Submission to the Productivity Commission enquiry on Public Support for Science and Innovation

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There is a great deal of sound analysis and many useful recommendations in the draft report on Public Support for Science and Innovation. There are several areas where the report requires, and some where it invites, further analysis.

1. Rationales for Public Support for Science and Innovation?

The report has a cursory discussion of alternative rationales , and this does not responsibly reflect the substantial debate on the strengths and limitations of alternative frameworks for innovation policy[2]. In particular, the lack of discussion of evolutionary/ systems approaches seems odd when Australian innovation policy statements, and the report itself, constantly refer to the 'innovation system'. This implies that a framework for assessing the performance of the system would be appropriate. A major aspect of the systems approach to innovation policy is the recognition of the importance of **change** in innovation systems – the capacity to form new competencies, new linkages, address new problems. This is not an understanding that is likely to come from aggregate analysis. It also implies that an assessment of the performance of the 'system' should look for leading indicators – the signs of the emergence of new strengths, responsiveness to new challenges, for example in the application of general purpose technologies, the capacity to adapt to a strong focus on sustainability, the growing pressure on manufacturing competitiveness.

The fact that there are different frameworks for analyzing innovation 'systems' and innovation policy suggests that there would be value in greater diversity in innovation programs as well as greater diversity in program evaluation. Program evaluations are too often not carried out as a mechanism for policy 'learning', but rather as quickly and cheaply as possible. Indeed in some cases the evaluations of significant innovation programs are not made publicly available, due to a veto by some departments. This is unacceptable not only because of the lack of accountability, but also due to the lost opportunities for learning.

While our overall economic performance might lead to the conclusion that there is little evidence of weak or missing components the Australian innovation 'system', in an increasingly turbulent international context, we really do not have sufficient research to answer that question confidently.

In this regard it is important to bear in mind that it isn't so much the research and related organizations that constitute the innovation system. Rather these organizations are the latent resources on which firms draw in developing **their own**

[1] These comments are individual views and are not intended to represent the views of any organization.
[2] See, for example, Georghiou etal (2003) and Fagerberg et al (2005).

innovation systems each focused on addressing the particular problems and opportunities they face. (Metcalfe, 1998). A central implication of this perspective is the key role of specialists, managers and entrepreneurs in innovation systems in 'leveraging the abundance of knowledge' rather than protecting a scarce reource – we do not have a sound understanding of the strengths and weaknesses of management and entrepreneurship in Australia, particularly with regard to building innovation-based global firms. Another implication of this perspective is that the objective of policy is not simply to build a static innovation system, but rather to develop an appropriate range of flexible organisations to provide knowledge and capability to facilitate the continuous change in networks and collaborations and to ensure the development of appropriately capable specialists, managers and entrepreneurs- all in the context of high uncertainty and the inevitability of failures. This is an increasingly important role for the policy maker – as discussed further below. A third implication is the recognition that vital externalities arise from testing new business models, forming different types of relationship, entering new markets, using technologies in different ways. These involve just as much uncertainty as technological innovation but are impossible to monopolise. There is a role for policy in encouraging and supporting these types of innovation.

2. International Comparisons

It is important to recognize the role of Australia's industrial structure in shaping the level of BERD (as in Appendix C). Indeed in so doing the PC recognizes the strongly sectoral nature of technological opportunity, R&D patterns, research-industry links, and patterns of appropriation. We might expect that recognition of the specificity of innovation processes to have a pervasive influence on the report and lead to a good deal of caution in assessing aggregate patterns, which may mask different sectoral patterns (see Appendix A). Unfortunately this is not carried through to an adequate extent. For example, when it comes to assessing whether our level of HERD expenditure is appropriate a crude aggregate international comparison is used – there is no discussion of whether our industry structure, history, particular challenges etc might provide a basis for a different level of HERD.

Again, caution is warranted because of the limited investment in systematic research into innovation in Australia.

3. Services

The discussion of services and public support for science and innovation in a couple of pages of largely theoretical discussion is not adequate for sectors that now account for 80% of GDP and almost 50% of BERD. In addition there is insufficient discussion of the important role of ICT in enabling productivity growth in services. The report recognizes the central role of innovation in services for productivity growth, yet other disputed work by the PC claims that ICT application has had a relatively limited role in productivity growth in Australia. These two positions are inconsistent. Services are extremely diverse and due to increasing international trade and investment, and the role of ICT, many are changing rapidly. A good deal of research in Europe suggests that the nature of innovation in services places particularly high demands on the quality of human resources and on where there are interactions with research organizations the relationships are often highly interactive (eg Howells, 2000, Howells & Tether, 2004 . We also know that knowledge intensive services, such as minerals exploration and other mining related technical services, and a diverse range of business services play an increasingly important role in problem solving and knowledge diffusion in the economy. There is also some

analysis of the growth of Australian exports of knowledge intensive services. But we know too little about the links between services and the public sector research system, about whether there are biases against service sectors in our research funding programs, and about the factors that support or impede the growth of new service sector in Australia, to make assertions based largely on a theoretical discussion[3].

