NATIONAL INNOVATION SYSTEMS: FINLAND, SWEDEN & AUSTRALIA COMPARED

LEARNINGS FOR AUSTRALIA

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INTRODUCTION

The Organisation for Economic Cooperation and Development (OECD) has estimated that innovation is the key driver for economic growth in developed countries, with at least 50 per cent of growth directly attributable to it. Furthermore, growth in the world economy will be increasingly dominated by knowledge-intensive goods and services.

A key element to competitiveness in the knowledge based economy is "interconnectedness" or linkages. **The nation that fosters an infrastructure of linkages (networks) among firms, universities and governments, gains competitive advantage through quicker information diffusion and product deployment.** In short, nations need national innovations systems.

National innovation systems can be broadly defined as all economic, political and other social institutions affecting learning, searching and exploring activities. This includes a nation's universities and research bodies, financial system, its monetary policies, and internal organization of private firms. The way all these work together to influence the development and utilisation of new knowledge and learning defines a nation's innovation system.

The purpose of this paper is to analyse the national innovation systems of Finland, Sweden and Australia and, based on the comparisons of the Nordic countries with Australia, to identify potential policy options for improving Australia's innovation capacity.

This paper is the condensed result of an extensive literature study into national innovation systems and their best practice as shown by the Nordic countries of Finland and Sweden in particular.

The full study is reported in a document entitled "National Innovation Systems: Experiences from Finland, Sweden and Australia Compared". This paper was prepared during 2003 and 2004 by Göran Roos and Oliver Gupta for the Australian Business Foundation[1].

ABOUT THE AUTHORS

Professor Göran Roos is the founder and Chairman of Intellectual Capital Services Ltd, based in London. He has previously held management positions in both American and European firms and has lived in Sweden, Norway, Japan, France and the USA before moving to England. He has founded or co-founded, managed and in some cases, successfully divested 15 companies over 20 years. The companies have all been knowledge-based and are or have been domiciled in the UK, Norway, Sweden, Finland, Australia and the USA.

Professor Roos holds academic positions at Cranfield University's Centre for Business Performance, Helsinki School of Economics' Centre for Executive Education in Finland and Mt. Eliza Business School in Australia. He has published extensively on the topic of intellectual capital as well as on the wider subject of strategy. His consulting experience in this field ranges across both public and private sectors in over 40 countries, including with Australian blue chip companies such as Fosters.

His co-authors for this study, Lisa Fernström and Oliver Gupta, are consultants at Intellectual Capital Services Ltd. Intellectual Capital Services Ltd provides research and advisory services in the field of management, measurement and valuation of intellectual capital. Intellectual Capital Services Ltd has acted as a consultant to public and private

sector organizations, covering a wide range of industries. The company conducts applied and theoretical research relating to intangible assets, their impact on share price, their disclosure, their measurement and their management. Much of this research has been published in refereed journals.

ABOUT THE AUSTRALIAN BUSINESS FOUNDATION

The Australian Business Foundation is an independent business research think tank founded in 1997 by the eminent industry association, Australian Business Limited, to help foster fresh insights and practical intelligence to boost Australia's capabilities and global competitiveness. The body of research over 8 years focuses on busines innovation, new forms of competitiveness and opportunities from a knowledge-based economy.

For more information and information about earlier research reports, visit the Australian Business Foundation at www.abfoundation.com.au .

NATIONAL INNOVATION SYSTEMS

In broad terms, a national innovation system (NIS) can be broadly defined as all economic, political and other social institutions affecting learning, searching and exploring activities (i.e. a nation's universities and research bodies, financial system, its monetary policies, and internal organization of private firms). This model is shown in Figure 1 below.

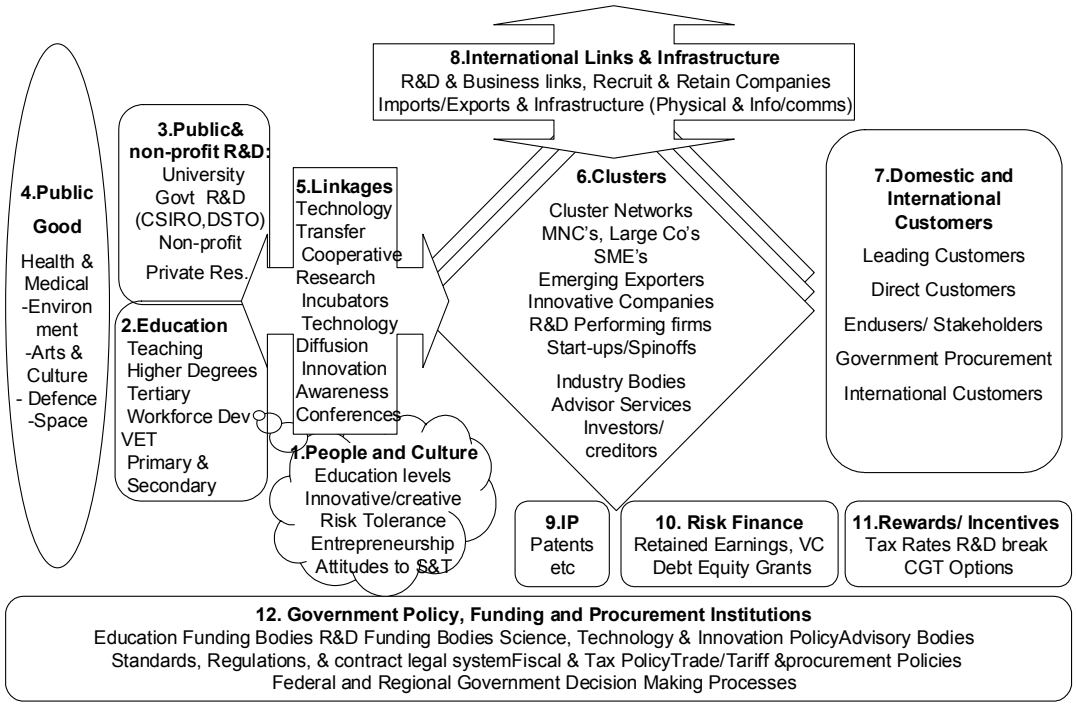

Figure 1: Constitution of National Innovation Systems

So what distinguishes a successful national innovation system from the mediocre? Successful national innovation systems are leaders in managing the transition to a fundamentally new approach to innovation policy and share the following characteristics:

- Recognition of the need for and cohesive, deliberate action by governments to invest productively in each of the elements of the innovation system, and in the way the structure works together as a whole. Too often, innovation policies focus on single components only like research and development investment, or access to venture capital.
- An economy which is flexible and adaptable, with a commitment to reform and a global focus.
- The existence of demanding sophisticated leading-edge customers.
- A high level of networking among innovators, and the existence of robust industry clusters.
- Improved linkages between science and industry.

- An increasingly diversified base of research and development performers.
- High business and government expenditure on research and development.
- A supportive financial system.
- Above average rates of investment in education, research and innovation.

This paper highlights that Australia can learn from the two Nordic examples of Sweden and Finland, which have been classified as showcases for development of their national innovation systems. The Finnish and Swedish national innovation systems are briefly described below, and the abbreviation of NIS is used for the remainder of this paper to indicate a national innovation system. (For the expanded paper demonstrating this case, please refer to the Australian Business Foundation web site at www.abfoundation.com.au.)

FINLAND

Finland was among the first countries to adopt the concept of a national innovation system (NIS) as a basis for its technology and innovation policy.

