# Investing in Innovation: Overcoming the Barriers

**A paper prepared for the**
**Foundation for Research, Science & Technology**

by

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***Executive Summary***

## Introduction

This paper examines and discusses barriers to innovation – both policy and systemic – and the scope for effective government interventions to reduce them. A key purpose of the paper is to promote discussion on how the policies, funding activities and resources of Government – and the Foundation for Research, Science & Technology (FRST) in particular - might be used to facilitate and encourage innovation in New Zealand.

# Section 1. Innovation and Economic Performance

## Defining Innovation

There are various definitions of innovation. The choice of definition may significantly affect both the understanding and choice of policies for "investing in innovation". FRST should specify a definition of innovation to ensure clarity and consistency in its policy development.

Innovation, or innovative capacity, underpins the achievement of each of the economic, social and environmental goals for Vote: Research Science & Technology (RS&T). This paper concentrates on the role of innovation in relation to economic growth. Although there are some similarities, concepts of innovation applied to RS&T expenditures in the social and environmental fields involve a number of very different issues. FRST would benefit from having a discrete innovation policy framework for each goal.

## Innovation and Business Strategy

There is often a fine line between successful innovation and good business strategy. FRST must be able to delineate between encouraging and supporting innovation and simply subsidising new business ideas. This distinction may prove much harder to make in practice than the corporate goal of "investing in innovation" may first suggest.

Confusing the two concepts may not only lead to unsound policy, it may also create problems in the separation of roles with other agencies, such as Industry New Zealand and the Ministry of Economic Development. From a public policy perspective, strategies for encouraging innovation are much too important for New Zealand's long term economic well-being to risk becoming confused with other ad hoc interventions.

## Innovation, Technological Progress and Globalisation

Improvements in technology ("technological innovation") play a fundamental role in increasing the productivity of labour and capital. By international standards, recent improvements in productivity in New Zealand have been modest, if not comparatively poor.

Empirical evidence suggests not only insufficient private sector investment in R&D, but an inability to transform publicly funded investment into commercially successful innovation.

In New Zealand, most private firms and individuals lack the resources to research and develop path-breaking "transformational technologies". Nonetheless, there are substantial opportunities for innovative firms and individuals in smaller economies to exploit the disruption created by the new waves of technology developed elsewhere.

In many cases, some of the information necessary for exploiting market opportunities created by these new technologies (and their derivatives) is already freely available. The key requirements for creating wealth from those opportunities are therefore an abundance of people with the expertise and knowledge for accessing, understanding and adapting information, plus the entrepreneurial commitment and expertise to commercialise successfully the resulting innovations.

FRST might therefore well ask: W*hy has New Zealand's high quality science over the last two or more decades failed to produce as much high quality innovation?*

## Section 2. Overcoming the Barriers to Innovation

### Policy Framework

Innovation policies are increasingly recognised as important factors in economic performance. However, there is much less agreement about what those policies should comprise. This paper proposes a two-pronged strategy:

1. At the macro level, policies which target the general environment for innovation, including national culture, attitudes to innovation and general economic policies;

2. At the micro level, policies which target specific barriers to building and using innovative capacity amongst firms, organisations and individuals, including educational policies, financing for innovation, technology transfer from publicly funded researchers, human capital development and business capabilities and information.

### Improving the Environment for Innovation

There is no doubt that "the best thing governments can do is to create the right climate for innovation". That climate comprises behaviours and attitudes, plus the broad economic policy settings of government within which commerce operates, and innovation occurs. Developing and maintaining *a culture of constant innovation* is now even more critical to wealth generation. In fact it is a matter of considerable urgency for New Zealand. Notwithstanding the high quality of much New Zealand science, there is substantial evidence from income, productivity and technology intensity data that New Zealand has been falling behind most developed countries in recent decades. Indeed, the question to be asked is "why is the New Zealand economy falling behind when the quality and public funding of science has generally been so high?"

The key characteristics of an innovative culture are:

- A strong ethos for encouraging and celebrating creativity
- Strong social and political recognition of the fundamental importance of a highly competitive business sector to all forms of national well-being
- A propensity for taking risks
- A strong belief in the ability to compete and succeed
- A strong ethos for encouraging, celebrating and rewarding high achievement
- Social and commercial recognition that encouraging innovation also implies tolerating, rather than punishing, occasional failures in research and business.

FRST has a key role in promoting policies and attitudes that help build a culture of constant innovation. Part of this task involves developing the community's understanding and appreciation of the high value of entrepreneurial commitment and skills as a necessary complement to the innovative process.

In promoting these cultural features, there is a need to correct perceptions that innovation is something that comes predominantly from the science sector, or that the innovation will be generated simply out of increased networks between researchers and industry. Publicly funded R&D has a role to play, but much of New Zealand's innovative potential lies within the talents and skills of existing managers and employees in firms and organisations.

**The Economic Policy Environment**

FRST - perhaps alone amongst Government agencies – has a capacity and a responsibility to identify and explain policies that specifically impact on innovation. Adopting a well-informed advocacy role is especially important at the present time when aspects of the current economic policy framework in New Zealand appear strongly inimical to innovation and to the retention of innovative capacities. FRST will need to determine how and to what extent it should allocate resources to monitoring, commenting, advising on and influencing the impact of general economic policies on Government's innovation objectives.

Smaller countries like New Zealand need to go beyond just having a neutral or moderately supportive policy framework to one in which policy-related obstacles to innovation are decidedly lower than in the rest of the world. FRST needs to build a coherent vision of what a highly innovative economy and society should look like in, say, 2010 as a benchmark against which to measure policies and progress in New Zealand over the next ten years.

The broad economic policy framework and conditions that are most likely to be supportive of innovation comprise the following key elements:

- A policy environment which unambiguously supports business and encourages economic growth.
- Comparatively low and stable – if not declining - business and personal income tax rates.
- Tax policies relating to private sector investment in R&D which are at the very least comparable with other countries, especially Australia.
- Reduced compliance costs for business, especially small business
- A competitive and regulatory framework which recognises the importance of innovation and the need to stimulate enterprise.
- Labour market and education policies which recognise that the utmost flexibility and creativity is essential for eliciting innovative potential and for aligning employment needs with transitory commercial opportunities.

However, simply advocating the importance of liberal economic policies for encouraging innovation may have little impact. FRST should approach the issue systematically; for example, by commissioning a series of projects to develop comprehensive policy recommendations in each of the above areas. Policies for regulatory reform aimed at promoting innovation and new investment amongst smaller firms – based on recent OECD work – would be good place to start.

**Directly Reducing Barriers to Innovation**

***The Education Sector***

Successful innovation requires an abundance of talent and an environment to support it. Few students emerge from secondary or tertiary education with a strong appreciation of the value of innovation in commerce and its contribution to building economic wealth. Employers also cite the general dearth of graduates – across many disciplines – with the requisite knowledge, skills and attitudes for taking innovative approaches to problem solving.

Most would agree that innovation cannot be "taught". Nonetheless, there may be several ways of improving the quality and impact of education in this respect. These include:

- targeting and involving the education sector as a key stakeholder in the design and implementation of innovation policies in education;
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- developing teaching modules for raising secondary school students' awareness of innovation: what is it, who uses it, what knowledge/skills/thinking processes are involved;

- applying the techniques of innovation to other components of the secondary curriculum;

- establishing enterprise and innovation scholarships for teachers;

- establishing and monitoring the achievement of targets for the numbers and ratio of computers and other advanced technology in classrooms (the latter being a matter of important specification not yet adequately focused on in any country);

- formally incorporating concepts, tools and opportunities for innovation and entrepreneurship in tertiary studies in science, commerce and technical disciplines;

- amending tax deductibility rules to treat all education and training expenditures equally.

***Technology Transfer***

Technology transfer - or "technological learning" - the process by which research and innovation are translated into commercially successful outputs, is at the core of FRST's interests and funding activities. The technology transfer model underpinning FRST's current funding activities relies heavily on cooperative relationships between publicly funded searchers and commercial users. However, the incentives facing these two groups are frequently not aligned. It's time to revise this model.

