AUSTRALIA'S STRENGTHS AND WEAKNESSES IN TECHNOLOGY TRANSFER AND R&D EXPLOITATION: GEM AUSTRALIA SURVEY "EXPERTS" VIEWS COMPARED WITH PUBLIC POLICY AND OTHER PUBLISHED DATA.

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ABSTRACT

There has been increasing public debate in Australia in recent years about research culture in universities and other publicly funded research agencies such as CSIRO and its impact on Australia's performance in generating economic, social and environmental benefits to the Australian community from the large amount of public funding for R&D. This is the supply side issue. On the demand side there is equally concern about the technology absorptive capacity of Australian business as illustrated by the low proportion of gross business research expenditure (GERD) spent by business (BERD). Against this background, this paper has explored the views of about 160 respondents specifically chosen for their expertise in areas relevant to entrepreneurship and new small business. They were systematically interviewed as part of the Australian Global Entrepreneurship Monitor (GEM Australia) studies in the years 2000, 2001, 2002 and 2003 on the issues, strengths and weaknesses of Australia's technology transfer performance as it applies to new technology small firms. The paper has also explored evidence for any longitudinal change over this period.

Key words: CSIRO, CRC, entrepreneurship, R&D expenditure, intellectual property.

INTRODUCTION

There has been increasing public debate in Australia in recent years about research culture in universities and other publicly funded research agencies such as CSIRO and its impact on Australia's performance in generating economic, social and environmental benefits to the Australian community from the large amount of public funding for R&D. This debate peaked at the National Innovation Summit in February 2000. This was followed by the Chief Scientist's report *The Chance to Change* in November 2000. The implementation of the Summit's outputs lead to a major Commonwealth Government policy document and funding initiative in 2002, *Backing Australia's Ability: Real Results Real Jobs 2002-2003.* This is the supply side scenario. On the demand side there is ongoing concern about the technology absorptive capacity of Australian business as illustrated by the low proportion of gross business research expenditure (GERD) spent by business (BERD) (Yencken and Gillin 2003). Against this background, this paper explores the views of the thirty "experts" interviewed in the Australian Global Entrepreneurship Monitor (GEM) studies in 2000, 2001, 2002 and 2003

on the issues, strengths and weaknesses of Australia's technology transfer performance as it applies to new technology small firms. The paper explores evidence for any longitudinal change over this period.

Methodology

The research methodology has involved qualitative research based on interview transcript and other text analysis. The first step has been to review the relevant and recent literature on these topics particularly relating to Australia. The raw data for this study came from the Nudist® text analysis of the GEM Australia expert interview transcripts to identify key issues and perceived technology transfer strengths and weaknesses. These extracts were further analyzed using NVivo® text analysis software used to explore any evident trends over the three-year period.

The final step was to relate these findings to published data on public policy and technology transfer performance that had previously been collected and analysed by the authors.

The GEM Australia expert interviews

Each GEM national team selects a minimum of 18 'experts' in entrepreneurship and conducts interviews with them. A different group was selected for each year's GEM Australia survey. The Australian interview target was thirty to thirty-five experts each year. The database thus includes transcripts of interviews involving over 100 different "experts".

> Each expert was asked what they felt were the top three weaknesses impeding entrepreneurial activity in Australia, the top three strengths supporting entrepreneurial activity in Australia and to suggest changes they believed would improve Australia's performance.
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> The interview content was then classified, using qualitative analysis techniques, into the nine framework conditions, with the freedom to create new categories where comments do not fit any of the framework conditions. Extensive use was made of sub-categories – for example Financial Support weaknesses might include a sub-category of problems relating to obtaining funding for early stage ventures (H. Appendix 4 p.35)

The Global Entrepreneurship Monitor (GEM) 2002 Executive Report (Reynolds et al al., 2002) describes the GEM experts interviewed:

> The national experts were a distinctive group in a number of ways: (a) 82 per cent were men. (b) 90 per cent were over 35 years of age, (c) 95 per cent had college/university degrees, (d) 69n per cent had post-college/university educational experience, (e) 57 per cent had over 10 years of work experience, and (f) they were evenly divided across the nine entrepreneurial framework conditions in terms of their respective areas of expertise (p. 39).

The nine framework conditions were (Hindle and Rushworth, 2002 p.56):

- *Financial Support*: availability of financial resources, equity, and debt, for new and growing firms including grants and subsidies.
- *Government Policies*: the extent to which government policies as reflected in taxes, regulations and their application, are either size-neutral, discourage, or encourage new and growing firms.
- *Government Programmes*: the presence of direct programs to assist new and growing firms at all levels of government of government – national, regional, municipal.
- *Education and Training*: the extent to which training in creating or managing small, new, or growing business is incorporated within the educational and training systems at all levels, and the quality, relevance and depth of such education and training.

