

Griffith University  
Submission to the  
Productivity Commission study of  
Public support for science and innovation

This submission is in 3 parts.

**PART 1: KNOWLEDGE PRODUCTION AND KNOWLEDGE DIFFUSION**

Part 1 is about the relation between innovation policy and research policy. It argues that Australia's innovation policy has effectively been a research policy, or that it has been so dominated by research interests that innovation has not been promoted fully. However, universities have been established to conduct teaching, research and service – innovation is only one part of its community service role. This suggests that public policy for innovation should extend beyond universities.

**PART 2: CONCENTRATING ON COMMERCIALISING INTELLECTUAL PROPERTY MAY BE MISPLACED**

Part 2 argues that concentrating on commercialising intellectual property may be an obstacle to its diffusion. It suggests that the better approach may be for universities to simply give away most intellectual property as a contribution to the general good. Universities may include in their intellectual property licensing agreements a general 'jackpot' clause that provides that should the intellectual property contribute to a 'jackpot' of revenues of, say, \$50 million over 10 years, there would be a sharing of revenue determined by a nominated commercial arbitrator.

**PART 3: CASE STUDY OF THE *PATHWAYS TO PREVENTION PROJECT*, AN EXAMPLE OF A RESEARCH-BASED INNOVATION THAT HAS DEMONSTRATED ECONOMIC BENEFITS BUT IS NOT COMMERCIALISABLE**

Part 3 is a description of the *Pathways to Prevention Project*, founded by Griffith University criminologist Professor Ross Homel. The project is a research-based developmental prevention (or 'early intervention') project focussed on the transition to school in the most disadvantaged urban area in Queensland. A rigorous evaluation has found that the project reduced the behaviours that are associated with crime and a range of other problem behaviours, and further that the cost of the interventions is richly repaid by savings to the criminal justice system in addition to improving peoples' lives. The project demonstrates that social science research can have economic significance in saving money if not making it.

## PART 1: KNOWLEDGE PRODUCTION AND KNOWLEDGE DIFFUSION

Part 1 is about the relation between innovation policy and research policy. It argues that Australia's innovation policy has effectively been a research policy, or that it has been so dominated by research interests that innovation has not been promoted fully. However, universities have been established to conduct teaching, research and service – innovation is only one part of its community service role. This suggests that public policy for innovation should extend beyond universities.

### **Australia's innovation policy has concentrated on research**

In its background paper for the innovation summit held in February 2000, the Department of Industry, Science and Resources (1999:9) defined innovation as 'the process that incorporates knowledge into economic activity'. The Department (1999:9) argued that 'Innovation covers 'the million little things' which improve the operation of firms or other institutions (Romer, 1992). It is a much broader concept than research and development (R&D), although the outcomes of R&D are among its most powerful expressions.'

Notwithstanding this insistence that innovation is not just about research and development, the recommendations in the final report of the innovation summit implementation group concentrated heavily on research and development. Of the summit's key recommendations costed by the group, 78% of additional expenditure was recommended on research and development – 60% on increased funding for research in higher education and 18% to support industry research and development through increased tax concessions. The Government's response *Backing Australia's ability - an innovation action plan for the future* concentrated even more heavily on research and development, almost all in higher education institutions. Of the \$2.8 billion committed over 5 years, 91% was for higher education, 4% for research and development tax concessions and 5% to compensate somewhat for the transfer of Commonwealth funding from public to private schools (Commonwealth of Australia, 2001).

The concentration on knowledge production at the expense of knowledge diffusion was continued in May 2003 when the Minister for Education, Science and Training Dr Brendan Nelson (Commonwealth of Australia, 2003:33) issued *Our universities: backing Australia's future* announcing that 'A comprehensive evaluation of the effectiveness of the Knowledge and Innovation reforms' would consider only the operation of the main university research block grant schemes. The concentration of innovation policy on research has led policy makers to direct attention to maximising knowledge production (research) rather than knowledge diffusion.

