GROUP OF EIGHT AUSTRALIA

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GROUP OF EIGHT SUBMISSION TO THE INQUIRY INTO AUSTRALIA'S INNOVATION SYSTEM

The Group of Eight (Go8) is a coalition of leading Australian universities, comprehensive in general and professional education and distinguished by depth and breadth in research. The Go8 universities undertake about two-thirds of the research undertaken at universities in Australia including over 50 % of the research funded by industry. They also hold 80% patents held by universities in Australia and receive well over 80% of the income from licenses received by the sector.

THE ROLE AND IMPORTANCE OF RESEARCH INTENSIVE UNIVERSITIES

Research intensive universities are central elements in any national innovation system. They form part of the research and education subsystems of the innovation system and play an important role in linking the national system with those of other countries.

The way in which they operate ensures the highest possible standards of performance across a broad range of disciplines and helps set national standards of excellence; their international standing provides substantial links to overseas organisations and a national credibility not otherwise achievable; and their broad perspective and ability to work towards the longer term provides the means for creating a better future.

While all the parts of an innovation system are important, universities play a particular and essential role in providing the highest quality people, ideas and information that flow to all other parts of the system – whether business, government or other universities – to ensure they work effectively. They are able to do this because of their unique culture, educational philosophy and a preparedness to go beyond the quotidian to strive for the otherwise inaccessible. Because of the extent and depth of their research and research training activities, the research intensive universities play a particular and important role within this broader system.

Research intensive universities have the comprehensiveness, facilities and international reputation necessary to meet and provide opportunities not available elsewhere in the innovation system. While maintaining this scale and breadth of capabilities is not low cost – and this is one reason why only a small proportion of the universities in any one country can achieve the status of research intensive universities – their role is essential in maintaining the health of the system as a whole and of its individual components.

Research intensive universities

Not all universities are the same: indeed, each university is unique in its history, culture and intent. As the importance of higher education has increased the sector has diversified in response to government policies, the demands of the market and local, regional or national needs. Taking a global view, some universities may specialise in certain disciplines, focus on educating certain professions, emphasise the use of distance education, or seek to attract students sharing particular characteristics. Some focus on teaching, others may concentrate more on building their research capacity; some on creating domestic networks, others on developing international linkages. The extent of this differentiation varies between countries.

Despite this diversity it is possible to recognise in most countries a group of universities which share a particular set of values, have a set of similar attributes and which together perform a significant proportion of the national higher education research effort. Some countries define these as their research intensive

universities because of the proportion of their total resources that they devote to research and related activities; in other countries there may be a less sharp demarcation between research intensive and other universities, but even when this is the case, a relatively small proportion of the total universities account for most of the higher education research expenditure. Interestingly, there is a trend in many countries to use funding and other policy tools to increase this differentiation within the university system to make it more effective and in particular to attract greater international recognition.

While all universities are communities of scholars and in some countries most universities perform research, the breadth and depth of research activity and of doctoral education in research intensive universities provides a particular texture to their academic environment. This helps provide a distinctive and distinguishing experience for the students, including and especially the doctoral students, and the academic staff. Moreover, as well as sharing some common attributes and promoting well-established values of scholarship with all other universities, the research universities tend to connect to each other, both directly and indirectly, through cooperation and competition that both strive after even higher levels of effectiveness, excellence and performance.

Research intensive universities promote excellence in research and education by emphasising the mutual dependence of these activities at the highest levels of learning. But they do more than this: the Millennium Declaration of 2001 on the future of research universities, prepared by a group of scholars from Western Europe and America stated:

> *In a society of shifting goals and uncertain values, the university must stand for something more than accurate data and reliable information; more, even than useful knowledge and dependable standards. The university is the custodian, not only of knowledge, but also of the values on which that knowledge depends; not only of professional skills, but of the ethical obligations that underlie those professional skills; not only of scholarly inquiry, disciplined learning and broad understanding, but also of the means that make inquiry, learning and understanding possible. In its institutional life and its professional activities, the university must reaffirm that integrity is the requirement, excellence the standard, rationality the means, community the context, civility the attitude, openness the relationship and responsibility the obligation upon which its own existence and knowledge itself depend.*

This is why governments around the world recognise that research intensive universities are crucial national assets. It is also why governments need to understand the complex but profound and necessary contributions that all universities make to national and global wellbeing, and the often indirect pathways through which they do so.