FRST needs to set targets for significantly reducing the focus of its funding activities from independent research providers to funding users and brokers (who may be existing research institutions) over the next three years. Effecting this re-allocation of funding could involve:

- An audit of current funding commitments to establish which research activities are genuinely innovative and have a predominant and direct commercial focus.

- Developing new instruments – possibly on a pilot basis initially – for funding innovative research and development proposals from commercial users and "knowledge brokers".

- Identifying longer-term research in which NZ providers display international leadership and comparative advantage, but which are still innovative and commercially relevant.

***Venture Capital***

The availability of venture capital is probably much less of a barrier to innovation in New Zealand now than previously. Although the amounts of available capital are not large - some industry estimates put it at about NZ$500 million currently – obstacles to financing relate more to the inadequate numbers and quality of project proposals.

Increased public funding for new ventures is not the answer: it may only reduce the number of viable projects available to private financing, generate problems of adverse selection and raise issues of mandate and delineation with other agencies. Rather, FRST should explore the viability of schemes that make the provision of existing financial resources and expertise easier and more effective, e.g.:

- local adaptation of the Swedish private sector Internet-based "Innovation Market" for venture financing;
- a private sector organised and operated "business angels" programme
- "one-stop shops" for assisting innovators to acquire financing and commercial or technical support.

At the same time, private venture capital does not meet all current needs for financing innovation. FRST should look at the best ways for closing the gap at the short-term end of its funding activities – ie between its NERF and traditional PGSF instruments which have mainly longer-term funding cycles and its near-to-market interventions such as TechNZ.

***Business Capabilities and Information***

One of the major shortcomings of business innovation in New Zealand is that many ideas are strong on technology but lack a market focus. In general, there is a low appreciation of how to get from "concept to market". Only 30% of New Zealand firms have an R&D policy and even fewer have an R&D budget.

A role for FRST therefore lies in educating and encouraging the business sector to systematically identify and pursue their innovative capabilities. Formulating strategies to develop this innovative potential should not be too difficult in a situation in which the total population of relevant industries – in some cases individual firms and organisations - is small enough to be individually known and case-managed.

Other measures could involve:

- Adapting the Australian Commercialising Emerging Technologies (COMET) programme to NZ industry and needs.

- Providing the business sector with information on – and possibly funding services for - benchmarking against international best practice in innovation.

- Investigating pilot schemes for unlocking existing innovative capacity and potential in the private sector – eg. supporting larger firms/organisations to allocate experienced senior managers as mentors or company "angels" to innovative and related small firms, start-ups or potential spin-offs.

- Improving New Zealand's international image and credibility as a source of technologically innovative services and products.

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## Introduction

This paper examines and discusses barriers to innovation – both policy and systemic – and the scope which may exist for effective government interventions to reduce them. However, in order to understand how these barriers occur, and how they may be overcome, it is first necessary to focus on the question of how innovation contributes to economic growth in general, and in New Zealand in particular.

A key purpose of the paper is to promote discussion on how the funding activities and resources of the Foundation for Research, Science & Technology (FRST) might be used to facilitate and encourage innovation amongst New Zealand firms, organisations and individuals. In accordance with the brief, not too much attention has been paid to whether the range of possible interventions discussed are within FRST's current mandate, or are more rightly the domain of other agencies of Government. Rather, the aim has been to see what, if anything, Government can do.

Precisely how the ideas and opportunities presented here can be converted into effective interventions - investment strategies or policy instruments - by FRST will be the focus of subsequent stages of analysis and discussion. Nonetheless, every effort has been made to present this discussion of the challenges in ways which could provide specific guidance to that process and therefore to FRST in implementing its key strategic objective of "Investing in Innovation".

*In most cases, the ideas and challenges presented here have been summarised in Italics in the text as "Discussion Points" in order to draw attention to them and to suggest a focus for further analysis and discussion.*

The analysis and discussion contained in this draft paper is based largely on a review of a number of documents, papers and texts discussing various aspects of innovation systems and policies, both in New Zealand and internationally. A bibliography of these sources is included.

This paper has not used primary research as a means of supporting the analysis and conclusions presented here. Such research may have involved considerable time and cost, yet be unlikely to alter significantly what is already known about the innovation process. Nonetheless, the paper identifies one or two areas where subsequent focused research could be valuable for better defining characteristics of the actual firms and processes involved and hence the design of specific public policies and/or public investment strategies.

The paper is divided into two sections. Section 1 discusses what is meant by "innovation" and aspects of its relationship to economic growth and development. Although quite general in nature, this discussion is nonetheless essential to the presentation of arguments and ideas in Section 2 for how Government might intervene to overcome barriers to innovation.

## Section 1: Innovation and Economic Performance

### 1.1 Defining Innovation

Innovation can be broadly defined (The Economist, 1999) as simply "*the creation of improved processes and products and/or better ways of marketing and distributing them"*.

One problem with this definition is that it does not adequately reflect an important distinction in the nature of the innovative process. In particular, when considering policies for investing in innovation, it may be useful to distinguish between:

- developing and applying new knowledge, and
- taking existing knowledge and applying it to new products, processes, etc.

Both processes may clearly involve innovative capabilities. And while there is not always a clear line between the two, the importance of maintaining some awareness of this distinction becomes apparent later in the context of the role which various organisations and networks may play, or be encouraged to play, in a country's innovation system[1].

A second limitation of the above definition is that it may not convey enough of the sense of breaking the mould. Innovation implies some kind of *quantum leap forward* in the way things can be done – ie a step increase, rather than just a modest progression. This distinction helps to underline the idea that real innovations bring significant, and sometimes spectacular, economic rewards.

Finally, there is a further limiting implication in the above definition that innovation is related only to *economic* activities. In fact, innovations may be applied in a much wider range of scientific and non-scientific activities or situations, such as weather forecasting or the delivery of a social policy or community service. These non-economic applications may be equally important for FRST which, in its Statement of Intent, specifically calls for supporting innovation in the context of (overlapping) economic, social and environmental goals.

For clarity, this paper discusses innovation largely in the context of the Government's *economic* goals. While some of the discussion is applicable to other non-economic objectives, some care should be taken in assuming that similar arguments apply.

*Discussion Point 1*

*One clear outcome of this paper is a recommendation that FRST needs to separate its understanding and support for innovation in economic activity from other objectives. "Innovation" may be something of a catch-all expression, but policy approaches to encouraging innovation can be decidedly goal-specific. Even within the economic sphere, the definition of innovation is important. FRST needs to define "investing in innovation".*

[1] The term "national innovation system" is often used in the literature on this subject. It is simply a catch-all expression for the full range of research, business sector, government funding and non-government organisations and individuals, and the networks between them, which, collectively, generate all the new ideas within any given country. The term may have particular usefulness when examining why some countries are more innovative than others: ie their national innovation system in some way produces more/better outputs.

## 1.2 Innovation and Business Strategy

If investing in "innovation' is the focus of FRST activities, then it's important to get the definition right. In practice, there may often be a fine line between successful innovation and good business strategy. The McDonalds approach to global fast food is a classic example of successful innovation. The commercial success of "The Warehouse", however, is not an example of innovation, just good business strategy.

This example (and there are many in the literature on innovation), indicates how difficult it may be to target government interventions which encourage innovation, but which do not simply subsidise new business ideas. The issue is relevant for Government policy as a whole and affects the role and activities of agencies such as Industry New Zealand and the Ministry of Economic Development, but the focus is sharpest for FRST because it's mandate revolves around the support for – and hence definition of - innovation.

Some difficulties are already apparent in this regard. The terms of reference for the new small grants scheme for assisting business which has been placed under FRST management are broad enough to include funding good business ideas, but which may fall well short of being considered as innovations. Thus, if innovation is defined broadly by FRST to include all good business ideas, then it could cease to have much meaning in developing appropriate funding strategies. (It may also, over time, greatly erode perceptions of the value added by FRST and complicate the task of defining appropriate separations in the role of various government agencies.)

