GOVERNMENT POLICY, HEI'S AND ENTREPRENEURSHIP IN INDUSTRY DEVELOPMENT: AN EXAMPLE FROM QUEENSLAND, AUSTRALIA

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ABSTRACT

Universities are seen as fundamental in knowledge processes and are increasingly encouraged to take leading roles in entrepreneurial development. This development occurs within a network of stakeholders who influence the development of firms and outcomes. This paper analyses knowledge processes and the role of government policy in influencing Higher Education Institutions' entrepreneurial behaviours and direct innovation creation and dissemination within an innovation rich, knowledge intensive industry: biotechnology. The results highlight the need to evaluate government funding and processes of access to resources including grants and the development of more specific evaluative criteria in grants access to reduce opportunism.

INTRODUCTION

Knowledge creation and utilisation has become a cornerstone of modern economic activity and policymakers have increasingly sought ways to encourage this. Researchers also increasingly acknowledge that, due to rapidly changing and highly competitive markets, growth oriented small firms are starting to exert a significant influence on national economies (Yeh-Yun-Lin 1998) and are responsible for making a disproportionate contribution to wealth and employment creation (Delmar and Davidsson 1998; O'Gorman 2000) within an economy. Higher Education Institutions (HEIs) have also been encouraged by government policy, to take an larger role in local economic development, through innovation (Cooke et al.. 2000; Boucher et al. 2003*)*. Australian universities for example, influenced by shifts in industry and more particularly government policy, have increasingly moved to a more entrepreneurial, commercial and managerial focus (O'Shea et al., 2005; Marginson and Considine, 2000). Further, Australian government policy generally has increasingly focused on support for these businesses, particularly in terms of encouraging clustering and exporting.

A range of government policies exist that focus on key industries such as biotechnology to drive economic growth. The development of the Australian biotechnology industry has also been seen to benefit from a governmental policy framework aiming to compensate for market failures (Orsenigo, 1989). Access to resources and incentives, in particular financial resources from government, is of great importance when evaluating this industry (Harman & Harman, 2004). Due to its higher risk profile, government funding enables a higher levels of R & D spending without which, spending may be less than the optimum for the economy and industry development (Erskinomics Consulting, 2003). Support for knowledge intensive

industries like biotechnology is perceived to increase economic stock in knowledge and research capabilities providing a platform from which to generate world class products and services.

Knowledge in the biotechnology firm also, often evolves as a result of synthesis of scientific, technological and business knowledge including managerial skills and these coevolve as the firm develops (Liyanage & Barnard, 2003). Biotechnology firm capabilities, therefore involve a continuous synthesis of scientific, technological and managerial skills and knowledge requiring input from various stakeholders within its environment to enable organisational learning and management strategies. The advancement of the biotechnology industry is therefore critically bound by knowledge and information and asymmetries associated with scientific, technological and business related knowledge.

The arguments surrounding this can be encapsulated within the knowledge spillover theory of entrepreneurship (Acs et al. 2004). This argues, essentially, that knowledge developed in one institution may be commercialized by other, and that entrepreneurship is one way that the 'economic agent with a given endowment of new knowledge' can best appropriate the returns from that knowledge. The complexity of knowledge intensive entrepreneurship often creates further barriers for firm creation. This may be result from (1) failure of private firms and public institutions to generate new knowledge; (2) failure of that knowledge to be disseminated efficiently; (3) failure of individuals to exploit new knowledge; (4) a range of other factors that make entrepreneurship difficult.

Evaluation of biotechnology and government policy more generally, with a focus on knowledge characteristics and its importance also needs to be accompanied by that of the capabilities of knowledge users and effectiveness of knowledge transfer/translation (Cooke et al., 1997; Braczyk and Heidenreich, 1998). Of central importance, is to link knowledge and innovation in the process of creation and how it's disseminated, with commercialised outcomes and improved firm capacity and growth. The multi-faceted nature of innovation creation processes highlighted by Leyesdorff (2000), for example, suggests key and inter-related roles for a range of stakeholders, specifically industry, government and its agencies, and institutions such as universities,. who have had long experience of directly utilising internal knowledge to turn discovery and technology into application, through strategic resources, provide support for commercialisation and technology transfer to industry through the use of physical spaces including equipment, laboratory space, human resources, and to utilise investment capital derived from outside sources ((Drury, 2002); Bird et al 1993; Allen and Levine, 1986).