4. Knowledge Intensive Business Services (KIBS)

Knowledge-intensive business services (KIBS) are firms that provide services into the business processes of other organizations based on technological or professional knowledge. The KIBS sector includes activities such as computer services, R&D services, legal, accountancy and management services, architecture, engineering and technical services, and advertising and market research. The growth of KIBS reflects growing demands for knowledge to deal with change – both technological and social- and also the growing level of interaction among firms in innovation activities.

KIBS have attracted increasing policy attention for five reasons:

- The rapid growth of the sector;
- The evidence of the important role of KIBS in enabling upgrading and innovation in firms;
- The role of KIBS in improving the innovation and export performance of SMEs; and
- The role of KIBS as intermediaries between public sector research organizations and business.
- KIBS are particularly important in assisting the formation and survival of new firms that are exploiting technological or market-based opportunities.

All five of these are important for Australia and suggest that KIBS may be an important focus for analysis and policy. They reflect the rising importance of dynamic efficiency in an increasingly complex and changing commercial, technological and social context.

What are KIBS?

Knowledge intensive business services (KIBS) are business services that draw on knowledge related to a specific domain and contribute to the knowledge processes within the client firm. They are a subset of the wider category of Knowledge intensive services. KIBS sectors are characterized by the proportion of their employees who are highly skilled. According to EMCC (2005) about 16m workers in Europe work in the KIBS sectors, with about 3 million in the sector in both the UK and Germany.

What are the Drivers of KIBS Development?

The growth of KIBS appears to be driven both by the growing demands for specialist knowledge inputs into production and change and also to the growth of **outsourcing**. While the extent of outsourcing is expected to grow so also is the growth of offshoring – the relocation of outsourced activities to another country.

[3] As Keynes said: "I'd rather be vaguely right than precisely wrong'.

India, in particular, has a rapidly growing services export sector, which is becoming increasingly knowledge-intensive and widening the range of services provided.

The increasingly significant and pervasive use of IT in business, and the continuous change in **IT systems**, has created a demand for IT-related services from system design and upgrading to the provision of services based on the providers IT systems. Similarly, **environmental services** (design, auditing, remediation) are an increasing sub-sector of KIBS. More generally, the increasing level of **regulation** in relation to, for example, environment, health & safety, liability, has led to a need for knowledge intensive services for testing, training and auditing. It may also be the case that the incomes, flexibility and variety of working for KIBS firms is attractive to highly trained workers, giving such firms an advantage in a tight labor market.

The growth of competition and of the **globalization** of trade has also led to a growth in demand for services in such areas as marketing, logistics, business law, risk assessment and public relations.

Miozzo & Miles (2002) suggest internationalization is both a stimulus for the KIBS firms in creating new demands and also a stimulus for "KIBS firms themselves to internationalise which, in turn, creates new pressures for these firms:

- they may need to internationalise in order to follow their clients into new operating environments;
- they may internationalise to find new markets;
- they are liable to face competitive challenges from overseas KIBS firms which enter the markets of more and more countries. Trade liberalisation agreements may facilitate such competitive pressures;
- the internationalisation of KIBS also allows for direct comparison with KIBS from other countries and their practices, and to learn and improve as a result;
- some informational elements of KIBS – design and delivery of services, remote management and coordination of service processes – may be facilitated through the application of new information technologies." (EMCC, 2005, p7)

These KIBS firms are combining generic knowledge and the specific knowledge of the clients business domain, and knowledge accessed from a wide range of other domains and from prior experience, to develop solutions to a client's specific problems. In this way KIBS firms develop as conduits and knowledge transfer mechanisms in the knowledge economy.