*Discussion Point 2*

*The definition of innovation is crucial for the design of effective policy interventions. It may also become increasingly important for distinguishing the role and functions of FRST from those of other business-supporting agencies and, more importantly, for helping it to avoid straying into unsound investments.*

## 1.3 Innovation and "Technological Progress"

Innovation – however defined - has always been a key driver of economic growth. It is closely related to (though not quite or always the same thing as) "technological progress". Improvements in technology – sometimes referred to as "technological innovation" – are fundamental to increases in the productivity of labour and capital. Gains from technological progress are now widely accepted as accounting for more than half of all economic growth. Understanding how this progress occurs is important for determining what role "innovation" may have played in this process.[2]

To a large extent, most new technologies simply replace older ones in what has mostly been regarded as an economically desirable process of "creative disruption". Such processes have tended to occur in cycles or "waves" driven by entirely new and different clusters of industries. During the last 15 years, the global economy has entered what is sometimes

[2] The distinctions here are subtle, but worth making. Take for instance the example of the Auckland electronics firm, Talon, which saw the capacity and opportunity contained in relatively cheap chip boards used in a brand of imported novelty telephones. Talon converted the chips for commercially successful use in sophisticated marine equipment applications – great innovation but not exactly technological progress.

referred to as the "fifth wave" of technological innovation in which digital networks, computer software and new media industries have overtaken fourth wave industries based on electronics and petrochemicals.[3]

The first wave led by iron, textile and waterpower industries lasted about 60 years.[4] What is most notable about successive technological waves is that their duration has become shorter and shorter. The current, fifth, wave began in the mid 1980s and is (arguably) already more than half way to maturity. It seems likely within the next 10 years to be supplanted by a second phase, or "sixth wave", based on advanced biotechnology applications, much more sophisticated micro-electronics and robotics and "third generation", wireless application technologies and even more advanced telecommunications systems.

Regardless of precisely how one chooses to characterise this technological progress, it is widely accepted that fifth wave industries, and those now developing to replace them, are based on the ownership, control and application of knowledge. This compares with previous waves in which wealth derived from the new industries was based largely on the ownership and control of land, natural resources, plant and equipment. The most successful and wealthy of fifth wave innovators – Bill Gates – owns remarkably little in the sense of traditional business assets. Knowledge is the new basis of economic wealth – hence the "New (Knowledge) Economy".

Throughout this process, three features are especially relevant to innovation. Firstly, those countries that adapted the new technology most quickly to industrial and commercial applications gained the greatest wealth advantage by exploiting the new disequilibrium. Thus, over the last 150 years, the locus of world economic power and wealth has shifted sequentially (and broadly) from Britain to Germany, US, Japan and now back to the US as each country seized a predominant competitive edge in the new wave of technological progress.

Only ten years ago, US economic policy formulation still involved much soul searching about that country's erosion of economic power and competitiveness as a result of Japan's dominance of fourth wave electronics and automotive industries.[5] How quickly that problem has changed. Unnoticed by most policy makers and advisers at that time, significant shifts in economic power were already taking place as US industry was forced to surrender fourth wave industrial supremacy to Japan and move into entirely new fields. Now Japan is struggling to catch up.

Innovative capacity, and the ability to commercialise it successfully, have been the decisive factors in leadership of each new wave, and even more so in the 1990s in relation to knowledge-based industries. This, as we shall argue later, contains some essentially good news for small countries like New Zealand.

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[3] Much of the credit for this interpretation of technical progress goes to Joseph Schumpeter. However, some historians and economists prefer to explain these changes in terms of successive industrial revolutions, with the second beginning at the end of the 19th Century and the third beginning towards the end of the 20th Century. The principle concepts are similar in both cases, but the Schumpeterian approach is more helpful in understanding business cycles and the nature and duration of the commercial opportunities created by breakthrough technologies.

[4] The second and third waves were led by industries based, respectively, on steam, rail and steel and subsequently electricity & chemicals.

[5] For example, President Clinton's economic summit in 1992 and best selling books such as L. Thurow, "Head to Head: The Coming Economic Battle Among Japan, Europe and America", also published in 1992.

Secondly, dominance of the technological change has been achieved in each case as a result of massive investment by both the public and private sectors in path-breaking research. Industry scale, and the investment resources that has afforded, has therefore been a critical factor in promoting and supporting innovation amongst networks of researchers, developers and entrepreneurs - the latter two usually, but not always, in the form of large national or international companies.

In this respect, wealthier countries with larger corporations have had a decided advantage in mobilising these resources. For example, although small-scale entrepreneurs/innovators like Hewlett and Packard could have grown up in any country, it is less likely that they would have achieved what they did outside of the combined knowledge/financing/marketing/labour market networks available in California. (There are certain parallels here with the experience of successful software developers in New Zealand needing to move offshore once some critical scale of business operations is reached. However, as we discuss later, this tendency does not need to be seen as a negative outcome of efforts to support innovative potential.)

Thirdly, globalisation has greatly shortened the period during which extraordinary profits are earned from new technologies, Thus, as each technological wave has involved a shorter duration, the importance of successful innovation for getting and staying ahead of competing firms and countries has greatly increased. Of parallel importance has been the flexibility necessary for re-allocating substantial volumes of finance and resources within the innovation process.

This description of the globalising nature of innovation should not imply that small countries cannot be world leaders in important spheres of technology and science and hence sources of major innovation. One New Zealand study that may assist FRST in this kind of analysis is the work prepared by McGregor (1997) on the New Zealand knowledge base. However, such areas in which small countries (thinking here in terms of the collective economic welfare of the nation state) can sustain a competitive advantage over the longer term are generally quite rare.

*Discussion Point 3*

*Small countries are at a substantial disadvantage in terms of their capacity to lead new waves of technological progress. However, depending on their knowledge base, they may have substantial opportunities to exploit the disruption created by new wave technologies. Also, with the right policies, small countries can move resources flexibly in response to the opportunities created by new technologies.*

## 1.4 Innovation and Productivity

In general, innovation enables more and better products and services from proportionately less input of capital and/or labour. In short, it increases factor productivity – the key source of increasing wealth.

If this is correct, the innovative bubble of the last 20 years should be reflected in much improved factor productivity levels. Unfortunately, it isn't – either in New Zealand or the US. If anything, factor productivity has declined according to official statistics in many developed countries.

What's the problem? Well, it may be statistical. For example, thanks to Starbucks, many Americans now get a much better cup of coffee than they used to. However, a $2.50 cup of Starbucks requires much more input of capital and labour than the old 50c cona standard. Unless one accounts accurately (how?) for the improved taste, choice, ambience, etc it might look like Starbucks has considerably lowered factor productivity in its innovative approach to making and selling a cup of coffee.

We know, however that these kind of statistical problems can't explain all of the perversity in the productivity data. Moreover, if innovations have in some way involved increased "consumption" of the environment or damage to public health (neither of which is usually accounted for in the national data) then they may have actually lowered productivity even further than the data suggests.

Clearly, something strange is going on. How has overall wealth managed to increase despite declining productivity? Unlikely, but the mystery remains to be solved. Some new data for the US suggests that productivity may have risen substantially in the last decade, but there is still much disagreement about this.

The outcome of these discussions does, however, have implications for New Zealand. While comparisons of GDP per capita usually highlight New Zealand's relative income decline, GDP per hour worked may be a much more informative measure of the crucial issue here: productivity growth. For example, when measured in GDP per hour worked, the US slips from 2$^{nd}$ to 9$^{th}$ on the OECD table and Japan from third in GDP per capita to eighteenth in GDP per hour worked. In other words, two of the leading countries measured in terms of sources of innovation and increasing wealth over the last 25 years are shown not be the most productive. The reality is that, leaving aside distributional issues, these countries have higher average per capita incomes because their workforces tend to work longer hours than many others do.

Data on GDP per hour worked for NZ could be usefully collected by FRST, if only to see where this relocates us on the OECD scale. It may emerge that while we interpret collective economic decline from relatively declining GDP per capita, we may be performing significantly better (or worse) in terms of productivity and (taking into account the issues raises earlier) consumption of the environment, longevity etc.

That said, data problems should not alter the basic facts: the New Zealand economy fares very badly on standard measures of productivity performance in the 1990s (see OECD, 2000, page 2). However, more research in these areas could add new perspectives and insights on why New Zealand's innovative performance has been relatively poor for at least the last two decades, if not the last 50 years.