### **Selectivity, scale and concentration of research**

Research funding is allocated selectively when choices are made between priorities or between researchers, but this does not necessarily concentrate resources in larger groups. Research funding may be more selectively allocated to active or productive researchers, but they may still work alone or in very small groups, or be widely dispersed amongst departments or institutions. Selectivity of research funding is considered desirable because less benefit is obtained by allocating resources to research which is less productive, of lower quality or to areas which are less important. The extraordinarily high number of higher education researchers per 10,000 workers in Australia compared with almost every other OECD country (OECD, 2003) may very well be an argument for greater selectivity in allocating research resources (presumably in this case mostly time) but it is not necessarily an argument for greater concentration of research.

The term ‘critical mass’ is used to argue for several quite different outcomes. Its original meaning is in physics: the minimum amount of fissile material needed to maintain a nuclear chain reaction. By analogy it may be extended to the organisation of research as the threshold value for size (Evidence Ltd, 2003a:21) – the minimum size of a research unit to maintain a viable or good research program. Johnson (1994:34) concludes that there is a threshold effect in many fields of the physical sciences below which the amount or quality of the research performance is reduced. He estimates the threshold at from 3 to 5 academic researchers plus postdoctoral fellows, postgraduate students and technical staff. Johnson (1994:31) further reports evidence ‘that the optimal size of a research group is about six fully qualified scientists working in the same problem area with perhaps another dozen support staff, graduate students and postdoctoral fellows, . . . [and] as many foreign visitors as can be accommodated’, which is supported by von Tunzelmann *et al* (2003:11).

While the minimum size of a successful research group may be quite small and the optimal size not much bigger, there may nevertheless be a scale effect. Larger research groups may be more successful or productive per researcher than smaller research groups, and one might expect that this scale effect plateaus or even becomes negative for groups larger and much larger than the optimal size. Evidence Ltd (2003b) tested the existence of a scale effect by examining data from the UK’s research assessment exercise for 2001. Evidence Ltd (2003a:22) notes that the unit of analysis ‘is . . . not necessarily an academic department but is the group of staff submitted by a university to an RAE Unit of Assessment. These will usually be from one academic resource centre (department or school) but they may include cognate researchers from other schools and one school may be split into two or more units of assessment’.

Evidence Ltd (2003a:23) found that big units perform more effectively in research than small units on average, but there is great variation in the performance of small units. Many small units perform worse than big units but some perform at a standard comparable with the biggest. This pattern produced a statistically significant correlation between unit size and research income per full time equivalent staff, PhD awards per full time equivalent staff, publication output per full time equivalent staff and research performance or impact measured by average citations per paper (Evidence Ltd, 2003a:23). However, Evidence Ltd (2003b:63) reports a very large amount of residual variance even where there is a strong correlation, indicating many exceptions to the otherwise strong pattern.

Evidence Ltd found this broad pattern across a wide range of disciplines not only in the sciences but also in the arts and humanities. Evidence Ltd (2003a:23) concludes that ‘there are size factors associated with research performance and they evidently occur across many disciplines but causation, correlation or consequence cannot be determined at this stage.’ This is because ‘small units that become good at research acquire the resources to become large units. Conversely, large units that do badly at research lose resources and decline in size as well’ (Evidence Ltd, 2003a:24). von Tunzelmann and colleagues (2003:5) argue that there may be a problem with inferring causation because it is quite possible that the very existence of bigger universities or departments may disproportionately attract grants: ‘If so, we have the econometric problem of *‘simultaneity’*, and the coefficients thus estimated will be biased and inconsistent unless they can be ‘identified’ in some other independent way’ (von Tunzelmann *et al*, 2003:5, original emphasis).

Evidence Ltd (2003b) cites several earlier studies which found no clear evidence that unit size contributes to research achievement –

Johnston notably comments that ‘the widespread introduction of policies of resource concentration around the world are found to have been based on little examined assumptions and in operation to be at times counter-productive’. Cohen argued that the size of groups and their productivity simply increased proportionally and that there was no reliable evidence for the existence of a size or a range of sizes for research group that maximized output per unit of size. Seglen found no correlation between group size and productivity for Norwegian microbiologists. Rey-Rocha similarly concluded that team size among Spanish geologists did not appear to be as important for scientific productivity as the status of team members.