Because of this close interaction with the client firm the effectiveness of KIBS provision is significantly related to the competencies of the client firm, and the provider and client are involved in the 'co-production' of the outcomes. The outputs of that co-production are: the service itself, the learning by the provider and the client; the enhanced capability of the client; and possibly innovation by the client. However, it is generally acknowledged that the provider- client interaction has not been sufficiently analysed to provide a general basis for understanding (Miles, 2002). Knowledge intensive services have been shown to contribute to the diffusion of new

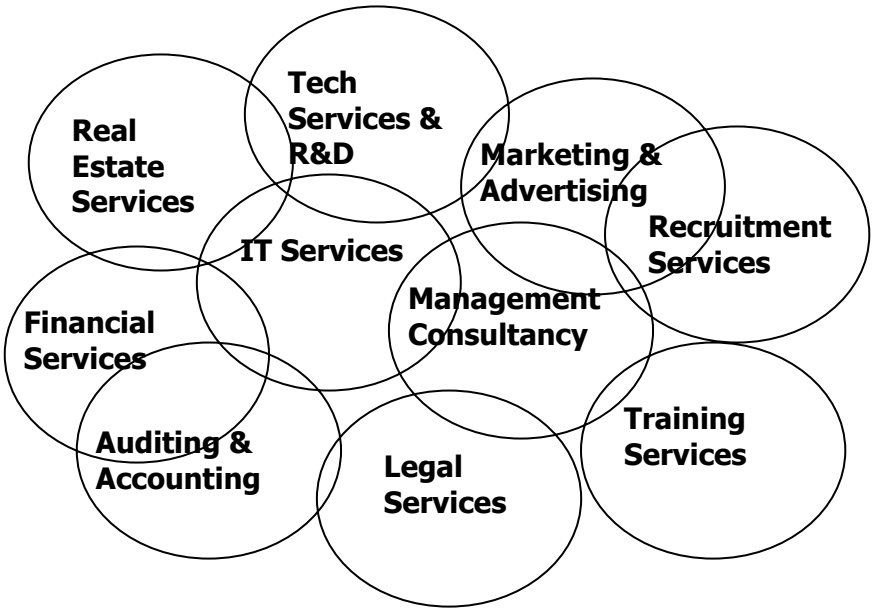
technologies and management approaches so enabling the renovation of firms. (Leiponen, 2004, Miles, 1999; Muller & Zencker, 2001)

How will KIBS Sectors Evolve in the Future?

Employment in KIBS appears to be growing substantially more rapidly than overall employment. According to Toivonen (2001) the KIBS sector in Finland grew by over 40% over the 1990s – much of this growth from technical and computer related services.

An number of trends are shaping the development of KIBS. While many sub-sectors are characterized by relatively small firms and active processes of new firm formation, increasing concentration (nationally and internationally) is evident in other sectors, such as computer services. There is also evidence of increasing convergence between KIBS, driven in part by KIBS providers seeking to standardize services wherever possible and by clients seeking integrated services. Toivonen (2004) suggests that the main patterns of convergence are those shown in Figure 1. Some commentators expect to see larger platform firms emerge, integrating a range of services, while many specialist firms will continue in niche areas.

Figure 1 Convergence Among KIBS Sectors



Toivonen- reproduced in EMCC (2005).

Internationalisation and offshoring will continue as strong shapers of evolution. Many specialist KIBS firms internationalise by following their clients, others are 'born global' as they focus on a narrow niche where markets are global. Others develop global activities or alliances with overseas KIBS firms through addressing the information needs of their national clients.

Does the Growth of KIBS Raise New Policy Issues?

KIBS is a policy issue both because of the significance of the growth of the sector, but also because of the systemic role of KIBS in the knowledge economy. KIBS are

among the most active innovators in the services sector, as well as an important influence on the innovation activities of client firms (see Miles, 2005).

There is increasing recognition of the extent to which innovation policies are oriented toward manufacturing sectors and may be far from neutral in relation to service sectors. Innovation in services typically involves less emphasis on R&D as a source of innovative knowledge, less organisation of innovation through R&D departments and managers, and more through project development teams; greater emphasis on organisational innovation; and less use of patents for IPR protection. Some European countries are developing R&D programs oriented to services sectors, but possibly only Finland has developed innovation policies focused on KIBS sectors. For the last several years in Finland ICT-using services sectors have been growing more rapidly than either ICT- producing services and ICT-using manufacturing (Kuusisto & Meyer, 2003).

The role of KIBS in innovation processes may be particularly important, particularly for SMEs and for firms in more remote or less dynamic regions. But the non-transparency of KIBS makes it hard for the potential user to asses the value of buying services from a potential supplier.