Owing to this, evaluation of the nature of knowledge, its characteristics and the effectiveness of knowledge transfer/adoption, in addition to the capabilities of entrepreneurs is required. This paper develops such a framework to examine the roles of stakeholders and factors of importance to dissemination in Australian biotechnology. The paper is structured as follows. Following examination of the literature, a broad conceptual framework is established. Australian and Queensland development policy for biotechnology is evaluated, the methodology section provides information on the nature of the data obtained and the methods used to analyse it. The subsequent results obtained are then outlined, with conclusions concerning the role of government and HEIs, and the need for further research, finally discussed.

LITERATURE

Conventional processes for fostering organisational learning and innovation are based primarily on individual behaviour and linear models. These are now increasingly viewed as the exception rather than the norm, as it is more generally acknowledged that learning, knowledge creation and innovation occur through highly interactive, iterative, networked approaches (Lundvall 1992; Weick, 1990; Cooke, 1998). Current paradigms therefore emphasize the need for multi-disciplinary and interactive knowledge production between governments, universities, research institutions, and firms to further develop industry growth and profitability. This was recognised by Etzkowitz and Leydesdorff (1997) who developed the 'Triple Helix' framework arguing that innovation and the cooperation occurs at the intersections between government, university and industry.

Frenz et al (2005) discovered however, that the level of UK firm-UK university cooperation is very low, concluding more generally that firms must have a certain level of absorptive capacity that provided legitimacy before entering into cooperation with a university. Once established, however, this cooperation was found to have a positive and significant effect on innovation. They also argued that human capital enhances the absorptive capacity of firms, facilitating local technology transfer, local and regional

knowledge spillovers and growth. If, therefore, knowledge generation encompasses the "triple-helix" elements of Leyesdorff's (2000) model, it is also important to consider the factors which help stimulate, manage and diffuse created knowledge and innovation, as part of an overall knowledge and innovation management framework. Links between SME growth, innovation, and networking, for example, has led to an increasing focus on entrepreneurial firms and the development of the various networks that enable innovations (Asheim and Coenen, 2006).

Owing to this, issues surrounding the management of networks, the structures and fora in which the actors operate and the role of education including learning and training are important. There are a range of fora and structures, for example, in which and through which knowledge creation and dissemination can occur including in the case of biotechnology: direct spinouts of companies and collaborations with various stakeholder groupings from industry supply chains, government institutions and universities. Cluster and network theory (Wright et al. 2005) also suggests a range of other formal and informal mechanisms in which knowledge creation and dissemination can also be encouraged (e.g licensing, technology transfer). The suitability of the structures and fora used, however, will be factors of crucial importance in determining the success or otherwise of the knowledge creation and dissemination process.

It is recognised that knowledge has both codified and tacit elements which further creates complexity within education and learning activities between stakeholders. The transfer of codified knowledge is not seen as strongly dependent on geography as codified knowledge can be transferred across geographic regions fairly readily, and reductions in costs and improved communications increase access to codified knowledge, rendering it less important as a source of competitive advantage. Tacit knowledge, it has been argued, however, does not always travel well, making it a key source of 'the *geography* of innovation' (Asheim and Gertler, 2005). This includes knowledge flows between firms, research organisations, institutions and public agencies that are embedded in a regional context. Frenz and Ougthon (2006), therefore, argue that, since proximity facilitates the transfer of tacit knowledge transfer and learning - both of which are important determinants of innovation. Both Boschma's (2005) and Frenz and Oughton's (2006) reviews of the theoretical research suggest, however, that the borders of innovation/enterprise systems can be blurred (also see Narula, 2003) as the growing importance of trade and multinational enterprises (Simmie *et al* 2002) create sectoral and technological processes that cross national and regional borders

Regardless of geographical concerns, effective and appropriate management of knowledge and innovation creation and diffusion structures and fora are also vital to this process. The three basic modes or mechanisms that can be applied to this are hierarchical state or corporation based, the market, or social networks (Lowndes and Skelcher, 1998). Markets are sometimes, however, perceived as unable to adequately bundle the relevant resources and capacities between science and industry, and the complete vertical integration inherent in hierarchy restricts flexibility and incentives (Menard, 2002). Conversely pure networks of relationships based on trust and reciprocity are often insufficient forces to secure necessary directed outcomes (Rhodes 1997; Keast, and Brown 2002). Hybrid approaches therefore have the ability to limit or balance out the negative effects of an over-reliance on one governance mode (Menard 2002), through exhibiting a number of possible combinations and recombinations of contract and trust to form effective strategic partnerships (Schaeffer and Loveridge 2002). The suitability of the management mechanism used in a specific context will influence the success or failure of knowledge creation and dissemination, particularly given that there are a range of processes and motivations of importance when examining these issues, depending on the nature of the network being utilised.