- *Research and development Transfer:* the extent to which national research and development will lead to new commercial opportunities, and whether or not R&D is available for new, small and growing firms.
- *Commercial and Professional Infrastructure:* the extent of the presence of commercial, accounting, and other legal services and institutions, that allow or promote the emergence of new, small and growing businesses.
- *Market Openness/Barriers to Entry*: the extent to which commercial arrangements are prevented from undergoing constant change and re-deployment preventing new and growing firms from competing and replacing existing suppliers, subcontractor's and consultants.
- *Access to Physical Infrastructure*: ease of access to available physical resources - communication, utilities, transportation, land or space-at-a-price that does not discriminate against new, small and growing firms
- *Cultural and Social Norms*: the extent to which existing and cultural norms encourage, or do not encourage, individual actions that may lead to new ways of conducting business or economic activities and in turn lead to greater dispersion of wealth and income.

The extracts used were under the heading *Research and Development Transfer,* defined as "the extent to which national research and development will lead to new commercial opportunities and whether or not R&D is available to new, small and growing firms (Hindle and Rushworth, 2002 p.57)".

AUSTRALIA IN AN INTERNATIONAL CONTEXT

> The most commonly used indicator for comparison purposes is the ratio of expenditure on **R**&**D** to gross domestic product (GDP). As table 25.3 shows, in 2000-01 Australia's **R**&**D** expenditure was 1.53% of its GDP, ranking it below Sweden (3.78%), Finland (3.37%), Japan (2.98%), the United States of America (2.70%), Korea (2.68%), Switzerland (2.64%), Germany (2.48%), France (2.15%), Denmark (2.09%), the Netherlands (2.02%), Belgium (1.96%), the United Kingdom (1.86%), Canada (1.84%) and Norway (1.70%).
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> In terms of business enterprise **R**&**D**, Australia's ratio of **R**&**D** expenditure to GDP (0.72%) is again below the ratios for the industrialised countries referred to earlier, and is also below the rate for the Czech Republic.
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> For government sector **R**&**D** as a percentage of GDP, Australia ranks higher. An **R**&**D** to GDP ratio of 0.35% places it fourth in the group of OECD member countries for which data are available, behind only France (0.38%), Korea (0.36%) and Finland (0.36%). Government sector **R**&**D** as a percentage of GDP is much higher for Australia than for the United States of America or Canada.
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> For the higher education sector, Australia ranks in the top half. With an **R**&**D** to GDP ratio of 0.41%, Australia ranks behind Sweden (0.81%), Switzerland (0.61%), Finland (0.60%), Canada (0.57%), the Netherlands (0.53%), Norway (0.49%), Belgium (0.47%), Japan (0.43%) and Denmark (0.42%) (ABS 2003).

The literature (Forsyth 2000, Gruen and Stephens 2000 and Productivity Commission 1999) has shown that productivity improvement across business sectors in Australia has been uneven. It also suggested that innovation in regulation and to some extent services has been

the important contributor rather than in product. The importance of process innovation is however almost certainly evident in sectors such as mining and agriculture. The much less important contribution of technological innovation to multifactor productivity (MFP) growth in Australia has been consistent with Australia's poor innovation performance among OECD countries:

- In proportion of manufacturing firms with 20 or more employees undertaking technological innovation, ahead of only Spain, Mexico, Belgium, Poland and Turkey;
- In expenditure on technological innovation as a percentage of total sales, manufacturing sector 1996, the second lowest percentage figure, ahead only of Spain (Marceau et al 1997).

These findings have shown that high levels of innovation do not necessarily and /or immediately lead to increased MFP growth rates. In Australia (unlike the USA) in recent years regulatory and services innovation have been the key contributors to MFP growth, with computer and communications technology still to make an important contribution outside the communications sector. There has however been evidence of a strong contribution from technological innovation, particularly process innovation, in the more traditional mining and agriculture sectors. These sectors historically (Gregory, 1993) have seen high levels of research expenditure both by government and from industry funds. The conclusion has to be that technological innovation will be an important contributor to total factor productivity growth in *some but not all* market sectors.

Commonwealth and State governments have in recent years, particularly in the aftermath of the National Innovation Summit, have started to recognise the importance of innovation and to devote resources to support it.

In Australia, the main emphasis has been on increasing public sector R&D expenditure and on programs to promote and facilitate the commercialisations of these public sector research outcomes (Yencken, 2003). At the same time, increasingly there has been concern at the low level of business investment in R&D (BERD). The recent House of Representatives Standing Committee on Science and Innovation *Inquiry into Business Commitment to Research and Development in Australia* concluded with some qualifications that

> …the public sector in Australia…is supporting R&D at an internationally competitive level but that the level of business R&D is less competitive (p.6).

Attention has also been drawn (Yencken and Gillin, 2003) to European research showing the linkages between business R&D investment and national technology absorptive capacity as measured by the BERD to GERD (Gross Expenditure on R&D) ratio or the percentage of a nation's research scientists and engineers employed in industry and business generally. For Australia, this latter percentage is 27 per cent (DEST, 2002 Chart 9). The latest OECD data for other countries highlights this issue:

> In 2000, approximately 2.1 million researchers (about 64% of the total) were employed by the business sector in the OECD area. In the major economic zones, the share of business researchers in the national total differs widely. In the United States, four out of five researchers work in the business sector but only one out of two in the European Union (OECD, 2003 p.56).