ATTRIBUTES OF RESEARCH INTENSIVE UNIVERSITIES

Openness and autonomy

One of the most important characteristics of all universities is that they have no external agenda, are non-partisan and independent. Moreover, they have the autonomy and freedom needed to pursue ideas and research, no matter where they might lead and without constraints set by the need for immediate usefulness or quick results. This means that they can provide a focus for the disinterested analysis and debate of often contentious issues free from ideological, political, economic, religious or other constraints. This freedom and openness also covers the right and responsibility to publish their results and participate in national debates.

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Detached engagement

One reason universities play such a central role within broader innovation systems is that while they closely engage with, monitor and analyse current events, operate in an environment that is constantly changing, and interact with all parts of society, this engagement is detached in the sense that universities look to the future, the big picture and the universal, as well as to the present and local. They value learning in its own right, not just as a tool with which to change the world. While they respond to the immediate and provide capabilities that can address the urgent, their main value comes from their ability to look and act beyond the short-term.

While all university education seeks to create people with the ability to work well in the jobs they take up after graduation, in many countries education in a research intensive university emphasises the need to produce graduates who are able to work effectively in jobs that do not yet exist – and who have the creativity, imagination and habits of rational evaluation that will lead to the development of these new jobs and new industries. Universities need to work with business and other employers to identify the kinds of knowledge and skills that are important but then have to go beyond this to address the needs business does not yet know it has.

Radical conservatism

If a university works only to respond to existing needs and demands, it is not fulfilling its proper function which has to go beyond the present and the superficial. A major role of the any university is to use reason to test and challenge the status quo, to search out ways of doing things better and to find ways to view the world in new and more informative ways.

While universities are agents of change, they are also repositories and guardians of past knowledge and knowledge about the past. Research intensive universities should also be the custodians of unpopular or out of fashion disciplines, maintaining broad research capabilities not least because an unexpected event might suddenly create a need for them. This radical conservatism permeates the teaching, learning and research of the research intensive universities, as well as all their other activities.

ROLES OF RESEARCH INTENSIVE UNIVERSITIES

Education

A research intensive university is a centre of learning because research permeates all of its operations and is the basis of its reputation and the foundation for its further development. Learning requires research, discovery and critical inquiry. While some education can take place through the simple transmission of information, practice and skills, learning takes place through questioning and debate. The aim is not just to identify and transmit best practice but to question and test it. This means that students are not passive receivers of information but active contributors to learning – in their interactions with each other as much as with the academic and other staff. Learning, like innovation, is a social activity, not an individual one.

The purpose and role of a university is not to produce students equipped to move into a particular job or type of job; it is to prepare students to live in a complex and unpredictable world in which they will need to respond to situations, challenges and opportunities which we cannot forecast, and take advantage of them; and produce graduates who are flexible, resilient and have the self confidence necessary to take responsibility for their own actions. This requires a continued willingness to learn, a valuing of certain ways of thought and a set of attitudes that is open and humane. A pervasive research culture is important because it enables universities to focus on learning rather than teaching, thinking as well as doing, debate not just assertion. One reason this is

becoming ever more important is that sources of information are multiplying exponentially, as are the technological means of accessing information. There is usually no problem in finding information whenever and wherever someone needs it. However, the ease of acquiring information places even more onus on universities to help students develop the ability to evaluate information, assess its status and quality, and then convert it through independent thought to knowledge and wisdom.

A good university is one that provides an exciting environment, one that stimulates the passion and motivation of its students by exposing them to zealous and motivated educators in a setting permeated by the creation of new knowledge and the application of rigorous debate. The benefits of this learning go beyond the provision of particular disciplinary information – which is readily available elsewhere and will often quickly become out of date. University education aims to support the balanced development of the whole person. Achieving this outcome requires the application of rigorous standards of academic excellence and an emphasis on generic characteristics such as curiosity, probity, rational inquiry, and placing a higher reliance on evidence than on authority; it is also an outcome of the academic environment as a whole, requiring an academic community that transcends disciplines and builds on the interactions that take place outside any formal teaching arrangements.

