

COMMERCIALISATION OF PUBLIC AGENCY RESEARCH: AN OVERVIEW

John Yencken: Swinburne University Of Technology, Hawthorn, Australia

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Contact: John Yencken, Swinburne University of Technology, PO Box 218, VIC 3122
Hawthorn, Australia, (T) 613 9214 5870, (F) 6139827 8381, Email:
jyencken@groupwise.swin.edu.au

ABSTRACT

New knowledge as such has no value until it is applied.. The objectives of this paper relate to the processes involved in the application of new knowledge for such value-adding applications. The constructs involved include knowledge itself, knowledge transfer, technology diffusion and technology absorptive capacity for existing companies and the critical factors in establishing viable and high growth new spin-off ventures. The key success factors that have been identified are few: careful selection of new business and commercialisation channel, adequacy of resources available initially, and effective planning supported by established commercial competence.

Key words: Absorptive capacity, commercialisation, knowledge transfer, learning firm., R&D, spin-off.

INTRODUCTION

Universities and other publicly and privately funded research providers in OECD countries in 2004 (the last year for which OECD published data is available) invested globally over US\$68 billions in Gross Expenditure on R&D (GERD) in science, generating new knowledge and developing new or improved applications of existing knowledge (OECD, 2005: 6 and 71). Similar investment by other countries, such as Brazil, China, India, Korea, Russia, that are not OECD members, will greatly increase this figure. New knowledge as such however has no value until it is applied for some value-adding commercial, medical, social or environmental application. The objective of this paper is to present an overview of some ten years' research and consultancy related to the processes involved in the application of new knowledge for such value-adding applications. The constructs involved include knowledge itself, knowledge transfer, technology diffusion and technology absorptive capacity.

Commercialisation of research outcomes from investment in R&D through licensing of intellectual property and generation of new spin-off companies is only one of several groups of channels through which the social, environmental and economic—and particularly regional employment—benefits diffuse into the local community. A recent study (Kirchhoff et al. 2007) draws attention to the importance of secondary firm births brought about by diffusion of unprotected new knowledge generated by local R& investment as being as important or even more important than the primary outcomes, that are new spin-off companies.

Our results demonstrate that university R & D expenditures are positively related to new firm formations, and that these new firm formations are positively related to employment level

and change...These findings suggest that university R & D expenditures are an important indirect contributor to overall economic growth by encouraging primary and secondary firm births.

New knowledge

F.A. Hayek (1945) was an early proponent of the importance of knowledge and its distribution in a well functioning economy...Hayek's pioneering work provides a starting-point for analyzing how the distribution of knowledge affects organisational structure... (Jensen and Meckling 1992: 252).

Hindle and Yencken (2004) discussed the different types of knowledge involved in the commercialization process:

Knowledge inputs in the early stage of new ventures include prior knowledge in the discovery stage, background and new intellectual property and both codified and explicit knowledge and tacit or implicit knowledge:

Codified knowledge inputs include:

- the published knowledge base of the science or engineering involved in the 'discovery'
- new knowledge, contained in patents, copyrights, registered designs etc.
- the codified content of postgraduate or undergraduate training in entrepreneurship and/or technology management.

Tacit knowledge inputs are no less important and include:

- the ability to find ideas that can be converted into opportunities (Johnson et al. 1999; Fiet and Migliore 2001); Shane's prior knowledge (Shane 2000)
- technology and scientific background brought to the new ventures by the ongoing involvement of the original inventors (Thorburn 2000)
- familiarity with the particular product/industry sector (Cooper et al. 1994)
- entrepreneurial experience, including startup management, risk management, established access to business networks, finance raising (Legge & Hindle 1997).