The relationship between learning, structures and governance modes therefore provide the mechanisms to bring participants (and the various stakeholders) together to share resources and knowledge that are present in individuals, teams or organisations. One scenario, for example, might see a myriad of key stakeholders from industry, government, and institutions (including universities and government research departments), utilising these interconnected mechanisms to generate and disseminate knowledge, innovation, skills, and training, and to operate management and governance structures appropriate to their own particular circumstances. Synthesising these multi-faceted relationships between knowledge, how it is disseminated through the network, innovation processes and growth, creates a comprehensive evaluation framework as follows:

- *Knowledge-creation* relationships (i.e. between firms, government and its agencies, and institutions, such as universities) .
- How *knowledge-dissemination* occurs though the fora or structures for disseminating knowledge (e.g. via spinouts, alliances, collaborative networks etc.), management and governance of the relationships between the sets of actors, and the education, training and learning required for effective dissemination. and
- *Knowledge-adoption* by the companies themselves for innovation-specific and more general growth-related outcomes

What the university role (and the supporting government policies) should be, however, is still the subject of much debate. Kitagawa (2004), for example, argues that that there is a need to examine the complementary relationships between university institutions, policy initiatives, and other support organisations. Direct university commercialisation of innovation, for example, is a process increasingly encouraged by government policy in many countries, both in terms of spinouts and also high-technology based clustering initiatives.

Reid and Schofield (2006) also highlight the potential use of technology "brokers" (which can be represented as groups of universities) as conduits or fora through which knowledge and innovation transfer from academia can occur. In terms of fora, the university can exhibit a range of behaviours and structures (e.g. incubators, licensing, joint ventures, start-ups and spin-outs) which has the potential to enhance or inhibit firm innovation performance and growth. This has important policy implications for start-ups (Smilor et al., 1990). Geographic clustering in certain highly R & D intensive industries also often occurs within close proximity of leading universities in a region (Galambos and Sewell, 1996). These insitutions provide access to knowledge and information which is often tacit, sticky and place-specific, and the ability to transfer information may reduce with distance (Bell, 2005). University-based training in specific skills and access to human resources including staff can also facilitate understanding and absorption of innovation, benefiting and enriching the local labour market and providing an incentive to attract further researchers into the location (Carlsson and Mudambi, 2003). These modes of commercialisation are often reliant on externalities and internal process linkages within these environments.

Druilhe and Garnsey (2004) point out, however, that spin-out companies develop within a wide variety of conditions, and the literature indicates that spinning out from academia is complex, because of the number and diversity of team members involved. Conflicts of interest can arise as a result of their divergent motivations, needs and interdependence. Birley (2002) also highlighted a considerable number of potential management and governance-related barriers necessary within the new paradigm of an entrepreneurial focused university (e.g. see Bok, 2003, Clarke 1998 and 2003, Etzkowitz, 2003, Morrison, 2004). It is acknowledged however, that within the context of university technology transfer and commercialisation, there has been little research on particular institutional structures or processes (Powers and McDougall, 2005) for access to resource provision and utilisation. The more "entrepreneurial university" model differs from more traditional views of university purpose and values.

University values traditionally have been: knowledge for its own sake; making knowledge freely available to all (Behrens and Gray, 2001); organised scepticism (Kenny, 1987); and learning. The new paradigm, in contrast, involves more of a focus upon value creation and academic freedom (Slaughter, 1988, Bird and Hayward, 1993; Behrens and Gray, 2001; Harman, 2006). Traditional values, however, still remain important to the science and technology academics from which hi-technology spinouts evolve (Senyard 2007). Research conducted with this group of academics in the Australian GO8 universities in 2000, for example, demonstrated that 73 per cent agreed with the proposition that creating knowledge for profit is less important than creating knowledge for its own sake, while 40 per cent agreed that basic research is more important than applied research (Harman, 2006).