As well as producing the highly educated people who move into the workforce and help drive innovation, increased productivity and the exploitation of new opportunities, universities play an essential role in awarding the credentials that bestow confidence that professionals are properly qualified and able to provide the service people are buying from them. A rigorous approach to assessment and evaluation within the university provides people outside the university with the confidence that alumni possessing particular credentials have achieved high levels of learning and standards of excellence with respect to the knowledge and skills that they possess.

Research

By definition three important characteristics of research intensive universities are the excellence, breadth and volume of their research. This will extend from the curiosity-based, investigator-led basic research to much more applied research and the developmental work usually funded by business.

Performing across the whole range of the research spectrum is important in keeping universities linked to the shorter-term needs of business, government and society as a whole. This also adds to creation of a stimulating teaching and learning environment. However, a core role of higher education research, and the one scarcely performed by any other part of the innovation system, is that of performing basic research. Academic researchers aim at the huge leap forward in understanding, rather than the incremental advance; at creating opportunities rather than exploiting them; and at exploring and understanding the human condition. Because they account for a high proportion of the higher education research effort, the research intensive universities play a particularly important role in this area.

Some university research which advances knowledge can quickly provide direct and indirect opportunities to support business innovation, create completely new commercial opportunities, inform government policy, and provide information that supports community well-being. However, the research that has the greatest impact frequently turns out to be that which was conducted without any direct intention of being useful. In many cases the advances made by fundamental research are essential to advances across a wide range of different technologies but this impact can take many years to become apparent. Any hindsight study attempting to trace back the origins of important technologies or economic developments quickly finds dependencies on research, the performers of which could never have forecast how their research might find practical application.

The research performed by universities has impact in the non-academic world through many pathways, most of which are indirect and not very visible, particularly when there are long time lags between the performance of

the research and business or other sectors recognising and building on its potential. The universities are creating potentialities that others can realise. Moreover, there is a considerable level of contingency in the use of basic research, for example in the way in which a research advance in one area can suddenly create ways of using earlier discoveries in other disciplines. Time and scale work together to create opportunity in many unexpected ways. Basic research influences but does not control the research in other sectors that builds on the knowledge created through basic research.

Another important role for the research intensive universities is to help position the standards and benchmarks for research quality. Because of the volume of research they perform and their international links and reputation, the research intensive universities compete against each other in the global research environment. This prevents the development of parochialism and means researchers in these universities are matching themselves against the best in the world. In turn, this helps set the domestic standards for the country in which the universities are operating and this helps lift the performance of other researchers.

Store of knowledge and capabilities

Universities act as a storehouse of knowledge and capabilities. University academics have world-class expertise, their research facilities may be of a kind unavailable elsewhere and the domestic and international networks of universities can potentially provide access to an even broader range of expertise and facilities. University researchers, especially those performing basic research, necessarily have a broader view of the global research effort than do researchers in business, who tend to be narrowly focussed on the technological development necessary to implement their firm's business plan.

Innovation

Because of their international links and breadth of research experience, research intensive universities have the potential to take a lead and demonstrate new pathways in higher education. This goes beyond the excellence of their current performance and arises from them looking ahead, adopting and adapting to change made possible or necessary through variations in their external environment, and monitoring or directly participating in overseas developments. Even more important is the way that universities can drive innovation across both their educational and research activities, responding to the opportunities created by new knowledge, technologies or even attitudes. Research can drive improvements in curriculums and pedagogy; the demands of the problems facing the world can promote integration of knowledge across disciplines and other boundaries; the speed at which research makes disciplinary knowledge out of date can lead to a greater emphasis on learning to learn.

Reputation and international networks

Almost by definition, universities are elite organisations – not in the sense that they are bastions of inherited privilege but in the sense that they are citadels of ability and excellence. They seek excellence and ability in their students, no matter what their background, because this is the only way to retain the university's distinction and effectiveness. The ethos and practice of a university is meritocratic. In a university the students form an essential part of the academic community and interactions between students forms an essential component of the learning experience, so that only the best will do.

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Any research intensive university works hard to attract the very best and most talented educators and researchers in order to maintain its position. Having a visible international presence and an international ranking is paramount in the global fight for talent. Excellence attracts excellence and a research intensive university, so long as it is financially robust, can serve not just as a centre of national excellence but as an international beacon, signalling the capabilities and contributions of its country to a global audience. A strong research university has its own global brand that flows not from sophisticated and expensive marketing but from the credibility and strength of its operations as measured by its peers, by independent ranking and other external assessments. The reputation of these universities reflects substance, not public relations.