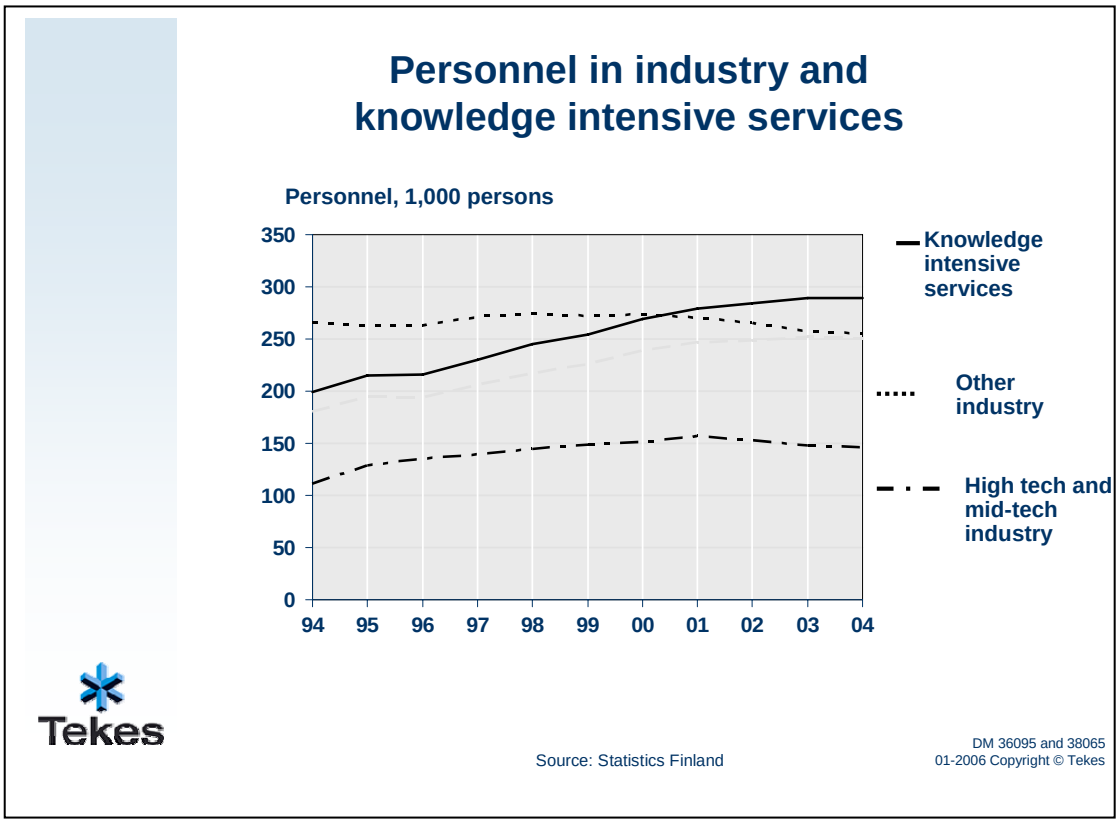
Among the policy issues that may support the development of dynamic KIBS sectors are:

- Greater support for training of high level professionals to develop competencies in the combination of managerial, interpersonal and technological skills that enable them to develop effective solutions, work in teams and interface with clients.

- Greater support for SMEs to access KIBS services through, for example, encouraging industry associations to work to bundle a range of clients to access support for shared needs, or subsidizing access to basic services in association with innovation or regulatory or sustainability objectives (as is the case through COMET, and was the case in the past through NIES).

- Support case studies of the role of KIBS in different types of change activities in different sectors, to enable potential users to asses the value of the services.

- Support systematic research on the role of KIBS in improving the flow of knowledge from public sector research organizations to Australian private and public sector organizations. The question of the role of public sector research organizations in what is increasingly a service economy is attracting increasing attention – it may be the case that the nature of change in economies makes it more difficult for them to function effectively.



5. Complements to the CRC Program.

The proposal to reorient of the CRC Program to again include Centres with 'public interest' outcomes is applauded. This is the case for several reasons: such outcomes are every bit as valuable as direct commercial outcomes, some of the most effective CRCs are of this type; the CRC model is often very relevant to research in areas such as health or the environment; and some of our major national challenges can be addressed through coordinated research and capability building in CRCs.

The draft report also suggested there may be a case for a 'more nimble' mechanisms for business – research collaboration than the present CRC program.

