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Paper Title: Engaging with Industry: Entrepreneurial Orientation at the Australian Universities

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Engaging with Industry: Entrepreneurial Orientation at Australian Universities

Abstract

There is a global recognition that innovation is a key driver of international competitiveness. Since the 1980s attention has been given to the concept of the National Innovation System (NIS), in which a range of public and private institutions interact with each other to foster innovation and diffuse new technologies. Universities play a key role in these NIS and it is for this reason that such a lot of attention has been given to how university-based research can be unlocked and disseminated for commercial benefit. Despite its relatively small population, Australia's university sector is internationally respected for its scientific research across many academic disciplines. However, the success with which Australia's universities have been able to commercialise this scientific output is much less notable. Around the world many universities have engaged actively in the process of commercialisation and technology transfer and Australia's are no exception. However, there are many barriers that need to be overcome before academics will become fully engaged with what might be seen as an entrepreneurial orientation. Several Australian universities are putting effective processes in place for this. These processes and the challenges facing academics to perform are discussed along with implications for policy and practice.

Introduction

The concept of the National Innovation System (NIS) emerged in the 1980s with the work of (Freeman 1987) and (Lundvall 1985). It was the success of economies such as Japan, Germany and the United States in linking their public investment in R&D with the growth of successful technological innovation that triggered strong interest in the NIS concept (Lundvall 2007). Interest in the NIS concept has continued steadily over the past 30 years (see: Nelson 1992; 1993; Edquist 1997; Lundvall 1998; Schienstock and Hämäläinen 2001), and is now officially recognised by many nations (OECD 1997).

A key area of interest within NIS studies is the role played by universities in their interactions with industry. According to (Lundvall 2007) this nexus between industry and universities for the transfer of technological innovation has been based largely around the experience of the biotechnology and pharmaceuticals industries in the United States. The success of such networks elsewhere around the world has been less clear, although it has not stopped its emulation – with some success – in a number of other countries, most notably South Korea (Park 2001).

Innovation is the key to ensuring the long-term economic prosperity of the Australian economy. A more complete understanding of business innovation in Australia and its management, particularly within Government, enhances policy frameworks that may assist Australia to achieve greater innovation success. In particular, it enables public policy to take a broader, more holistic view of the range of policy structures that influence business innovation, rather than a narrow focus on science and technology policy. A major component of Australia's national innovation system is its investment in university-based scientific research. However, a shift away from the narrow scientific approach to innovation and commercialisation to a greater recognition of the importance of management and marketing within the research and development area will improve business innovation (Boter and Holmquist 1996).

This paper examines the entrepreneurial orientation of Australian universities in the process of commercialisation of their research, and the process of managing the transfer of intellectual property (IP) from its emergence in fundamental scientific research, through to its diffusion into markets. In doing so it explores the findings from a series of case studies from institutions engaged in nanotechnology research.

The role of Universities in the National Innovation System

Historically the nexus between university-based research and industry can be traced back at least to the late 19th Century in Germany where "entrepreneurial" university activity was driven by state education ministries sponsoring highly autonomous chaired professorships. Following World War Two the United States' university system was stimulated into "entrepreneurial" activity with the introduction of large-scale competitive grants systems and specialist graduate schools dedicated to doctoral education. In both systems what was fostered was organisational innovation, the concentration of research activities and the capacity to make a contribution to the development of new industries (Lehrer, Nell and Garber 2009).

Since the 1970s governments throughout the industrialised world have launched a range of initiatives designed to link universities more closely with industry in the process of innovation. These initiatives generally seek to stimulate local economic development by encouraging universities to transfer out their technology to industry. Engaging the inventors in this commercialisation process has been viewed as important (Agrawal 2006; Alexy 2008). This is due to the recognition that many new technologies are highly complex and may not be fully understood by industrial end-users (Linton and Walsh 2004). Universities have been viewed as having a role to play in this technological development (Sprinkle 2006).