A high international reputation enables a research intensive university to become an active participant within an invisible college of other research universities. This facilitates strong, diverse and apolitical links with other countries, as well as an awareness of overseas research developments and the potential for collaborative work. An important way in which these connections develop is through the free movement of students and staff. A globally ranked university can attract the best students from many countries. On returning home and taking up academic appointments, jobs in business or government positions, these students will retain their links with each other, with their mentors and form part of a global alumni network that maintains productive connections beyond any narrow political or other affiliations.

The international reputation of research intensive universities plays an important and even essential role in any nation's fight for talent and in its ability to play an effective role in international discussions on global and other problems; it also plays a part in the willingness of companies to consider direct investment in a country. World-class research universities help draw in investment and other funding from overseas and add to the perception of a country as being a superior place to live and one that recognises quality and distinction. Strong international networks also provide the means through which one country gains access to the research performed in other countries in ways that go beyond the codified knowledge transmitted through publications.

Economic and social mission

The most important economic and social contributions of universities arise from the movement of their graduates into the broader workplace, taking with them and applying the knowledge, skills and attitudes the university helped to instil; and from the direct and indirect application of the research the universities perform and the transfer of information and technology to other sectors, domestic and international. However, universities are part of local and national communities and linked to them in many ways. One consequence of this is that universities play a more direct and important social role that can have effects beyond the immediate location of the campus and extend far into their local community.

Universities employ large numbers of staff directly and can draw in students from a large catchment, including overseas. A university having a strong research base and international reputation can also draw in funds from far outside its own region. In some cases the multiplier effect associated with the economic activity of these staff, students and their families can account for a significant part of the local economy. In attracting fee paying overseas students, the universities can also be contributing to an important export industry within their region.

The employment opportunities the universities provide are diverse – not just academic staff and the technical staff required to support research but people having a wide range of professional and other skills. The fact that a significant proportion of these staff are themselves highly educated, well informed and articulate can have important flow-on effects for the standard of services the local community has to provide. The way in which the universities attract a diverse group of students can also have positive effects on the diversity of the local population and its broader economic structure.

In some ways as important as the direct economic effect of the university is the contribution the university, its staff, students and its varied activities make to the artistic and cultural life of the community of which they form a part. Universities, their staff and students create a concentration of cultivated and experimental taste which directly and indirectly adds to the vibrancy of the social and cultural life and reputation of a region. In part this arises from the cultural activities performed in and by the university but it also results from the demand from highly educated and creative people seeking entertainment, recreation and other activities outside the university.

CHARACTERISTICS OF A RESEARCH UNIVERSITY (*HEFEI STATEMENT)*

The Go8 along with the Association of American Universities (AAU), the Consortium of China 9 Research Universities (C9), and the League of European Research Universities (LERU) issued a statement on the Characteristics of Research Universities (*Hefei Statement on 10 Characteristics of Contemporary Research Universities* https://go8.edu.au/article/hefei-statement-10-characteristics-contemporary-research-universities) in 2013. The statement identifies the key characteristics that make research universities effective and the need to promote a policy environment which protects, nurtures and cultivates the values, standards and behaviours which underlie these characteristics and which facilitates their development if they do not already exist. In the absence of a supportive environment, research universities will be unable to impart the major competitive advantage and global recognition that all nations seek from them.

DEVELOPING AN EFFECTIVE INNOVATION SYSTEM

An effective innovation system requires productive interactions between all its parts. Business and universities play complementary roles within the innovation system but have many interdependencies and the effectiveness of the system depends on them working together.

Not least, universities are producing the graduates that business employs, many of whom will become change leaders, supporting business innovation, growth and the creation of new firms. University research provides a supply of ideas, opportunities and technologies that business can use; and universities store knowledge, competencies and capabilities that business can draw upon.

Business has its own, different but complementary capabilities, technologies and information that it can feed into the strategic development of universities and which it can use to support the educational and research activities of universities.