There is a strong case for evolving from the present portfolio of programs, based on the nature of change in technology and markets, and the features of the Australian context:

- As both competition and the knowledge intensity of innovation increase firms are becoming more specialized – both in terms of their business models (particularly their positioning in value chains) and their innovation-related competencies – and the corollary of specialization is interdependence (Scott-Kemmis, et al, 2005). Consequently, all indications point to an increase in collaboration, between firms and with research organisations;
- Collaboration along value chains for goods and service production, and collaboration for knowledge production and acquisition, are becoming more international;
- The rate of change is increasing - in terms of the growth of new knowledge, innovation, product cycles, etc, and rate of change and the uncertainty is brings means that firms external networks are both more important and less permanent, Consequently firms must build and renovate **their** knowledge/innovation systems;

- ❖ Speed of change does matter – there are often substantial benefits to being an early entrant capturing the benefits of increasing returns;
- ❖ Innovation is becoming more multidisciplinary – for example many ICT applications in service sectors involve business process, organizational and technological innovation.

These trends present particular challenges for Australian firms for several reasons:

- ❖ A relatively very high proportion of BERD in Australia is carried out in SMEs- while small firms may be more nimble they are also often more specialized and less able to monitor global market and technology trends.
- ❖ There are very few large research-intensive firms or major areas of technology intensive industry that provide strong focusing devices for knowledge generation in our universities and research organizations;
- ❖ Innovation activity is relatively highly dispersed across sectors and regions;
- ❖ We have usually not seen demand as an important aspect of innovation policy and hence have made relatively little effort to use demand (whether through public procurement or private demand shaped by regulation) as a focusing device for research and innovation [compare our approach with the SBIR program in the US Lerner, J. **The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program** *The Journal of Business*, Vol. 72, No. 3. (Jul., 1999), pp. 285-318; http://www.cbr.cam.ac.uk/pdf/SBIR%20Full%20Report.pdf]

- ❖ Innovation management and entrepreneurship are relatively underdeveloped fields in our management schools, for this reason and due to our history we have a limited cadre of managers experienced in manager innovation-based businesses;
- ❖ We have no strategic or coherent national approach to international collaboration in research – despite the increasingly international nature of research, and our distance from major international research centres. In this regard the government's slow response to the new opportunitiesfor international collaboration opened by e-Research is disappointing.

Faced with similar challenges many other countries have developed new institutions to promote and support innovation, but equally importantly to develop the competencies and linkages that enable more rapid change. One characteristic of the more successful initiatives appears to be that they have a high level of operational independence within broad agreed strategies and highly consultative arrangements. While there are many different programs and organizations the functions that they perform include:

1. Undertaking foresight and roadmapping to identify related social, market and technology trends, assess their implications for different groups, and consult extensively to develop and communicate an informed and generally shared assessment;
2. Developing research and innovation programs around identified priorities (usually linking the demand and supply side) that aim to raise awareness, develop new competencies, stimulate and link innovation to challenging demand in the public and private sectors, and build new national and international innovation-related relationships (ie institutional capital);

3. Developing an integrated innovation rather than research-centred approach designed to identify and address all of the processes and capabilities involved in the path to market – and hence facilitate the coordination of research, training, regulatory, etc policy.
4. Assessing innovation performance at the technology and sectoral level and hence developing an understanding a of regional, sectoral and national innovation systems.

The TEKES in Finland provides an exemplar of what appears to be a very successful model.

Finnish Funding Agency for Technology and Innovation (TEKES)

http://www.tekes.fi/eng/

http://www.tekes.fi/eng/publications/Policies2005.pdf

TEKES has three core activities:

1. Services to Stimulate Innovation – expert advice in innovation awareness, management and planning.
2. Technology Programs – foresight and roadmapping to identify opportunities in significant application and technology areas and the development of national and international collaboration in these priority areas;
3. Selective Project Funding – support of projects that create new competences.

In 2005 TEKES dispersed 430m Euros, contributing to 2,134 projects with a total cost of 811m Euros: 250m in companies and 179m in universities and research organizations. Funding went to 1,174 companies and over half of the funding to companies went to SMEs.

TEKES stimulates and supports challenging projects proposed by companies, research institutes and universities. These projects account for about half of TEKES funding – the other half is directed to technology programs in selected focus areas. - 25 were in operation in 2005, involving 2000 companies and 500 research units. These focus areas involve both application areas and technology areas (see figures below) and a particular priority is linking these – and also relating to geographical concentrations of research and industry.