*Discussion Point 4*

*For FRST, the key issue here is that the links between innovation, productivity and wealth creation are unclear and often poorly defined. Support for innovation for its own sake may be less fruitful, in some instances, than support for innovations which raise specific elements of the overall wealth function – e.g. employment, public health, environmental values etc. Perhaps this provides some insight has to how FRST could interpret and explain its task of encouraging innovation in the context of multiple and overlapping public policy goals.*

## 1.5 Innovation Systems and Innovation Processes

Designing effective interventions to encourage innovation requires a correct understanding of the New Zealand context in which innovation occurs. This is not easy or straightforward and, as noted earlier, the context for economic innovation may be quite different from that of other scientific or non-scientific disciplines. As discussed below, one of the key problems here is that policy makers seem to expect (hope?) that substantial economic innovation will result from a largely science-based innovation system.

In an abstract sense, a country's innovation system can be thought of as "multi-dimensional web" of flows and interactions between research funders (public and private) research providers (such as CRIs, university research departments, private researchers), firms, private entrepreneurs and a small number of community and non-government organisations. Piric and Campbell (1999) have observed that one can characterise this system as either:

- a philosophical concept,
- a science and technology paradigm,
- an institutional framework, or
- a policy platform.

In some senses, it is all of these. However, one can also view the innovation system as a "given" and try to make it work (interact) better. This was, in essence, the principle underpinning the Foresight Project. Alternatively, one can see the system as capable of substantial change and development – i.e. a malleable configuration capable of generating new knowledge and successfully transferring it to different agents.

The choice matters when one is contemplating or designing government interventions. At present, FRST is using its resources across a range of strategies for bolstering various aspects of the innovation system: underlying capacity (human capital development), provider-initiated research programmes, new ("blue skies") knowledge, defining property rights, firm-specific investments, non-specific research provider expenditures, supporting networks, education providers, and rewarding educational/innovative achievement. This broad-brush approach has merits – it supports to some extent virtually all components of the innovation system – though it certainly favours traditional research providers. One could argue, however, that it may also indicate a lack of strategic assessment in terms of knowing which aspects of the innovation system need most, and respond best to, government-funded interventions.

*Discussion Point 5*

*Two key policy issues therefore arise:*

1. *Should FRST simply try to involve existing institutions equally and as much as possible, or perhaps more explicitly favour (or exclude) institutions on the basis of analysis and evidence of their innovative capacity and potential for contribution?*

2. *Does FRST's brief extends to designing instruments which might significantly alter the alignment of players in New Zealand's innovation system – such as funding R&D brokers rather than research providers - and, if so, how should that be done?*

These issues are explored further in Section 2.

Innovative processes are quite a different issue, though they overlap to some extent with the concept of national innovation systems. In general terms, innovative processes describe how innovation may occur within firms – i.e. within and between various departments - and between firms and outside agents – i.e. research providers, R&D departments or contractors, other entrepreneurs, financiers, government funded research etc.

Clearly, the process by which innovation occurs may vary significantly depending on a range of factors. These could include, for example, the size of the firm, the size of R&D budget, the position of the firm in local/international markets (e.g. a niche player or a leading ledge competitor), parent/subsidiary relationships (including R&D strategies/locations), the absorptive capacity of the firm (including its access to and knowledge of relevant research), and its relationship to research providers.

The size of the New Zealand economy is both an advantage and disadvantage in these respects. The advantages are several:

1. The number of applicable models of the innovation process is quite limited.
2. Models of innovation that are relevant to FRST's mandate are even more limited – perhaps not more than three or four.
3. The numbers of firms and organisations within those descriptions of the innovative process relevant to FRST are so small as to make it possible for FRST to understand their processes (and needs) almost on an individual (case-managed) basis.

In summary, the basic models of the innovative process in New Zealand are[6]:

1. Research providers identify areas of research need or special scientific or academic interest and go looking (usually subsequently to research activity commencing) for partners and applications for their expected results. (This model is common, but of questionable effectiveness.)

2. Established smaller firms develop ideas and identify opportunities in-house. (Common, but major breakthrough successes are relatively rare.)

3. Larger firms - including industry boards - conduct globally competitive R&D operations internally. (Rare and important but may be outside FRST's mandate, especially if they are subsidiary companies of foreign or global organisations.)

4. Medium and larger NZ firms - still comparatively small by international standards - receive innovative stimuli/direction from parents/partners abroad. (Common, but may also be outside FRST's mandate.)

5. Individuals and small groups develop new technologies and ideas without the benefit of any commercial structure or resources – ie. garage workshops and "start-ups". (Common, potentially important and directly relevant to FRST.)

[6] These basic models are extended and presented in a matrix format with policy implications in Attachment 1.

*Discussion Point 6*

*In short, the "scatter-gun" approach taken by FRST to supporting innovation may have developed simply on the basis that the organisation could not understand or document adequately, for policy targeting purposes, the variety of innovative processes in New Zealand industry. A further explanation could simply be that it has been subject to diverse pressures and lobbies from different sections of the community over time.*

*However, with just a moderate degree of analysis, it may be possible to develop instruments based on two or three relevant models of innovative behaviour and the specific barriers identified within those models.*

## 1.6 Innovation and Globalisation

Globalisation has a fundamental impact on innovation over the last two decades. Intensified competition in many products and services, closer integration of markets, world wide sourcing, inter-firm collaboration and increasing cross-border ownership of business have combined to alter the way much innovation is driven and managed, especially amongst larger firms at the front end of fourth and fifth wave industries. Moreover, globalisation of product, service and financial markets has created a strong new demand for new and improved information and telecommunications technologies that, in turn, have accelerated the globalisation process in other markets and industries. This process has meant that economic performance in the new global environment:

> "increasingly depends directly on the learning ability of individuals, firms, regions and countries. Learning is necessary both in order to adapt to the rapidly evolving market and technical conditions and in order to achieve innovation of processes, products and forms of organisation." (EU, 1998, p.13)

While financial markets lead the globalisation process, closely followed by an increasing range of products and services, international flows of labour and information are often more constrained. The nature and extent of these latter flows are especially important for the design of innovation policy in a small economy like New Zealand with relatively few restrictions on the mobility of human capital and information.

Although there is argument around this point, one of the limits to globalisation concerns the spatial mobility of knowledge. While information and codified knowledge can be accessed and transferred relatively easily and at low cost across national boundaries,

> "know-how and tacit knowledge is not so immediately transferable. In the learning economy crucial elements of knowledge remain specific and tacit, and rooted in specific organisations and locations. This is the basic reason why patterns of international specialisation in trade remain reasonably stable over time and why technology gaps persist between regions and countries… If all knowledge were readily transformed into information to which everyone had easy access, there would be relatively little incentive for firms, regions and nations to invest in R&D and technology gaps between regions and countries would be minor and temporary." (Ibid, p.14)

As the previous discussion has shown, most technology gaps internationally are neither minor nor *very* temporary. To the extent that the information necessary or useful for exploiting further innovations is codified, New Zealand firms and individuals must develop the ability to acquire that information relatively cheaply and without the need to invest heavily in the kind of research which has underpinned it. The key requirement in this regard is that New Zealand industry possesses people with the expertise and knowledge for accessing, understanding and adapting that information for innovative applications combined, of course, with the entrepreneurial commitment and expertise to commercialise it successfully.

To the extent that New Zealand industry does not possess sufficient skills and knowledge for its innovative needs, it must accept the need to pay internationally competitive salaries etc in order to "import" them, regardless of the extent to which these levels of remuneration may diverge from domestic "norms".

*Discussion Point 7*

*Innovation in New Zealand is mostly <u>not</u> about "transformational technologies". It is about honing technologies for target (niche) market opportunities or filling service gaps left by dominant companies. FRST policies for investing in innovation need to reflect this reality.*

*However, to the extent that many firms, particularly smaller firms and start-ups, may not have the capacity to identify and acquire relevant codified knowledge, national innovation policies should consider and address how it might be provided or encouraged – e.g. through specialised "knowledge brokers".*

*For acquiring essential tacit knowledge, public attitudes must be conditioned to accept the need for New Zealand industry to pay internationally competitive remuneration rates for people who can expand and enhance the capacity of domestic industry for exploiting innovative opportunities.*

There is also a negative side to this spatial mobility of information and knowledge for small countries. The more commercially valuable or complex the information, the more likely it is to be held tacitly (or if it can be codified, held under various forms of security or legal protection). To the extent that important knowledge/information can therefore only be acquired by transfer of human capital, developed and well-educated economies which are also comparatively poor (lower income), such as New Zealand, have a harder job in retaining or acquiring valuable people.