Australia has 47 universities of which nine are ranked among the top 200 universities of the world (Coleman 2009). While some have greater "research intensity" than others all these institutions are engaged in scientific research with gaps closing between the bottom and top tier universities over recent decades (Ville, Valadkhani and O'Brien 2006). The Australian Government through the Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) invests billions of dollars in research in Australia. For example, in 2008-2009 Government Expenditure on R&D (GERD) was around $28 billion or some 2.24% of GDP. This compares favourably to most other economically developed countries within the Organisation for Economic Cooperation and Development (OECD). The majority of this funding goes via grants and tax concessions directly to businesses, with higher education in second place. Australia's universities received around $6.7 billion in R&D funding in 2008-2009 (DIISR 2011a; ARC 2011).

The *National Survey of Research Commercialisation*, conducted by the Department of Innovation, Industry, Science and Research (DIISR), collects data on the commercialisation activities of publicly funded research organisations (PFROs) in Australia, including universities and Cooperative Research Centres (CRC). In 2008-2009 PFROs, universities and CRCs reported gross incomes totalling $315 million from licences, options and assignments, and $1.2 billion from contracts and consultancies with end-users. By 2009 the PFROs recorded having an equity holding in 175 start-up companies (DIISR 2011b).

This compares to data available from the United States National Science Foundation which shows that U.S. universities spent US$43 billion on research in 2004. Surveys by the

Association of University Technology Managers suggest that in the same period, there were 598 exclusive license agreements signed with start-up companies. This amounts to about US$70 million in research for every start-up license.

In general terms the focus of university research is primarily to advance scientific knowledge not to create start-ups. Yet most researchers would agree that their ideas and inventions could have a much greater impact on society if the commercialisation system worked better (Wadhwa 2007)

Reflecting on this development, governments throughout the OECD countries are investing heavily in strengthening the research capacity of their universities (OECD 2010). They are not doing this for its own sake, but in the expectation that this investment will show a return to the economy and the society through improved innovation performance and hence, stronger economic growth. While the universities are increasingly important as sources of ideas, those ideas will only show an economic return if they can be effectively applied by business (Jones-Evans and Klofsten 1997; Wiggins and Gibson 2003). This means that an important element of an effectively operating NIS will be the quality of the linkages between the universities, business and finance providers (Lockett, Wright and Franklin 2003).

In the knowledge economy that has emerged over the past 20 years, universities, as major centres of learning and research, are becoming increasingly important as the source of ideas that can be turned into new products, processes and systems (OECD 2010). This is particularly so in the enabling technologies such as information and communications technologies (ICT), biotechnology and nanotechnology.

There is also a distinction between traditional technology transfer and knowledge transfer. Technology transfer is a term used to describe a formal transfer of rights to use and commercialize new discoveries and innovations resulting from scientific research to another party (Feldman, Feller, Bercovitz and Burton 2002). Universities typically transfer technology through protecting (using patents and copyrights), then licensing innovations. The major steps in this process include the disclosure of innovations, patenting the innovation concurrent with the publication of scientific research and licensing the rights to innovations to industry for commercial development (Siegel, Waldman, Atwater and Link 2004).

Knowledge transfer is an element of the so-called informal technology transfer and it includes student placement, consultancy, research and training for industry, technology licensing, and spin-off company formation. Universities are tasked with knowledge creation and the dissemination of this knowledge. Research faculty members are the key agents of knowledge transfer. Social networks through academic and industry scientists, university administrators, Technology Transfer Offices (TTO) directors, and managers/entrepreneurs allow knowledge transfer to work in both directions. It is vital that university and other stakeholders are very clear on the university's objectives on knowledge transfer, the motivations behind it as well as its benefits (Harman and Harman 2004).

It is recognised, that the universities contribute to economic, social and environmental objectives in a variety of ways. The main benefit channel is associated with the education of people. However, universities also generate benefits associated with the creation of ideas. Some of these ideas will flow freely into the community through publications and other processes, while others will be transferred to businesses that purchase ideas from universities through contract research or will be used directly by the universities through their control of intellectual property (IP) (Alves, et al 2007). The understanding of effective business models and adoption of strategies that enhance university commercialisation, and which create a shared vision, are vital in the current economic environment (Kirchhoff et al 2007).