Many projects are run by companies and companies are usually part of the teams on projects carried out jointly with universities and research organizations. Focused support is provided for start up and commercialization through loans, grants and expert support. TEKES also provides assistance to companies in sourcing knowledge and developing technology plans and research
Funding assistance to companies can be a loan or a grant up to 50% of project costs. Research grants to universities and research organizations can be for 50 to 100% of the costs.
Projects encourage collaboration between firms and research organizations and between large firms and SMEs.
TEKES develops international cooperation in its research projects and in 2005 almost 40% of projects were internationally networked.

TEKES has an Innovation Centre in China that acts as a network linking Finnish and Chinese companies, universities and research institutes.

FIGURE 3. APPLICATION FOCUS AREAS

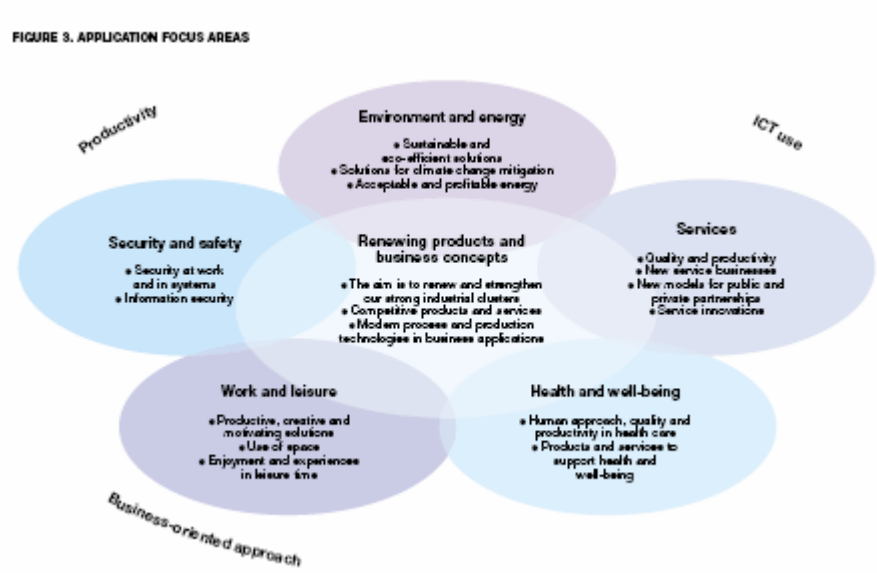
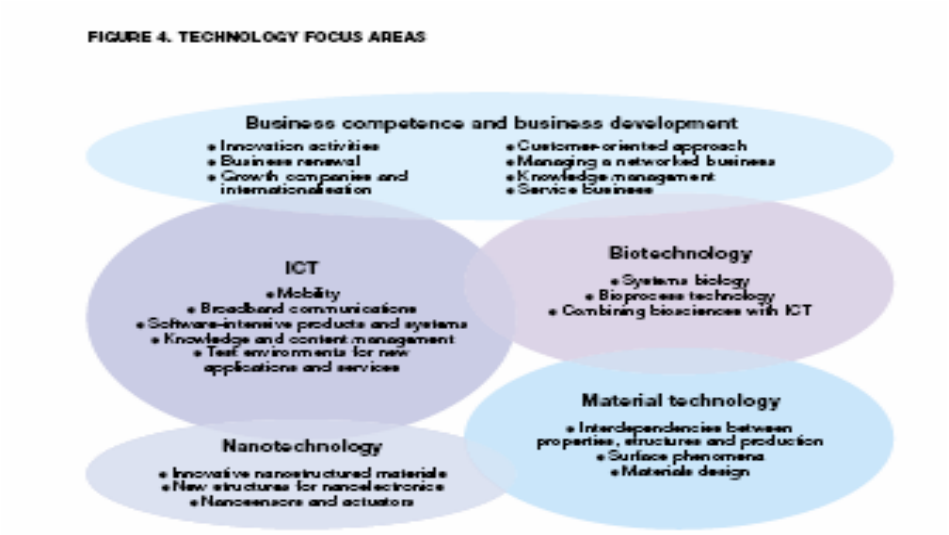


FIGURE 4. TECHNOLOGY FOCUS AREAS



There is a strong case for developing a functionally similar organization in Australia to complement our existing organizations and programs. Funding for such an initiative could be drawn by the transfer of some of the funding from the Commercial Ready Program, the CRC Program, the NHMRC, international S&T programs and the ARC Linkage Program. Initially the only new funds required would be those for development of the core functions of the program.

