

**QUT Submission to Inquiry into the Australian Innovation System**

There have now been several public reviews of Australia's innovation system, most of which have focused on the role of government, universities and public research organisations in the development of the scientific, technical and managerial capability of the nation. A capability focus is viewed to be the mechanism for achieving improved economic competitiveness. While capability development remains an important focus of attention for Australia's future prosperity, it is an insufficient basis for achieving industrial development and transformation in an era in which economic activity is increasingly fragmented and coordinated across national boundaries. The current review must consider the implications for Australia's industrial competitiveness of changes in forms of industrial organisation which have emerged as a consequence of advances in information and communications technologies. New technologies have enabled lead firms to fragment and co-ordinate a range of production and business functions across national and regional borders including finance, design, manufacturing, marketing and distribution. As such, the future competitiveness of the Australian economy depends on the positioning of its firms within existing and emerging global value chains. Innovation policy must focus not just on national research and human capability development, but also on the competitive insertion of Australian industries in increasingly globally distributed industrial networks.

**Australian governments and universities have a dual role in promoting the economic prosperity of the nation through publicly funded research that underpins entrepreneurial transformation and through the coordination of Australian industrial development and transformation in global value chains.**

**The role of government***The contribution of public research to industrial transformation*

While public discourse associates entrepreneurship with private sector initiative, there is mounting evidence of the substantial and arguably unrivalled contribution of public sector research organisations and publicly funded university research to major technological and entrepreneurial transformations (Mazzucato 2013; Weiss 2014). Marianna Mazzucato's recent book, *The Entrepreneurial State*, traces the history of development of all of the major revolutionary technologies that underpin the iPhone and the iPad to publicly funded research origins. This includes the internet, GPS, touch-screen displays and communications technologies. She also shows that 75% of all new biopharmaceutical inventions have come from publicly funded research laboratories (p. 188) as did the grant that led to the algorithm that underpins Google's search engine (p. 166). Her analysis concludes that "in biotechnology, nanotechnology and the internet, venture capital arrived 15-20 years after the most important investments were made by public sector funds" (p. 23). Global corporations, including in the pharmaceutical and IT sectors, typically enter the 'innovation ecosystem' towards the end of the innovation cycle after the public sector has assumed a substantial degree of the risk of new technology development. There are two critical implications from Mazzucato's work. The first is that entrepreneurial economies depend greatly on substantial levels of public investment in research. The second is that there needs to be a much stronger public awareness and celebration of the strategic, visionary and risk-taking contribution of public sector research initiatives.

**Government provides the institutional environment for the entrepreneurial transformation of the national economy, primarily through substantial public funding of the national research base. Publicly funded research underpins the most radical technological transformations and its contribution to the economy and national prosperity requires greater public acknowledgement. Australia requires continued and improved public funding of research in combination with the introduction of mechanisms to better communicate the massive economic and social contribution of public research investment.**

*The role of government in coordinating industrial development and transformation*

A further critical role for government relates to the coordination of the nation's industrial development in global value chains (GVCs). Gereffi and Sturgeon (2013) argue that the objectives of policy relating to industrial development have shifted 'from creating fully blown, vertically integrated national industries to moving into higher-value niches in global value chains' (p. 338). They describe the Brazilian government's development of the consumer electronics industry as an example of GVC oriented public policy. Brazil's feature phones and desktop computer industry has been increasingly displaced by smart phones, tablets and notebooks and as a consequence feature phone producers in Brazil such as NEC and Nokia withdrew from local production. The government's strategy for addressing this decline focused on bringing global contract manufacturers to Brazil through tax incentives to support local R&D, component manufacturing and assembly. As a consequence, Brazil has been able to attract electronic manufacturing service (EMS) providers who are contract manufacturers for firms such as Apple. Taiwanese Foxconn now assembles iPhones and iPads in Brazil and also manufactures and assembles for Hewlett Packard in Brazil. The government has a requirement for Hewlett Packard to engage in R&D spending in Brazil at the level of 4 percent of sales and as a consequence HP Brazil employs engineers and researchers across the country and collaborates with universities. HP also conducts contract R&D for some of its competitors who do not have the facilities to meet their own R&D spending quotas.

The role of government in industrial transformation is also demonstrated by the development of the liquid crystal display (LCD) industry in South Korea. Lee, Heo and Kim (2014) show how the government supported the economic development of regions by subsidising the technical infrastructure while integrating the LCD industry with global markets through the attraction of foreign direct investment. The government supported intensified university-academic cooperation through public-private R&D consortium and it provided substantial funding for commercialisation institutions to support local firms in the LCD space to nurture local suppliers to the LCD industry. The role of government has become critically important with the proliferation of global value chains in order to balance the very substantial power of global lead firms who are able to increasingly benefit from local resources and capabilities and who have unequal bargaining power relative to small firms operating in competitive segments of global markets (Parker et. al. 2014).