(Evidence Ltd, 2003b:50)

Evidence Ltd’s finding of a scale effect for research may reflect assessment panels’ being unduly influenced by the size of units in judging ‘quality’ (von Tunzelmann *et al*, 2003:4), the particular dynamics of the UK’s research assessment exercise – its reward for a particular construction of research establishing path dependence (Geuna, 1999:171) or its construction of data that generates a scale effect. Alternatively it may reflect the particular way the research assessment exercise constructs units of assessment, which don’t necessarily correspond to actual research teams. Evidence Ltd (2003a:22) notes that ‘research units may be teams, laboratories, departments, schools or institutions. Because these different kinds of units may bring research together in different ways their scale relationship with research performance should be studied separately. For example, a team is made up of various numbers of individuals, a department consists of individuals in one or more teams and a university is home to many people in a smaller or larger number of departments. If we considered scale factors solely in relation to staff FTE across these different organisational layers then we would be obscuring essential structural information.’

Evidence of a general scale effect for research would be an argument for concentrating research until each research unit were of the optimum size. But notwithstanding a common misapprehension, a scale effect for research would not be an argument for concentrating research by institution. There is little evidence of an economy of scope in research production – that a research team in one field benefits by being organisationally linked to teams in other fields, or even that research benefits from being produced jointly with teaching (Geuna, 1999:27). (There is, however, evidence of an economy of scope in the production of the knowledge that results in US patents. Jaffe *et al* (1993) found that approximately 40% of patents’ citations of other patents are from another of about 400 technical classes and that from 12% to 25% of citations are from another of five broad technological fields.) So research units of appropriate size and great quality may be located within universities which do not have many other such units. Some 54 units with the highest ratings of 5 or 5\* in the UK’s 2001 research assessment exercise were in institutions with three or fewer units rated so highly (HERO, 2001). Conversely, universities which have numerous research units of appropriate size and high quality also support research units of indifferent quality and sub optimal size. Morgan (2004:468) observes ‘that the old adage that ‘all universities are good at something and none is best at everything’ is also confirmed. So, despite some careful selectivity, 9% of the Loxbridge [London, Oxford and Cambridge] ratings fall below level 5; and 91% of new universities have at least one [unit] attaining level 4 or 5’.

## **Diffusion of research requires dispersion of researchers**

Concentrating research resources in units of appropriate size and of the highest quality may maximise research productivity and quality on the criteria normally used to assess research performance, but it may reduce the community's benefit from research. This is because research has to be incorporated in the productive process to generate economic benefits. As Salter & Martin (2001:512) observe paraphrasing the OECD, 'knowledge and information abound, it is the *capacity* to use them in meaningful ways that is in scarce supply' (emphasis in the original). Lundvall & Borrás (1997:154) argue that knowledge production at universities needs to be integrated more closely with the innovation process since much innovation depends on tacit knowledge (Polanyi, 1967) which is socially embedded in organisational networks as Lundvall (1992:8-9) had earlier observed. Lundvall & Borrás (1997:154) argue that innovation blurs the conceptually distinct but in practice continuous stages of invention, innovation and diffusion. Concentrating research expertise distant from their sites of potential use may inhibit the diffusion of research as quickly and as thoroughly as desirable. This is supported by Moussouris (1998:93-4) who argues that there is too much concentration on research 'breakthroughs' and too little attention to the importance of research diffusion in generating economic development.

Some argue that proximity may not matter so much for modern research collaborations. Adams & Smith (2004:38) referred to a study by Katz which found that 'the median distance for research collaboration (the distance within which 50% of collaborators may be found) tended to increase between 1981 and 1994'. Outside London, the pairs of collaborations that occurred within 20 kilometres decreased from 39% to 19% of all collaborations. However, Gibbons and colleagues (1994:87) argue that for industry to access knowledge generated in universities geographical proximity is important since it facilitates information exchanges and informal contacts necessary to build and maintain the trust needed for collaboration. Adams & Smith (2004:43) suggest that proximity may still be important for companies that are not intensively involved in research and development, and it may be important for innovations not directly stimulated by major new research findings.

Nowotny and colleagues (2001:41-2) argue that the new forms of knowledge production are locally embedded, and therefore that 'locality' is still important in how research operates. Hence 'the imperatives of innovation generally are local, even if the competitive thrust has acquired global dimensions. This is why contextualised knowledge is increasingly produced in, and perhaps primarily relevant to, particular and localised environments and the problems generated within those sites' (Nowotny, 2001:109).