Commercialisation of research can involve many different channels and processes (Table 1). The essential processes involved can be illustrated by a decision tree (Figure 1) with two key decision points. The first decision is whether to protect any new knowledge as intellectual property (codified knowledge) or to publish and put the knowledge into the public domain. In the public domain application of the knowledge will take place by diffusion and there will be less scope to harvest the tacit and prior knowledge of the scientist generating the new knowledge. Access to this tacit knowledge has been shown to be important for success in commercialising new scientist generated knowledge (Thorburn 2000). The inventor's prior knowledge has also been shown by Shane (2000) to determine how an entrepreneur identifies a new business opportunity. There is a strong case to ensure the continuing involvement of the original inventor(s) or generator(s) of the new knowledge involved in a commercialisation event. However, as discussed later, scientists so involved will rarely have the commercial experience and competence to drive such a new business beyond the technology development or proof of concept phase (Yencken and Ralston 2005).

The choices available for protection of intellectual property include, patents, copyright, product licences (important for example for software), circuit designs, plant breeder's rights. In some situations keeping information confidential will be sufficient on its own or will provide added protection for more codified knowledge such as in patents.

The second decision point then—in situations where an earlier decision to protect the intellectual property prior to publication had been taken—has to be the choice of commercialization channel (Table 1). Hindle (2007) and Davidsson (2003) have identified two major schools of thought in the entrepreneurship research perspective. One focuses on the development of the *opportunity*, the other on the "emergence and development of *new organizations*". This paper will address issues involved in the licensing of intellectual property but will particularly focus on the use of new organizations, that is spin-off companies, as a commercialisation channel, that is entrepreneurial events leading to new -

hopefully high-growth - technology-based firms (NTBF). Its subject thus lies in the emergence and development of new organizations rather than on the development of the opportunity

The demand side

The demand side for technological innovation has to do with the technology absorptive capacity of existing businesses. Technology absorptive capacity (ABCAP) is an important and complex construct. On a national scale technology transfer capacity has been shown to be highly correlated with the proportion of the population of research scientists and engineers and the related proportion of gross research expenditure that are employed by or is spent by business (Lankhuizen 1998; Yencken and Gillin 2003). On the firm scale, Zhara (1996) uses the definition of 'a dynamic capability pertaining to knowledge creation and utilization that enhances a firm's ability to gain and sustain a competitive advantage' and stresses the multi-dimensionality of the construct. He adds the concept of *potential capacity* to Cohen and Levinthal's (1990) focus on *realised capacity*. The latter authors were much more focused on investment in R&D as creating the capacity to assimilate and exploit new knowledge and the conditions that hinder or enhance this (p.126).

The nexus between business R&D investment and technology absorptive capacity has important implications for national research commercialization strategy and policies. Australian business R&D expenditure, while it is rising, is still a low proportion of Gross R&D Expenditure at 48 per cent by comparison with that in the USA, 75 per cent. To optimize the level of commercialization of the research outcomes from university and other public research agencies that takes place in Australia by Australia based ventures, there will be a greater need to support the creation of new technology-based firms (NTBFs), given the limited R&D and hence limited technology absorptive capacity of Australian companies and the migration of Australian manufacturing overseas. This clearly has implications for innovation policy.

The learning firm and new knowledge diffusion

An increasingly important element in strategic thinking about the firm is the attitude within a firm and by its management to learning and thus acquiring and exploiting new knowledge as it becomes available.. The more volatile the market place and the greater the threat of destructive innovation by others the greater will be the need for a firm both to acquire and to be able to exploit new knowledge. Established firms in the past generated most of their new knowledge in their in-house R& D facilities. Chesborough (2003) has documented a change in knowledge accumulation practices with increasing emphasis on outsourcing and open innovation involving diffusion of knowledge. The critical internal human resource increasingly has to do with the ability to find the new knowledge required externally and apply it profitably internally. A company's success at such outsourcing and technology absorptive capacity could be expected to be correlated to a company and its management's attitude to learning. Research exploring this relationship hopefully is awaiting publication.

Technology transfer process: diffusion and commercialisation channels

The decision tree shown in Figure 1 illustrates in stripped down format the process involved in commercialisation of research outcomes and new knowledge more generally. It starts with a *disclosure* of some new knowledge that may have a potentially commercial application (as defined earlier). In this context disclosure has been defined as occurring when 'a device, substance, method or process that is apparently new, useful and involves an inventive step is made known to personnel within an institution who have responsibility for managing the institution's patenting and research commercialising activities' (ARC, CSIRO, NHMRC 2002:16).