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http://www.isi.fhg.de/publ/downloads/isi01a02/kibs.pdf

Appendix A

Sectoral Approaches to Industry / Innovation Policy

The dynamics of innovation, the critical innovation policy challenges and the stakeholders (who play a part with government in analysis, policy development and policy implementation) vary significantly across sectors. A sectoral or technology orientation to innovation policy can serve as a focusing device for the design and flexible implementation of a suite of general programs. The increased emphasis on sectoral approaches arises in part from the nature of change in economies and in part from the changing views about the rationale for innovation policy.
There are three reasons for the renewed debate about the appropriate rationale for intervention in the market-based economy (Chaminade & Edquist, 2006; Rodrik, 2004):

- The market failure theory is the generally accepted basis for intervention in the market economy, but it provides little guidance to policy makers in determining the level or focus of intervention to correct 'market failures'. While the theory provides only general policy implications and tends to support horizontal economy-wide interventions and to focus on the research and invention aspects of innovation. The foundations of the theory rest on assumptions that are unrealistic and as a result give rise to policy interventions that are often ineffective. In particular, the assumptions that knowledge is information and that all economic agents have perfect information is at odds with the central dynamic of innovation and competition in a market based economy – competence in all of its forms is clearly unevenly distributed among firms. Where knowledge is the most important resource and learning the most important process, a theory that assumes away such resources and processes is an inappropriate base for policy – see Table 1 (Lundvall, 2006).

- The systems of innovation approaches has had an increasing influence on innovation research and policy over the past decade. It focuses more on the overall system that creates and distributes knowledge than on the actions of individual firms. It recognizes the role of tacit knowledge (which is not information) and (as discussed above) the essential role of asymmetric knowledge in innovation and competition – such asymmetries are market failures in the neo-classical framework. It also emphasizes that firms do not innovate in isolation but that interaction is a characteristic of innovation. Such interaction involves both market-based and non-market relationships and is shaped by a wide range of institutions. Recognising that the market is only one of the institutions that play a major role in innovation, this approach emphasizes the role of intervention in addressing systemic problems where the market mechanism is not effective (see Table 2) - typically at the early, and fast growth, stages of the emergence of new sectors or adjustments to major shifts in general purpose technologies. However, it is important to recognize that it is increasingly difficult to define the boundaries of a sector and this blurring of sectoral boundaries is likely to continue.

- The historical evidence shows that government intervention has played a vital role in the emergence of major new technologies and sectors – this is well recognized in the case of biotechnology and IT in the US. As the issue of

structural change and innovation-related competition becomes more important, policies have become more concerned with the capacities of economics (and innovation systems) to renovate and to generate new capabilities and sectors.

Table 1 Frameworks for Innovation Policy

	Neo-Classical	Systems of Innovation
Underlying assumptions	Equilibrium Perfect information	Non-equilibrium Asymmetric information
Focus	Allocation of resources for invention Individuals	Interactions in innovation processes Networks and Framework conditions
Main policy Main rationale Government intervenes to (examples)	Science policy (research) Market failure Provide public goods Mitigate externalities Reduce barriers to entry Eliminate inefficient market structures	Innovation policy / Systemic problems Solve problems in the system or to facilitate the creation of new systems: Induce changes in the supporting structure for innovation: support the creation and development of institutions and organizations & support networking Facilitate transition and avoid lock-in
Main strengths of innovation policies designed under each paradigm	Clarity and simplicity Long time series of science-based indicators	Context specific Involvement of all policies related to innovation Holistic conception of the innovation process
Main weaknesses of innovation policies designed under each paradigm	Linear model of innovation Framework conditions are not explicitly considered in the model (e.g. institutional framework) General policies	Difficult to implement in practice Lack of indicators for the analysis of the IS and evaluation of IS policies

Source: Chaminade and Edquist, 2006

Table 2: Types of Systemic Problems – Broad Categories

- *Infrastructure provision and investment problems*
- *Transition problems*
- *Lock-in problems*
- *Hard and soft institutional problems*
- *Network problems*
- *Capability and learning problems*
- *Unbalanced exploration-exploitation mechanisms*
- *Complementarity problems*

Source: Chaminade and Edquist, 2006. See also O'Doherty and Arnold, 2003.

The study of innovation processes has shown the differences across sectors in the sources of innovation, the characteristics of the process, the actors involved, the

nature of interactions, the role of public sector research and the organization of innovative activity. (Malerba, 2005).[4] At the same time the growing focus on the role of institutions in economic growth and change (eg Soskice & Hall, Varieties of Capitalism) highlighted both the marked and persistent differences in sectoral composition among economies and the extent to which the performance of sectors was related to the characteristics of national institutions – as well as to chance events and subsequent path dependence. For example, despite the emphasis on promoting biotechnology in many countries it is recognized that the characteristics of the US economy and society that, among other things, encourage entrepreneurship provide a favourable environment that is very difficult to replicate in other countries.[5]

Again, this perspective emphasizes that systemic problems are usually sectoral – such that the particular problems may only be important in some sectors or that the specific nature of the problem may vary significantly between sectors. Similarly, this perspective emphasizes that the impact of horizontal policy may differ greatly across sectors – neutrality is often unintended selection.