The UK's Lambert review of business university collaboration (2003:6) accepted that public funding should be concentrated on 'world class' research, but argued against increased selectivity of research funding because not all research valuable to business is assessed by peers as world class. The review (Lambert, 2003:13) said that 'a less research-intensive university can play an extraordinarily valuable role in working with local business in a way that might make no sense to one of the big research universities'. The review (Lambert, 2003:70) cited Little (2001): 'Physical proximity is important in scientific collaboration. The era of the Internet does not remove the need to build relationships by personal contact, even if they can then be sustained through electronic means. Indeed ... the importance of proximity is growing, because of an increasing need for companies to look outside for technology, ideas and co-operation'.

Lambert (2003:71) also cited a community innovation survey which asked firms which universities they collaborated with. Results were analysed by type of the firm's main market and location of their collaborating universities. The survey found that firms with local markets overwhelmingly collaborated with local universities, but even 37% of firms with national markets collaborated with local universities.

TABLE 1: LOCATION OF UK FIRMS' COLLABORATING UNIVERSITIES, BY TYPE OF FIRM'S LARGEST MARKET

Type of firm's largest market	Location of collaborating university		
	Local	National	Overseas
Local	88%	12%	0%
Regional	47%	53%	0%
National	37%	47%	16%
International	26%	48%	26%
<b>All</b>	<b>36%</b>	<b>46%</b>	<b>18%</b>

Source: Lambert (2003:71) from Community Innovation Survey, (UK), DTI/ONS, 2001.

This echoes the much earlier finding by Jaffe *et al* (1993) that knowledge flows from universities to firms are highly localised and that US patent citations including self citations of other patents (the transfer of knowledge from one application to another) are from 5 to 10 times more likely to come from the city in which the inventor is located than from elsewhere. Lambert (2003:13) concluded that 'proximity matters when it comes to business-university collaboration. SMEs, in particular, find it difficult to work with research departments on the other side of the country. If resources are increasingly concentrated on a small number of world-class research departments, there is likely to be a negative impact on the level of business-university collaboration in the UK.' 'Even large companies may find it more efficient to work with research departments in their own locality' since 'Personal contact is the best form of communication' (Lambert, 2003:70) and 'Informal networks cannot easily be sustained over long distances' (Lambert, 2003:13) or as a much cited phrase of Glaeser *et al* (1992:1127) says, 'intellectual breakthroughs must cross hallways and streets more easily than oceans and continents'.

### Other mediating bodies

Since a country normally wants to foster innovation more widely than it can afford to maintain research-intensive universities and institutes, more widely dispersed bodies have a role in knowledge production and reproduction. Nowotny *et al* (2001:90) argue that since the knowledge economy depends on the dissemination of research 'the small number of universities which are research-led rather than access-orientated . . . no longer occup[y] such a central role in this new economy. . . . Indeed, it is possible to argue that non-elite universities [and other institutions] may be better placed to play these 'knowledge games', because they have more experience of – and less distaste for – training and building up 'knowledgeable' communities.'

Shapiro (1993:60) argues that 'It will, in the final analysis, be the quality of the mediating social, political and cultural institutions that enable a society to actually benefit from the value of its investments in higher education.' Edquist and colleagues (2001:17) argue that organisational learning is important for gaining benefit from the knowledge economy and that

this is developed by interaction with a range of organisations, presumably not just research-intensive universities and institutes. Rosenfeld (1998:4) argues that in the US ‘community colleges are particularly helpful to small and midsized enterprises, since they are better positioned to reach them than universities, consultants, and service agencies, many of which prefer not to bother with ‘know-how’ needs that may not be technologically challenging or of a scale that can be sufficiently profitable’. Wolfe (2002:22) argues that the highly decentralised nature of the US’s post–secondary education is, amongst other factors, ‘absolutely central’ to the formation and success of Silicon Valley and many other innovative clusters studied in the US.