There exists another important difference in focus between Australia and EU countries that is particularly relevant when discussing GEM findings. The EU sees the generation of *new technology small firms* (NTSF) as a very important factor in regional development and job creation, whether they end up as new high growth businesses or remain quite small *quality of life* businesses. In many countries, their formation is facilitated, their progress measured and their identities recorded and broadcast by their research provider parents. European data suggests that this latter group of entrepreneurial new ventures involves twice to three times as many ventures as classical research provider spin-offs (Chalmers; 1992; ERI, 2002)

RESULTS AND IMPLICATIONS

Interview data analysis

The inter-relationships underlying the analysis of the selected GEM Australia *expert* interview data have been illustrated in the model in Figure 1, which was developed alongside the coding frame for the second stage NVivo® analysis of the Nudist® extracts.

The data has been analysed under five main headings

- *Intellectual property*
- *Demand side*
- *Growth and development* including *New ventures*
- *Government policy, initiatives and R&D performance*
- *Research provider attitudes.*

For some of the resulting tables positive or neutral responses have been shown in separate but a parallel columns to negative responses. The GEM Australia reporting year in which the interviews took place has also been shown in some tables to allow longitudinal comparisons where possible. These comparisons have been hampered by the differing analysis frameworks used for the original Nudist® analysis of the interview transcript data.

Intellectual property

The responses on intellectual property issues (Table 1) tended to be neutral or negative rather than positive, that is suggesting the need for changes in present practices, but the changes suggested were constructive, rather than suggesting the need for radical change to Australian IP policies and systems. The changes indicated related more to the application of the system by IP owners and their advisers.

Table 1 Intellectual property system and performance

Positive	*Neutral*	*Negative*
IP protection is dependent on industry sector - in bio-tech, for example, it is very important because it can take 10 years to develop a product to market readiness and you need protection during that time. On the other hand, in IT, first mover advantage counts for more and in many cases it is better to have your IP public so you can be the one who sets the standard.	Universities have to have a system for giving credit where it is due to the originator of the IP - provide individual incentives for commercialisation rather than regarding it as community property. Unis are not comfortable with the technology transfer process and each one does it differently - fragmented approach. Valuing IP is a major barrier to entrepreneurship in educational Institutions.	Protection of IP is driven by how much money you have to defend it which gives the big players with deep pockets a major advantage. Need to ensure that IP laws do not impede innovation by allowing a few multinationals to own break-through knowledge e.g. gene patenting.
There is reluctance by the technology sector (including government) to embrace licensing - perceived as 'selling the farm'. In reality, this is a useful way of generating cash flow and building infrastructure for further R&D.	Protection of IP in the form of artwork and cultural artefacts is a huge issue for the indigenous population. They are becoming much more aware of the need to get paid for their IP and are demanding proper contracts.	Many government and university schemes don't give sufficient ownership of IP to the actual researchers - inadequate incentive.
It is becoming imperative for entrepreneurial businesses to keep up with the latest technology in order to grow or even survive.	Good lawyers in IP are expensive, but there are a few firms now who are prepared to take equity at least in part payment. Many of the problems of IP protection require worldwide cooperation to resolve - Australia can't fix alone	Government funded [university] research is often poorly organised w.r.t. IP protection - varies by university.
IP rights are a major issue (globally, not just in Australia) in the marketing and media industries - examples: - If a company is paid to design a logo, is fee for service adequate compensation for what might become a worldwide trademark? - Does the artist who worked on the logo have a right to royalties on the design - debate currently happening about this - "moral rights" issue. - If a marketing strategy produced by a consultant turns around a company, should the consultant have a right to a share in the upside?	There is too much emphasis in technology commercialisation on gaining patents. Patents are only one way of protecting intellectual property. In some cases it is better to publish the IP and put it in the public domain. Focussing on patents can make academics reluctant to disclose discoveries even to their own colleagues. Each university needs a process and resources by which academics can optimise disclosure of new knowledge and get help to assess the appropriate path for a particular discovery. Most universities in Australia do not have such resources. University of Queensland and Sydney University are exceptions and have high disclosure rates.	There is belief that companies sometimes invest inappropriately in IP protection (where for example early mover advantage is adequate), on the advice of legal professionals who have a vested interest in promoting registration of patents etc. People don't protect their IP early enough - they worry about cost and effectiveness Australia does not tend to disperse the R&D and share with others; instead it is sold off and not commercialised. More sharing needs to take place.
		There isn't enough focus on the technology/IP that arises from government R&D programs - if the program doesn't succeed in commercialising it, it shouldn't be just forgotten - it is a potentially valuable resource.

Demand side—drivers and blockers of innovation

The demand side of a national innovation system is about generating and sustaining demand for new knowledge and for the exploitation of the new opportunities that may result. This will lead to new technologies, innovations generating new products and process improvements—that result in commercial success and consequent employment and wealth creation or in other community social and environmental benefit. All such activities carry varying levels of risk for various stakeholders. There are therefore both drivers for such technological innovation and barriers or blockages that put at risk successful commercial development of the opportunity. As might have been expected, the demand side comments (Table 2) were generally critical of the inadequate demand coming from *existing* businesses for R&D outcomes from others, eg public sector research providers or from their own R&D investment.