Research managers often find themselves attempting to promote and facilitate industry engagement with universities while knowing relatively little about the nature of such relationships. Of particular importance is the ability of academics to adopt a more entrepreneurial approach to the commercialisation of their research, with research findings that suggest a positive correlation between entrepreneurial activity and research productivity (Van Looy et al 2011).

However, the barriers to sustainable research partnerships between universities and industry are many and the 'cultural gap' between academia and industry is significant impediment to successful collaborations. Many of the university researchers have a fairly accurate understanding of industry motivations, needs and expectations, and valuable insights into how the cultural divide between industry and academia might be bridged. It would be practical to draw upon their expertise when putting strategies, policies and mechanisms in place to increase the attractiveness to industry of engaging with academia (Berman 2008).

Innovation management measurement is described in many studies (Tsai 2009), however Adams, Bessant and Phelps (2006) have conceptualised this as a process commencing with inputs and moving through to the end point of commercialisation. They specifically note that:

> "*The area of commercialisation appears to be the least developed of the issues involved in innovation management. This is a huge gap because, without this last step, the previous steps of assembling inputs, project management, etc. will not result in a commercially viable outcome for the firm. We believe that this area of innovation is in urgent need of further development, from both theory and measurement viewpoints*" (Adams et al 2006: 38).

Entrepreneurial Orientation and Entrepreneurial Universities

The concept of "entrepreneurial orientation" refers to the processes, practices and decision making styles that an organisation may undertake in order for it to behave in an entrepreneurial way (Lumpkin and Dess 1996). Of importance is the management team's capacity to embrace innovation, manage risk, and deal with complex, uncertain and dynamic or turbulent environments (Covin and Slevin 1989). Academic research into entrepreneurial orientation and how it might be measured within organisations has been undertaken since at least the 1970s (see Khandwalla 1977; Miller and Friesen 1982; Covin and Slevin 1989).

Lumpkin and Dess (1996) recognised that the entrepreneurial orientation of an organisation's management team was likely to be defined by their level of innovativeness, achievement orientation, risk taking proclivity, competitive aggression, proactivity, autonomy and strategic capacity. Key indicators of entrepreneurial orientation within business organisations are: innovativeness (measured by R&D investment, new product development and product adaptation); pro-activity (measured by competitive action, new techniques and competitive posture); and risk-taking proclivity (measured by risk taking and environmental boldness) (Kreiser, Marino and Weaver 1996).

From an applied perspective the most relevant attributes of entrepreneurial orientation within organisations are thought to be autonomy, innovativeness, competitive posture, pro-activity and risk taking (Certo, Moss and Short 2010). For universities the level of autonomy granted to academics in what they research is generally very high. Innovativeness, at least in terms of the generation of new or novel ideas is also high as the peer review system of academic publishing is globally competitive and forces academics to find new and original findings. Academics might also be viewed as having a strong capacity for pro-activity, at least in relation to finding new and novel approaches to the solution of fundamental problems (Oshagbemi 2000).

However, it is in the areas of risk taking and competitive posture that most universities tend to remain subdued in relation to entrepreneurial orientation. This is due to the organisational design of universities which emphasizes teaching and research for the public good as its primary functions rather than commercialisation. Yet this is now changing with greater pressures on universities to embrace commercialisation within their business model (Zemsky 2005; Slaughter and Rhodes 2004). For many universities the creation of TTO has assisted in the strengthening of their commercialisation output (Siegel et al 2002). Such entities have a dedicated management team with the mission of assisting academics to transfer, licence or spin out their intellectual property (IP) (Lockett et al 2003).

The advent of dedicated research centres within American universities following the Second World War has been attributed with the successful transition of that country's higher education system from one primarily focused on teaching, to one focused upon research (Geiger 1990). The creation of research centres and institutes had the effect of building within the universities, managerial competencies and related infrastructure that could engage with industry. In return, industry was able to more readily identify and work with such units on a level not easily achieved within traditional teaching schools.