The first decision is whether there is any intellectual property that needs or is worth protection. The decision whether or not and how to protect such new intellectual property can be quite a difficult decision. There are often ethical issues where new medical technology is involved (Harman 2001; 2002). There can be disclosure or diffusion leakage risks with patents involving new software. Such a patent may alert a competitor. Patents, once they get to the PCT stage start to become quite expensive. A full multinational filing is likely to cost up to \$50,000 before even maintenance costs have to be paid. On the other hand, it is sometimes necessary to take out a patent to ensure that the new knowledge is effectively applied. Investors will be reluctant to provide new equity investment unless they are satisfied with the level of intellectual property protection. 'Dirty IP' is one of the most common causes of deal failure. Particular care must be taken when a student is listed as one of the inventors.

The next step is to decide the best commercialisation channel. The options were listed earlier in Table 1. The choice of channel depends first on the new knowledge itself, particularly its degree of protection and its market potential. It also depends on practices of and resources available to the research provider where the new knowledge originated. Creation of new spin-offs from universities is relatively rare. For example, ninety two per cent of licenses relating to research outcomes from US universities are with existing companies (AUTM 2001). As will be shown later, adequacy of resources available to a spin-off at the time of its birth is crucial for survival and tends to be available in Australia from only a few universities (including as examples Melbourne Ventures at the University of Melbourne and Uniquist at the University of Queensland).

A critical issue at the point of decision making is resource access. Resources for the following activities are required irrespective of whether a spin-off or licensing to an existing company is being considered.

1. funding for the 'D' phase: achieving proof of concept or development of a working prototype. Potential licensees, just like business angels, expect technology that works. Equally an investor will be impressed if he or she can be shown a prototype. Those handling the commercialisation process internally need resources for the applied R&D to achieve this.
2. preparation and filing of patents, at least to the provisional stage, or implementing other means of IP protection.
3. initial commercial/market intelligence to allow estimates of potential market value, particularly intelligence about potential competitors.

The process leading up to the commercialisation channel selection must be tough minded and highly selective (DeGroof and Roberts 2004; Yencken 2006). Equally, it is essential that the licensor/developer have access to high level commercial competence. Technological competence is less critical, but Thorburn (2000) has shown the importance of maintaining access to the tacit knowledge of the original inventors at least throughout the 'D' stage.

A recent Australian Institute of Commercialisation study has confirmed the serious lack of availability in Australia of the small amounts of money that are needed to support this stage of the commercialisation process.

From the results of this survey the existence of a gap in funding at the very early stage is verified by 87% of investors and 88% of clients. Respondents believe that there is a demand for finance below \$2.0M that is unmet by the current financial market. From comments provided by respondents, this is not necessarily only the result of a lack of available funding for specific equity investment, but also a combination of several other issues (AIC 2004).

Historically in technology licensing and more recently some of the Pre-Seed Funds established with subsidies from the Australian Commonwealth Government (See <<http://www.ausindustry.gov.au/content/level3index.cfm?ObjectID=449BFCED-8D0C-40D1-9E68AAA0F34F8965&L2Parent=...>>) have sought to overcome this shortage by offering a cash sum to fund the research to reach proof of concept in exchange for an exclusive first refusal option to license the intellectual property involved.

Spin-off companies: traps and success factors

The remaining discussion will be focused on high expectation/growth companies. In a detailed analysis of data from the Global entrepreneurship Monitor (GEM) Autio (2000) showed that high expectation companies, just 15 per cent of the total, expected to generate 75 per cent of the indicated new employment potential. The focus here is therefore on high growth companies. At the same time the literature (Yencken 2005) shows many small NTBFs that are essentially quality of life companies and are quite successful but will never have more than a few employees. In this section two aspects of spin-off company growth and survival are discussed: first, policy initiatives to support high-expectation/high-growth companies, and secondly success factors for high growth.