The two main themes in the GEM Australia 2000 comments were:

- Australia as a *branch office* with R&D investment decisions made elsewhere
- the low level of private (business) investment in R&D
- R&D as a cost rather than as an investment.

These perceived attitudes well illustrated the demand side negative perceptions of the "experts" interviewed. There were some indications of a change in focus from the year 2000 to the year 2003 responses, with a greater emphasis on the importance of attracting large companies/multinationals to spend more of their research budgets in Australia. This may possibly have had some connection with the termination of the Commonwealth R&D syndication investment program and the reduced rate of tax deductibility (earlier 150 per cent of R&D expenditure). This change would have had a greater impact on large companies with large taxable revenue streams than on smaller companies (eg new technology based small firms) with small or negligible taxable earning streams.

Table 2 Demand side comments

Year	*Comment*
2000	Australia becomes a minuscule player on the world stage - big players in Australia are mostly multinationals with their R&D focus elsewhere in the world. There is a head office / branch office issue with foreign owned multinationals with a large presence in Australia, which makes it hard for the 'branch offices' to take initiative.
2000	Decline of private investment in R&D is of great concern. Aversion to investing in technology beyond 'throwaway' dollars
2000	Australia is very reliant on R&D transfer because there is so little private R&D and public R&D is not commercially oriented. Level of R&D in the private sector is appalling by world standards. Corporate Australia regards it as 'not our business' - expects it to be done by government agencies such as CSIRO.
2000	Business needs to get actively involved, not just scientists and governments. Amazed that so few big companies have academics/scientists on their board. How do they expect to understand the potential of R&D?
2000	There is an urgent need for better linkages between the university sector where much of our scientific and medical research goes on with industry. If we don't get that working better, we will find it very hard to achieve our potential and at the moment the gulf between those two areas is huge. There are many people who would rather have a $50,000 government grant than $500,000 from industry. CRCs are helping to change that situation.
2000	We have to have R&D within the big corporations that plugs into global needs and global analysis. Within those corporations, they actually have to internally capitalise those developments - they need a vibrant R&D - they need staff who actually are R&D staff.
2003	The 'pull' side of R&D transfer needs to come from large companies and most of these aren't interested as a strategic direction. Any support that comes from them tends to be as a result of the personal interest of the CEO and when that person moves on, the support disappears with them. So links between researchers and industry that are sustainable over time are very hard to build. Also an alliance with the Australian branch of a multinational doesn't necessarily give you access to foreign markets because the Australian CEO doesn't have that much influence over the purchasing or investment decisions of Head Office.
2003	We are all about science and there is too much pressure on our science community to make money. The industry base spend is a fundamental weakness. As a country we divert a lot of money directly into the science end rather than into industry. We should put more money into industry, which should then flow through science as needed.
2003	There is an obsession with 'sexy science' ie developing new technology. Historically, Australia has been very good at invention and technology development, so there is a tendency to build on this historical strength. This fails to recognise the importance of entrepreneurship in commercialising these technology developments. As a result, insufficient resources are put into commercialisation, many promising technologies do not get commercialised successfully and therefore businesses are less willing to invest in R&D because they have not realised the benefits they hoped for. This generates a downward spiral in R&D investment in the private sector.
2003	There is still a legacy of the protectionist culture of the past which limits innovation especially in big businesses - tendency to rely on the government to do research, keep Australian businesses price competitive etc We don't grow big companies in Australia - they get to a certain size and either stop growing or are bought out by foreign companies and become 'branch offices'.

Growth and development

The responses (Table3) showed an awareness of the importance of science and technology in driving economic growth and again drew attention to weaknesses in the Australian national innovation system. In these responses, the focus tended to be on the lack of effective industry policies and strategies, both overall and for specific sectors such as information technology (IT) and biotechnology.