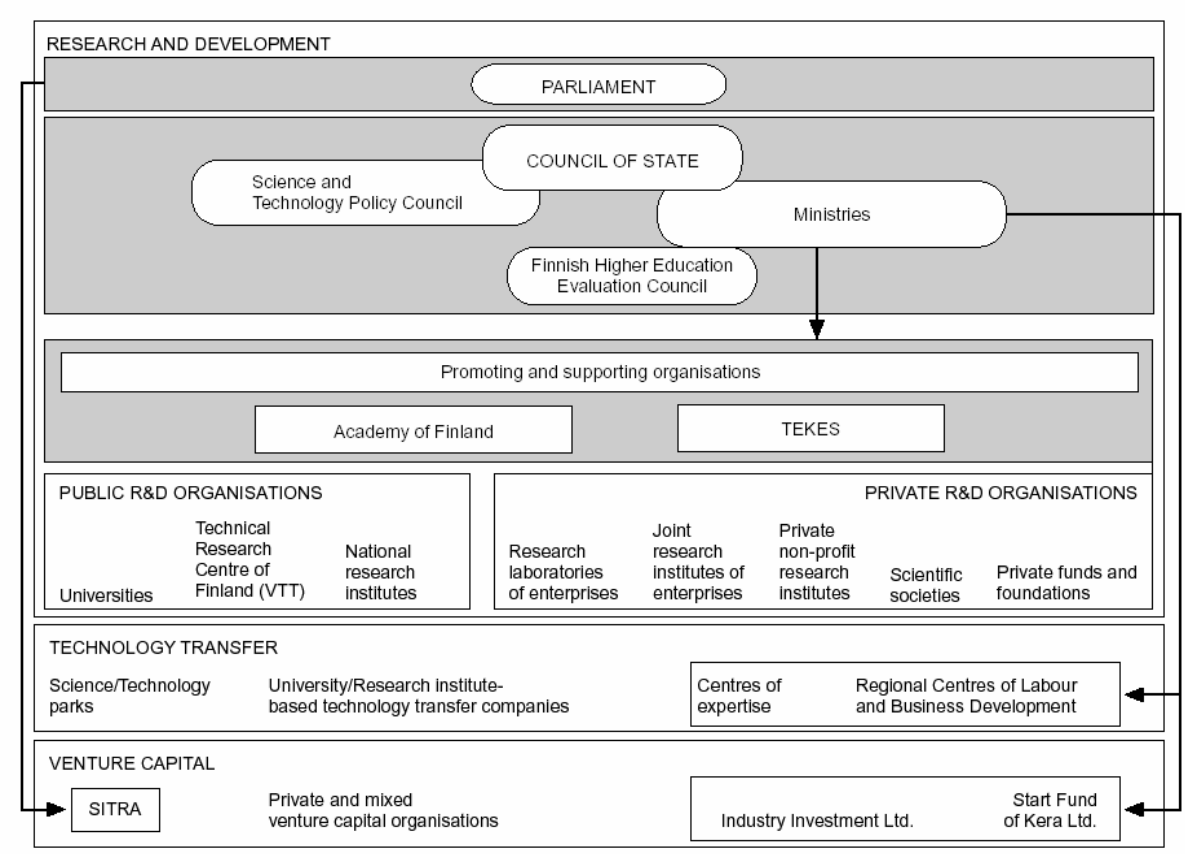

Figure 2: Key Flows between Actors of Finland's National Innovation System

Key organisations in the Finnish system include (see Figure 2)[2]:

- Academy of Finland;
- National Technology Agency of Finland (TEKES);
- public research and development organisations;
- technology transfer agencies; and
- capital providers.

TEKES is the principal organisation for implementing technology policy and is part of the Ministry of Trade and Industry in Finland. It supports companies engaged in risk-bearing product development projects with grants and loans, and finances the projects of research institutes and universities in applied technical research. TEKES launches, co-ordinates and funds technology programs to be implemented together with companies, research

institutes, and universities. Also, TEKES has expertise abroad including coordinating international cooperation in research and technology.

The public research and development organisations include universities and polytechnics, national research institutes and the Technical Research Centre of Finland (VTT). The combined expenditure of these organisations is about 30% of the total national expenditure on research and development. The private sector's expenditure on research and development is approximately 2% of gross domestic product (GDP) and is growing. There are very strong linkages between the research and development efforts of business and universities and other public sector research and development groups.

The Finnish NIS has always had a strong focus on regional development through technology transfer and there is a diverse range of capital providers for innovation, both private and public. SITRA is one of them and provides capital for start-up technology firms, always as a minority investor, as well as services to match SMEs with 'business angels'. SITRA also provides funds for:

- research projects for existing companies, both large and small;
- training projects;
- technology transfer; and
- foreign venture capital funds.

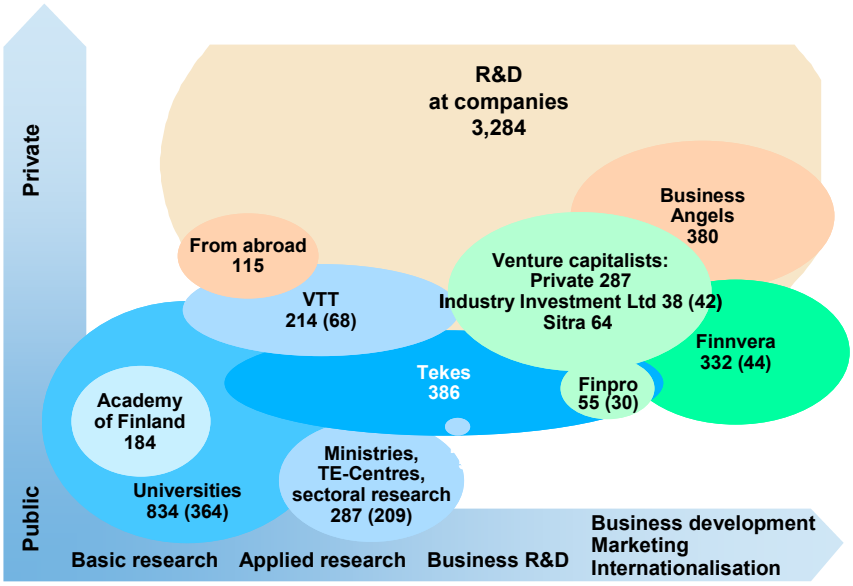

Figure 3: The Finnish Innovation System: Sources and Funding 2001

One important feature of the Finnish NIS is the operation and role of Finland's Science and Technology Policy Council (STPC). Chaired by the Prime Minister, the STPC has several important facilitating roles in innovation policy making:

- it acts as a coordinating body between the Ministries on research and development issues;

- it provides a platform for policy discussion among Ministers, industry, funding organisations, unions, universities and government officials; and

- it defines the over all guidelines for government research and development funding.

A discussion of the lessons to be learned from the Finnish NIS follows.

COORDINATING THE NATIONAL INNOVATION SYSTEM

A key learning from Finland is the need to **develop a coordinated National Innovation System**. Finland has made considerable advances in generating a coordinated NIS. The high frequency of consultation, deliberation and effective linkage creation between government, its programs, and industry has been productive. The Finnish process begins with the recognition that in the knowledge-based economy, knowledge can be fostered to produce economic benefits.

From the late 1980s, nation-wide networks of technology parks and centres of expertise were set up in Finland. The technology parks have initiated spin-off projects and incubators.

The "spotter" system employed in incubators encourages flows of knowledge out of the laboratories into fledgling firms. Undoubtedly, the management of the incubator is critical to the success of such incubated firms; however, it is the coordinated flow-on benefits that follow in Finland which are impressive. These benefits include entrepreneurial training, linkages to prestigious TEKES grants, and the informal imprimatur to investment through SITRA and Finnish Industry Investment Ltd for small and emerging firms.