For the Australian biotechnology industry, Stephens et al (2006) argues that research strength os underpinned by its universities, its federal research body (Commonwealth Scientific and Industrial Research Organisation (CSIRO), and other leading institutions. The strong role of universities can also be seen with in allocations of government R & D funding. The biotechnology industry, at the end of 2004, comprised almost 400 dedicated biotechnology firms, the majority of these being small to medium enterprises (Hopper and Thorburn, 2005). The majority of Australian biotechnology firms in 2004 (60 per cent) were also less than six years old (Department of Industry Tourism and Resources, 2004) and the

industry is developing through small, dedicated entrepreneurial firms staffed mostly by scientists (Curtis, Ferguson, & Kuo, 2006). Australian State Government initiatives have also shown an increased focus on biotechnology agendas (see Table 1). Specifically, current programs developed by the Smart State Strategy related to Queensland's Biotechnology Strategic Plan 2006 include:

- Smart State Innovation Projects Fund: Consists of $60 million over the next four years to support national and international alliances and collaborations between research organisations and industry.
- Biotechnology Commercialisation Pipeline: Assists new biotechnology firms to access private sector finance and enables them to progress along the commercialisation pathway.
- BioStart Fund: Provides access to early stage financing for star tup firms.
- Current commercialisation training opportunities will be extended through the
- Mentoring for Growth and Innovation Start-Up Scheme program.
- Queensland Biocapital Fund: Through the QIC to l stage later venture capital financing to ensure the establishment of globally competitive bio-businesses.
- The Government will raise investor readiness by encouraging participation in the Commercialisation Bootcamp and Masterclass Program through the Australian Institute for Commercialisation.
- Smart State Innovation Skills Fund: Providing 12 million to attract and retain leading scientists and build skills in Queensland.

The biotechnology industry in Queensland, therefore, provides a suitable context of strong government support and policy initiatives, with a strong pivotal role for universities in industry development. It also provides suitable context for key governance issues on knowledge processes, their management and development for the most effective outcomes, given stakeholders' diversity. In related policy, governments worldwide have also been drawn to science and technology parks in an attempt to create to create concentrated economic advantage via agglomeration and clustering. Consequently, governments have been highly instrumental as the initiators and often even the developers of these parks. Despite this central involvement, and perhaps because of these two different functions of both creating and supporting functions, there remains, however, a level of uncertainty around the actual role of government in these arrangements as well as the types of support that they should provide to incubate and sustain their operations.

Table 1: Summary of Australian Government Policies

Package	Overview	Total Funding and Duration	Key Human Resources Strategies
Backing Australia's Ability (BAA I and II)	General science and Innovation package, focused on three key elements in the innovation process: • strengthening Australia's ability to generate ideas and undertake research; • accelerating the commercial application of ideas; and • developing and retaining Australian skills.	Total duration: 2001-11. Total Funding: $8.3billion.	Developing and Retaining Skills The package supports the long-term sustainability of Australia's skill base in the enabling sciences and the encouragement of positive attitudes toward science and innovation in the community. It promotes this by: • Funding an extra 5740 higher education places in ICT, mathematics and science at Australian universities ($350.5m) • Improve teaching in Innovation, Science, Technology and Mathematics ($38.8m) • Enhance capabilities of government schools to build stronger scientific, mathematical and technological skills of Australian students and to encourage school-based innovation ($373m). • Questacon Smart Moves: an initiative to raise awareness of science and innovation among young Australians and encourage participation in science and innovation industries ($15.1m) • Science Connections Programme: initiative to raise awareness of the contributions of science and innovation in the broader Australian community ($25.8m)
National Biotechnology Strategy (NBS)	Provides a framework for the development of biotechnology in Australia. The strategy addresses six key themes: • Biotechnology in the community; • Ensuring effective regulation; • Biotechnology in the Economy; • Australian biotechnology in the global market; • Resources for biotechnology; and • Maintaining momentum and coordination	Total duration: 2000-08. Received initial funding of $30.5m in 2000, followed by additional contributions of $66.5m and $20m through BAA I and II.	HR for Biotechnology Development The key objectives are: • enhance management skills in the biotechnology sector; • attract high quality researchers and experienced leaders; • encourage entrepreneurship; and • monitor demand and supply for specialist skills. The key strategies are: • Improve management of research, intellectual property and technology within established firms and new enterprises; • Develop, attract, motivate and retain high quality researchers, particularly in those fields where Australia has strong capacities to commercialize research outcomes; • Maximize technological awareness and capabilities throughout industries that will be developing and applying biotechnology • Develop programs and systems to foster entrepreneurship • Monitor emerging skills needs in the biotechnology sector and develop appropriate responses.