Table 3 Growth and development

Year	*Comments*
2000	It is becoming imperative for entrepreneurial businesses to keep up with the latest technology in order to grow or even survive. Studies of the fastest growing Australian businesses show an increasingly large gap between the most successful businesses that invest in technology and in R&D and the majority who are being left behind.
2000	Australia has a much lower level of R&D than we should have (OECD reports) because we are not willing to invest in strategic industry policy. R&D is seen as a cost - it isn't a cost, it's an investment and should be viewed as such. If a company doesn't invest in R&D to keep itself up to date then it will go out of business. If government doesn't invest in R&D then the country's skills base will decline and Australia will not be attractive as a country to build a business in.
2000	Companies need a formalised system for channelling ideas which is manageable in terms of resources required to operate it and is timely enough that windows of opportunity are not missed. Such systems exist - there are well-researched 'stage gate' models, but very few companies apply them. Few companies can afford to do basic research, so it makes more sense to outsource it to specialist research centres such as universities.
2000	Many industries are very fragmented and don't look at themselves in the global sense. So anything that encourages them to start to work together is a step in the right direction and should be encouraged by R&D programs. New manufacturing, which embraces the whole supply chain from lab to market All processes occurring concurrently with all disciplines working together in projects - no silos.
2000	R&D under the one heading represents a psychological contradiction. R = 'dreaming' - creative, unstructured; D = implementation - methodical, structured, focused. Most big companies try to put the two together in one department and end up with big R, small D.
2000	There is a need for industry sector networks to make it easier to pull together all the resources which are needed to get a new venture off the ground in a particular industry.
2000	There is a lack of focus in the IT industry in particular. Instead of getting niche focuses going in businesses with specialised IT skills, they are trying to cover too much and losing out to the bigger players. Australian companies are not doing enough fundamental research to understand where they are [with respect to competition, state of the art etc.] There is a need for industry sector networks to make it easier to pull together all the resources which are needed to get a new venture off the ground in a particular industry.
2000	Concerned about the huge growth in number of undergraduates doing courses in business, finance and accounting in preference to science and engineering, where enrolments are dropping. Undergrads are attracted to 'glamour industries' - where does this leave our base skill level for scientific R&D?
2001	So we need a coordinated strategy for biotech, because at the moment you have got Victoria, Bio 21, you know, da, da, da, you have got Queensland powering away ..... and various other initiatives. You have got New South Wales suddenly realising after several false starts that it actually hasn't got off the ground Because the other thing which probably is less recognised is that the time frames in biotechnology can be very, very long, and the amounts of money increasingly large.
2003	It is becoming imperative for entrepreneurial businesses to keep up with the latest technology in order to grow or even survive. Studies of the fastest growing Australian businesses show an increasingly large gap between the most successful businesses that invest in technology and in R&D and the majority who are being left behind.
2003	The R&D tax concession does not give enough incentive to persuade businesses to invest in R&D. It is just sufficient for financially literate businesses to structure their accounts to get a tax benefit from existing activities that can be classified as R&D, but not sufficient to encourage businesses to do R&D that they would otherwise be unable to afford. Also not enough businesses know about even this limited incentive.
2003	R&D under the one heading represents a psychological contradiction. R = 78: 'dreaming' - creative, unstructured; D = implementation - methodical, 79: structured, focused. Most big companies try to put the two together in 80: one department and end up with big R, small D.

The responses on issues to do with new technology based ventures (Table 4) were disappointing—given that they derived from a national survey of entrepreneurship performance. They were generally limited to operational issues such as incubator strategies.

Table 4 New ventures

Year	*Comment*
2000	Australia needs to find more creative ways of achieving efficient and profitable technology transfer - the Innovation Summit demonstrated this. Israel has an excellent government incubator program: Companies get $350,000 over 2 years, $50,000 of which must be privately funded. The entrepreneur must retain 50% of equity and reserve 10% of employee options. Incubator usually gets 20% and private investor up to 20%. Theory is that at exit point, entrepreneur has something to trade. Also reduces uncertainty ('equity blues'). Excludes *dot.coms* because two-year period is too long for them, but works well for other sectors. Means that Israel is not focused on *dot.coms* alone.
2000	There is a lack of understanding of the stages to market, the risk / reward curve and the different players who should be involved at each of those stages.
2000	The idea/technology is one tenth of the business - it is the people and the business model which really matter.
2000	Australian university incubators have not developed the strong links with local business which have worked well for incubators in the USA (for example). Local businesses will get involved because they see the incubator spin-offs as a potential client or supplier. - Penn State has the most impressive program (the Ben Franklin program) and could be used as a model for Australian universities.
2001	I used Vision Systems as my example of the sort of business we can grow in Australia and I think when you look back at what he started with and the fact that the business employee 600 people and is growing and in addition to that it provide jobs for 1000 others as suppliers if we could breed 10 of those a year for the next decade.
2001	I think about people who have come up with really very good business ideas and have created very successful businesses but I tend to think about and it is something we haven't yet explored in these opening remarks and perhaps needs to be clarified. I tend to think about start-ups, and I tend to think about good starts up, I tend not to think about more major companies that have successfully re-thought their business. And I don't know that I have many domestic examples of the second category. Of course I can think of lots of examples of the first category.
2001	And the third one, I think the focus on biotechnology as a sector, as much because it is identified as an area where we believe we can succeed, and it is an area that is an emerging area, not one where we are just getting in as the sun is setting, and it is where we would like to see entrepreneurial activity in terms of a possible ..... but we also need it because we need 100 people to be out there, because only one of them will actually break through, so we need that multiplicity of endeavour.
2001	Well the biggest single issue is commercialisation, in other words the essence of what entrepreneurship is about. It's turning our good ideas into good businesses and we've been very good in Victoria and in Australia in developing and creating ideas, we've creative a common if you like has always been a strong theme but where we've fallen down badly is in commercialising and it doesn't matter whether your scientific R&D, or even IT R&D, R&D generally we've been always strong on the research side, we've been weak on the development side.
2002	More schemes such as technology Park in Brisbane, which encourage start up companies to get together physically. Not an incubator - later than that. At the moment start-up companies are located in different parts of the city, which prevents critical mass and slows down the planning process.
2003	COMET is a good program, but the funding balance is wrong. It places too much emphasis on technical development and not enough on developing the necessary management skills. That component - the MDS scheme - is tiny. It leads to the problem of running out of money for business development… and having to go to the public equity market too early.