It is significant that international technology transfer is the primary province of investment houses and their links back through the research system.

The evaluation of the impact of government programs on areas such as jobs, turnover and exports has become a significant tool in determining the value of their outputs. This adds to the integrity of performance of both the programs and the firms.

A lesson that should not go unnoticed is that of using the sale of utilities to generate a substantial endowment fund for establishing government investment agencies (SITRA and Finnish Industry Investment Ltd). However, it is probably not able to be replicated elsewhere.

Australia could usefully consider the simple membership listings of some of Finland's science parks (involving universities, government, regional governments, financial capital funds, and firms). Furthermore, Australia can learn from clustering of the industrial supply chains, which have been built up from the connections between the technology parks, firms and investment funds, in addition to the firms involved.

Unfortunately, the Finnish examples provide no clear picture of the "ideal" incubator model. However, they do offer an interesting contrast between, on the one hand, the Viikki Biocentre (a research cluster), and on the other, the Innopoli/Oteniemi (an incubator for emerging firms). Both are based at universities, but show markedly different patterns of association and linkage, in the former case to international companies as well as indigenous ones. (See further information in the box overleaf.)

The strategic plans offered on a triennial basis through Finland's Science and Technology Policy Council provide the blueprint for continued integration and development of the Finnish system and could readily be emulated in Australia if it can be agreed that this is considered a viable "way to go".

The considerable achievements of the Finnish Government in stimulating the economy to reach the highest levels of research and development expenditure from the private sector, and public/private combined will need to be carried forward in new growth firms.

SOURCES OF CAPITAL

Until the mid-1980s the banking system model in Finland was based on continental Europe's central bank system and a weakly developed risk capital market, presenting weak conditions for nurturing entrepreneurship and financing new small and medium-sized enterprises.

After that time, a vibrant venture capital market emerged as a result of the liberalization of the financial sector. This provided unparalleled financing opportunities for innovative "high-tech" firms, which are now able to enter the market already at a relatively early stage of product development.

The amount of venture capital investments increased more than tenfold between 1995 and 2000. It is estimated that about one-third of private equity investment in Finland went to information and communications technology during this period. This underscores the need to strengthen the sources of capital

Viikki Biocenter

The Viikki Biocenter[3] of the University of Helsinki is located in the Viikki campus. It was built in 1995 and it is the core of the Helsinki Science Park, which also includes the buildings of the Faculty of Agriculture and Forestry, the student village, a biobusiness incubator building and the residence for international scholars. The Viikki Biocenter consists of four major teaching and research institutes of the University of Helsinki. These are Departments of Biosciences and Pharmacy and part of the Department of Applied Chemistry and Microbiology, and the Institute of Biotechnology[4]. The latter is an independent research institute, which was founded 10 years ago to promote molecular biology and biotechnology research in the University of Helsinki.

The Viikki Biocenter harbours some 70 research groups and many of these groups are carrying out studies in cell biology. Five of the cell biology groups are located in the Institute of Biotechnology. They are studying protein folding in yeast (Marja Makarow), virus replication (Leevi Kaariainen), cell morphogenesis and migration (Johan Peranen), glycobiology (Ossi Renkonen) and the actin cytoskeleton (Pekka Lappalainen). The research activities of other cell biology groups at the Viikki Biocenter include neuronal development and plasticity (Heikki Rauvala), leukocyte adhesion (Carl Gahmberg), intracellular membrane traffic (Esa Kuismanen), and signal transduction (Mathias Bergman, Merja Auvinen, Ragna Ronnholm).

Owing to the good research funding situation in Finland, the Viikki Biocenter has modern instruments including an up to date electron microscopy facility and two modern confocal light microscopes. It also harbours excellent technical core facilities. These include a protein chemistry laboratory with mass spectro-meters (MALDI-TOF and Q-Tof electrospray mass spectrometers) and protein sequencing instruments, as well as a DNA laboratory with expertise to synthesize various specialized DNA fragments and capillary electrophoresis sequencing instruments for high output sequencing. Furthermore, Viikki Biocenter has a modern structural biology facility with one 800MHz and two 600MHz NMR-spectrometers as well as an X-ray crystallography unit.

Innopoli/Oteniemi

The City of Espoo, together with Finnish industrial companies and insurance companies, established Innopol. This is a concentration of high-tech research, training & business facilities at the Oteniemi Science park – including the Technology University and VTT (including the VTT technology transfer unit - Finntech). The park also has a strong business incubator structure

The Helsinki University of Technology has taken the lead in establishing the Oteniemi International Innovation Centre. It's tasks are international technology transfer and marketing, searching for new technologies, and recruiting and business services.

and to **facilitate venture capital investments**.

Most notable is the outward investment view taken by SITRA – primarily as a mechanism to gain expertise for the Finnish venture capital market. It is, however, the direct linkages to the USA that are held in highest regard, and this is intended to be emulated in the international cooperation platform of TEKES. Fund management in the Australian venture capital market could also benefit from the influx of USA know-how in this field.

It is equally significant that investment in new ventures is generally shared amongst the institutions, with the universities as the central player in most cases, and a particular emphasis on regional development plans for the economy and employment.

A further notable development has been the growth and internationalization of the Helsinki Stock Exchange (HEX). With the ratio of market capitalization to GDP at below 20 percent and limited foreign portfolio investment until the early 1990s, the stock market was not a very important source of capital. After Nokia's breakthrough, however, foreign investors discovered the Finnish market. The market capitalization rate had risen to well over 200 percent by 2000, around 70 percent of shares were held by foreign owners, and many companies other than Nokia had significant foreign ownership. HEX recently merged with the Stockholm Stock Exchange.

SKILLED LABOUR

The success of the Finnish information and communications technology industry was further dependent on the availability of a skilled labour supply. The Nokia case shows that the initial breakthrough in the telecommunications sector was made possible by the availability of specialized skills, largely built up as a result of the mix of technical solutions chosen by the many competing telecom operators. The 1980s were characterized by a shortage of the labour skills needed by Nokia and other high-tech firms, and the companies invested substantial funds on specialized in-house training programs, sometimes in collaboration with Finnish universities[5].

By the early 1990s, the shortage of educated manpower had come to the attention of the government, and a broad expansion program in higher education was initiated. The total intake in universities nearly doubled in the five years between 1993 and 1998, and the number of students in polytechnics tripled over the same period. This increase in the supply of labour has been essential for the expansion of the information and communications technology cluster.

It should be noted that Finnish high-tech companies still suffer from a chronic shortage of educated labour, and total employment in the cluster would certainly be much higher without this restriction. This underscores the lesson of needing to **ensure a sufficient supply of skilled labour.**

NETWORKING

Finland is a clear lesson in the need to **encourage networking**. Networking between industry and science is so well developed in Finland that in the mid-1990s, 40 per cent of all innovative firms reported that they cooperated with universities or public research institutions, which is among the highest in OECD.

Collaboration reaches well beyond university participation in corporate research programs. In many of the current high-tech fields (including information and communications technology), technology development is so fast that the skills demanded by companies cannot be found in textbooks. Industry is therefore actively involved in

training and knowledge transfer to the universities, and a large number of internships are provided to link theoretical studies to practice.

The information and communications technology cluster is a case in point, where Nokia has acted as a catalyst in creating vertical relationships with suppliers and subcontractors, covering not only production but also research and product development. In many cases, this networking has been mandated by TEKES (which is co-financing Nokia's research) and it has often necessitated substantial transfers of technology from Nokia to its partners, at least in the initial stages of the relationship.