Linkages require reciprocity and both sectors need to play a role in initiating and strengthening them; neither sector can act in isolation from the other and all parties need to respond to the needs and concerns of the others. There are many different types of business-university linkage and a diversity of mechanisms that the parties can use to initiate and support these linkages. They may be direct, indirect or system level; strategic and long term or ephemeral. As a minimum they require the flow of information; in many cases they also involve the flow or transfer of money and people.

While research linkages tend to receive the most attention, cooperation in other areas of activity can be just as important if not more so; linkages can relate to education, employment, knowledge and technology transfer, the development of strategy and to philanthropy, although there are interconnections between all these areas. Impediments to the development of effective linkages can include differences in culture and values; the lack of incentive structures; problems in identifying the right people or areas within a university, or in identifying a suitable business for potential cooperation; bureaucratic complexity or barriers; lack of knowledge or resources within small firms; matters relating to the valuation, ownership and management of intellectual property; the lack of funding to make university research outputs ‘business ready’; and a range of other matters. However, when there is a will to cooperate, none of these potential barriers is unsurmountable.

Universities, businesses and their respective peak bodies can all take actions to increase and improve business-university linkages. Government also plays a role through the programs it develops and the policy environment that it sets. However, linkages are not an end in themselves but a means to achieving an outcome – beneficial to all the participants – that would not be possible in the absence of the linkage. Empirical data and studies of innovation show that in Australia the availability of creative and skilled people is a bigger barrier to innovation than access to research, ideas and technology. Shortages can occur at a broad, often discipline level – such as a shortage of engineers or health workers. However, there is also concern among business that graduates lack some of the skills and competencies that business needs and expects. Closer linkages between business and universities have the potential to address some of these issues, help universities respond better to the broader needs of business and improve the transparency and relevance of the credentials they award. Increased diversity within the sector might also help better target the efficient and effective linkages needed to help universities better meet the national interest.

How universities help business

Universities play a central role in Australia's innovation system and support the business sector, and individual firms, in many direct and indirect ways. Universities provide Australia with a continuing supply of highly educated graduates, knowledgeable about the most recent developments in their disciplines and able to apply their expertise, understanding and skills within the particular circumstances of their employment. Universities are also major generators of the new knowledge which advances understanding and, through its integration with complementary expertise and existing practice.

Universities engage with business in many ways and business will often make direct use of university capabilities, including their research expertise, facilities and outputs. Direct connections are important and this kind of engagement provides value to all the participating parties. However, university research also has to provide the foundation for developments that business and other sectors cannot yet imagine but which will provide the backbone for progress and sustainability as the world moves forward. This is the research supported by public funding and is a particular responsibility of the research intensive universities because by definition they account for a high proportion of public expenditure on higher education research.

At a time when separate but related announcements are starting to suggest that Australia's economy is undergoing an unprecedented rate of structural adjustment, it is important to start thinking about the performance and effectiveness of those institutions that will help create our future. Government and business will both play an important role in determining Australia's development trajectory but both depend to an often unappreciated extent on the higher education system. For this reason it is essential to understand the role that research universities play in economic development, to explore how these universities connect to business and to develop some creative ways to improve the effectiveness of existing linkages between the sectors and to create new ones. This paper provides an outline of the most important ways in which universities support business, assist economic development more generally and help create a resilient society able to respond flexibly and positively to the contingencies of economic and other changes.

An educated population

There is no doubt that Australia's future will depend increasingly on the creativity and business acumen of its people. Internationalisation is leading to a geographical segregation of business activity with increasing specialisation between countries. Australia will need to depend more on high-value-added activities that depend on the creation and imaginative use of intellectual property as well as the inspired development of new business models. Even within these sectors, continuing innovation will be necessary to maintain competitiveness as other countries strive to catch up. Universities provide the continuing supply of graduates who take up positions in business. In moving from universities to business, graduates carry with them the

knowledge, skills, expertise and awareness of modern technologies and thinking they developed through their university education. Graduates are aware of the most recent developments in their disciplines, and of the relevance of these advances, because university research activities inform their teaching. In addition, university education builds broader skills and competencies such as critical thinking, effective communication and cultural awareness that underlie much modern business. Graduate recruitment provides access to the latest research and in itself can provide informal links to university staff. This is important because the empirical evidence suggests that the major factor limiting business innovation is the lack of creative people and people having the necessary skills and expertise, not access to information and research.