Government policy, initiatives and R&D performance

The single most surprising conclusion from all this examination of experts' comments (Table 5) was that there were many comments on the poor R&D investment history of Australian business (BERD)—with much attention given to inadequate taxation and other government financial incentives. There were no specific comments suggesting that the present level of government funding of R&D was inadequate. This was in clear contrast to recent agitation by sectors of the Australian research community, particularly the biotechnology and medical technology sectors.

The critical comments related to the way in which existing R&D funding was used, and particularly to the poor performance of the Australian national innovation system as a whole

in ensuring a nationally effective focussing of this innovation effort and in more efficiently commercialising and utilising public financed research outcomes. This in turn reflects the confusion in Australian innovation related policy a making between, invention or small-I innovation and wealth creation arising from BIG-I INNOVATION involving the whole process of exploiting new knowledge for commercial and community benefit (Hindle, 2002; Hindle and Yencken, 2003; Livingstone, 2000)

Cooperative Research Centres (CRCs)

Cooperative Research Centres (CRC) are competitively bid joint ventures involving research providers (universities and government research agencies) and research users (both business and public good) with government funding for usually seven-year terms (See <www.crc.gov.au>). The few comments on CRC performance in contributing to creating value out of intellectual property were mixed:

> 2000: Businesses receive tax breaks for their role in R&D. The respondent stated that they promote work that is interesting, but not necessarily related to entrepreneurial activity. In particular CRCs are not adding any value to the company. Instead they are just providing tax breaks. The respondent said that the issue is that there is no follow through commitment with the results. Also that big businesses make a small contribution for big tax breaks and that the CRCs ill advise the Government on their direction. The cycle needs to stop, by making business more accountable for their output of R&D.
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> 2002: More needs to be done to encourage people with commercialisation skills to work with researchers. Some CRCs are doing this well, but more of this activity needs to be encouraged.
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> 2003: Respondent was involved in a CRC in the past and found it of little value. Believes Government funded research centres tend to be too academic and not sufficiently commercially focussed.

Table 5 Government R&D and other policies and R&D performance

Year	*Positive*	*Negative*
2000	Suspects that a lot of the former government monopolies did some very innovative research, but didn't have a commercial focus. May be there to be exploited?	There isn't enough focus on the technology/IP that arises from government R&D programs - if the program doesn't succeed in commercialising it, it shouldn't be just forgotten - it is a potentially valuable resource.
2000	Government needs to continue to fund pure research because it will never be funded by the private sector, and if you lose that pure research base, you don't see the impact till 20 years down the track and by then it is too late to catch up.	Government-funding for R&D can undermine corporate activity because their lack of commercial focus means they sell of their research outputs and research activities too cheap. Once they reach their target, anything else is a bonus and hence often sold off well below true market value.
2000	Industry sectors need to form networks to create a unified voice to convince governments to change their attitude and allocation of resources in favour of the entrepreneurial sector. Business needs to get actively involved, not just scientists and governments.	R&D allowances have not been very successful. They have failed to stimulate private sector research and have been exploited in some cases. Australia is near the bottom of OECD countries in terms of private sector
2001	First of all, we have always had great tech. You know, I think it is 300 world firsts, what seven Nobel Prizes. So we have always been really good at the .....and that came because of our culture. We are a long way from Mother England. We used to buy machinery from overseas, the damn thing would break down, you couldn't get parts for eight to ten weeks. So Australians are very inventive and they would invent a solution to keep their businesses running. And that is translated into some huge innovations for Australia.	
2001	A long-term investment in basic research which has laid down a solid foundation of skill and knowledge in several areas of science and technology and a small, isolated marketplace that provides strong motivation to go global early. And the other sort of natural advantage that I think we have in Australia is, that for a long time we've been throwing a lot of money into education and hence basic research, so there's just good raw technology in Australia.	
2001	The fact of the matter is that the government, I think, recognises it's key role, because unlike the US, we don't have any major Australian corporations that are involved in R&D. You know, there is not the equivalent of Bell Labs, for example, that we have. And we certainly don't have deep pocket companies, even CSR and BHP in their prime, were not, you know, they did let us say, product support R&D. They never did any fundamental research. And so, you know, the Australian government is cast in the role of being the seeder of some of these ideas through some of the grants and programs they actually have. And it is a little bit like, you know, in 1948 with the Cold War in the US, that the R&D for some of the defence, was too risky for industry, so the government stepped in. You fast forward 30 years to Australia and you have got the government has obviously got deep pockets and it can afford to take the risk, and in fact, the payoff is for future generations of Australia in terms of high paying jobs from technology businesses created by this	

	initiative.	
2002	Improve federal government financial support of R&D to encourage commercialisation of innovative new technologies and companies.	The respondent says that science needs to meet entrepreneurship. He went on to say that unfortunately too much money is thrown at R&D and science. The government will not change their policy if they are not personally educated in the meaning of ethical entrepreneurship and process for economic and social growth.
2003	The federal government should restore and improve incentives for the private sector to invest in R&D. Cutting the R&D tax concession led to reduced business expenditure on R&D and Australia is now well behind other countries in this respect.	The R&D tax concession does not give enough incentive to persuade businesses to invest in R&D. It is just sufficient for financially literate businesses to structure their accounts to get a tax benefit from existing activities that can be classified as R&D, but not sufficient to encourage businesses to do R&D that they would otherwise be unable to afford. Also not enough businesses know about even this limited incentive.

