and WIPO, The Global Innovation Index 2014: The Human Factor in Innovation. 2014.
[10] T. Lyons J. Kennedy, F. Quinn, The continuing decline of science and mathematics enrolments in Australian high schools. In press.
[11] Office of the Chief Scientist, Health of Australian Science. 2012: Canberra, Australia.
[12] The Australian Industry Group, *op. cit.*
[13] OECD, *op. cit.*
[14] Scientific and Cultural Organization Institute for Statistics United Nations Educational, UIS.STAT, UNESCO Institute for Statistics. 2013: Quebec, Canada.
[15] Department of Industry. 2013, *op. cit.*
[16] *Ibid.*
[17] *Ibid.*
[18] Department of Innovation, Science and Research Australian Innovation System Report - 2011. 2011, Commonwealth of Australia: Canberra, Australian Capital Territory, Australia.
[19] Department of Industry. 2013, *op. cit.*
[20] *Ibid.*
[21] Business Council of Australia, Action Plan for Enduing Prosperity. 2013.
[22] *Ibid.*
[23] Department of Innovation, Science and Research, Australian Innovation System Report - 2012. 2012, Commonwealth of Australia: Canberra, Australian Capital Territory, Australia.
[24] *Ibid.*
[25] The Australian Industry Group, *op. cit.*
[26] Productivity Commission, *op. cit.*
[27] *Ibid.*
[28] Congressional Record, An Open Letter to President Clinton. 1996, Congressional Record Online p. E1888.