Australia has experienced a similar trend in relation to the emergence of entrepreneurial orientation within its university sector (Wood 1992). The creation of the Cooperative Research Centre (CRC) system in the 1990s was designed to facilitate greater linkages between universities and industry. However, after a decade concerns remained over how effective this CRC network was at achieving the desired outcomes. A review of the centres recommended they be retained and suggested that many criticisms were due to differing expectations and perspectives (Mercer and Stocker 2000). As noted in their conclusions:

> "*One of the most important benefits of the Programme is already evident in the changed attitudes and perspectives in industry and research organisations. Commercialisation is a heterogeneous process and not simply the transfer of intellectual property to the private sector. Commercialisation within Australia of major new technologies is likely to be preferable to licencing off and should be pursued as an objective where ever possible"* (Mercer and Stocker 2000: 5-6).

In their review of the commercialisation activities of Australian universities Harman and Harman (2004) observed that a major factor determining whether universities and academic researchers play an active role in technology transfer is the nature of the institutional environment. In particular the culture within which the academic works, the existence of a "culture of competition", and the legal ownership of intellectual property (IP). While the legal rights to IP within American universities are vested with the institution not the academic, this is the reverse in Australia. This issue has been significantly highlighted since the Gray v. UWA case in which Dr Bruce Gray successfully challenged the right of his employer, the University of Western Australia (UWA), to claim ownership over his IP rights to the commercialisation of small particle technology in the treatment of liver cancer.

The Federal Court ruling – subsequently upheld on appeal to the High Court – recognises the unique public role of universities and the fact that academics are not employed to invent but to teach and conduct research for the public good. They therefore have the freedom to choose what they research and the direction of their projects, as well as whether they choose to share and disseminate their findings (Still 2010). For Australian universities seeking to engage in commercialisation the challenge of building an entrepreneurial culture within which their academic researchers willingly collaborate for mutual benefit has just increased.

Methodology

The research procedures involved in this study saw the development of seven case studies of Australian universities engaged in nanotechnology research. All were identified as having sought to commercialise their IP in collaboration with industry. (Eisenhardt's 1989) process for the development of theory from case study research was used as a guide to the study. Each of the eight steps she advocates was followed, along with the principles of case study design and analysis recommended by (Yin 1989).

Over 40 in-depth interviews were undertaken with directors of research centres, university managers, academics, postgraduate students and the managers and directors of technology transfer offices and their industry partners. Documentary and verbal data was collected with a case study protocol developed within an initial pilot case used to provide consistency of focus across the seven cases.

A conceptual framework developed by (Lare'do and Mustar 1996) to explain the principles of Techo-Economic Network (TEN) Theory was used as a key frame of reference for the analysis. This model comprises the following elements:

$$\mathbf{S} \Rightarrow \mathbf{[ST]} \Rightarrow \mathbf{T} \Rightarrow \mathbf{[TM]} \Rightarrow \mathbf{M}$$

Where:

S = Scientific activity (e.g. research fundamental & applied)

T = Technological outcome (e.g. patents, prototypes, software, models)

M = Market diffusion of products.

[ST] & **[TM]** = Transfer points.

The cases were chosen according to a theoretical sampling procedure. All cases had to cover as many states of Australia as possible to ensure effective representation of the country. Each case had to show the diversity of approaches to commercialisation process inherent in the university system. Every case had to be active in nanotechnology research. The universities chosen had to have a commercial structure for managing the process of innovation, typically in the form of a TTO. It was also necessary that the cases showed either success or failure in commercialisation. Each case had to have experience in attracting funding for research, and all cases needed to be willing to participate in the study. The cases were chosen as the extreme situation and polar type in which the process of interest was "transparently observable." One case of clearly successful performance was chosen and one unsuccessful case. This sampling plan was designed to build theories of success and failure (Eisenhardt 1989).