Research provider attitudes

Comments in the 2000 GEM Australia survey on research provider attitudes (Table 6) were strongly negative in relation to both research provider policies and their implementation and to individual academic researcher attitudes. The limited data from surveys in later years suggested some softening of these attitudes between the year 2000 and the year 2003 GEM Australia surveys. Findings from parallel research in this area by the authors (Yencken and Gillin, 2002) have supported these indications. Comments on Cooperative Research Centres (CRCs) (as indicated earlier) and particularly on CSIRO (Table 7) were limited but tended to be negative. CSIRO is Australia's large publicly funded research agency involved in a very wide range of research fields, supporting both business and public good research users (See www.csiro.au).

Table 6 Research provider attitudes

Year	*Positive/Neutral*	*Negative*
2000		Many government and university schemes don't give sufficient ownership of IP to the actual researchers - inadequate incentive.
2000		Universities do not understand the value of the 'D' part of the equation - they expect to get 25% of a venture for the 1% 'inspiration' without recognising the 99% 'perspiration' that has to follow.
2000		Transfer between IT companies is working well across Australia and internationally. BUT transfer between university sector and IT industry pretty abysmal. Major gulf between the pure research of the university IT arena and the applied needs/research of the IT industry. Gulf put down to difference in cultures between the two worlds and to a misalignment of the way universities are funded for research by government.
2000		Australian universities lag way behind the rest of the world (especially USA) in commercialising university research. It is not seen as core business of a university. Australian universities do not have sufficient external focus to stimulate start-up activity i.e. they do not build the necessary networks with local business and government and they do not employ entrepreneurial people on university staff
.2000		Australian universities do not have sufficient external focus to stimulate start-up activity i.e. they do not build the necessary networks with local business and government and they do not employ entrepreneurial people on university staff.

		Best practice incubators have a very strong business committee and ventures without a sound business plan don't get in. We don't see that in Australia.
2000		Universities develop too great a focus on deep research: graduates could benefit from more exposure to applied research on shorter time frames
2001	More significantly in the last year across Australia there were 42 new bio-tech start ups, and 18 of them in Victoria so we're running at nearly half of all new start ups and I just think that you'll look in the future where bio-tech and the like sciences are going to go, more and more of it will be focused around the medical research aspects, we are so strong in that area, both in our medical research institutions, you know all the minds there all the top ones in Australia plus you know the strength of our university system.	
2001	We have had to be smart about knowing our own environment and science has been a factor over in the agricultural and mining areas. So naturally we've sort of been clever and we are acknowledged internationally as being clever, I mean we've had Noble Prizes and so on. So there's no question about the innate capability of our skills population.	
2001	Broadly I guess in terms of the university as a key part of our society, I think attitudes to the entrepreneurial activities that the university is doing are very positive, a sign of a successful university and I think it is perceived that way. About the people leading the charge, Oh I think probably some of them are viewed as being cowboys within the university community if that's what you mean, but I think your dealing in there with sort of a very much a clash of cultures but I think basically they're respected and admired for what they've done.	
2001	Obviously scientists are getting more and more into ownership and activity in their own ventures.	
2002	The process of commercialising university research needs to be better understood. Academics rarely make good entrepreneurs, but a company needs an entrepreneurial champion, so a 'surrogate' entrepreneur needs to be brought in to manage the venture through the critical start-up stage. Later this person will usually be replaced by a more traditional CEO.	
2003	Academic researchers need to be rewarded for building external relationships as well as for publishing academic papers. An ARC study (1998/99) found that only a third of academic researchers were interested in building external relationships. You don't need to turn researchers into entrepreneurs - just put them in touch with entrepreneurs or people who can lead them to entrepreneurs. There is a need for scientific researchers to be educated in the basics of commercialisation. This will help them apply for commercialisation grants or even become part of a start-up	Academic career advancement is based on publications. Exploring commercial opportunities takes time that could be spent on producing more publications, so not only is there no incentive to do it, there is a definite disincentive. The few researchers who have commercialised their work have done it in spite of rather than with the help of their research institutions. Many researchers are happier staying within the lab, so external bridge builders are needed to raise their awareness of commercial opportunities. To some extent they need to be 'dragged out'.

	business. universities and other public research institutions think commercialisation has happened when you have a working prototype. They are not good at assessing whether a market for the product or process exists. Once they understand the commercialisation process, they realise they can't do it alone. Once they accept that, they become a very valuable member of a team because they usually have excellent analytical skills and that often complements the skills of the people with business experience.	
2000		If you consider developing university research as an engine of economic growth as a traditional S curve continuum, then Australia is still on the flat - we haven't really got off the ground at all - whereas the USA is on the growth.