Source: Stephens et al (2006)

METHODOLOGY

The method chosen to examine the issues in this context was to conduct 30 in-depth interviews with a range of key stakeholders from government, industry and universities, purposively selected e.g. Patton (1990) based on their broad roles in the biotechnology industry. These stakeholders in the 'triple helix' included industry professionals (including industry association Ausbiotech members, commercialisation managers, venture capitalists, biotechnology employment specialists, entrepreneurial managers of established start ups) Government (both Federal and State Government), and academia (scientists, commercialisation managers). Owing to confidentiality arrangements, the individuals are not explicitly identified. The research protocol included open-ended questions to allow a natural conversation flow around the common set of issues (Patton, 1987), identified in the literature as focused around the structures and fora used, knowledge processes, and management and governance issues. Key questions were developed around common themes that evaluated the relationships between the various stakeholders and the structures through which knowledge processes were embedded. Interview lengths ranged between one to two hours. Further, to examine government support policy in the related area of encouraging agglomeration and clustering in such hi-technology based industries, semi structured interviews were also conducted with a range of stakeholders in Queensland science and technology parks. These evaluated broad scope knowledge of awareness of categories, the use of government assistance and attitudes towards government in these science technology parks.

RESULTS

Biotechnology-Specific Results

Interviews with key stakeholders indicated question marks over the (strong) role of government hierarchical-based management in focusing university agendas in particular, in biotechnology and commercialisation. Certainly, universities are seen as having to take more commercial responsibility for managing knowledge and outcomes of research.

> 'The main change has been really almost foisted upon universities by government policy and that is the sense that they have to manage the outcomes of their research, which was never ever something that was really on the agenda in universities. Ten years ago it was that there would be papers published, there would be a contribution to the academic arena, but there would not be necessarily be any transfer of that information into commercial value or into industry.' PAC

Following this agenda, government funding and start-up programs have been reflected in changes of firm development. Several respondents argued that this may just be an indication of being able to access funds, rather than the policy creating sustainable firms or growth. This further indicates strategic asymmetric behaviours of start up firms, with deliberate opportunistic behaviours.

> 'For instance, the state government in grants that invest in commercialisation of new technologies have to be granted to a company. So you see universities doing things like forming a small, really, shell company, so they can take an $80,000 ISIS grant or a $100,000 COMET grant because they have to, not because it's necessarily the right vehicle to put that piece of [knowledge] IP in at that point in time.' TS

Other respondents recognised similar results in start-up behaviour in universities, questioning the appropriateness of start- up fora.

> 'And part of [the university] their charter was to create X number of spin-outs in a certain amount of time…Whether any of them would be useful or not is another thing and also the state government at that stage had a particular funding scheme that allowed, [name omitted], to set up spin off companies and get funding for them. …They have a certain amount of intellectual property; they're managed by the head of the [name omitted, commercialisation unit] plus a commercial development officer who's working on it part time and it's pretty much a cart without wheels. It just sits there and does nothing.' RB

The majority of government funding, however, was allocated towards the university (Hopper and Thorburn 2003), with only 13% of private for profit industry based firms receiving government funding. The appropriateness of the allocation of funds to public institutions, including universities, for research and developments versus private institutions and research centres was also questioned by several industry respondents:

> 'You look at the major recipients of funding out of government. Go back and look at the last seven years, since they announced in 1999 that they were going to concentrate on biotech. Have a look at all the funding for life scientists you'll find about 95 percent has gone to universities.' NA

In contrast to the hierarchical governance push on universities and industry from government, commercialisation through spinouts as a way of disseminating knowledge seemed to be more towards a market-based approach than hierarchical. An examination of the commercialisation structures utilised by universities themselves, also highlights a focus on more market-based governance modes, separated from other parts of university management, with continuing conflicts between this and more traditional university approaches.

> 'Commercialisation is not a core business for the University. That's why – I think that's why UQ puts it out into UniQuest, because it's not actually a core business. Whereas their core business is education, teaching.' AC

The inherent challenge for the academic scientist however, is how to manage the more complex role this additional commercial responsibility has produced:

> 'There's always this tension. When you're outside the system you think "why don't they do this? Surely they want to commercialise what they've done". But when you're in a university you're fighting for grants, you've got PhD students, you've got your teaching work, you've got your research, you've got your administrative duties, and then they want you to commercialise. Yeah, and you've got insecurity of tenure. …' TS

The more-market based current approach to exploitation of university knowledge, in a university model otherwise characterised by more hierarchy-based mechanisms also highlighted the key role of the commercialisation manager, who has to act as a conduit between government, industry and university policy, and the motivations and needs of industry and academic scientists. The process of undertaking this role, however suggested more reliance on knowledge network-based governance for commercialisation managers, particularly with regard to their relationships with academic scientists.