Theory-building researchers typically combine multiple data collection methods. While interviews, observations, and archival sources are particularly common, inductive researchers are not confined to these choices. Some of these data collections were used in this research. The rationale is the same as in hypothesis-testing research. That is, the triangulation made possible by multiple data collection methods provides stronger substantiation of constructs and hypotheses. Systematic data create the foundation for the theories; it is the anecdotal data that enable the researchers to do the building. Theory building seems to require rich description, the richness that comes from anecdote. All kinds of relationships are uncovered in the hard data, but it is only with the soft data, the explanation is possible (Eisenhardt 1991).

The reflections and analysis on the data retrieved from the field led to creating codes, which started with a provisional list and continued throughout the investigation. The list initially came from the conceptual framework, pilot exploratory study and list of research questions. The first stage in the process was to abstract first order but substantive conceptual categories from the raw data; the second was to find relationships or axial codes between the conceptual categories; and the third was to develop a model or theoretical framework, in which the conceptual categories and their inter-relationships were accounted for at a higher level of abstraction (Brent and Slusarz 2003).

In this study, the NVivo qualitative data-analysis software package and manual techniques were used for data analysis. The NVivo software was used for coding the material and enabled the coding of sources to gather material by topic, for example, the researcher could gather all the content relating to the concept of *Market* (QSR 2008).

The TEN theoretical framework of commercialisation, used as a foundation for this study, proved helpful in identifying the nature of the process. As predicted by the TEN theories, the transfer points of [ST] and [TM] were where the greatest weaknesses were found. Most of the comments during the interviews reflected the need for two major focal points; more funding, and better networking in the engagement with the industry and government organisations. This was not surprising. However, the reason why universities do not demonstrate better industry engagement than they currently do remained less clear. Also unclear was that within an ever-tightening funding environment, how can universities access more funding?

Results and Discussion

Table 1 shows the list of the type of universities selected as cases for study in this research. Analysis of the cases with a focus on the commercialisation process and the organisational structure of the universities TTOs identified three dominant models. The seven cases are organised into four different categories based on the various commercial processes they follow. These cases were selected on the basis of their performance in nanotechnology. However, the Federal Government's Excellence in Research for Australia (ERA) report of 2010 (ARC 2010) showed only two of these universities as outstanding performers at above world standard in the field of nanotechnology. This can be explained in terms of the measures used by the ERA, which focused only on the publication of peer reviewed journals and not on the universities engagement with industry or the commercialisation of research. For many institutions the publication of findings in peer reviewed journals actually reduces the opportunities for commercialisation as the protection of intellectual property is weakened through such public disclosure. This can create a dilemma for many academics that are uncertain as to whether their focus should be on publications or patents.

Table 1 Universities covered by the case study research

University	Year Established	No. Students	Model	TTO
Case 1-Pilot-(UCO1)	1911	21,000	1	Commercial Office
Case 2-(UCO2)	1946	16,715	1	Commercial Office
Case 3-(UCO3)	1975	18,000	1	Commercial Office
Case 4-(UCO4)	1850	49,061	1	Commercial Office
Case 5-(UC1)	1992	16,030	2	University Company
Case 6-(UC2)	1949	31,000	2	University Company
Case 7-(CC)	1909	45,583	3	Commercial Company

The importance of support, environment and culture

The relative success of the universities technology transfer process appeared to rely on two important concepts. The first is the quality of the support that is given to the academic researchers. The second is the environment and culture that is created within the university that encourages the commercialisation of innovation. All the case studies suggested that the ARC discovery and linkage grants represented very good support from the government. Most of the funding for fundamental and applied research within the universities was sourced to these national grant schemes. However, the management of intellectual property and the technology transfer process enjoyed substantially less support and recognition. Both these areas demand good management and are both complex and costly.

The interplay between innovation, environment, organisational structure and performance

Tidd's (2001) model of the interrelationship between innovation, environment and performance was used within the analysis to support the case study development. This model suggests that a relationship exists between the type of innovation (e.g. incremental or radical), the organisational configuration of the business (e.g. structure and processes), the organisation's performance (e.g. growth and market share), and the environmental contingencies (e.g. uncertainty and complexity) that must be dealt with. The degree of complexity and uncertainty within the environment affects the degree, type, organisation and management of innovation. Further the greater the fit between these factors, or the more coherent the configuration the greater the performance. It is suggested that researchers should examine organisations in a holistic manner, rather than just their parts. The following comments from the interviews reinforce these points.