The above discussion shows the significance of global value chains in affecting the industrial trajectories of advanced economies and the role that government has played in linking regional economies with global market opportunities in a range of competitor nations. This analysis provides a foundation for thinking about how the role of government might shift in Australia to ensure that new global industries are formed around our competitive public research infrastructure. While the

Australian government has made substantial investments in the public research base, particularly in sectors such as medical and health sciences, much more is required to develop Australia's commercial capability and participation in global value chains including in the life sciences industry. Disconnect between the public research base and national industrial capacity is best demonstrated by a comparison of the sectoral distribution of research activity in higher education in Australia with business research expenditure. The gap is strongest in relation to the medical and health sciences in which the University concentration of research activity is much higher than in business. This suggests that Australia has failed to develop industrial value chains linked to its underlying research capacity.

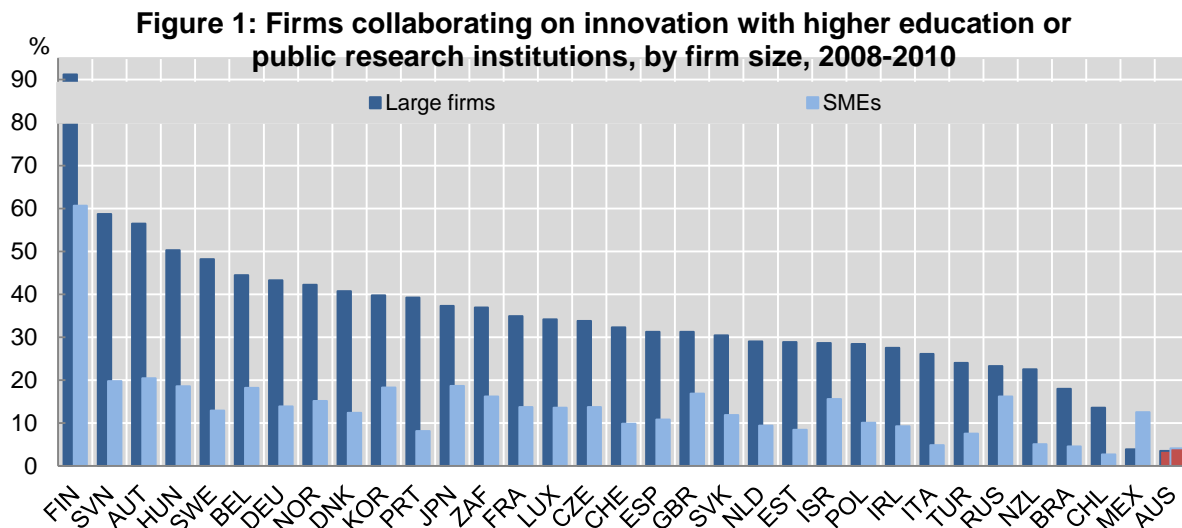
A further feature of the aggregate data might be explained by patterns of research activity at a field level. While Australia has a reasonable track record in attracting industry funding for higher education research expenditure (see Figure 2), it suffers from a low level of collaboration between firms and universities for innovation (see Figure 1). In 2010 businesses spent 52 per cent of their R&D outlay on Engineering, universities spent 9 per cent. Businesses spent 28 per cent on ICT, universities spent 4 per cent. On the other hand while universities spent 39 percent of their research expenditure on Medical and Health Sciences and Biological Sciences, the comparable figure for business is 6 per cent. Australia has developed a similar research funding mix to nations such as the UK which have a much different industrial structure and in which the pharmaceutical and life sciences industries comprise a greater share of economic activity. This disparity is likely to intensify as a consequence of the proposed Medical Research Future Fund announced in the recent Federal Budget. The mismatch between higher education research expenditure and business research expenditure is a potential explanation for low levels of collaboration between Universities and industry as it demonstrates that Universities are not undertaking research in fields which are aligned with the industrial structure of the national economy. It also demonstrates that the government is funding research in fields in which Australia does not have well developed national industrial capacity. This suggests a much stronger role for both government and industry in forging industrial development and transformation linked to publicly funded research investments.

**A critical role for government in the national innovation system is the coordination of Australian industry participation in value added segments of global value chains and the provision of the collective resources necessary to secure a balanced distribution of economic returns between lead firms, small and medium sized enterprises and regional economies. Australia requires a strategic policy unit to develop expertise on the nature of global value chains and to develop policy instruments to support the competitive insertion of Australian industries in global markets in key manufacturing, ICT and life sciences industry segments.**

### **Role of universities**

#### *The contribution of university research to industrial transformation*

As with government, a critical role for universities is to undertake research which will support the entrepreneurial transformation of the Australian economy. This requires universities to engage with industry in their research initiatives. OECD data suggests that Australia currently performs poorly by international standards in the extent to which business collaborates with higher education institutions for research and innovation (see Figure 1).