To the extent that domestic wage and labour market policies (and attitudes) restrict remuneration levels for highly skilled and innovative New Zealanders to below international norms, they increase the probability that such tacit knowledge will be sought and acquired by offshore users. The only way to reduce this loss - short of imposing undemocratic, politically unacceptable and probably unworkable emigration constraints - is to ensure that remuneration levels also remain internationally competitive for New Zealanders with internationally tradeable skills, experience and innovative capabilities.

*Discussion Point 8*

*The accelerating pace of innovation, derived in large part from the increasing competition associated with globalisation, therefore leaves policy makers with a complex task, especially in small countries like New Zealand. Small countries cannot expect to derive major strategic*

*opportunities from the increasing spatial mobility of knowledge, without recognising that their knowledge assets are equally vulnerable in return. This reality will gain increasing momentum.*

*As with trade, monetary and fiscal policies, effective participation in the global economy involves accepting that global rules apply – in both acquiring and surrendering innovative opportunities and capacities. New Zealand's innovation and labour market policies must acknowledge the realities of increasingly global labour markets and the nature of the opportunities and incentives that these markets create for the transfer of national innovative resources and capacities.*

## 1.7 New Zealand's Position Amongst Globalising, Innovating Economies

Viewed in the overall context of this discussion so far, it is not difficult to see why New Zealand has slipped from one of the wealthiest countries in the world in the early 1950s (which involved, however, something of a spike for commodity exporting countries) to 17th place amongst OECD countries alone in 1998. NZ per capita income at US$ 17,700[7] is now little more than just half that of the top two countries of Luxembourg ($34,500) and the US ($30,500). Recent movements in the US/NZ dollar exchange rate will have significantly widened that gap.

While many domestic industries have adopted technological changes quite readily, New Zealand's economic base in the primary sector has not shifted significantly despite at least three new waves of technologies that have underpinned global economic growth and development over the last 50 years. As the Institute of Economic Research has suggested the continuing comparative advantage in various forms of primary production has almost acted as a *disincentive* to innovation and technological change *in economic production*[8] over that period.

Not surprisingly, then, primary exports continue to make up over 60 percent of New Zealand's export receipts. In 1995, over 90% of the value of New Zealand's exports come from just 250 companies. That ratio has changed little in the last 5 years.

At the same time, the tertiary education system produces an overwhelming bias in graduate numbers in arts, humanities, commerce, law and medicine. For most of these graduates, there are good employment opportunities in New Zealand and overseas. Hence these disciplines mostly represent "safe" career choices, but they are not disciplines that generally participate in, encourage or celebrate innovation.

What does the analysis imply for small countries like New Zealand?

Firstly, it implies that small countries cannot generally command the resources that place them at the leading edge of any new wave of technologies. At best, they may be able to adopt positions – such as Finland in telecommunications and Ireland in computer-related industries – where they play a leading role in the commercialisation of specific technology sectors or applications. However, even this requires a combination of strongly supportive factors that may not generally be present.

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[7] OECD data, purchasing power parity basis.

[8] This is highlighted because individual New Zealanders are generally considered to be comparatively quick on the up-take of new technologies in the home and office and in recreation.

Applied to New Zealand, this means that a strategy of attracting a major company/industry to locate in New Zealand – e.g. a "Motorola" type company – may rarely produce a positive result, and only then if New Zealand is willing to out-bid other countries through concessions, subsidies, tax exemptions etc. This suggests clutching at straws. It is not a viable basis for "investing in innovation".

Secondly, the development of technological progress and competitive advantage outlined above suggests that significant opportunities for small countries can develop around the edges of new technologies – especially as they enter a "maturing" phase where the underlying knowledge and technology has been disseminated and a variety of new uses and applications for the initial breakthrough technology may be identified. This has happened already within the software industry in New Zealand since about 1995 with local software developers beginning to compete effectively – as very small firms - within various niches in a global market. A similar process may also be just commencing in some very specialised corners of the emerging biotechnology industries.

This "coat tails" development scenario does not overlook the fact that New Zealand regularly produces a small number of *individuals* who may be world leaders in developing aspects of the new technologies. (However, retaining and using those individuals more effectively is another issue, addressed later in the paper.) Besides, being small, and potentially more flexible in allocating resources, can be a decided advantage in exploiting the disequilibria created by technical change, without needing to commit the high levels of R&D to actually leading that change.

Until about 20 years ago, New Zealand firms and individuals were arguably not much more, or less, innovative than anyone else. However, two recent developments have changed that: technology and commerce have become increasingly sophisticated, and the periods for which many products and processes remain internationally competitive have become shorter. Developing and maintaining *a culture of constant innovation* is now even more critical to wealth generation. Despite the high quality of much publicly funded science – or perhaps because of it? - there is substantial evidence from relative income, productivity and technology-intensity data that New Zealand has started falling significantly behind most developed countries.

*Discussion Point 8*

*What are the current and emerging disequilibria in the global economy that FRST might determine provides viable opportunities for NZ firms and individuals to exploit? How might such opportunities be combined with what is known about innovative processes in New Zealand and their opportunities for effective interventions? Why has high quality science not produced high quality innovation?*

## Section 2: Overcoming the Barriers to Innovation

### 2.1 A Policy Framework

There is virtually unanimous agreement that innovation policy is crucial for economic performance. However, there is much less agreement about the nature and scope of what governments can do effectively in the way of encouraging, much less investing in, innovation within their national boundaries.

This section of the paper discusses general and specific barriers to innovation in the New Zealand economy and what, if anything, the New Zealand Government can do to reduce these. The framework adopted for the design of innovation policies is one in which there are two main categories for possible action:

1. Policies which target the general environment for innovation, including issues of national culture, attitudes to innovation and general economic policies;

2. Policies which target specific barriers to building and using innovative capacity amongst firms, organisations and individuals, including specific issues of educational policy, technology transfer, financing for innovation, human capital and business capabilities and information.

FRST should not adopt a piecemeal or ad hoc approach to what is clearly its over-riding goal – encouraging and supporting innovation. It must tackle the requirement on both of the above levels: macroeconomic and microeconomic.

There is a third element to the policy framework that not addressed in this paper, due in part to constraints of time and expertise. This concerns the extent and manner in which innovation policies may address redistributive issues – including social, ethnic and regional imbalances. The EU (1998) considers this a critical element in the design of innovation policies.

*Discussion Point 9*

*In addition to the challenges presented here, FRST may wish to consider addressing separately the issue of whether and how the social and redistributive goals of government can be appropriately, or effectively, included in an innovation policy framework.*

### 2.2 Policies for Improving the Environment for Innovation

At the macroeconomic level, there is wide agreement in the literature on innovation policy that "the best thing governments can do is to create the right climate for innovation".

#### *The Cultural Environment*

The Information Technology Working Group (1999) stated that New Zealand is "innovation rich and capital poor". In an otherwise useful discussion of IT industry issues, this conclusion was unsubstantiated and wrong on both counts. Despite frequent references to New Zealanders' abilities with a piece of No. 8 wire, we do not exhibit or encourage an exceptional culture for innovation. In fact, as the No. 8 wire analogy arguably indicates, the cultural environment is traditionally more one of pragmatism, rather than innovation.

There is no objective evidence that New Zealand individuals or firms are, on average, more innovative than anyone else. On the contrary, as The Economist (1999) has pointed out, New Zealand probably belongs at the bottom end of a group of countries – including US, Canada, Australia, U.K. and Hong Kong - whose innovative capacities have, if anything, been dulled by the influence of English culture and attitudes. Hence there is plenty of scope for raising innovative capacities in New Zealand.

At some aggregate social level, a "culture of innovation" has several key characteristics:

- A strong ethos for encouraging and celebrating creativity
- Strong social and political recognition of the fundamental importance of commerce to almost all forms of national well-being
- A propensity for taking risks
- A strong belief in the ability to compete and succeed
- A strong ethos for encouraging, celebrating and rewarding high achievement
- Social and commercial recognition that encouraging innovation also implies tolerating, not punishing, occasional failures in research and business.