> 'Researchers understand that they've got to have a conversation with someone that's knowledgeable before they take that particular publication. [However] clearly you can't have a commercialisation officer company vetting every publication.' TB

The university context creates additional dimensions that affect the knowledge dissemination and utilisations relationships between the scientist and commercialisation manager. The commercialisation process was traditionally carried out by academics who had limited restrictions on knowledge process of creation, dissemination, and utilisation. The introduction of the commercialisation manager as a knowledge gatekeeper, protecting university interests and managing the process would suggest a more efficient system. However, the academic scientist, without a contract signing over knowledge to the university can still distribute knowledge: whatever they choose, to whom they choose, and when they feel like it. One of the commercialisation managers recognised the specific context of universities and their limited influence over knowledge dissemination by academic scientists.

> 'Remember as business manager, commercialisation manager, you've got no power to make people do anything [discussing scientists who tell other scientists on current results of research]. Particularly in universities. I mean in business you say "Okay, if you don't want to do that, you'll have to leave the organisation." In the universities "If you don't want do that, I can't stop you." There's no power within the system.' AC

This highlights the varying motives and outcomes that the commercialisation manager has to manage: the scientist and their motive to publish and dissiminate the knowledge, the university and their motive to dissuade the scientist to publish if it will impact on the value of the knowledge, its potential returns, and the motives of the commercialisation manager who wants to manage the information to give industry and government a compelling proposition to attract significant funding. Developing a cooperative culture between the business units, universities, and government was therefore recognised as integral to the relationships needed:

> 'So you need people in universities – and there are not many of these people – who can bridge that gap between the science and the science culture and the business and the business culture.' PR

A range of skills are also therefore required for network development, maintenance and evaluation between the key actors. Specifically, commercialisation managers may be the conduit of knowledge flows between government and policy, the central university research program and academic scientist, and separately, need to manage a plethora of industry relationships, using and being affected by different governance modes. The types of start up behaviours and knowledge spillover in terms of geographical clustering as a result of spin-outs, questions were also raised :-

> 'What is happening is that with the [name omitted] and the [name omitted] and a few other smaller features we are getting clustering but it's not in the like industry. So you are going to get a few biotechnology firms coming together and we are still getting minor cross fertilisation and some synergy but not to the extent of the actual clustering theory.' JT

This also emphasises the use of universities in knowledge spillover indirectly through the provision of centralised facilities, education and training. This may assist in innovation dissemination in ways other than spinouts, university proximity also being discussed in terms of providing (agglomerational) access to resources.

> 'You are also finding more satellite-like clusters coming out of universities. I don't think it's an issue of dependency on the universities. It's more like a security blanket, of the university is right there, and from the scientists who utilise not only the human capital but also the equipment capital.' JK

This is also consistent with recent literature related to biotechnology genomics firms, who have been found not to be conducting R&D with local competitors, because of 'open science' and localised knowledge spillovers occurring between firms competing in highly specific local niches (Owen-Smith and Powell, 2004; Caniëls and Romijn, 2006).

To conclude, traditionally, government funds were seen to provide seed capital for basic research. The results suggest, however, an increasing expectation for applied research. It also indicates a very hierarchy-based governance structure approach, with the requirements of due process, paperwork and specific evaluation of results at specific periods. Recognising previous academic values based on open science and academic freedom towards knowledge, universities' new knowledge management and IP policies indicate and align more closely with market-based governance approaches. Knowledge dissemination at the university level occurs, but only at the right price or right outcome for the university. Individual key stakeholders (i.e. commercialisation managers) integral to managing the development of the firm's relationships and networks utilise a more network governance based approach. The focus is on network development by building links between university research teams and academic scientists, industry ties to increase market attractiveness and government programs for funding and legitimacy.

Science and Technology Parks

Investigating the role of government policy further in terms of concentrated technology policy, the companies interviewed were provided with a set of nine (9) possible programs and services of assistance (located at both federal and state levels), and were asked to indicate which they had used in undertaking their business activity. The responses are set out in Table 2.