The networked production paradigm, enhanced by cooperative long-term relations, can be seen behind much of the superior performance of Nokia and the Finnish information and communications technology sector in general. This is not only a feature of Nokia's operations: networking solutions have become increasingly common in the information and communications technology industry at large.

A SYSTEMS APPROACH

A systems approach is necessary to use existing resources efficiently and to **identify bottlenecks and obstacles to growth and development**. It is necessary to examine all the elements of a national innovation system (customers, government regulators, technology transfer organisations and incubators, research and development bodies, financial institutions and so on), not just single components.

It is not enough to support the development of the specific assets of individual firms in the chosen cluster. Demand, supporting and related industries, and conditions in the factor market need to be taken into account as well. For example, to support adequately the development of mobile handset software, it is essential that the demand side industries (eg. Nokia and TeliaSonera), the supporting industries (eg. providers of hardware and software needed for the development), and related industries (eg. other mobile services) are present in close proximity to lay the grounds for successful development. In addition, there is a need to ensure the availability of trained people, suitable inducements for entrepreneurial activities, the presence of good locations and other issues related to factor markets and assets.

POLICY DEBATE

It is not sufficient to delegate responsibility to any individual ministry, agency or department; the main actors, including industry, universities, labour market organizations and other central players should be represented in the policy discussion. For best effect, there is a strong need to establish a broad foundation for the policy debate on innovation.

SWEDEN

The Swedish national innovation system (NIS) is characterized by internationalized research; industrial orientation towards resource-intensive industries; rapid adoption of new techniques; high expenditures on education; and a relatively costly financial system. Large authorities aided by small ministries dominate the governmental part of this system. The authorities are independent units whose task is to carry out the plans of the government, but also to initiate relevant projects of their own, aiming at a specific goal. Most of the responsibility is allocated to the authorities rather than the ministries.

Sweden invests more in research and development than any other country in relation to its GDP. As a result, Sweden is a world leader in scientific output per head of population, measured in terms of scientific publications. In addition, Sweden plays a prominent role in registering patents. Yet despite undertaking considerable investment in research and development, Sweden's long-term economic growth rate is low.

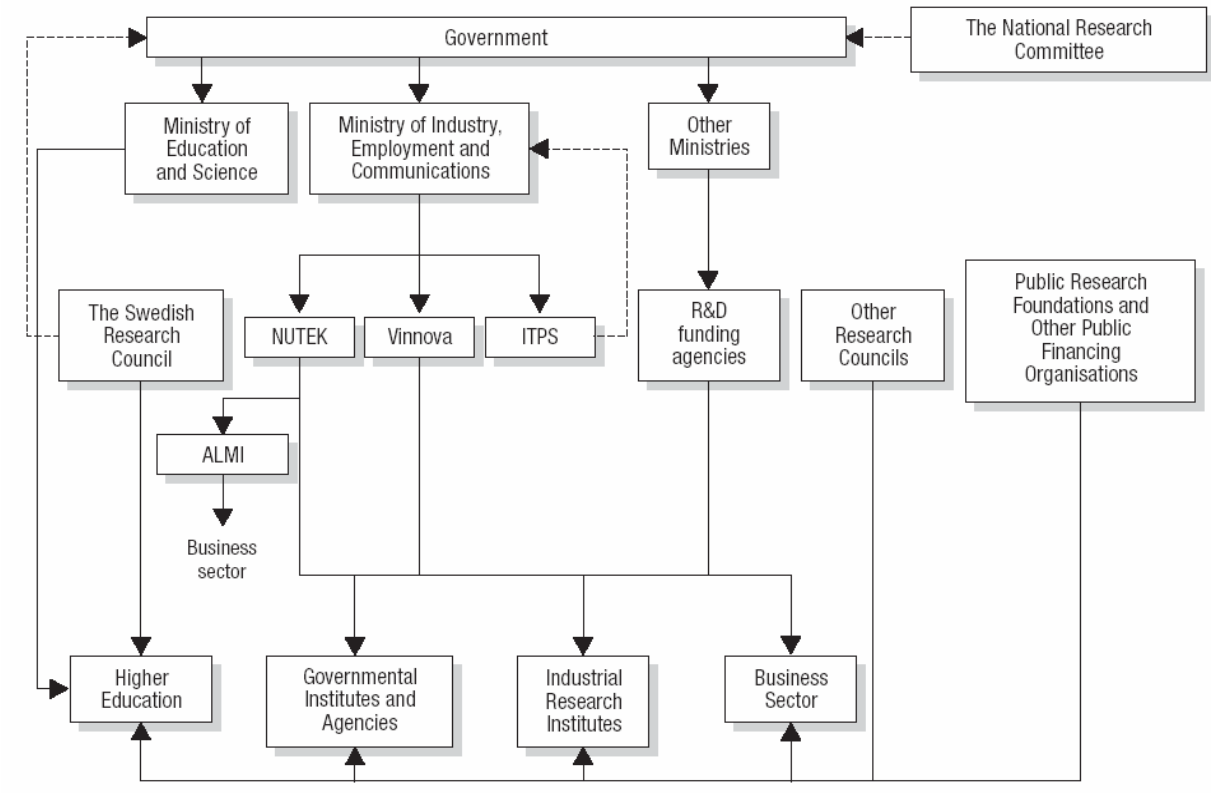

Figure 4: Structure of the Swedish National Innovation

The Swedish NIS recently underwent restructuring in order to reduce the number of agencies and clarify their mission. The former NUTEK has been divided into:

- Swedish Business Development Agency (NUTEK);
- Swedish Agency for Innovation Systems (VINNOVA); and
- Institute for Growth Studies (ITPS).

NUTEK is Sweden's central public authority for questions related to economic development. Its functions include financing for companies, regional economic development, information and advice services, as well as networking and meeting places. It aims at cluster building. Seed-financing is one of the main instruments of NUTEK. It does not finance research and development.

The Swedish Agency for Innovation Systems, VINNOVA, funds needs-based research and development to support innovation systems and sustainable development and growth by means of problem-oriented research and the development of effective innovation systems. It is funded by the Government (AUD200 m/Year plus AUD 60 m (2003-2005) for research and development institutes plus AUD15 m/Year for long-term strengthening of research and development institutes). Activities comprise support for research and development in technology, transport, communication, and the labour market.

The Institute for Growth Studies, ITPS, aims at increasing the competence of future oriented growth policy, by analysing the economic and technical changes, evaluating political actions and ensuring the quality and availability of data related to growth politics.

The ALMI Group aims at stimulating and motivating SMEs for ongoing growth and development, mainly by offering loans to SMEs. ALMI also offers management programs, business-development consultation and advice for the companies, from its 21 regional offices spread out over the country. The state and county councils own the regional ALMI companies. In the beginning of 2001, the ALMI mother company was merged with NUTEK. The challenge is now to combine effectively the culture of a corporate commercial entity with the culture of a public agency.

The Swedish Research Council (*Vetenskapsrådet*), which is to support fundamental research in all scientific fields, comprises several separate councils: the liberal arts and social sciences, natural sciences and technology and medicine and also an education committee. These bodies distribute funds within their own areas of responsibility. The Swedish Research Council has particular responsibility for maintaining the quality of Swedish research and providing analyses of research policy and advice on research issues for the Government.

Other public-sector sources of research funding include various research foundations. The Swedish Foundation for Strategic Research supports research in natural science, engineering and medicine. Its total annual disbursements in 2000 were about SEK1000 million. The Foundation for Knowledge and Competence Development (KK-Foundation) is to promote information technology, research at Sweden's institutes of higher education, and bridge the gap between the academic and the business worlds. Since 1994 it has invested SEK 1,500 million in approximately 500 projects.