Several of these characteristics are closely aligned with entrepreneurship. In practice, the two concepts are closely linked and highly compatible. However, innovation and entrepreneurship are not the same thing and FRST's objectives of investing in innovation need to recognise the slightly different roles which each plays in carrying good ideas through to commercial success. FRST needs to promote and support a "culture of innovation" aggressively while also developing the community's (including the science community's) understanding and appreciation of the value of entrepreneurial commitment and skills as a necessary complement to the innovative process.

Government policies and attitudes that directly or indirectly reflect and promote the cultural values and attitudes identified above will therefore improve the environment for innovation and hence economic performance. (The extent to which several key current policies of Government fall short of these objectives is discussed in the following section.) However, influencing the cultural environment for innovation is not just a matter of current policies. It also involves longer term strategies – including strategies which operate at the level of primary and secondary school curricula and methods – which will shift learning and career directions for the next generation of tertiary students and work force entrants towards more innovative occupations.

Finally, in this general context, it is appropriate to note what a culture of innovation is <u>not</u>. It is not an environment in which existing government agencies, research institutions and industry interests within the national innovation system simply talk and network more actively (MoRST, 1999). Although this feature can help in small ways, the drive for innovation must come from attitudes, practices and opportunities identified in the private sector, supported by government policies that not only don't hinder commerce and innovation but emphasise and encourage commercial investment, competitiveness and profitability. In terms of the discussion in Section 1.5, there is a need to view the current innovation system – and the quality of its performance – as thoroughly inadequate as a science and technology paradigm and to reposition it as a target, rather than a platform, for innovation policy.

*Discussion Point 10*

*If FRST has an objective of investing in innovation, it must also take a role in improving the culture for innovation. This is likely to mean at least the following three things:*

1. *developing a vision of what a highly innovative economy and society would look like in 2010 as a benchmark against which to measure government policies and progress over the next ten years;*

2. *promoting and encouraging public policies and attitudes which reinforce the achievement of those characteristics of an innovative society, possibly through a more active educational and promotional role in schools and beyond, and*

3. *recognising and acting on the need for an overhaul of the national innovation system so as to ensure that the incentives, capabilities and responsibilities for innovation are generated more within the commercial, rather than the science, sector.*

### *The Economic Policy Environment*

A considerable amount of international analysis and research has been undertaken to examine what kinds of economic structures and policies contribute to innovation. The analysis has not been especially conclusive in several important respects as discussed below. However, while innovation may be the "new theology that unites the left and right of politics", it is clear that some policies are certainly more effective than others in encouraging innovation.

It is also evident that having the right policies in place is especially important for smaller countries. Without the right policy environment, they are likely to experience the more ravaging effects of globalisation on innovative capacities. In fact, smaller countries like New Zealand need to go beyond just having a generally supportive policy framework to one in which many policy-related obstacles to innovation are decidedly lower than in the rest of the world. In other words, New Zealand needs much more than a neutral policy environment for the support of innovation if it is to significantly improve its innovative capacity, economic performance and comparative living standards.[9]

*Discussion Point 11*

*FRST may not currently have an institutional responsibility for developing or commenting on general economic policy. It does, however, probably alone amongst New Zealand Government agencies, have the capacity to identify economic policies that may promote, or inhibit, innovation specifically. Given this unique capacity, it should seek an active role in leading and encouraging public debate and awareness on these issues.*

Successful innovation on a national level does not require Malaysian-style ("super media corridor") approaches, even assuming New Zealand had the financial resources for this. Rather it requires an abundance of talent and a culture and environment that supports it.

[9] This approach is certainly not extreme: the Australian Innovation Summit Implementation Group (2000) have recommended to the their Government lifting the R&D tax concession to 130%, plus additional related tax concessions.

The broad economic policy framework and conditions that are most likely to be supportive of innovation comprise the following key elements:

***An environment of economic growth.*** In aggregate terms, economic growth improves the profitability of the business sector, thereby making available additional resources for investment in research and development, new market opportunities, etc. as well as adding to the expectation that new investment will generate further profits. It almost goes without saying that policies or regulations which constrain growth, necessarily constrain innovation.

***Comparatively low and stable, or preferably declining, business and personal income tax rates.*** Improved profits - and hence higher income - are the major, if not the sole, incentive for most commercial innovation. Increasingly, innovative firms and individuals can and do relocate internationally according to where the best, after tax, returns can be obtained. To remain competitive, small countries like New Zealand must offer an internationally attractive tax environment. In fact, given other locational disadvantages such as distance from major markets, it is highly desirable that income tax rates are substantially lower than alternative country locations. Conversely, innovation policies cannot hope to be effective or credible in an environment of rising income tax rates.

***Neutrality, at least, in tax policies relating to investment in research and development.*** Although there is no conclusive evidence, either way, that the tax treatment of R&D expenditures affects innovation decisions in isolation, it is clear that such policies have effects on the locational decisions of firms. Small countries like New Zealand simply cannot afford to be perceived as less attractive locations for R&D expenditure, especially in relation to Australia to which firms, and the employment they provide, can most easily migrate. The OECD (1998) has ranked New Zealand's tax treatment of R&D expenditures as the most strongly negative amongst member countries.

Similar issues may well apply to comparative treatment of tax credits and other company tax issues.

***Low compliance costs for business.*** Several studies in New Zealand have linked the comparatively high compliance costs imposed especially on small businesses with a reduction in managerial time and resources and hence reduced incentives and resources for innovation, research and development. Given that much of New Zealand's innovative activity and potential occurs in small firms, policies that reduce compliance costs for these firms must have benefits for innovation.

***Competition and regulation.*** In general, the literature on innovation is divided on the impact which different levels of market competition, and regulation, may have on innovation. Competition clearly increases incentives to develop new technology and exploit new market opportunities, however market dominance often assures a level of profitability that enables major investment in R&D and hence the development of transformational technologies. These are complex issues and there has not been time and opportunity in this review to consider carefully how the international evidence might apply to New Zealand. However, we question the extent to which innovation issues are a consideration in Commerce Commission investigations and note that FRST may have a role in drawing attention to these issues.

Special consideration should also be given to the impacts on innovation from other major pieces of regulatory legislation such as the Resource Management Act.

***Labour market flexibility.*** To the extent that innovative capacity is all about the use and application of human resources, highly flexible labour markets are consistently cited as one of the key elements in a successful innovation policy. In fact, the rigidity in European and Japanese labour markets is regarded by some prominent analysts – e.g. Thurow (1999) and Porter (2000) respectively – as a major explanation for the extent to which those countries have fallen behind the US on technological innovation and competitiveness in the last 10 years. For countries like New Zealand with a predominance of small firms, the ability to acquire and employ human resources selectively and creatively is even more crucial for innovative activity. Current government policies to re-introduce rigidities in the labour market are nonsensical in terms of an effective innovation policy.

*Discussion Point 12*

*Creating an environment that encourages and supports innovation in New Zealand involves consideration of a wide range of general economic policies that may impinge on those goals. FRST needs to determine how and to what extent it should allocate resources to monitoring, commenting, advising on and influencing the impact of general economic policies on its innovation objectives.*

*Discussion Point 13*

*Simply noting the importance of the economic and regulatory environment for innovation can seem a little trite. FRST could well approach the issue systematically; for example, by commissioning a project to develop comprehensive recommendations for regulatory reform for smaller firms aimed at promoting innovation and new investment. The menu of relevant issues and opportunities identified in OECD (1999) might provide a useful starting platform.*

## 2.3 Directly Reducing Barriers to Innovation

On the question of what drives innovation at the microeconomic level, The Economist (1999, p. 6) draws largely on work by Peter Drucker in concluding:

> "Two things set apart all organisations with a good record of innovation. One is that they foster individuals who are internally driven – whether they are motivated by money, power and fame, or simply curiosity and the need for personal achievement. The second is that they do not leave innovation to chance: they pursue it systematically."

While improving the general "environment" for innovation as outlined in Section 2.1 is the best thing any government can do, these issues are mostly within the realm of Treasury and Ministry for Economic Development. Micro level interventions are explicitly the function of FRST, but as the Drucker quote makes clear, there are real difficulties for designing any public policy for getting to the heart of the innovative process.