Policy initiatives for high growth

The following section follows on from a working paper by Hindle, Yencken and O'Connor that has not yet been published. The paper analyses the implications for Australia of recommendations of a further GEM study on policy initiatives to support high-expectation/high-growth companies (Autio et

al. 2007). This GEM report reviewed policy initiatives in a number of OECD countries and concluded that a number of dedicated initiatives contributed to best practice: These are summarized in the text box on the following page.

Other critical issues identified by the Autio study included:

Some initiatives, such as Finland's Growth Firm Service, proactively approach potential high-growth firms for support. Instead of waiting for the firm to approach them, the service actively scans the environment for potential high-growth firms with the idea of developing individually customized support packages for these. As concerns policy **design**, the multi-faceted nature of the entrepreneurial process means that a single policy department, or a single policy initiative, is unlikely to produce lasting results. To comprehensively address high-growth entrepreneurship, **broad-based collaboration between multiple policy departments and ministries is essential...**

To effect the requisite collaboration across policy departments for an effective program, **the horizontal program should be supervised by a board consisting of high-level government ministers**, preferably chaired by the **Prime Minister**,

An important aspect of getting entrepreneurship policies better focused on supporting high-growth entrepreneurial activity concerns **monitoring of policy effectiveness** Implementation...

...a better coordination among policy initiatives would result in a **more comprehensive and longitudinal coverage of the early phases of the process of creating innovative new firms**, all too often, innovation, SME, and educational policies are designed and implemented in separate policy silos, with little or no coordination between these. Administrative barriers create obstacles in knowledge spread and innovative collaborative solutions for policy implementation.

One natural context for the implementation of orchestrated policy measures is provided by universities and other HIs, because many processes involving the creation of high-growth firms tend to revolve within and in the vicinity of universities. A particularly relevant domain of collaboration involves **SME, innovation, and educational policies...** universities and HIs a natural focus point of high-growth entrepreneurship policy, even though not the only one.

Policy-makers... should be ready to accept casualties. High rates of survival may imply insufficient dynamism.

Particularly in high-income countries that have small domestic markets, internationalization becomes a necessity, rather than choice...

Remove disincentives. Finally, an important facet of high-growth entrepreneurship policy should address disincentives for entrepreneurial growth. For example, compliance requirements tend to increase progressively as firms grow (Autio, 2007: 77-78)

Best practice in government support policies

In summary, dedicated initiatives addressing high-growth entrepreneurship should:

- be highly selective, particularly when addressing later stages of venture development
- require strong growth motivation from participants
- be proactive in inviting prospective growth firms
- consistently address managerial motivation and skills
- involve close collaboration with private-sector service providers
- nurture an image of professionalism, competence, and a certain degree of exclusivity
- implement sustained and focused development efforts
- involve highly customized and tailored management development activities that involve experience sharing and apply an interactive approach
- link grants and participation to growth aspiration and achievement of milestones
- be prepared to accept casualties
- involve seasoned managers who have experience in rapid growth

Source: Autio et al, 2007:76.

Australian performance against Autio Best Practice criteria

The initiative in almost all the Australian government programs comes from the business or its owners. The exceptions are the role of case managers in the Australian COMET program, who have to go looking for clients, and the venture capitalists in the Pre-Seed Fund program subsidized by government, who are even more highly selective in their approach.

Autio (p.75) notes that ‘only a small minority of all entrepreneurial ventures are both motivated and able to achieve rapid growth’. He uses this to support a proactive approach by government agencies involved to identify potential high-growth firms for support, ‘a major reversal of the traditional SME support philosophy, under which SMEs approach public sector support sources to seek solutions to problems and needs’. Valuable initiatives in assisting such proactive selectivity in Australia, particularly by the private sector, are the Deloitte Smart Company and Business Review Weekly (BRW) lists of fast growing companies. Particularly for the Deloitte list, the application for a Smart Company award can be a starting point in identifying emerging needs, whether or not they are already recognized by the firm applying for the award.

