the case for a public role in innovation

Taxpayers demand that their money is well spent, so when it is proposed that a program of public spending or the provision of subsidies should be undertaken, a clear case has to be made. The purpose of this chapter is to make an 'in principle' case which is drawn upon in developing specific recommendations in this Report. Supporting innovation is somewhat different to other investments that governments make in that the returns are medium to long term and difficult to quantify ahead of time. Only a small proportion of entrepreneurs and innovators succeed but their successes can be so large that they outweigh the costs of failure. Indeed, in the innovation process, the failures are just as important as the successful because, without their willingness to experiment and risk their capital and the capital of others, there would be no innovation process. The role of government is to encourage them to do this. In the first part of the chapter, the theoretical case will be made and the supportive evidence overviewed. In the second part, the key design principles that policy makers have to follow, to ensure that their strategies are likely to be effective, are identified.

The Theoretical Case for Public Intervention

A case for public innovation policy relies on identifying areas where intervention in the innovation system can generate enough improvement in the outcomes to outweigh the costs associated with public intervention. A fundamental challenge is to identify reasons why such intervention will improve on the outcomes generated by individuals and firms operating freely and interacting through markets.

The case rests largely on those properties of information and ideas which are central to all forms of innovation.

- *Knowledge is non-rival*. An idea, unlike a consumer good or service, has to be produced only once and it can then be used many times without detracting from its value. Toyota does not have to reinvent the blueprint for the hybrid engine every time it opens up a new manufacturing plant.
- *Knowledge is cumulative*. The current stock of knowledge provides the fertile ground from which further research develops new knowledge.
- *Knowledge is reproducible at negligible cost*. With recent developments of computer and communication technologies, digitised knowledge can be reproduced and transmitted at close to zero cost – for example recordings of music or online journals or analysis of the principles behind the hybrid engine.
- *Knowledge is only partially excludable*. Inspection of patent applications and reverse engineering can reveal most of the information in product innovations. Toyota may be able to patent specific aspects of the manufacturing design of its hybrid engine, but it is not possible to stop others from utilising freely the idea of transferring the energy generated by braking a vehicle into stored energy that can then power the vehicle, energy that would otherwise have been dissipated as heat.
- *Knowledge is an intangible asset*. It is not a tangible asset that can be recovered by an investor in the way that a building or a machine can be recovered.
- *The generation of new knowledge involves fundamental uncertainty*. Most investments involve risk which is quantifiable, but by definition the generation of new knowledge takes us beyond what we know and can quantify into the area which economists refer to as irreducible uncertainty. In the famous and lucid words of Donald Rumsfeld, research takes us into the area where

  > *there are also unknown unknowns, the ones we don't know, we don't know.*[1]

These properties of knowledge have profound implications for the economics of the knowledge economy. The cumulative nature of knowledge, its non-rivalry and cheap reproduction imply that it is socially efficient for knowledge to be made freely accessible so that diffusion of innovation can occur as quickly and cheaply as possible. On the other hand, the difficulties of exclusion imply that innovators

1 *US Department of Defense news briefing*, 12 February *2002, http://www.slate.com/id/2081042/*

will not reap the full rewards stemming from their innovation because competitors will be able to copy it and erode some of the profits through competition. This provides arguments in favour of strong patent rights to provide strong incentives for innovation. Patent protection, however, creates monopoly pricing power which leads to inefficiently low levels of production and slower diffusion.

This is a classic market failure problem which does not lend itself to a universal solution. The most common pattern of public intervention is for government to fund basic research on the condition that the results are freely distributed, whilst commercial innovation is granted limited patent protection. Patent protection provides only partial excludability, however, as rivals are able to use the information from the patent application as an input into their further research, and rival firms are sometimes able to benefit freely from the observable generic aspects of an innovation. These spillover benefits provide justification for the partial subsidy of commercial innovation.