Source: OECD, (2013) Research and Development Statistics Database, [www.oecd.org/sti/rds](http://www.oecd.org/sti/rds).

The purpose of university-industry innovation collaboration is to ensure the ‘relevance’ of academic research. The problem of ‘relevance’ is sometimes conceptualised as a *knowledge-transfer* problem, in which academic researchers fail to communicate their findings in languages or forums which are readily accessible by those outside of academia. This approach implies that the ‘relevance’ of university research is something that can be managed at the end of the research process. However, innovation researchers have shown that *relevance* is achieved through the co-production of knowledge involving engagement across academic fields and with end-users *throughout* the research in which academics from a range of disciplinary backgrounds work together with partners outside academia to identify/diagnose research problems/questions that are theoretically significant and practically relevant, design research models to guide data collection, jointly access and analyse data and collaborate in the implementation and evaluation of findings. This involves deep, repeat and ongoing engagement between academics from a variety of disciplines and end-users of research (Van de Ven 2007).

**Universities should undertake research which supports the entrepreneurial transformation of the Australian economy. This requires universities to engage with industry and society throughout the research process in a process of genuine co-production of knowledge. Engaged research forms the basis for producing *relevant* publicly funded research.**

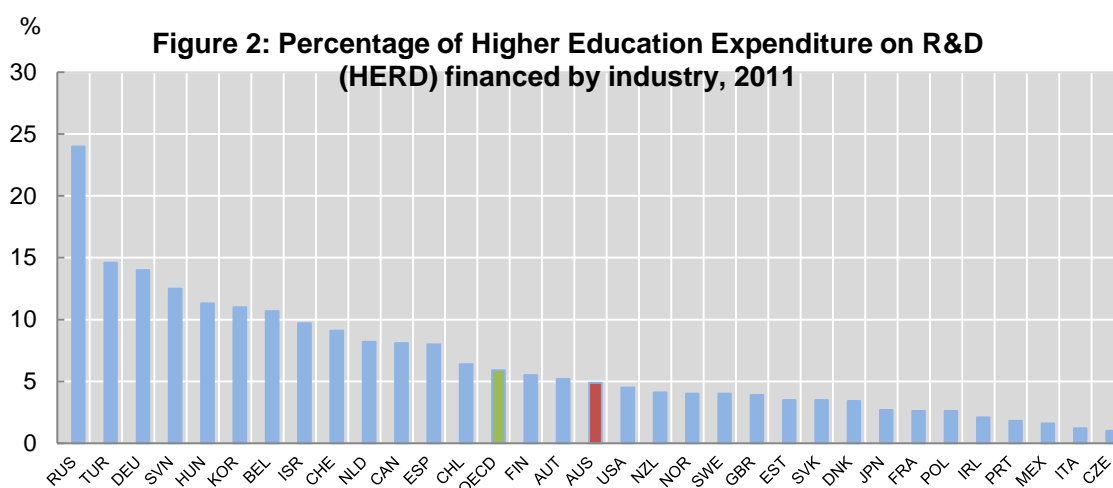
Several institutional factors discourage the kinds of attitudes and behaviours necessary for genuine knowledge co-production. First, the Excellence in Research Australia (ERA) initiative evaluates the quality of University research outputs either through citation counts or in some disciplines through a process of peer review. The quality measure is essentially the extent to which the research is valued by *academic* communities. Currently, research impact (beyond academic communities) is not part of the evaluation framework. Research evaluation exercises based solely on academic quality have been shown to create a strong disincentive for academics to collaborate across disciplinary boundaries or with end-users (given that interdisciplinary research and end-user applied research is given less value within academic communities) (Rafolsa et. al. 2012). This creates a challenge for the longer term relevance of university research in Australia which will become increasingly oriented

towards academic measures of excellence. The focus on academic quality has been exacerbated by the growing influence of international rankings of Universities. While a quality system is an important component of a national framework for research excellence, the current rules relating to the ERA initiative drive academics to an exclusive focus on quality academic outputs. Work needs to be done to identify ways in which the drive for academic quality can be balanced against other innovation system goals including promoting higher levels of university-industrial collaboration. One possibility worth investigation would be to modify the ERA rules to limit the number of outputs that can be submitted for each FTE researcher to four outputs over five years (or say three in three years) which might free up academic time to focus on undertaking relevant research. The UK equivalent of the ERA (the REF) incorporates such a limit. The absence of a limit in Australia potentially causes academics to be driven to produce as many high quality outputs as possible, leaving them with very little time for engaged research. Australia should carefully examine the UK impact assessment exercise and its contribution to changes in the behaviour of academics in the UK.