Autio recommends: ‘...involve close collaboration with private sector service providers, the need to consistently address managerial motivation and skills, nurture an image of professionalism, competence and a certain degree of exclusivity, implement sustained and focussed development efforts, involve seasoned managers who have experience in rapid growth’. Hierman and Clarysse (2004) in their study of high growth firms in Belgium found initial access to resources and commercial/business skills as the significant factors affecting growth performance. Interviews by the authors for the GEM study in Australia showed that the major concerns both of public servants and industry practitioners were the shortage of seasoned and serial managers (and also serial business angels) competent to drive high growth and the need for improved training and development to fulfill these roles. These questions involve the private sector as well as government and educational institutions at all levels. Schools have a role in creating awareness of entrepreneurial opportunities and

forming one's own business. Universities need also to be involved in awareness creation and in postgraduate high-growth management training. There is as yet only limited recognition of these needs in the Australian educational system and indeed in large areas of the Australian national innovation system.

Success factors for high growth

McKaskill (2006) has produced a set of 14 'principles' that he believes commonly guide new businesses aiming for high growth rates.

- | | |
|--------------------------------------|--------------------------------------|
| 1. <i>Right place, right time</i> | 2. <i>A clear vision</i> |
| 3. <i>Innovation as the driver</i> | 4. <i>The compelling need to buy</i> |
| 5. <i>The right customer</i> | 6. <i>A competitive advantage</i> |
| 7. <i>Sustainability</i> | 8. <i>Channels to market</i> |
| 9. <i>Robust margins</i> | 10. <i>Scalability</i> |
| 11. <i>A capable management team</i> | 12. <i>Profitability</i> |
| 13. <i>Management of risk</i> | 14. <i>A long term strategy.</i> |

Degroof and Roberts (2003) have a similar list (Table 2) for success with spin-off company formation.

The other studies of conditions for survival and high growth for NTBFs have a much shorter list of success factors. Clarysse et al. (2001) in a large econometric study in Belgium showed that only statistically significant factors with growth as the dependent variable were initial resource access and commercial skills/experience. Technical skills were not significant. A similar study in Norway identified commercial competence as the only significant factor.

In a set of case studies of 21 Australian and Scottish companies, those that conformed to Bhidé's definition of corporate spin-offs, that is where they were well planned and adequately resourced at the time of birth, showed a survival rate of 75 per cent after five years. Those that did not meet these criteria had a survival rate of only 57 per cent over the same period (Yencken and Gillin 2006).

It would be possible to draw up along list of 'don'ts' or traps . Only a few that the author has encountered directly are listed:

- • When a large pharma reneges on its commitment to handle the commercialisation and marketing of your exciting new drug, do not rush and immediately set up a spin-off.
- • If your intellectual property is not considered 'clean' enough by a potential licensee/ investor, do not think that a spin-off will solve the problem
- • Do not consider a spin-off if you cannot provide adequate start-up finance: too little has been called toxic revenue resulting in failure or atrade sale at a heavily discounted price.
- • As a general rule, look for the opportunity for multi-product, not single product development.

Finally, if you are taking on new equity investors, you need to do as much due diligence on them as they do on you. Are you culturally compatible?

CONCLUSIONS

Australia's historically low proportion of gross R&D expenditure spent by business suggests a greater need to develop more new high growth new technology based companies (NTBFs);, more Cochlears and Resmeds.

The conclusions from the analysis in this paper are quite straightforward. Successful commercialisation, whether through a strategic alliance with another company, licensing to an existing company or setting up a new spin-off company, will only succeed if the commercialiser's focus is on the market rather than on just technological excellence. The literature contains much evidence that very few

academic researchers become successful technopreneurs (Yencken and Lissom 2005). Most academic researchers have as career objectives continuing to do useful research in their field. Success in commercialising their research therefore requires easy access to people experienced and skilled in intellectual property, contract law and generally commercial skills, preferably close by (Edinburgh Research and Innovation 2003; Yencken and Ralston 2005).