Lasuen (1973:186) observes that innovation is promoted by successful agricultural extension programs that build constant technical assistance on long-term sales contracts because they reduce the adoption risks of agricultural innovations. He argues that the same measures should be introduced in industry and services to favour the adoption of innovation. So part of the explanation for the high efficiency of much of Australian agriculture, which is in stark contrast to many other OECD countries, may be the broad diffusion of research and innovation through the applied research laboratories, demonstration farms and extension and outreach activities of State departments of agriculture that operated during most of the 20<sup>th</sup> century (Moodie, 2004:99). The Centre for International Economics (2003:xi) notes that Australia’s rural research and development corporations all emphasise the E – extension – in R&D, although they adopt different approaches to extension depending on the nature of the industry and the beliefs of board members. In contrast there is no comparable applied research laboratories and diffusion, demonstration and outreach for secondary industries in which Australia’s performance has generally been much weaker.

Agriculture also highlights the role of State governments in diffusing innovation, since many of the bodies that have mediated between researchers and the users of their research were established by State Governments. Griffith University is very fortunate in having a State Government and two large local governments that support university research not only financially, but also by having policies to stimulate research relevant to regional needs and encouraging its adoption by government and business. The Queensland Government’s ‘Smart State’ policy and program is prominent and well known. This approach also informs local governments in south east Queensland.

Three ‘fundamentals’ of the Gold Coast City Council’s (no date) economic development strategy are ‘learning city’, ‘innovation city’, and ‘creative city’. In addition the Gold Coast City Council funds the Griffith Centre for Coastal Management (2006). Recently Griffith University and Gold Coast City Council contributed \$4 million each to win a Queensland Government smart state innovation building fund grant of \$10 million to build the Queensland smart water research facility to bring together scientists, water authorities and water technology companies to develop innovative solutions to Queensland’s growing water supply challenges. The important role played by Queensland’s large city council may be played by regional development organisations in the States with smaller local government bodies.

### **Innovation is not a dominant objective of Australian higher education**

While maximising innovation should be one of the factors in organising university research, it should not be the only factor. Sub section 2-1(b) of the Australian Government’s Commonwealth’s *Higher Education Support Act 2003* (Cth) provides that applying knowledge is only one of the distinctive purposes of universities, the others being education and the creation and advancement of knowledge.

## 2-1 Objects of this Act

The objects of this Act are:

- (a) to support a higher education system that:
  - (i) is characterised by quality, diversity and equity of access; and
  - (ii) contributes to the development of cultural and intellectual life in Australia; and
  - (iii) is appropriate to meet Australia's social and economic needs for a highly educated and skilled population; and
- (b) to support the distinctive purposes of universities, which are:
  - (i) the education of persons, enabling them to take a leadership role in the intellectual, cultural, economic and social development of their communities; and
  - (ii) the creation and advancement of knowledge; and
  - (iii) the application of knowledge and discoveries to the betterment of communities in Australia and internationally;recognising that universities are established under laws of the Commonwealth, the States and the Territories that empower them to achieve their objectives as autonomous institutions through governing bodies that are responsible for both the university's overall performance and its ongoing independence; and
- (c) to strengthen Australia's knowledge base, and enhance the contribution of Australia's research capabilities to national economic development, international competitiveness and the attainment of social goals; and
- (d) to support students undertaking higher education.

So just as innovation policy should not be dominated by research, research policy should not be dominated by innovation.

## PART 2:       CONCENTRATING ON COMMERCIALISING INTELLECTUAL PROPERTY MAY BE MISPLACED

Recently all Australian governments have pressed universities to commercialise their intellectual property as a way of both further diversifying their revenue and ensuring that full economic benefit is obtained from universities' research. However, this policy may be counter-productive. First, the potential for universities to generate revenue from intellectual property may be overstated: it seems that even highly research intensive and entrepreneurial universities in Canada, the UK and the US earn no more than 3%-4% of their revenue from intellectual property sales and licensing. Secondly, it places too much emphasis on research in the innovation value chain, encouraging universities to overvalue their research. A view repeated more commonly than there is probably data to support it is that to turn a new idea into a product for every 1 unit of currency invested in research 10 have to be invested in development and 100 in retooling manufacturing. (Although for some empirical support see West, 2004:29.) Thirdly, it may impose obstacles to the transfer of research to application since formal legal agreements have to be negotiated and implemented.