> *"The pathway to commercialisation is not linear."*

> *"From all of the research we carry out, half a dozen gets into the Technology and Market each year."*

"But a lot of these licenses will not bring in royalties, even those that do can take a really long time! What to do to increase it is a challenging question and one that we are working to answer. There is no easy way out."

"It is important to reflect and take stock at this time of financial crisis is to me a good time to do that. It has forced us to look at our processes and activities and especially various policies and press forward. It is a time for recalibration and looking at what is the priority and where the actual value is. We are looking at the process of the fundamental research and its relation to the IP. It is the crisis that to my opinion will lead to victory."

The role of strategic networks

The network is also defined as a coalition of institutions (Fdez et al 2006). This situation might lead to conflicts of interests between partners, both in the contributions (resources) and in the sharing out of results. The most important factor the study suggested is the consideration of R&D networks as a multidisciplinary and complex phenomenon. Therefore, it should be tackled from a general viewpoint, from which to generate a methodology for its study and management. Unquestionably, the current global economic recession challenges the very survival of some companies—yet, it also creates new opportunities. Corporations that survive the economic downturn will have used their R&D engine to create options for new revenue, new business models and new partnerships (Chowdhry 2010).

"*Networking is critical. It has to be local, national and international. The global network is very important*." CC Research Institute Director

"*This is very important because geography can become a barrier. It is nice to be close. Chatting over coffee, especially when the research is multidisciplinary, close proximity is important*." CC Research Institute Director

"*Networking is absolutely critical to commercialisation. We need to get people out there to meet new people. They go to conferences, talks, workshops. We have retreats to brainstorm and plan. The leaders of research groups are very keen to promote spin-off companies, and, therefore, meeting interests is essential. This is easy in the US. There is a culture there. It is very hard to create it in Australia. There is a healthy dialog in the US between the commercial arms of the Universities. It is KPI (Knowledge Product International) working in collaboration*." CC Research Institute Director

Process of knowledge networking (Langlais 2004) is knowing more about what happens to the communication, integration and generation of knowledge during an innovation process, which is very valuable for ensuring its success. It is not the general experience-based capabilities of companies or institutions, but much more their specific strategic network positioning and the efficiency with which they choose their partnerships, that increases the likelihood that partnerships will continue (Hagedoorn 2006).

Connectivity between innovators and industry partners

Regional company representatives and entrepreneurs, who respond favourably to the project and its technology transfer goals based on their growing knowledge of the developing community and work to link members with other people or companies that would be motivated to work with them to fill a need or solve a problem, are more successful. Where appropriate, staff set up individual meetings between potential collaborators. Before or after seminars and technology screening panels are good times to schedule these individual meetings. This helps attendees accomplish two things at once and feel that they had spent their time profitably. When word spread that these company events help attendees learn about strategically important emerging technologies and make productive and valuable contacts, other locals were motivated to attend these events to get the same benefits (Kapfer 2007). However, as the relationships between collaborative networks and product innovation performance show, some firms achieved better product innovation performance than other companies under the same level of collaboration with different types of partners (Tsai 2009). Companies should seek to balance the level of networking (Luo and Morsheda 2009).

Social networking has also become very important. Only five years ago, most people did not use search engines (Kurzweil 2007). Just three years ago we did not hear the terms "blog," "podcast," or "social network." Furthermore, three years ago, people thought that it was impossible for a business to make money through Internet advertising. Today, we have Google, a company with a $ 157 billion market cap that does just that. The pace of change is already so fast that the world will be a very different place by the end of the three-year planning cycle of typical business projects currently under way, let alone the six- or seven year venture capital horizon.

The effect of networks and entrepreneurial orientation suggests, that the ''fundamental'' networks of academics involved in the firms assists in the identification and exploitation of initial opportunities to internationalize. In particular, it suggests that many such firms progress through pre-internationalisation behaviour, preparing them to attempt to enter global markets. This is a result of the nature of technology developed by these firms being global in nature. In addition, the study recognizes the importance that networks play in successful internationalisation.