The production of knowledge and researchers Universities are an essential component of Australia's research system. University research produces new knowledge, new technologies and new researchers. Many of these new researchers move on to work in the business, government or non-profit sectors after completing their PhD or after subsequent postdoctoral experience in academia. University research serves the needs of government and the community, as well as business. Moreover, publicly funded university research complements business research but does not duplicate it. Much university research creates the understanding and technological opportunities that individual firms can draw upon to develop their own products or services. University research a lso extends beyond the boundaries of business research in addressing generic issues vital to business operations such as trade issues, human behaviour, economics, international law, or intellectual property. This kind of research can inform policy development and Australia's standing in international discussions and help create an environment favourable to Australian trade and commerce. The research performed by universities is readily available because academics publish in journals that researchers in business access and read. Academics also present at conferences that business people attend and make information available through web sites, newsletters and many other means.

A storehouse of capabilities

University research is important in its own right but also creates a breadth and depth of national research capabilities which far exceeds that found in business, even though business expenditure on research exceeds that of the higher education sector. Business research tends to focus on very specific areas of immediate concern. The breadth of university research capability (covering both expertise, specialised equipment and university networks with overseas researchers) provides an essential resource that business and government can draw upon as they need. Business can use these capabilities by seeking advice, through consultancies, research contracts, cooperative ventures (including Cooperative Research Centres or CRCs) and many other mechanisms, including board appointments. The availability of university research capabilities is especially important in Australia where the small size of many firms means that most do not have ongoing research programs but stop and start their research as the need arises.

Attraction of foreign talent

Australia is a small country and the best people are usually elsewhere. If it is to become more competitive internationally, Australia needs to attract them. It is instructive to note that foreign-born entrepreneurs started a quarter of U.S. technology start-ups over the past six years. Over 40 per cent of the engineering and technology ventures in Silicon had at least one immigrant as their founder. Moreover, as of 2010, one-third of the 314 laureates who won their Nobel Prizes while working in the United States were foreign-born. Australian research universities which have an international reputation are able to attract the best and most talented people from wherever they are. This applies not just to academic staff and researchers but to students. Educating students from overseas has many cultural and international networking benefits, as well as being a multibillion-dollar export industry in its own right. Just as important is that some of the most talented undergraduate and research students might stay and work in Australia. Even when they do not, their links with Australia can have valuable personal, diplomatic and commercial benefits.

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International reputation

Capital is more internationally mobile than ever and international reputation will always play an important part in the investment decisions made by major businesses and even individual investors. While the government plays an essential role in creating the investment environment and in ensuring competitive settings in areas such as sovereign risk or tax structures, many multinational enterprises (MNEs) take specific note of the reputation and capabilities of a country's universities and the implications this has for the supply of skilled labour, research expertise and facilities, and international networks. This reputation is important to government as university research often provides the credibility necessary to play an effective role in international negotiations on matters as diverse as fisheries management, climate change and international tax regimes.

Australia's research universities support business in many different ways but these are not independent of each other. Moreover, these avenues of support all depend, to one degree or another, on the universities having a culture of excellence through all of their activities. In particular, the excellence of the research performed by a university feeds directly into all of its other activities and has a huge impact on the level and quality of support a university provides to the business community.

The Group of Eight (Go8) universities provide a good example of this. As shown by the various international rankings, they receive global recognition as world-class institutions based on the quality of the research they produce. They are also the preferred research universities for businesses wishing to commission research from universities or to make use of the technologies that the universities have developed through their own research efforts. Excellence in academic research creates the breadth of knowledge, expertise and capabilities that industry can draw upon to meet its own specific research requirements.

One measure of this is that in 2011 the Go8 universities (which together make up 20% of Australia's universities) received 68% of the total research income received by all universities, 74% of the total competitive grants funding that supports academic research and 66% of total 'industry and other' research funding. This funding led to significant technology transfer activity and other business outcomes. For example, the Knowledge Commercialisation Australasia (KCA) Commercialisation Metrics Survey Report 2010 provides aggregated data for Australian public sector research organisations, including 21 member universities, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Australian Nuclear Science and Technology Organisation (ANSTO) which together represent the overwhelming majority of public sector research nationally. This report shows that the Go8 universities together accounted for 71% of invention disclosures, 70% of the Licensed/Options/Assignments executed, 95% of Licensed/Options/Assignments income, 67% of the startup companies formed during the year and 65% (by value) of the contracts and consultancies entered into over the year. While these data are impressive, it is important to remember that these direct commercial activities together represent only a very small proportion of the benefits that these universities are providing to business, even though they might be some of the easiest to quantify.