The emphasis on commercialising intellectual property has led many universities to establish commercialisation units, either as a central service unit or as a controlled entity. However established, most commercialisation units are staffed by managers with business backgrounds and a strong commercial orientation. Universities establish revenue targets for their commercialisation units and do not expect them to engage in public good activities: these are typically the responsibility of a separate unit established to promote community engagement. This may cause universities to ignore potential applications of their research which may benefit industry, but at a cost or with no clear financial benefit to the university. An entirely different approach is taken by Australia's rural research and development corporations.

The Centre for International Economics (2003:x) notes that the rural research and development corporations commercialise intellectual property only when it is the best way to promote adoption. Some corporations see commercialisation as an important pathway to adoption for their industry, for others it is largely irrelevant (Centre for International Economics, 2003:xiv). While some rural research and development corporations report a modest cash return on intellectual property, the return rarely covers the corporation's cost of commercialisation (Centre for International Economics, 2003:x). All corporations take a value chain approach that recognises the contributions to industry outcomes of all the links from primary producer to consumer, but because the benefits of research and development are passed up and down the chain the benefits are not captured at any one point such as the point of research and development adoption as is commonly thought (Centre for International Economics, 2003:17-20). If this is true it suggests that universities are unlikely to be able to extract much revenue from commercialising their intellectual property.

The better approach may be for universities to simply give away most intellectual property as a contribution to the general good. This would encourage universities to concentrate on research transfer and adoption, not commercialisation of their intellectual property. Universities may include in their intellectual property licensing agreements a general 'jackpot' clause that provides that should the intellectual property contribute to a 'jackpot' of revenues of, say, \$50 million over 10 years, there would be a sharing of revenue determined by a nominated commercial arbitrator.

PART 3: CASE STUDY OF THE *PATHWAYS TO PREVENTION PROJECT*, AN EXAMPLE OF A RESEARCH-BASED INNOVATION THAT HAS DEMONSTRATED ECONOMIC BENEFITS BUT IS NOT COMMERCIALISABLE.

[http://www.griffith.edu.au/centre/kceljag/pathways/content\\_pathways.html](http://www.griffith.edu.au/centre/kceljag/pathways/content_pathways.html)

*Pathways to Prevention* is a universal, ‘early intervention’, developmental prevention project. It is based on the assumption that mobilising social resources to support children, families and their communities before problems emerge is more effective and cheaper than intervening when problems have become entrenched. The key is to work early in the developmental pathway, which does not necessarily mean early in life.

The project had its beginnings in the Federal Government report, *Pathways to prevention: developmental and early intervention approaches to crime in Australia* (Homel *et al*, 1999), written by a group of scholars from several disciplines that came together as the Developmental Crime Prevention Consortium under the leadership of Professor Ross Homel from Griffith University.

The social services provider Mission Australia and Griffith University formed a partnership to develop a demonstration project along the lines recommended in the *Pathways to Prevention* report. The demonstration project focused on the transition to school in the most disadvantaged urban area in Queensland. It combined child-focused programs delivered through state preschools with services for families within a community development framework.

A rigorous before-and-after statistical evaluation found that the project reduced the behaviours that are associated with crime and a range of other problem behaviours. A detailed economic analysis found that the costs of treating children early in the developmental pathway (preventative interventions) are significantly lower than interventions later in the pathway (remedial interventions). Therefore significant savings appear to be a very real prospect if more funding were directed to the front end, that is, early in the developmental pathway. The study found that diverting one child from a reading recovery program as a result of a preventative program has the potential to save approximately \$20,500 per child in future costs. The work was supported by the Australian Research Council and published in an international peer-refereed journal (Freiberg *et al*, 2005).

That established the academic foundation of the work, but there was obviously no commercial benefit in extending the demonstration project notwithstanding the potentially considerable economic as well as social benefits to the community. Nonetheless, Homel and his team and their partners Mission Australia and Education Queensland attracted support for an extended program from the Westpac Foundation, the John Barnes Foundation, the Criminology Research Council, the Queensland Government and the Australian Research Council.

The *Pathways to Prevention Project* has been working successfully since 2002. It was one of three winners of the 2004 National Crime and Violence Prevention Award and it has become the ‘template’ for the new Australian Government Communities for Children program. This program has funding of \$142 million and is a central part of the new Stronger Families and Communities Strategy launched by the Prime Minister on 7 April 2004. In 2006 the Queensland Government allocated a further \$890,000 to the *Pathways to Prevention Project*.

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