Implications

Once the policy framework departs from the model of an economy based on perfect competition, complete knowledge and the attaining of equilibrium, the role of the policy maker moves to a role focused on continuous adaptation in the context of uncertainty and change. This is particularly important because intervention is most important and effective at the early stages of the emergence of new sectors/technologies – when uncertainty and risk limit private investment.

There are four major implications that follow from this perspective:

1. An emphasis on intervention to address systemic problems, and particularly new activities, leads to a focus on **selectivity** – ie to addressing specific problems generally associated with the emergence and diffusion of new **technologies** or the development or significant renovation of **sectors**. From this perspective the additionality criteria refers to the role of policy in addressing the systemic failure, and not increasing the profits of individual firms.
2. Systemic innovation and industry policy focuses on facilitating change in whatever dimensions of the context are relevant to the creation, acquisition, diffusion and application of knowledge. Consequently, it is recognized that one of the key challenges for innovation policy is managing coordination – the policy governance challenge. Innovation is systemic and as innovation becomes a more important policy focus, relative to static efficiency goals in an increasingly complex and changing world, horizontal coordination becomes a key capability. Such coordination seeks to integrate a range of policy domains: regulation, education, research, industry measures, etc. Without such an approach the systems of innovation policy framework is only window dressing.

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[4] One consequence of this is that the relevance of specific indicators of innovative activities varies markedly from sector to sector to the extent that aggregate national indicators are often of limited meaning.

[5] . In general, entrepreneurship in new activities has high social returns – in the context of an economy such as Australia typically higher than private returns.

3. As we recognize that policy making involves continuous adaptation we see also that it involves continuous learning. This emphasizes the importance of three other issues: the necessity for a close connection between policy making and policy delivery, and the key role of evaluation as a mechanism of learning rather than reporting.

4. The necessity for the policy making organization to have significant degrees of freedom in the design and implementation of policy – within frameworks and goals set at a higher level in government.

This leads to four specific challenges for policy

1. While there may be a suite of more of less general intervention mechanisms (R&D support, support for business services, training) the mobilization of those should be through sectoral and technology programs that integrate a combination of initiatives to address specific objectives – ideally including mechanism/measures from a range of portfolios. Coordination across programs and between business and government organizations will be more effective and realizable at a sectoral or technology level, where all stakeholders have accountability to other stakeholders at that level.
2. The development of sector/technology programs should be the result of extensive consultation with a wide range of actors (cf Action Agendas) and substantial analytical efforts such as the 'roadmapping' exercises of an increasing number of firms, research organizations and funding agencies – to the extent that criticisms of bureaucrats picking winners would have no relevance [6];
3. The focus of programs should be on supporting new activities where market mechanisms are weakest but externalities/ additionality is highest;
4. The entity developing and implementing sector/technology programs should have a high level of independence but a high level of governance and accountability in pursuing high level goals.

An example of an innovation policy initiative that has been designed from an innovation systems perspective is VINNOVA in Sweden, which promotes innovation systems at a national, sectoral and regional level, noting that the interaction between these levels is often vital for growth. VINNOVA develops most of its specific initiatives on foresight exercises that involve a wide range of actors in discussion of emerging technologies and growth opportunities. This leads to a major focus on the emergence of competencies and links in new activities, as shown below;

Table 3: VINNOVA: Priority Growth Areas

Growth areas	Sectors
Telecom systems Micro and nanoelectronics Software products	Information and communication technology

[6] National priority setting and policy initiatives that are not developed through transparent and participatory processes not only have little credibility, but erode the integrity of the innovation policy system.

E-services in public administration IT in home healthcare The experience industry	Services
Pharmaceuticals and diagnosis Biotech supply Biomedical engineering Innovation in foods	Biotechnology
Complex and assembled products Wood manufacturing Intelligent and functional packaging	Manufacturing
Light materials and lightweight design Material design, including nanomaterials Green materials form renewal resources	Materials
Innovative vehicles and systems for different transport modes Innovative logistics and freight transport systems	Transport

Source: VINNOVA

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