Maximising the benefits of university research

Australia's universities spend over $8 billion a year on research and it is important to maximise the return on this investment. In considering how to do this, it is important to recognise that university research is multipurpose and contributes to the production of many direct outputs.

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Those that can result directly from a single research project include:

- New knowledge and understanding
- Trained researchers
- New technologies
- Capabilities
- Networks
- Institutional and researcher reputation

Each of these can lead to other outputs and outcomes. For example, new knowledge can lead to research papers, to higher quality teaching that draws on the most recent developments in a discipline, and to the creation of a stimulating intellectual environment that promotes learning and the development of the questioning culture that promotes innovation. Ideas for new technologies can lead to improved research tools or to patent applications. While many of these research outputs add value to the universities that created them, in many cases their further development, and the consequent extraction of greater value, depends on other parties taking up these research outputs and investing more time, money and complementary expertise in their further development. For this to happen there is a need for pathways which transfer the proximate outputs of university research to those having the capability to make use of them and the interest in doing so.

Transfer pathways

While in practice there are many different and often complex pathways through which university research finds its way to potential users in business, government, or even other higher education institutions, they all involve the flow of information. In some cases but not all, the exchange of money supplements this flow of information and increases the likelihood that the receipt of information causes some response. The money acts as a lubricant that facilitates productive interactions. In the best cases the flow of information takes place through the movement of people. This is because people not only possess the knowledge, they also have the expertise necessary to use it in response to the particularities of a specific situation or problem; they possess the tacit knowledge and know how that supplements the codified knowledge passed on through publications.

It is important at this point to emphasise that some of the most effective (and easily observed) transfer pathways involve the two-way flow of information and long-term relationships. They build on an interactive and iterative flow of information, creating a situation in which each participant learns from the others, and responds in appropriate ways as a result of this learning. However, it is even more important to note that in most cases the flow of information does not involve the development of a relationship between the university and the business or other party using the research outputs the university has produced. To make this clear it is useful to make the distinction between direct and indirect transfer pathways.

Direct flows of information often involve face to face contact, draw on two-way flows of information and will always include the tailoring of information, advice or service to the particular needs or circumstances of the collaborating parties. Examples include contract research and consultancy services, or the development of specific courses based on the needs of business or government.

Indirect flows of information take place at arms' length and do not allow the supplier of the information to customise it to particular needs. Examples include the transfer of information through publications, web sites, seminars and workshops, and a whole range of other mechanisms. However, by far the most important indirect mechanism is the movement of people.

Students in research universities receive an education that exposes them to the latest thinking, concepts and developments in their disciplines and to a research culture based on questioning, testing, logical analysis and rational argument that builds on evidence. Business, government or non-profit sector organisations employing

new graduates are gaining this knowledge and expertise, as well as the capability to keep a watching brief on research developments of relevance.

Modes of transfer

Linkages between the users of research and universities can follow two quite different modes. The first occurs when a university develops information or technology that it believes might be of use commercially, or for some other purpose. The university then seeks a partner to develop the invention to the stage it can realise its full potential. This is the technology push mode.

Alternatively, a firm or government organisation might experience a problem or develop a need but does not itself have the in-house capabilities necessary take this forward. Such a requirement to draw on outside help can lead to university consultancy work or research contract research. These draw directly on the capabilities – expertise, physical research infrastructure and research networks – that the university research has developed. This is the market pull approach.

In practice these two modes are not nearly as distinct as they seem and long-term strategic partnerships between universities and non-university partners will normally include elements of both.

Innovation is a system outcome

In examining how to improve the level of national benefits Australia receives from its investment in university research, it is necessary to recognise that any non-trivial innovation requires the bringing together of different but complementary expertise and resources from many different sectors. One of the characteristics of a system is that you cannot optimise its operation by concentrating on just one of its components – all are equally important.