Table 2: Government Support Programmes in 2005 and Uptake by Respondents

Programs and services	**Numbers of Respondents utilising Assistance**
Federal Programs:	
R & D tax concession scheme	12
START or COMMET schemes	8
Other Federal Government e.g. Ausindustry/ Austrade	4 Export Market Development Grant

Assistance	
State Programs:	
Start Up Assistance	4
Market Research assistance	2
Technical assistance	1
Managerial or legal advice	
Other state government	2 ODS; 1 OSDI direct support

The results indicate there here were a range of attitudes towards the availability of government support and how to access it. Some were negative:-

> "Now being located in the Park I am starting to learn about government grants and subsidies and government. Once again this was only a fluke, I think it was only when you sent around the questionnaire that I became aware of these".

This, however, highlights the importance of the science and technology park manager's role in the provision of developing knowledge which, as the networker, can be seen by providing links between government and interview respondents. Ties with government were seen to be important not only for the respondent's business, but also for the region

> "It would take years to find out what grants are available and what the basic requirements were. You get in the grant and go through all the paperwork and at the end of the day you are none the wiser. But by the same token it is a two way street – you need to invest money in conjunction with the government for the future of your business and jobs for Queensland". SM

Others questioned the short term results focus of applied research, with a recommendation of valuing a longer basic knowledge creation research paradigm.

> "I guess that one comment that I would make from the government programs is that I think too many of them have become very project oriented. One of the things that I think are needed too, they need to go for a period of time. I find a lot of the grants are for a year, two years, and then finished that one, time to get something else. They lack continuity. The models I looked at in Denmark and Germany are based around 25 years span. This is commonsense, but the Australian outlook is short term. PH

In comparison, the government's role in provision of financial assistance, for one respondent, was only for further growth.

> "I never expect anything from government, although we did have a grant to set up this facility, which I would imagine from the company's perspective they would have been very grateful for. My view on grants is that they shouldn't exist because they don't teach you anything. A grant for a business of this size or any business should be given after it has stood on its own two feet for further development not to get there" T.W

There was, in particular, a question over the responsibility of government in these arrangements, with one respondent describing the process as 'being spoon fed' (S.M). The majority of respondent park tenants, however, sought government assistance and support.

> "A legal support system for small entrepreneurs would be great. The model has already been tested with EFIC – the Export Insurance that used to be part of Austrade. In essence the legal support service would assess the deal for its integrity, reality and maybe even for a small % there would be there as a backstop if big partners decided to play rough. It isn't a simple thing, it isn't an event and it isn't a short term 'get votes quick policy', but it would be a powerful underwriting of Australian initiative" P.H.

Some sought knowledge in start up processes, and knowledge in developing resource capabilities.

> "We have made some inroads with government departments – T-tech and START. We are looking for some grants for a start for research, that type of thing, especially resources to develop. It isn't just a question of manufacturing a product"

One respondent also requested knowledge about how to manage fluctuating environmental shifts, and tax concession information.

> "There is nothing to help technology companies when they get slammed. The downside is, the shocking side is the risk. If you get slammed, you wear that, there is no assistance anywhere as there is for some sectors and when you do recover, you pay crazy taxes anyway, Whereas in Singapore, one of our ex people has now set up a company in Singapore, the tax rate there is 20-21% and you don't get a tax break bill till you hit $300 000 dollars a year (P.H.)

It was apparent from the interviews, however, that most respondents did not have knowledge on government assistance programs and what was available. One respondent was unaware that there was even a state government department responsible for the support and advancement of SMEs. More specifically, in terms of building technology park/clusters as the architects and administrators, at least initially, governments have had to undertake a key role in establishing and resourcing park/cluster managers.

Creating these areas without the appropriate support/network and manager will potentially dampen further success in the firms themselves and regionally. These managers use a hybrid, network governance model and act as the conduit to bring the divergent resources together, creating and establishing knowledge processes and systems and networks through which resources can be found. Although facilitating connections and network development was considered to be a key function, it is also important that these stakeholder relationships be leveraged to achieve the best possible outcomes for those involved.