The literature quite clearly indicates the success factors:

1. tough minded selectivity in choosing commercialisation projects
2. effective planning, including particularly commercial intelligence about potential future competitor intentions: CRCs (See <https://www.crc.gov.au/>) with their commercially focused boards of directors have been particularly successful in high growth spin-off development. (CRCA 2002; Yencken 2005; Yencken and Gillin 2006)
3. access to adequate (particularly financial) resources: inadequate initial resources can be 'toxic revenue' that results in an early failure or a trade sale at a discounted price.

For research providers (university and others) which do not have access to pre-seed funding resources, commercialisation strategies may be better focused on licensing to existing companies, strategic alliances and research contracts rather than attempting to generate new spin-off companies.

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Table 1 Commercialisation routes

Route	Participating entity
Publication	Public domain
Education/Training	
Collaborative research	Single company Industrial consortia, eg AMIRA for the mining industry (1). Cooperative Research Centres (2)
Contract research	
Industrial consultancy	
Licensing	Existing companies New companies
Joint ventures	
Spin-off companies	From an existing company From a university or other public research agency
Start-up companies	Staff and/or student initiative

Notes: 1. Australian Minerals Research Association

2. Initiative of the Australian Government Department of Education, Science and Training.

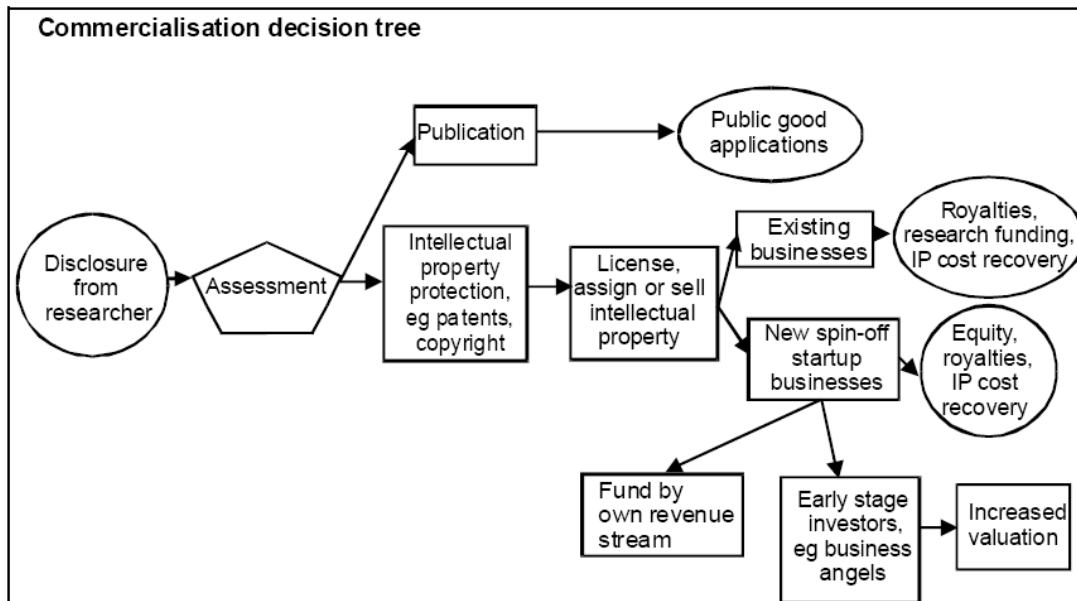
Source: Scottish Enterprise 1996, modified by present author.

Table 2

Summary of fourth spin-off archetype: Comprehensive support and selectivity (CSS)		
Opportunity identification	IP protection testing Strong IP capability	Internal advising capability Network support
Proactive opportunity search	Business concept testing	Local network + strong international network of the research institutions
Opportunity selection	Market research – product development with help of outside consultants	Firm’s management team, board, advisors, shareholders
Strong IP capability	Selection	
Very selective – specific criteria for transfer of technology via spin-off strategy	Strong selectivity: target VC funding (Firm founding after 12-18 months of concept testing within the academic institution)	

Source: Degroof and Roberts (2003: 52-54).

Figure 1



Source: Yencken (2005)