The lessons for Australia that can be learned from Sweden include the following three insights and are discussed in more detail below:

- Competitiveness requires flexibility;
- Dependence on the international environment; and
- Leveraging opportunities for change.

COMPETITIVENESS REQUIRES FLEXIBILITY

Sweden had a very competitive system for a long period after the Second World War and grew very fast, but the policy environment was designed to benefit a small number of large actors at the expense of domestic heterogeneity, competition, and entrepreneurship.

The concentration of economic power in the hands of government, unions, and a small number of large multinational companies created an environment where the distribution of profits overtook growth as the main objective, and where costs increased rapidly since no party was interested in disruptive conflicts.

Despite the fact that this was already obvious in the mid-1970s, no change in the overall policy environment took place until the early 1990s. Various interest groups wanted to keep the system intact, with detrimental effects on long run growth.

DEPENDENCE ON THE INTERNATIONAL ENVIRONMENT

Globalization has made governments more and more dependent on the international environment. By setting up international production that exploits the comparative advantages of several countries, multi-national companies can maximize their efficiency. They may also force governments to adjust to the competition between alternative locations, and create a more favourable business environment. Sweden is probably the best example of this.

The stagnant Swedish model survived as long as multinational corporations were still tied to their home country by various restrictions on the international mobility of goods, services, capital, and labour. As these restrictions were reduced, in some cases at the regional rather than the global level, the high costs and other weaknesses of the Swedish model became critical, and motivated firms to move attractive jobs out of the country. This, in turn, forced the government to start reforming the system.

LEVERAGING OPPORTUNITIES FOR CHANGE

Although many of the weaknesses of the Swedish model were well known and widely discussed for many years, nothing happened until the financial crisis interrupted the fixed positions between various interest groups.

Many of the reforms introduced in the wake of the crisis would not have been politically viable only a few years earlier. The point to note is that crises provide rare opportunities for reforms in societies with strong established interest groups.

Continuous monitoring of an economy's relative strengths and weaknesses is particularly important at these times. Those economies that have a ready-made blueprint for reform are clearly in a stronger position than countries where the reform agenda must be decided in the turbulent environment following the crisis.

THE ROLE OF NATIONS IN NATIONAL INNOVATION SYSTEMS

Before examining how Australia compares with the two Nordic examples and identifying learnings that Australia can use to strengthen its national innovation system, it is important to understand how nations can take deliberate action to shape the character and results of their national innovation systems.

While the actions of firms are critical in determining the level of innovation in an economy, firms don't act alone. Interrelationships exist with public policy makers and regulators and with other players in the economy (eg research and development bodies, education, technology and infrastructure institutions).

To succeed, firms do not need to belong to an 'ideal' type of innovation system whose character can be prescribed in advance. Rather they need to belong to an innovation system whose character interacts positively with their policy environment, both nationally and internationally.

The challenge for policymakers is, therefore, to develop policies which aim to identify relevant complementarities between firm and country-specific advantages and disadvantages. Rather than simply trying to attract foreign direct investment, policies should aim to be selective by discriminating in favour of those investors whose strategies and organisations complement national advantages.

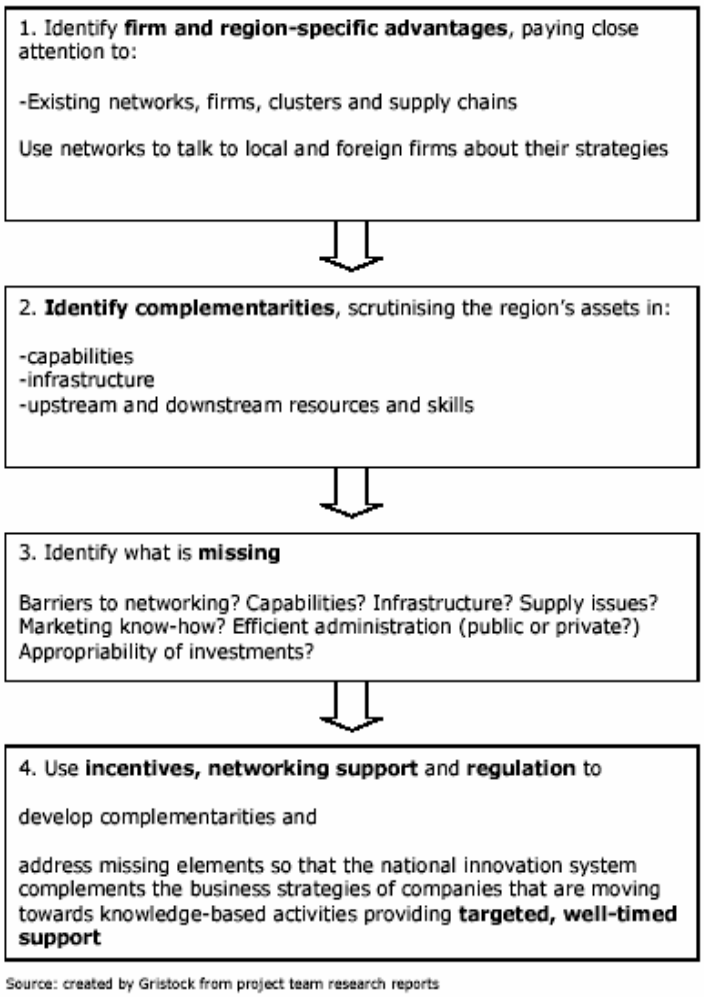

Figure 5: Identifying policies for growth through network alignment: a process

But what might this mean in practice? The country-specific, sector-specific and even firm-specific nature of innovation system development dictates that policy advice cannot take the form of a 'best practice' checklist of actions that would be universally appropriate. Strategies need to be conceived in relation to the firm-, sector- and country-specific advantages and disadvantages in the different parts. However, what would be useful to

policymakers is a process for identifying these firm and country specific advantages and disadvantages, with policy examples and the contexts within which they have proved successful in the past. One such possible guide is described in Figure 5 above.

Policy challenges and responses to boost the level of innovation in a nation are to some degree, country-specific and will depend on historical context and heritage as well as on the prevailing features of the economic and innovation systems

Countries also differ markedly in:

- the capacities and traditions of their science and technology policy institutions;
- the division of responsibilities between central and sub-central levels of government;
- the role of different ministries;
- the nature of government/industry relationships; and
- the scope for public/private partnerships.

The priority tasks of technological and innovation policy are somewhat different. For example, some countries (eg. Japan) place greater emphasis on strengthening the science base, while others (eg. the USA) concentrate on leveraging mission-oriented public research and development, and still others (eg. several European countries) try to build a more innovative culture, especially among smaller firms.

Illustrations of good innovation policy practices are shown in the sample typology of good policy practices described in Appendix 1. Examples given there should not be viewed as the single best practice in a given policy area, but rather as illustrations of possible sound responses to a generic innovation policy challenge in a specific national context.

TYPOLOGY OF GOOD POLICY PRACTICES

The 'path dependency' of innovation and technology policy increases the risk of inefficient government initiatives but can also lead to unique strengths in innovative ability. National technology policy institutions have developed specialised skills and corresponding toolkits, which may help or hinder accomplishing policy aims. For the most part, governments address current challenges with administrative structures and policy instruments that have been shaped by responses to past problems. These distinctive national features are both constraints on policy choices in the short term and possible targets for policy reform in the longer term. They form the national policy context in which policy options must be analysed and spending prioritised.