**The Excellence in Research Australia initiative encourages a narrow focus on academic publishing which potentially detracts from the role of Universities in supporting economic transformation and human and social progress. A better balance between quality and relevance could be achieved by limiting the number of outputs to be submitted in the ERA process from each FTE researcher to four in five years (or an equivalent number over a three year period).**

The second institutional barrier to effective university-industry research engagement relates to the imperative for academic researchers to raise funds from business to support their research activity. This is creating pressure for academics to engage with industry *for funding purposes*. Australia has a reasonable track record of attracting industry funding for research undertaken by universities and public research organisations. Evidence from the OECD suggests that around 5-6 percent of higher education research expenditure across many advanced economies is funded by industry and that is also true for Australia (OECD 2013). Despite Australia's mid-range performance in this area, much of Australia's policy framework for encouraging university-industry research collaboration is focused on universities attracting a greater share of industry funding for their research. Arguably it is difficult if not impossible to attract industry funding for research which will underpin significant economic and social changes given the low-risk profile of private sector research funding (Mazzucato 2013). Further, genuine co-production of knowledge involving public and private sector participants can occur in the absence of industry funding because it is not about who pays, it is about how knowledge is created and how research problems are defined. That is why some countries (such as Sweden) do very well in firm collaboration with higher education researchers for innovation (Figure 1) but do not perform well in attracting industry funding for research. In Australia the CRC program and other schemes promoting university-industrial research collaboration, including the ARC Linkage and Industrial Transformation Research Program, are critical in addressing collaboration shortfalls and should be supported and extended.

**An over-emphasis on industry funding of higher education research has the potential effect of discouraging Universities from pursuing high risk radical research which has fuelled many of the most fundamental technological advances. Instead, a focus on research impact, relevance and collaboration ensures that publicly funded research is directed to critical social and economic problems and involves end-user engagement.**



Source: OECD, (2013) Research and Development Statistics Database, [www.oecd.org/sti/rds](http://www.oecd.org/sti/rds).

Business funds Australian higher education research expenditure at around the level of the OECD and at a higher level than the USA, Sweden and the UK (see Figure 2). Despite our reasonable performance in this area, policy instruments in support of university-industry research collaboration have tended to focus on increasing the level of industry funding of university research. Instead, we need to introduce a research impact assessment exercise which ensures that publicly funded university research is undertaken in a collaborative way such that it is likely to contribute to economic and social transformation over time.

**Policy frameworks need to encourage genuine co-production of knowledge involving academics from a range of disciplines engaging throughout the research process with end-users of knowledge. This could be achieved through an appropriately designed research impact assessment exercise to supplement the ERA exercise.**

### *The role of universities in coordinating industrial development and transformation*

Arguably in healthy innovation ecosystems, universities play a crucial role in the coordination of industrial development and transformation and not just research and education. A more expanded role for universities is now well recognised in the innovation literature (Etzkowitz 2000). As a key source of scientific and technical knowledge and human capability development, the university sector has the potential to lead the development of new industries and transform existing industries in collaboration with key economic actors (Parker 2008). Research impact exercises need to focus on the broader role that universities should play in the innovation system and not merely on the impact of individual pieces of research.

There are limitations in both models of research impact assessment currently proposed in policy debate in terms of their ability to secure the broader coordination role of universities in the innovation system. The first proposed model is a case study approach in which universities submit narrative accounts of how their research has resulted in significant social, health, environmental or

economic outcomes. The second is a metrics approach focused on 'pathways to impact' (such as the graduation of higher degree research students, commercial research income or licensing/patents).

In relation to the case study approach, a key limitation is the difficulty of dissecting the contribution of a particular research program to a social or economic outcome where the outcome is often a result of inputs from a large number of researchers and end-users throughout the innovation system both within universities and beyond. In addition, the time-lag from high risk research to impact is such that universities would need to be discussing the impact of research involving researchers employed decades earlier, many of whom would have left the organisation. A case study approach would amount to a historical exercise and would not provide a good indication of the likely impact of current research agendas.

A metrics approach also has limitations as one of the key measures it would inevitably focus on is the level of commercial research income in a University's research funding profile. As indicated above, this would encourage academics to engage with industry for funding purposes when the more critical problem facing the innovation system relates to collaboration for knowledge generation. An alternative approach would focus on Universities articulating their mission for research impact in which they would need to demonstrate that they value and support engagement between academics from different disciplinary backgrounds and with innovation actors throughout society and the business system both nationally and internationally. A research impact assessment exercise needs to assess the extent to which universities adopt a strategic leadership role in industrial development and transformation through collaboration with key innovation actors throughout the economy.

**As key source of scientific and technical knowledge and of human capability, the university sector has the potential to lead the development of new industries and transform existing industries in collaboration with key economic actors. A research impact exercise needs to focus on the broader role that universities play in the innovation system and not merely on the impact of individual research projects.**

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