These problems are compounded in New Zealand. The Technology Learning Review (1998) concluded:

> "The overall evidence from the review suggests that the most difficult user sectors for the PGSF to contribute to are heterogenous sectors that are dominated by individual companies, where the research needs are often firm specific rather than generic of

industry wide, and where the science and technology base tends to be international in nature rather than characterised by high New Zealand specificity. Examples are manufacturing and processing and information technology sectors." (P.18)

Well, those sector "examples" already sum up a fairly large proportion of New Zealand industry relevant to innovation policy.

***Educational Policies***

As noted previously, long term strategies for encouraging innovation commence with the education system. In general, students do not emerge from secondary or tertiary levels of education in New Zealand with a strong appreciation of either the importance of innovation for professional and economic development or with the knowledge, skills or confidence for taking highly innovative approaches to problem-solving.

Most would agree that innovation cannot be "taught", as such. Nonetheless, several ideas can be put forward for improving the quality of education in this respect. These include not only pushing a "message" of innovation early in schooling, but actively developing a structured component/module for the secondary schools curriculum around innovation: what is it, who uses it, what knowledge/skills/thinking processes are involved, how can these processes be developed, how can it be encouraged in individual and organisational settings, how organisations and economies develop through it, and what added rewards (societal and individual) may be gained from it. Another (Australian) proposal involves establishing enterprise and innovation scholarships for teachers.[10]

The IT Advisory Committee (1996, p.19-20) recommended that the use and place of IT needed substantial up-grading in most secondary schools. It set targets for the number/ratio of computers in classrooms, but also emphasised the need to bring out for students the business and innovation possibilities of IT (including the Internet), not just its learning-aid capabilities. It is not clear whether those targets were adopted by Government nor what progress has been made towards them over the last four years.

Much employer dissatisfaction with the education system has been expressed in relation to the quality of tertiary education (see for example Unlimited, September 2000, p.48). There are two quite distinct issues here: the numbers of graduates in various disciplines (discussed under Human Capital Issues) below, and the business and problem-solving skills and aptitudes of graduates in general.

The second of these issues is directly relevant to innovation policy. Unfortunately, it is unlikely that it will be tackled by the current, rather misplaced, debate around whether tertiary institutions should be run according to so-called "competitive" or "co-operative" models. That debate will almost surely fail to influence the key issues here: the real barriers to accessing more valuable forms of higher education and the quality of those educational outputs.

The need for, and challenge, of building innovation and entrepreneurship into tertiary studies in science, business and technical professions is one which FRST could usefully pick up. The goal is relatively simple: to build more innovation- and business-oriented skills into the learning programmes of these disciplines. By making the graduates' skills and capabilities

[10] Innovation Summit Working Group (2000)

more attractive to business, it would extend the range of science and technology employment opportunities beyond the traditional focus of CRIs and universities, thus increasing these enrolments.

Finally, the nature of innovation is such that there are limits on the extent to which individuals can "prepare" themselves with this capability through structured personal investment. Since innovation may involve an element of "breaking the mould" formed by one's existing employment and skills, any form of further education may be helpful in developing innovative capabilities, irrespective of whether they are related to current income or employment. Tax deductibility rules on education and training expenditures should reflect that fact – plus the importance of lifelong learning - by treating all such expenditures as fully deductible.

*Discussion Point 14*

*FRST's traditional stakeholders have been the research providers (CRIs and university research departments) and, to a lesser extent, sections of the business community. It has not generally regarded the education sector as one with a major interest in, and potential for contributing to, innovation. Considerable scope exists to target the education sector specifically as a key stakeholder in the development and application of innovation policies.*

***Technology Transfer***

Technology transfer - or "technological learning"[11] - the process by which research and innovation are translated into commercially successful outputs, is at the core of much of FRST's interests and funding activities. Policies in this area – and in the areas of human capital development and business practice discussed below – are probably the most important in terms of the range and type of effective interventions the organisation can make in reducing barriers to innovation.

The basic thrust of FRST interventions in the innovation system and process in recent years has been through the role of research providers, predominantly CRIs. Despite its supposed contestability, over 80% of PGSF funding has been allocated annually to CRIs. Thus the implicit model for technology transfer has been one based on standard "linear" explanations of innovation built around traditional R&D-to-market concepts. (see Webber, 2000 for further discussion of the problems with this approach). Government's S&T policies have increasingly been based on attempts to make this "science push" model work by driving providers into network relationships.

New Zealand has not been alone in this approach. The Economist (1999, p.6) concluded that, despite what we know about how innovation really works,

> "The irony is that officials, academics and even entrepreneurs pay far more attention to the riskiest form of innovation (trying to exploit some science-based discovery) than to the easiest and quickest type of innovation with which to turn a profit (capitalising on some unexpected success)."

[11] This latter term is preferred by the authors of the New Zealand report "Technological Learning and Knowledge Application Review" (1998, p.8) on the grounds that it "provides a better conceptual framework for envisaging the processes through which the PGSF and Ministerial Schemes contribute to maximising desired *outcomes* rather than *outputs*…(ie) whether the results of the PGSF and the Ministerial Schemes are adopted and applied by users." Maybe, but technology transfer is the more widely used term in the innovation literature.

This approach is arguably even more risky in small economies where critical mass in the science sector further lowers the probability of break-through success.

Technology transfer involves bringing innovative concepts to commercial success. To commercialise an idea successfully in practice, a number of increasingly difficult "stages" must be completed. These stages essentially involve finding solutions to various technical, manufacturing or marketing problems, while "bridges" involve mobilising the resources needed to move progressively between each stage (EU, 1998).

Hence, there is a basic problem in this regard with the main thrust of FRST's traditional approach of using research providers as the focus of public R&D funding. Although the *quality of the science* contracted is often high, this mechanism does not lend itself well to overcoming very considerable difficulties in the various stages and bridges which underpin the commercialisation of a promising innovation or idea. No amount of networking – for which the incentives are also not well aligned – can overcome that problem.

Even within a firm, managing the commercialisation process for an innovation may be extremely difficult. In a network environment, where a range of institutions, funding relationships and rules apply, the process is even more difficult. This is particularly the case in the New Zealand innovation system were the rewards and incentives amongst the participants are also problematic.[12] (Again, however, we note that the focus and relevance of this discussion is in relation to economic, as opposed to environmental or social, innovations.)

However, before we come down completely on the impediments which a science push approach to innovation will encounter, we need to recognise the argument – made especially well in the EU report (Ibid, p. 80) - that the barriers between research institutions and industry are functional, as well as dysfunctional. These barriers are functional in the sense that they may allow scientific institutions to build up competencies and knowledge over time that may later become in great demand amongst innovating firms. In the short-run, with no apparent market purpose, such competencies may never have developed in private firms. Also, these barriers may enable the occasional serendipitous discovery that almost surely would not have occurred in a fully market-focused innovation system.

That said, dysfunctional barriers certainly predominate. Better connectivity between provider institutions and users may reduce those dysfunctional barriers, but it cannot alter the fact that the underlying model is fundamentally at odds with the nature and requirements of New Zealand's economic structure and its opportunities and requirements for commercially successful innovation. When was the last time an audit of CRIs was conducted to establish what proportion of their activities had a predominantly and directly commercial focus within a relevant (eg. 0-2 year) time-frame?

*Discussion Point 15*

*The task for FRST is to realign its funding decisions according to the nature and needs of the innovative process in New Zealand. While this should not imply abandoning the public funding of research institutions, a focus on "investing in innovation" requires that the*

[12] See, for example, report of "Technology Learning and Knowledge Application Review" (1998), p.11.

*current balance and direction of funding be drastically revised, particularly with regard to investing in economic innovation.*

*With regard to the need for publicly funded "long term strategic research"; does FRST have a clear and well-supported view as to where New Zealand's priorities lie?*

***Venture Capital***

The availability of venture capital, effectively any financing for "high risk" new start-ups and technology developments, is frequently cited as a key barrier to innovation in New Zealand. Although the trading banks have mostly been unwilling sources of risk capital – especially in the period immediately after 1987 - it's not clear that this is still a major impediment. At least for the last two or three years, there have been a small number of venture capital firms established in New Zealand, though their level of activity has not been particularly impressive. Some industry estimates suggest that there is about NZ$500 million currently available for this type of lending.