> "We haven't had much to do with the other companies. I think it is the same for most companies, the reason is that when you get here you are totally focused on what you are doing and so you don't have time to think 'I wonder if that fellow would help me, I wonder what we have in common with him'. I think that there needs to be some guiding along…I don't believe the park managers, and I am not being critical of them, but I don't think that they have understood what needs to bed done to engender this … the word is synergy. Whether it is speaking together, to the government or seeking to increase facilities. I think of all the knowledge that we are missing, there are all these strangers out there and we don't know what they do and they don't know what you can do, so you really need some kind of means of making it happen. You cannot always make this happen, obviously the park manager can't force people to make people be involved but there are ways of engendering enthusiasm" (J. B.)

In one case, although this paper highlights the potential value of park managers to create within location links, some do not actually create this within their park.

> "I haven't met the people in the Park, that's why it would be nice if we could network and find out who does what (S.M.)

This may be because this task isn't explicit. Similar to university commercialisation managers, the cluster facilitator / manager has a key role in developing affiliations between other industry partners and government relationships.. Respondents recognised that in the early stages of development generic facilitation skills are very important, in order to get "buy in", build up levels of trust and establish a common way forward, to promote members working together rather than competing against each other. During the later stages of the cluster the facilitator was seen to require more commercial skills that are directly relevant to the cluster, to allow the mobilisation and leveraging of resources, putting together bids etc. More broadly, the role of government was also seen as in need of adjustment, towards the following :-

- Entrepreneurial and management training for potential entrepreneurs
- Schemes of cooperation between the local universities and high education centres, and the new companies, enabling the commercialisation of research of academics.
- Permanent managerial advice and support from the STP management team
- Access to international networks
- Seed-capital availability

Such activities require a range of value added services that could not easily be accessed on an individual basis, but can become available due to the synergies provided by parks and their management teams. These, among others, are the real tasks for a Science and Technology Park (STP) to fulfil, differentiating them from other, more traditional, industrial settlements. The most important goal for technology parks is the development of long term success of the firms and through this, the cluster. These tasks require a management team which has a focus on knowledge provision, the skills and abilities to assist and support start ups in knowledge creation, the development of networks which enable more effective uses of key stakeholders, their resources and the increased potential of innovative behaviours through the creation of knowledge spillovers within the cluster.

CONCLUSIONS

The results clearly indicate the heavily government-influenced nature of industry-policy in this area and the need for examination of both how government policies affect behaviour in biotechnology, both in terms of the policies themselves and also the governance strategies associated with them. The evidence presented from this initial examination of the Queensland biotechnology industry and the scoping interviews, seems to highlight, in particular:

1. The need to evaluate government funding and the process of meeting criteria for firms and public institutions.

2. The development of more specific evaluative criteria to reduce opportunism with further information and access to be provided to private institutions (where appropriate)."

3. University needs to reconsider the management and governance of the relationships between itself , the role of the commercialisation manager and other stakeholders.

A number of different (and at times incompatible) governance modes at work simultaneously, with a strong government hierarchical mode seemingly in place between the main stakeholders of government, industry and universities, alongside specific knowledge dissemination activities required for access to funding. Simultaneously, there is an (incomplete) move towards a more market-based regime for universities in dealing with commercialisation, with increased focus on knowledge value and management of its ability to provide greater returns to the university. The commercialisation manager (as well as the technology park facilitator /manager) role can thus be seen as of crucial importance in dealing with knowledge processes and innovation, requiring mediating between the different governance modes at work, and thus providing a conduit for the hybrid governance structures between the different internal and external stakeholders, mediating and facilitating their different needs. This role, in particular, would seem to be in need of further policy focus in the future, given its apparent importance where spinouts are deemed appropriate. The stated concerns over the appropriateness of s spin-out model driven by government policy provided to universities rather than as a result of joint decision-making between government, industry and universities, however, may also suggest, that some adjustments in governance modes or policy may be necessary, though this may be difficult given the requirements and needs of government, industry and institution.

This is, however, clearly only an initial, superficial evaluation of the biotechnology industry in Queensland, and there is a specific call for additional research in this area, in order to identify the most appropriate knowledge management and governance structures for the industry locally and how these governance models effect start up firm development and outcomes. The examination of STPs suggests that the issue of governance is also of importance more broadly in clustering and technology based economic development policy. Further research could also examine the role of cross-locational linkages given that Fntes (2006) has recently highlighted that biotechnology firms may also form collaborator relations with 'distant networks' to augment their own research and (often-non networked) spillovers from their own localities. This research thus acts as a starting point, highlighting the need for a more developed understanding of the knowledge management and governance processes at work, in this highly important, government policy influenced, industry.

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