Table 7 CSIRO

Year	*Positive/neutral*	*Negative*
2000		Organisations like CSIRO have great difficulty commercialising outside of the government sector. There are restrictions on holding shares in spin-offs.
2000		Linkages between business sector and research sector (CSIRO, universities etc) need to be improved
2000		Government research organisations such as CSIRO have no marketing plan. They are very creative, but they do not know how to sell what they create.

Conclusions

> "I think we're very smart coming up with ideas, I don't think we're smart translating them into outcomes."

This individual comment (which has appeared time and time again in many recent studies of Australia's research commmercialisation activities) encapsulated the experts' comments generally. In this present study, there was wide recognition that Australia had invested well in publicly funded research and that nationally we had the creativity and inventiveness to benefit from this investment. The perceptions of Australia's R&D performance were surprisingly high The strength of these views was in surprising contrast to widespread demands from academic researchers for more money for research. Both Queensland and Victoria were going to be the world's leaders in biotechnology — in a tiny domestic market with only a very small proportion of the developed world's research expenditure on biotechnology. The need for more collaboration and strategic alliances and less *going it alone* were clearly expressed. There were comments about the lack of national (as opposed to State level) industry strategies for key sectors such as IT and biotechnology

Respondents also recognised that not all research had to have a commercial outcome and that there were risks in trying to turn good researchers into indifferent entrepreneurs. The comments on research commercialisation and technology transfer performance generally reflected other published data, but tended to show greater confidence in potential and achieved community benefit. At the same time, gaps in the public support structures for research and its commercialisation were identified. Given the small number of respondents there was little evidence of longitudinal change in attitudes despite significant Commonwealth and State government initiatives in R&D expenditure and support for innovation. There were indications of changing attitudes in universities to commercialization of research outcomes, supporting other evidence to this effect (Yencken and Gillin, 2002; Yencken 2002).

Future implications

This study illustrates the potential use of expert opinions in a Delphi mode to explore trends longitudinally. The continuing GEM Australia Surveys will be able to provide qualitative data on the ongoing perceptions of a balanced group of "experts" on important national issues such as those relating to R&D investment, research commercialization and technological innovation and their impact on new, growing and small firms generally.

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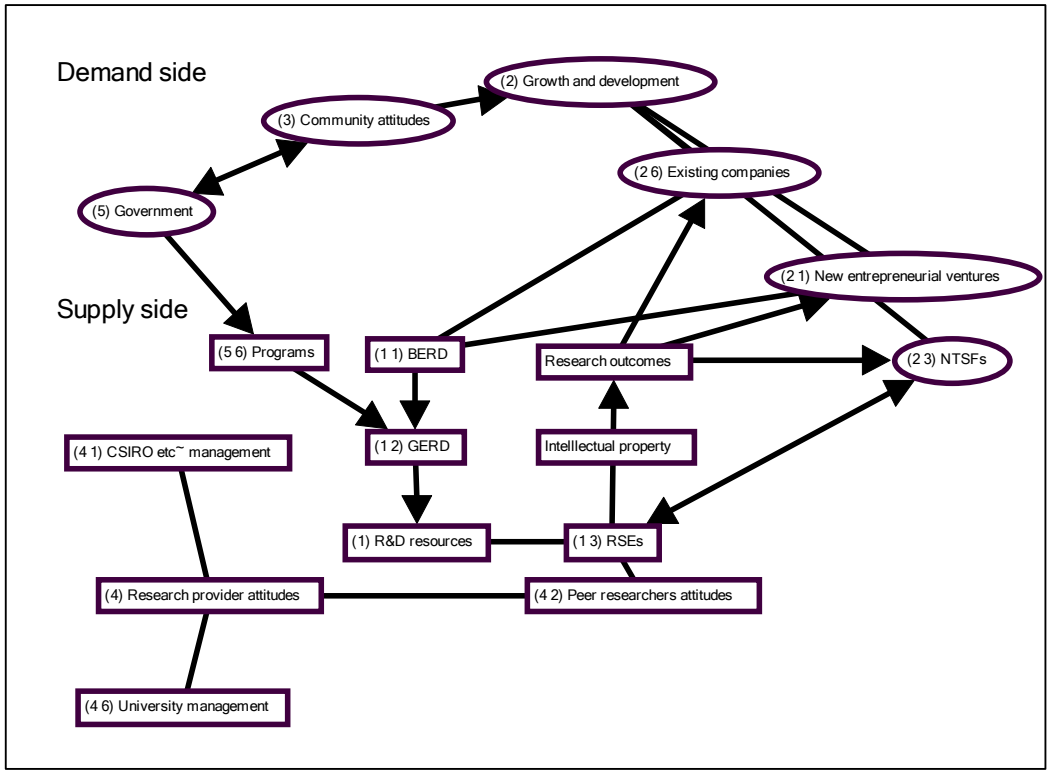
Figure 1 GEMAustralia data nodal relationships



Source: NVivo® model of code structure for GEM Australia interview transcript analyses.