Of particular importance is the fundamental network of the academic who developed and commercialized the technology, and these networks can only be fully leveraged if the application of the technology is within the area of the academic's interest. Thus, the lesson for university commercialisation units, is that there may need to be trade-offs made between the application with the maximum commercial potential, with that which interests the academic.

Conclusions and Recommendations

This research not only highlights the potential of high technology firms developed through the commercialisation of academic research in international markets, it also provides guidance for university and government policy makers. In particular, our findings suggest that both universities and the government need to create an environment and supporting systems that encourage commercialisation and furthers the successful internationalisation of local firms (Styles and Genua 2008).

The study also points to specific areas of weakness in the organisational culture and environment created at many universities for the process of commercialisation and industry engagement. As noted, the weakest links were found at the two transfer points (ST) and (TM) in the Techno-Economic-Network model of commercialisation. Both of these require future attention.

The first is related to the mechanisms, structures and systems that can identify commercially valuable intellectual property within scientific research (S) and move it towards the (T) pole, so as to create commercialisation opportunities. The second transfer point is related to the commercialisation pathways through which the technology moves towards the market (M). This can involve the interplay between a range of actors (e.g. universities, private companies and venture capital investors).

The contribution of this research towards the important area of commercialisation at the universities in Australia is twofold. First, is the focus on the strategies adopted at the macro level by government and other relevant institutions and the second is how the collaborators namely academics, commercial managers and practitioners may work together at the micro level in an environment which is conducive to economic growth.

At the macro level Australia needs to consider not only its total R&D investment (e.g. GERD), but also the output of commercially relevant IP from this innovation pipeline. The *Global Innovation Index* (GII) (Dutta 2012) ranks Australia 23rd in a global field of 141 countries. In terms of research inputs Australia does relatively well, but in areas of knowledge and technology outputs the picture is quite different. Key areas of weakness are the registration of patents, royalty and licence fees, trademark registrations, copyright and knowledge diffusion. Although Australian academics do relatively well in the production of peer reviewed scientific and technical articles, the track record of commercialisation of such IP is less impressive.

Australia's NIS is more dependent on its university sector that is the case for many other OECD countries. This is due to the relatively small size of the Australian manufacturing sector, and the absence of large, multinational and R&D intensive businesses located here. If Australia is to enhance its international competitiveness through innovation government policy settings need to facilitate change in how universities work with industry.

Government can help by creating opportunities for the industry, university and community organisations and groups to come together in an open environment for knowledge exchange. As discussed, universities can contribute to innovation by knowledge management. Setting the right policies for universities especially for the commercialisation process, its structure at the university, the university engagement with industry and the community are important for growing economy.

Australia is rich in resources and the educational system has always played a major role here. At the core of this educational system is the university. The future of the country depends on its young people and their promising minds. The focus on the educational system in the NIS creating an open environment supporting universities and creating a culture of innovation will put Australia in a promising position in the world economy.

At the micro level universities can contribute to the innovation process with a sound commercialisation system. Individual players especially academics need to work in an open environment where teaching and research can remain their major focus. However, networking opportunities, which are healthy and based on mutual trust, should be created for the academics supported by the university through its commercialisation process. For those who choose to have meaningful relationships with industry and the community, sufficient support should be given by the university to collaboration with commercialisation managers from the TTOs and then to the market. Strategies need to support the diversity between the various players while simultaneously providing financial support, focus and direction.

The individual actors at the university (e.g. academics, TTO managers and staff and university administrators) can and should play an important role in creating a culture and organisational environment that is more conducive to entrepreneurial orientation and commercial outcomes. This can seek to foster interaction between researchers and industry, in particular private companies and investors. Not all academics will be willing to engage, but universities and research funding bodies such as the ARC and NHMRC can help facilitate the process by giving enhanced recognition and appropriate rewards to commercial outcomes from research rather than the current heavy emphasis on peer reviewed publications.

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