The availability of funding does not mean that there are no financing barriers to innovation. In fact there are several reasons why the venture capital scene is not especially dynamic:

- The quality of the accompanying business plan is often poor compared to the potential of the basic innovation. In other words, many innovators lack adequate business skills.

- Venture finance is something of a numbers game, for every successful project there are a much greater number of failures. With a relatively small number of applications, the risk profile of the venture capitalist increases, thus raising the hurdles that they must erect prior to funding.

- For related reasons, venture capitalist firms are sometimes perceived by innovators as being too greedy in terms of their expected level of participation in the enterprise. This has a tendency to encourage innovators to seek other lower cost / lower expertise sources of finance with consequent impacts on the rate and level of success.

- Not all the venture capital firms in New Zealand have a lot of business expertise to offer potential clients.

- There is an apparent absence of "business angels" in New Zealand – people who could provide financing and expertise directly especially to small start-ups. Given the relative shortage of successful individuals of this type in the community, perhaps there is a tendency to co-opt such potential angels onto various government agencies and boards when in fact their business-oriented knowledge and skills might be more effectively employed directly with new innovators. (A proposal for using "companies as angels" is outlined below.)

In fact, there may be more New Zealanders with funds and interest in investing in innovative start-ups than is currently assumed. Alternative mechanisms – such as the Swedish private sector "Innovation Market" which allows the public to trade in venture capital projects over the Internet and provides managerial/brokers to assist the business development aspects – may be worthy of investigation.

*Discussion Point 16*

*The venture capital market in New Zealand is small but growing. A focus for FRST may be in schemes which make the provision of expertise in these VC market relationships easier and more effective, rather than engaging directly in financing innovators in ways which only reduce the number of viable projects available to private financing.*

### *Human Capital Issues*

It is worth repeating that successful innovation requires an abundance of talent and an environment to support it. The section on educational policies reflects the fact that human capital must be the focus of innovation policy. Expenditures in these areas, however, can only be effective if supported by other policies, outlined above, which encourage the retention of these capabilities.

Statistical evidence reviewed for this paper indicates that:

- The numbers of tertiary qualified people in New Zealand are about equal, as a proportion of the workforce, to most other OECD countries.

- The skill/knowledge level of NZ graduates is on par with other developed countries, (though the important competitive advantage of English language skills is quickly being eroded).

- Contrary to popular wisdom, New Zealand does not have a shortage of science and technology graduates. What it does have is a shortage of jobs, relative to other wealthier (and more technologically intensive countries), in science and technology industries.

- The number of researchers in the workforce is significantly lower than the OECD average, reflecting the lower level of private R&D expenditure.

- New Zealand has a much lower proportion of technically qualified managers in industry (about 30%), compared to most other developed countries/regions (e.g. Europe 80%).

- Employer surveys consistently cite a poor understanding of business needs and principles in relation to research amongst S&T graduates.

*Discussion Point17*

*What is an appropriate human resource development component for FRST's innovation policies? If the problem for industry is not a shortage of S&T graduates, but a shortage of business-ready graduates, what are the messages and funding that FRST should be making to universities? Where do polytechnics fit in an HRD strategy focusing on innovation?*

### *Business Capabilities and Information*

Many of the problems associated with innovative capacities and processes in New Zealand firms have been described above. These include the fact that too many ideas have a technology rather than a market focus. There is a low appreciation of how to get from

"concept to market". Only 30% of New Zealand firms have an R&D policy and even fewer have an R&D budget[13].

A significant proportion of potential innovators in New Zealand are "orphans" from the start. In other words, they did not emerge from existing companies that might have provided direction and support to their ideas (even better than a venture capitalist). Perhaps scope exists for creating a mechanism to link "orphans" with established firms? One approach could involve encouraging larger firms and organisations in New Zealand see the experience and know-how in their senior management as an invaluable resource to be "contracted out" to small firms or new start-ups.[14]

In many cases, the interest of the larger firm might revolve around a potential commercial interest in the process, product, or service of the small firm, thus raising the potential of the company, rather than just the senior manager, to take an "angel" role. FRST could assist in the development of this concept as a government-supported programme providing, for example, a suggested legal and operational framework for the scheme, information and know-how, initial brokering of partnerships and small amounts of seed money.

For schemes like this work, the Government must first show that it is willing to create economic and cultural environments in New Zealand which are strongly "pro-business" – ie much more than just mildly supportive of private sector innovation and entrepreneurship. It must first convince people with the right expertise that there is value in using their time and skills in this way. This not the case at present.

At the very least, New Zealand firms could well benefit from better understanding of international best practice in relation to the encouragement and support of innovation in their organisations and industries. Providing the business sector with information on – and services for benchmarking against – international best practice in innovation would seem to be well within FRST's current mandate.

An important part of encouraging a culture of innovation amongst New Zealand firms involves getting them to understand the real extent and potential of the intellectual capital they already possess in their employees, products and processes. An important challenge involves revealing the extent of that capital as a platform for increased competitive advantage. Strategies to explore this potential should not be difficult in a situation in which the total population of relevant firms is small enough to be almost individually known and managed.

The Australian COMET programme may also be worth investigating in this regard.[15] However, more information needs to be obtained to assess the differences and possible advantages compared to TechNZ programme.

The business sector, especially smaller firms, are often not as well informed about the range and source of advice and assistance available to them as the bureaucracy might expect. The structure and promotion of government programmes requires regular review. The suggestion has been raised in Australia of "one-stop" shops for innovation support to business. Flows of

[13] Technology Innovation Working Group (1996)
[14] This proposal is a based on a similar concept adopted by Shell in Europe.
[15] The Commercialising Emerging Technologies (COMET) Program supports early growth firms to maximise their potential to trade in new services and products by helping them to develop sound management skills, an effective management team, conduct market research, and prepare sound business plans.

advice to government and business on innovation issues are also a function of regional (state/territory) "Innovations Councils". Similar concepts may have application in New Zealand, though proposals to erect new structures would clearly need to address the significant shortcomings encountered with previous regional business development boards and business funding agencies.

At the same time, FRST need to look at better alignment between the length of funding cycle which has operated in the past under the PGSF – often 3-6 years – compared to the relatively short time-frames in which innovation must now move to commercialisation. The New Economy Research Fund (NERF) has gone to the longer term end of the research and development spectrum. There is a need to close the gap at the short term funding end – though without harming the growth of private venture capital (see below).

The analysis in Section 1 has indicated that for New Zealand at least, the next generation of innovation will be based predominantly on small and start-up firms, many of whose ideas and technologies may be soon acquired by larger corporations. Hence promoting innovation will carry significant political risks: some prominent "successes" will be bought out by foreign owners, in many cases before significant domestic employment benefits have been realised, and other successful companies will shift off-shore to exploit larger and more profitable markets. This fact was not missed by the Technological Learning Review report (1998, p.18):

> "Many local companies are subsidiaries of overseas corporate, and act as processing, marketing, distribution or service businesses within the context of wider corporate strategies that are developed off-shore. Many small to medium sized technology based and R&D intensive companies that developed in New Zealand the post- (second world) war period have been taken over by larger overseas companies. Examples are Allflex, trigon and MAS. Most larger businesses with significant technological capabilities are fully or largely overseas owned."

Also, successful innovation necessarily creates relatively higher incomes amongst a comparatively small component of the population – basically, the rewards for creativity, enterprise and risk. Additional strategies may be needed to ensure that a balance of the benefits from public investment in innovation flow to other sections of the population. However, it is not clear how (or even whether) that should be considered in the context of developing innovation policies.

Some analyses have pointed to the fact that New Zealand may lack credibility as a source of high tech products. If such a reputational constraint exists, do tourism promotion strategies - such as "100% Pure" - reinforce it? What other forms of promotion may be needed to overcome negative international perceptions of New Zealand's technological capabilities? What role might FRST have in linking in with other agencies to address these issues through external promotion activities?

*Discussion Point 18*

*There would appear to be several opportunities for FRST to support innovation in the private sector without necessarily contributing investment funds. While much will depend on the quality of expertise available, a set of pilot programmes may be an appropriate way to explore new and more effective roles with the private sector.*

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