This means that taking advantage of university research outputs depends as much on the capacity of business and government as it does on the universities themselves. Moreover, this makes it very difficult to measure the individual contribution of any actor in the innovation process.

While it is possible to develop linear narratives that demonstrate that an individual research project or program made a significant contribution, for example to a specified commercial, economic or social outcome, this is very far from being able to measure the value of this contribution. Working backwards from the impact will generally show its dependence on a whole range of very different kinds of information, some recently discovered, some standard practice but flowing from earlier research. All research is cumulative and has to build on what is already known and conjectured. In many cases the financial and even intellectual contributions needed to convert a research output to a commercial success or agreed policy position will be more expensive in time and money than the initial university research. This is not to downplay the critical and fundamental importance of the research but even the very best research may become irrelevant if the potential users lack the necessary motivation, capabilities and imagination or are averse to risk.

Making the system work better

Innovation is a system outcome and a system depends on the effectiveness of all the linkages between its components. Increasing the returns Australia receives on its investment in public sector research creates the need to improve the effectiveness of existing linkages and increase their number. However, in considering how best to do this it is important to acknowledge what is already happening and the diversity of pathways through which the outputs of research flow to potential users. In particular, it is necessary to recognise the significance and pervasive influence of indirect mechanisms. This is especially so as innovation is as much about integrating information and solutions from many different sources as it is about singular inventions developed in

isolation. Indeed, it is doubtful that the latter exist.

There are many different avenues having the potential to improve university business linkages in particular. However, the many reviews and inquiries that have examined how to do this tend to identify a small number of general themes. It is possible to summarise these as follows:

- Remove impediments to information flow between the sectors. Make information coming from university research easy to access, cheap and understandable to those who might make use of it. Make it easier to find. Promote and facilitate the movement of people between the sectors.
- Address the cultural barriers and differences between universities and business. Have recruitment and promotion systems that value academics who work with or for business; and promote mutual understanding through work integrated learning, secondments and joint appointments.
- Identify ways in which all sectors can more easily identify potential collaborators in the other sectors.
- Identify ways to improve the absorptive capacity of business, including through the employment of more research capable employees, improved management training and the promotion of collaboration between the sectors.
- Market more effectively those government programs which support business research and require business university collaboration or help business to identify sources of advice and problem solving capacity.

Further discussion and elucidation of the issues covered can be found in the following Go8 publications:

Increasing the national benefit from higher education research. (https://go8.edu.au/publication/increasing-national-benefit-higher-education-research-0)

The university-business nexus in Australia (https://go8.edu.au/content/go8-backgrounder-26-university-business-nexus-australia%C2%A0)

The Changing Environment for Australian University Research (https://go8.edu.au/publication/changing-environment-australian-university-research)

Why Australia needs a domestic research effort (https://go8.edu.au/publication/why-australia-needs-domestic-research-effort)

Where should governments invest their research funding? https://go8.edu.au/publication/policy-note-where-should-governments-invest-their-research-funding)

The role and importance of research intensive universities https://go8.edu.au/publication/discussion-paper-role-and-importance-research-intensive-universities

Hefei Statement on 10 Characteristics of Contemporary Research Universities https://go8.edu.au/article/hefei-statement-10-characteristics-contemporary-research-universities

The importance of international education for Australia https://go8.edu.au/publication/importance-international-education-australia

The international tendency to concentrate research capability https://go8.edu.au/publication-type/backgrounders?page=2

Measuring the impact of research - the context for metric development https://go8.edu.au/publication/go8-backgrounder-23-measuring-impact-research-context-metric-development

Research Workforce https://go8.edu.au/publication/go8-backgrounder-19-research-workforce

Research Funding in the United Kingdom https://go8.edu.au/publication/research-funding-united-kingdom

The University-Innovation Nexus in Finland https://go8.edu.au/publication/go8-backgrounder-29-university-innovation-nexus-finland

Answering the Global Challenge- Experiences from European Excellence Initiatives https://go8.edu.au/publication-type/backgrounders?page=1

The university-innovation nexus in Singapore https://go8.edu.au/publication/go8-backgrounder-28-university-innovation-nexus-singapore

Research https://go8.edu.au/sites/default/files/docs/go8backgrounder15_research.pdf