The intangibility of knowledge renders it problematic as collateral for financing. A bank that will lend money for investment in a house, which can be repossessed in the case of default is much less likely to finance education where there is nothing tangible to repossess. This classic failure of financial markets provides a major rationale for the public provision of education – in the absence of which only the children of the wealthy would be educated. It also provides a rationale for governmental support of venture capital markets where start-up firms lacking physical assets (other than, in some cases, the family home) are strongly disadvantaged in their search for investment funds. An alternative to public support in this market is for innovators to sell their ideas to established and well-capitalised firms, but here they face the problem of asymmetric disclosure. To persuade the established firm of the value of their ideas the innovator has to partly disclose these ideas, thereby allowing the prospective purchaser to walk away from the deal with free and useful knowledge.[1]

This last example highlights something more than market failure. Rather it is the absence of a market. When it comes to selling a new idea, there may well not be a functioning marketplace where the idea can be fairly assessed and potential purchasers make transparent and binding bids. Rather the innovator can find themselves in the position of bargaining with an incumbent who has far more bargaining experience, expertise and resources. The asymmetry of information disclosure may also lead to broader failure in the

2 For a discussion of these and other problems in the 'market for ideas' see Joshua S. Gans and Scott Stern, The Product Market and the 'Market for Ideas': Commercialization Strategies for Technology Entrepreneurs, Research Policy, Vol.32, No.2, February, 2003, pp.333-350.

innovation system where potentially productive partnerships between firms fail to be realised despite the complementarity of their assets – one firm with the innovative ideas, another with the development and marketing expertise.

A further source of systemic failure in financial markets arises out of the fundamental uncertainty and path-dependency associated with innovative research and development. Not only is the outcome of a particular project unknown, but there may be a host of other competitive and complementary projects whose existence and outcomes are unforeseeable. For example, there may be definable risks and probabilities associated with research and development into solar power generating devices. But their commercial success will be dependent on complementary developments in the technology of electrical storage and on unforeseeable developments in hitherto unthought-of alternative generating technologies. Such fundamental uncertainty may render individual projects uninsurable and unfinancable. The system-wide returns to a diverse public portfolio of innovative research and development, however, may well be sufficient to make a case for public support and investment.

In the case of global public goods, such as the development of technologies to reduce greenhouse gas emissions, the case for public intervention is an international one and individual governments should be seeking international agreement on strategies for collaboration and specialisation.

Beyond the role of government in subsidising private sector R&D and responding to failures in the venture capital market, the case for further forms of subsidy or intervention in business innovation is problematic. One view of innovation policy, based on European policy experiences, is that its purpose is to directly encourage the development of innovative capabilities in firms[1]. In this view, effective innovation policy assists in building a range of capabilities in firms to help them learn about, search for, connect with and apply innovations – and doing so in a way that develops the ability of target firms to absorb and internalise these capabilities, thereby reducing the requirement for ongoing policy support. This perspective argues that governments should develop policies to build innovative capabilities for a number of reasons. First, the renewal and extension of innovative capabilities underpin the performance of firms, and decline is inevitable without their replenishment and augmentation. Second, innovative capabilities are unequally distributed; there are often significant gaps between actual practices and real possibilities. Third, innovative capabilities

1 Dodgson, M. and J. Bessant. *Effective Innovation Policy: A New Approach*. London, International Thomson Business Press. 1996.

can be learned. Firms, whatever their size and sector, can improve their performance and notions of learning play a central role. A primary target of innovation policy is to facilitate such learning.

Evidence on the public good nature of research and development

To the extent that benefits spill over to the wider community from research carried out in universities and in public and business laboratories, there is a strong justification for public support of that research. A very large number of studies have been conducted over the past few decades investigating the evidence on spillover benefits arising from research and development activities.

In Annex 4 (Evidence on the Economic Impact of Research and Development) we review these studies in some detail, and the highlights can be summarised as follows.

- Businesses benefit substantially from research carried out in government agencies and universities. This research generates knowledge and builds the skills of the graduate workforce.
- Large firms which have sufficient scale to run their own laboratories find having their own R&D activity is particularly important.
- Smaller firms benefit from the knowledge created in publicly funded research.
- The effectiveness of public research is enhanced by geographical proximity to private sector research laboratories.
- Businesses receive substantial productivity benefits from the research carried out in other firms - within their own industry, in other industries and internationally.
- Productivity growth in small countries like Australia requires the capability to adopt and adapt the 98 percent of new knowledge which is generated in other countries.
- Successful absorption of innovative ideas is heavily dependent on both trade with research intensive countries and on a country's own research capability.