As seen above, there is clear evidence that innovative companies are considered essential for the development and growth of nations. Nevertheless, what has to be emphasized in this section is the fact that innovation is considered an area where market failure exists. This was put usefully by the European Commission: " … the inability of a system of private markets to provide certain goods either at all or at the most desirable or 'optimal level'. Market failure occurs, therefore, when private companies cannot or will not provide something because they cannot make a commercial return even where there is demand or need for this something. Under these conditions, the rationale for public provision of or public assistance to private firms in providing this is normally justified as it will lead to employment and wealth creation that would not otherwise have occurred"[6]. Nevertheless, government should intervene only in the few cases in which both market failure and the ability of government to act efficiently is well documented[7].

HOW DOES AUSTRALIA COMPARE?

This section looks at how Australia compares to the two cases of Finland and Sweden outlined previously. An Innovation Index, developed by the US Council on Competitiveness,[8] paints a very contrasting picture between Australia, Finland and Sweden. Whereas both Sweden and Finland are placed within the top 6, the Index rated Australia 12th out of 17 major OECD countries. The index is based on per capita measures, which are:

- total research and development personnel,
- total research and development investment,
- the percentage of research and development funded by private industry,
- the percentage of research and development performed by the university sector,
- spending on higher education,
- the strength of intellectual property protection,
- openness to international competition, and
- a nation's per capita GDP[9].

A projection to the year 2005 based on 1995 data only lifts Australia's ranking to 11th out of 17 countries. Similar results is found if one looks at the World Competitiveness Yearbook[10] and the Global Competitiveness Report[11].

Looking at the growth competitiveness ranking (see Figure 6 overleaf), Finland posted improvements in its overall macroeconomic stability characterized by an increase in its government surplus, an increase in its national savings rate, and further reduction of its inflation rate and interest rate spread. Yet despite generally stable economic indicators, Finland posted the fourth worst deterioration in recession expectations (rank #69) as negative sentiment deepened over the economy's prospects in the immediate 12-month period. Significantly, Sweden's position in third place is unchanged, but underlying its ranking is one of the most striking improvements in scores, particularly in the area of public institutions. Sweden posted increases in the scores pertaining to the extent of organized crime and the perception of favouritism in the decisions of government officials. But like the United States, Sweden's continued leadership in the technology index (rank #4) belies a notable decline in patents granted.

Country	Growth Competitiveness ranking 2003	Growth Competitiveness ranking 2003 among GCR 2002 countries	Growth Competitiveness ranking 2002*
Finland	1	1	1
United States	2	2	2
Sweden	3	3	3
Denmark	4	4	4
Taiwan	5	5	6
Singapore	6	6	7
Switzerland	7	7	5
Iceland	8	8	12
Norway	9	9	8
Australia	10	10	10
Japan	11	11	16
Netherlands	12	12	13
Germany	13	13	14
New Zealand	14	14	15
United Kingdom	15	15	11
Canada	16	16	9
Austria	17	17	18
Korea	18	18	25
Malta	19	—	—
Israel	20	19	17

Figure 6: Growth Competitiveness

That Australia stays in 10th place underplays significant improvements in the public trust in politicians and perceptions of the extent of distortive government subsidies, as well as overall quality of public institutions. What did decline is the tertiary enrolment rate from 79.8 percent to 63.3 percent, which by itself accounts for a drop of 7 positions in the technology index and 2 positions in the overall Growth Competitiveness Index.

Australian business expenditure on research and development as a share of GDP is markedly lower than the OECD average and was falling between 1995-96 and 1998-99 while the average for OECD countries continued to rise. 2001-02 was the second successive year of significant increase but total business expenditure on research and development is still markedly lower than the OECD average. Sweden tops the list with Finland at 6th position.

Australia's total expenditure on research and development was around $8.8 billion in 1998-99. To put that in context, at the time it represented about one thirtieth of the level of research and development investment in the USA, the world's largest economy or only some 16.5 per cent more than IBM's expenditure on research, development and engineering. Australia's expenditure on R&D as a share of GDP in 1998-99 was 1.49%, placing it in the mid-range of OECD nations. However, its research and development intensity has been falling in recent years (until quite recently), running counter to the general OECD trend.

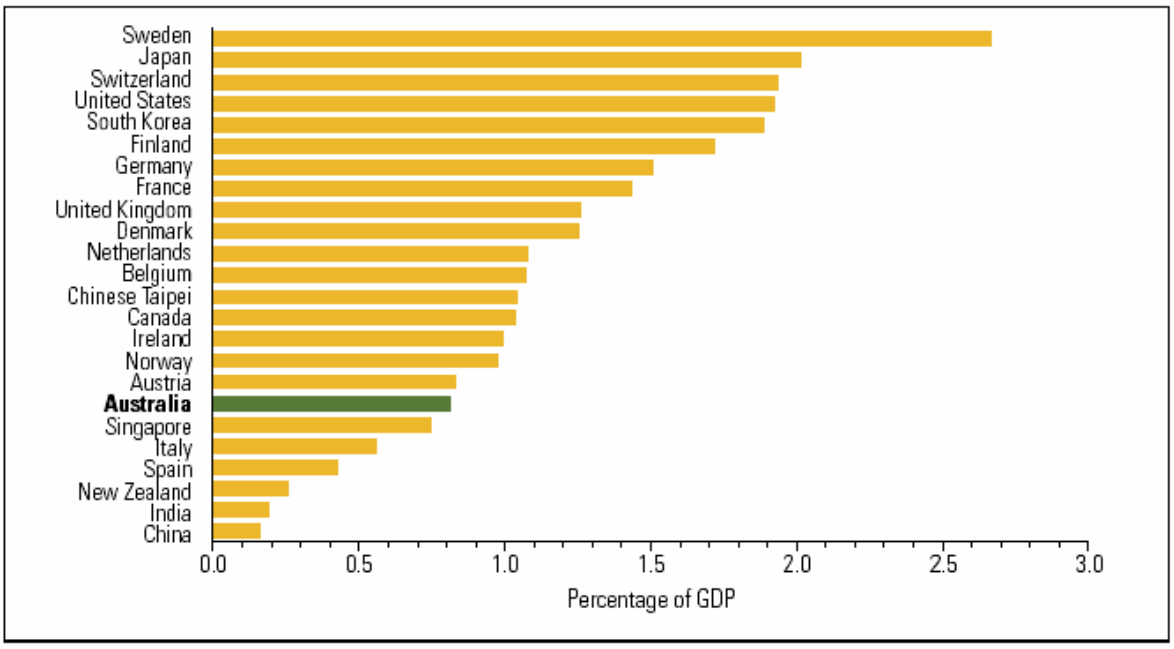

Figure 7: Business Expenditure on Research & Development as a percentqage of GDP - International Comparisons

CHALLENGES FOR THE AUSTRALIAN NATIONAL INNOVATION SYSTEM

Over the past quarter century, both public policy and private sector initiatives have transformed Australia from a classical "imitator to a second tier innovator economy. Although Australia has improved its innovation capacity over time, it not has not done so as fast as key international competitors"[12].

The public sector science and engineering base in Australia has generally been regarded as strong. However, as the international comparisons of innovation systems have shown, Australia is not ranked highly as an innovative country. Several of the emerging economies have now overtaken Australia, (for example, Korea and Taiwan) particularly in physical and engineering disciplines. International comparisons are also indicating that there is significant room for improvement in Australia's innovation performance.

The strengths and weaknesses of the Australian innovation system have been documented by various reports[13] with strengths including:

- a broad scientific base, world class in some areas;
- success in converting knowledge into patents; and
- high growth in several areas including biotechnology, pharmaceuticals and office and computing equipment. This growth has however started from a low base.