The dual role of domestic R&D in promoting not only domestic innovation but also technology transfer from overseas is particularly interesting. Quoting from Griffith, Redding and Van Reenen:

> *By actively engaging in R&D in particular intellectual or technological fields, one acquires .. tacit knowledge and can more easily understand and assimilate the discoveries of others. ... In other words, R&D is as crucial for technology transfer as for innovation and plays a role in developing 'absorptive capacity'.*[1]

The importance of own R&D for the acquisition and implementation of foreign-sourced technology is confirmed by Guellec and van Pottelsberghe de la Potterie[2]. They suggest that the most important criterion for effective absorption of particular technologies is active domestic research in the cognate field. The authors conclude:

> *If firms from a country want to take full advantage from international spillovers, they have to spend on R&D; the free rider approach clearly does not work.*

Design principles for innovation programs

Once a case has been made successfully for public intervention in the national innovation system, it is crucial that program design be addressed carefully following key principles.

Clarity about the problem to be solved.

Is there a clear and unambiguous statement of objectives and rationale? Does the policy or program target the problem effectively?

Inducement effect (additionality or behavioural change)

Is it clear how policy or program incentives will affect behaviour? Will it induce the desired new or different activity? Is it likely to have acceptable take-up? Is the scale of the program consistent with the desired outcomes?

Contestability and transparency

Should there be contestable funding arrangements? Deliberate choices should be involved in deciding between contestable or non-contestable arrangements.

Consistency and strategic fit

What are the possible interactions with other policies? Where does this policy fit within the overall policy portfolio?

1 Griffith, R. Redding, S. and Van Reenen, J., Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries, Review of Economics and Statistics 86: 883-895 (4, Nov 2004).

2 Guellec, D. and van Pottelsberghe de la Potterie, B., R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries, OECD Economic Studies 33: 103-126 (2001).

Duration

How long would the program need to be in place to produce the desired outcomes, or to produce sustainable results? It is also worth considering whether there is scope or benefit in program 'tranches', as in a venture capital model of migration through a development cycle. Finally, there is the matter of having a planned exit strategy.

Calculated risk

The basic element of risk criteria is understanding the nature of risks, and the difference between risk and uncertainty. There are some special aspects to risk which are usefully addressed by design principles.

(i) Adverse interactions with other programs

- This calls for attention to the possibility of conflicting signals arising from different programs or policies.

(ii) Unforeseen liabilities for government and 'moral hazard'.

- The biggest pitfalls arise from inadequate attention to possible 'contingent liabilities' for government, or the 'moral hazard' of policies which might leave government captive to the claims of sectional interests.

(iii) Strategic behaviour by firms

- This is code language for the risk that firms and beneficiaries may be able to 'game' the system. Poor program design may leave the way open for unexpected behaviours, some of which might undermine the integrity of a policy.

Administrative and compliance efficiency

While this is an obvious design principle, it is frequently ignored in practice. Problems arise when there is a mismatch between the inventive instrument or funding mechanism and the administrative framework. An example would be where a small grant program involves complex application and assessment procedures. A proportionality principle should apply.

Accountability and transparency

The strongest mechanism to promote accountability and transparency is the timely and open reporting of activity. The default position should be full public disclosure unless there are sound reasons for the introduction of limitations (such as the privacy implications or commercial sensitivities of a program). Where commercial sensitivities limit disclosure there should be robust independent audit processes to provide assurance about the integrity of programs.

Evaluation, monitoring and reporting.
The key principles here are:

- the development of the evaluation criteria and reporting requirements ex ante;
- a requirement for ex ante and ex post performance data; and
- the independence of the review function as an 'audit' process.

These design principles are further detailed in Annex 4.

In summary, the case is strong for public intervention to provide support for the development of innovative capacity and to aid the diffusion of innovations. Typically, markets either fail, or simply don't exist, when there is a high level of uncertainty about the future, as there often is in the case of innovation. In such circumstances, government can play a pivotal role in facilitating innovation and providing the basis for strong productivity growth and increases in the standard of living in the future. Of course, the presence of uncertainty also means that there are risks for governments in supporting innovation: money can be wasted unnecessarily and we can find examples of this in the past, both in Australia and overseas. This is why it is so important to adhere to a consistent set of design principles in developing an innovation policy. At the present time, Australia has a large number of policies to stimulate innovation that have been developed in a fragmentary and inconsistent way. This must change if we are to have a set of policy instruments that is both highly effective and economical.