Several weaknesses that have been suggested include:

- insufficient attention to the development of human capital (for example, entrepreneurship);
- low average company size which may impede ability to compete in new industries and innovate;

- in international terms, business expenditure on research and development is poor; and
- many research institutions have poor linkages with potential users of research.

Mismatches in national innovation systems are due to systemic bottlenecks or strains. The imbalances are caused by coordination and information failures and by structural (i.e. institutional) rigidities. As national innovation systems are complex, the identification of mismatches tends to be indicative rather than definitive and our coverage of Australia's NIS is based on observation and review of literature and is by no means exhaustive.

> *A weakness of the Australian innovation system is the innovation progression gap where applied research or experimental development ends and market introduction begins. This stage in the innovation process is prior to the point at which venture capitalists are normally prepared to invest.*
>
> *Australian Research Council (2001)*

Dominant themes in all recent reviews of innovation in Australia have been the importance of collaboration between industry, researchers and Government and the quality of systemic linkages with many questioning whether there is an innovation system in the sense that the policies and programs are closely linked.

POOR OR NON-EXISTENT SYSTEMIC LINKAGES

The Australian NIS is capable of leading edge research but often at less than optimum scale as there are often poor linkages between public and private agencies and little coordination of effort between Government agencies.

We have reviewed the role of and need for linkages in a modern NIS, such as complex patterns of complementarity between suppliers, producers and customers in the creation, production and distribution of goods and services. On the one hand, the quality of the organisations that support firms (ie. suppliers, customers, technical firms, advisory services, research and development, and educational institutions and so on) may be precisely what makes effective innovation possible in that context. On the other, the benefits of effective innovation by the firm may well spread across the whole system (or cluster or network) of supporting organisations, providing a range of social benefits in those organisations and improving the ability of the system to support innovation in other firms.

In either case, there are likely to be economies of scale which are external to the firms in the system. As the system grows, its costs fall. Yet because substantial cost reductions owing to scale occur outside individual firms, they are unable to capture all the social benefits their growth generates. These rich interdependencies and externalities justify a potential role for policy intervention. The following table matching specific market failures with examples of appropriate policy interventions is drawn from the work of the Ministry of Trade & Industry in Finland.

MARKET FAILURES	POTENTIAL PUBLIC SECTOR TASKS
Internal and external security	Maintenance of judicial system, property rights, police and army
Large cyclical variations	Aggregate demand management by monetary, financial and exchange rate policies
Barriers to competition	Competition policy, restraint in regulation and industrial subsidies, labour market reforms, liberalisation of international trade
Public goods	Provision of transportation and communications infrastructure
Externalities	Promotion of positive externalities (education and R & D) and reduction of negative externalities (environmental damage)
Large uncertainties and informational problems	Improvement of market information, export and finance guarantees, R & D support, development of venture capital markets
Structural adjustment rigidities	Promotion of structural change, provision of economic vision, conflict management between interest groups
Economies of scale and learning	Export promotion, facilitation of structural adjustment, public procurement

Figure 8: Market Failures & Policy Interventions
(Source: Ministry of Trade & Industry, Finland, 1996)

Australia needs to find ways to build much stronger links across the innovation system, particularly between research institutions and industry. This impacts adversely on:

- the development of critical mass in research and development infrastructure and institutional arrangements;
- mobility of personnel between research, government and industry sectors;
- diffusion and commercialisation of university research; and
- the general creation of a culture of innovation.

COLLABORATION BETWEEN RESEARCHERS, GOVERNMENT & INDUSTRY

In several recent papers and reviews on Australia, collaboration (or the lack thereof) between researchers, government and industry has been a common theme. This is not new. For example, such partnerships have been a part of the research system in Germany since the 1800s, while in the United Kingdom, academics in engineering and science have traditionally worked as consultants to industry.

However, concrete lessons on this issue for Australia can be inferred from the Finnish system. Finland has made major advances in developing a coordinated national innovation system with frequent consultation and highly developed linkages between industry and government. Finland also has a system of evaluation of government programs, which has been described as adding to the integrity of the performance of both the programs and the particular companies. This is because Finland evaluates government programs to determine their impact on jobs, turnover and exports.

The observation has been made that, in general, no country has ever developed a strong industry sector with the philosophy of promoting an arm's length relationship between government agencies and the private sector. An important part of industrial technology policy is a support network which encourages relationships between major groups such as the education and training and finance sectors and basic research organisations. This has not been a strong point in Australia.

INNOVATION – COMMERCIALISATION GAP

Broad empirical evidence from Australia shows that larger firms are more likely to innovate than smaller firms, which are even less likely to undertake formal research and development. This general trend has major implications for Australia given its SME dominated economy. Thus only a small percentage (<5%) of companies are categorised as large. The large firms also contain multinational companies who historically prefer to perform research and development activities close to headquarters and export technology into Australia. Still, multinational enterprises contribute with a significant share in research and development.

For SMEs, multiple factors have been identified to explain the lower innovation rate such as an inability to diversify risks, incomplete information and high capital costs. This is especially true for SMEs which are far removed from the major sources of knowledge-based wealth creation. Such firms are less likely to have the information, skills and financial resources to identify and to undertake an optimal program of innovation. Given the prevalence of such firms in Australia, it is to be expected that Australian firms on average undertake substantially less innovation than would be profit maximising, and hence on this account alone, less than would be socially optimal. Thus the structure of Australian industry is a factor clearly militating against higher levels of innovation in at least some cases and may justify suitable interventions.

Further problems characteristic to the Australian SMEs are the difficulties in matching their skill base and commercial imperatives with the public sector. Most SMEs are simply too small to conduct research and development or absorb high tech ideas from the science base.

The lack of ability by most SMEs to absorb new technology remains a huge issue that needs to be addressed for all parts of the Australian national innovation system.

On a personal note, the authors would like to make the reflection based on personal experience that Australian businesses, especially SMEs, seem very good at tactical problem solving as opposed to strategic innovation. In this sense they are very similar to Norwegian businesses, especially SMEs, that exhibit similar traits. This can pose an additional barrier to building an effective national innovation system, since it might create an attitude of complacency believing that "we are good at innovating because we are good at finding solutions". In fact, this approach is one of tactical problem solving as opposed to strategic innovation. Practical problem solving is mostly a defensive tool, whereas strategic innovation is an offensive tool with corresponding differing impacts on economic growth.

Australia's ability to develop large corporations from start up companies has also been of concern. Some believe that these issues are being addressed by the Cooperative Research Centre (CRC) Program, as well as by the efforts of the major public sector research institutions and new Australian Government programs. However, there continue to be views that both the level of coordination between government agencies and the level of interaction between companies are in serious need of improvement.

Low Private Sector Research and Development

This is a root problem which is exacerbated by poor linkages with the public sector. The share of private sector research and development is low relative to other OECD countries, in this case, especially Finland. Furthermore, Australia is also a weak research and development performer in medium and high technology industries relative to other OECD countries.

Reasons for low private research and development are many. Judging from the recent literature on Australia's NIS issues, public/private linkage and firm receptivity are often listed as the most pertinent issues. In addition, the public sector finds it difficult to match research needs and outputs with the capabilities of the local industry. This may be a result of how they set their priorities in the first place. Moreover, many firms simply don't know how to plan for and manage the innovation process.

Low Commercialization of Public Sector Research and Development

Australia has an excellent science base in some but not all areas. Historically, the country has not been judged to be very good at commercialising its technologies and technology products. This may be for many reasons – the scientific areas of excellence may not be aligned with the industrial base; there may be few links between industry and science etc. This matters because it means that while the national innovation systems clearly gets significant public gains from research and development, it appears to get comparatively little private financial return from the sizeable investment in public research and development. Other countries appear to do better.

In order to increase the level of research and development, specifically private sector research and development, and in order to strengthen the linkages with scientific institutions, successful commercialisation of research from the Australian public sector and universities is critical. Some of the commonly cited barriers include:

- management of intellectual property within universities and research institutions;
- lack of encouragement of commercial research outcomes;
- lack of adequate technology diffusion mechanisms;
- lack of support of entrepreneurship and new technology-based enterprises; and
- developing and networking technology and business incubators.

Given the research and development mismatches between the private and public sector, there is a further difficulty in linking public and private sectors as they face different rationales. Whereas the public sector role is to produce freely available knowledge, the private sector role is to capture the highest returns from commercially exploiting knowledge. How well the two sectors link is important to a country's innovation success, as some activities run the risk of not being taken up by either sector. Furthermore, mixed public/private outputs may raise tensions between sectors about competition and cooperation issues. The difficulty here is in determining the extent to which the public sector should behave like the private sector.

PRIORITIZING LONG TERM OBJECTIVES

There is an increasing desire for enhanced assurity of planning and resourcing with regards to national priorities/investment in dealing with longer term issues such as environmental sustainability, infrastructure, health etc. Lessons from other countries show that these are invaluable in maintaining a focus on solving longer term problems on a national basis.

Some research funding priorities have already been established by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Research Council, the Australian Federal Government Centres of Excellence program and various State Government initiatives. The Academies and Engineers Australia have also recently put forward priority listings. Without a coordinating body, priority criteria have varied and cross-checking reveals as many differences as overlap. Australia is not alone in this problem, when comparisons are made with recent announcements (for example) within the Japanese university system or the European Union 6th Framework.

WEAKNESSES IN AUSTRALIA'S INNOVATION CULTURE

It is claimed that Australia shows weaknesses in its innovation culture. Droege[14] conducted a worldwide study on what they considered to be the barriers and success factors of innovation, surveying the managers of companies in 16 countries on whether their company had these factors. Topics included whether managers felt they judged their future development positively and had clear visions; whether they had a clearly defined innovation strategy; and whether they had a clear structure to their cross-border innovation processes.

In all these areas, Australian managers scored behind the United States, Europe and Asia.

Another study on international competitiveness concludes that the entrepreneurial expertise of Australian managers lags behind five countries—including Japan, the United Kingdom and the United States—in areas including entrepreneurial skills, willingness to take advantage of new business, willingness to take financial risks, initiative in making friends with business people from another country, and creativity in generating new business advantages[15].

While these studies do not directly test the culture of innovation in Australia, they suggest that Australian managers may not be prioritizing innovation, as shown through activities like investment in research and development, seeking to establish relationships with overseas partners, and having a long-term vision of the development of their businesses.

Australia also displayed weaknesses in management style and capability. Australian managers were ranked lower on strategic response capability, entrepreneurialism, and global business perspective. These are abstract issues of creative and lateral thinking, precursors to innovative and creative behaviours. So, it is of concern, if Australian managers are poor at managing these things. It is worth noting that it is possible to be good at solving tactical and operational problems in a creative way, but to lack the ability to sustain innovation in a strategic way that enables continuous growth of an innovation based business.

RECOMMENDATIONS FOR FUTURE DEVELOPMENT

The purpose of this paper has been to identify more robust approaches for improving Australia's innovation capacity, by means of a comparison of Australia, Finland and Sweden.

It is important to build sound national innovation systems in order to increase exports, broaden the national industrial base, generate new jobs and expand community wellbeing.

From the authors' observations and analyses, high performance innovation systems are characterised by:

- high levels of research and development expenditure that is well-coordinated by business and government;
- strong emphasis in universites and public education on engineering and sciences;
- intensive linkages and cooperation between companies and public sector organisations; and
- a focus on national innovation and technology policy that is aimed at building and sustaining long term world class capabilities in local companies.

All of this occurs against a backdrop of an economy which is flexible and adaptable, with both a global focus and a commitment to reform. The end goal is innovation as a driver of economic growth and prosperity, tailored to the particular attributes and circumstances of the nation.

Looking more specifically on the case of Australia, based on the paper's analyses of the successful national innovation systems of Finland and Sweden, the following recommendations are seen as likely to strengthen the innovation system in Australia for the future.

CHAMPION A NEW APPROACH TO INNOVATION POLICY

A key message from observations of the success of the national innovation systems of Finland and Sweden is the role played by government. Government operates as an informed and demanding champion of policies and programs designed to drive both more innovative behaviour in firms and more long-lasting economic capabilities and outcomes for the nation.

The Swedish example clearly demonstrates that there are opportunities and benefits from this approach, even when starting from past policy settings unconducive to growth and productivity. With suitable policies and investments in human and physical capital, Australia has the capacity to upgrade its industry from raw material-intensive and labour-intensive activities to knowledge and technology-intensive sectors. The Swedish experiences also highlight the great importance of political will and commitment in providing a suitable environment for growth and development.

WHEN RESOURCES ARE SCARCE, FOCUS ON SPECIFIC INDUSTRY CLUSTERS

The discussion about Finnish development suggests that small countries with limited public resources for investment may need to focus on specific industry clusters. To facilitate specialization and positive externalities, it is necessary to promote linkages, knowledge flows, and technology diffusion within the cluster.

DEVELOP REGIONAL INNOVATION SYSTEMS

The positive experiences Finland has had with focussing on particular clusters also highlights the growing importance of the innovation system approach within 'regional development'. The Finnish network of higher education institutions, technology centres, centres of expertise and other similar operational players has promoted innovation in the regions to the extent that they are now referred to as regional innovation systems. In Australia, there are examples of persistent gaps in education between rural/regional and metropolitan students, creating barriers to full participation in the science and innovation system. However, in some places various factors come together to create a concentration of particular industries within a certain region, with clusters developing in some cases (eg. the wine industry in the Hunter Valley). These spatial clustering opportunities for boosting innovation capabilities should be fostered.

TAKE A STAKEHOLDER APPROACH

There is a need to establish a broad foundation for policy debate as has been successfully observed in Finland. Finland made major advances in developing a coordinated national innovation system with frequent consultation and highly developed linkages between industry and government. It is not sufficient to delegate responsibility to any individual ministry, agency or department; all the main actors, including industry, universities, labour market organizations and other central players must be represented in the policy discussion. Finland also has a system of evaluation of government programs which determines their impact on jobs, turnover and exports, and so improves the performance both of the programs and the companies involved.

REMAIN FLEXIBLE

Discussion of Swedish experiences points in particular to the need for flexibility. Reform of the Swedish model did not commence until the financial crisis of 1991-93 when it forced the Swedish Government to reduce the tax burden and to increase cautiously the emphasis on growth rather than distribution in its overall policies.

ADOPT AN INTERNATIONAL PERSPECTIVE

To remain competitive, it is necessary for Australia to adopt an international perspective on its business environment. There is no optimal model that will fit in spite of changing international conditions, but instead a need for continuous reform as demand, technology, and competition change. The explicit monitoring of competing economies and comparison against the best performers in various policy areas – benchmarking – is probably the only way to measure the strength of the national innovation system.

SUPPORT LOCAL VENTURES

One key difference between Finland and Australia is the way Finnish companies and the government support local ventures, resulting in the successful development of a range of biotech, telecommunications and hi-tech manufacturing companies. This is a mindset that

must be encouraged and developed in Australian businesses and government agencies, so local suppliers are considered not only in light of the value they represent, but for the longer term economic benefits that derive from their contracts.

Finland applies a highly co-operative partnering approach to industry development, with a range of private/public alliances driving growth. This is particularly noticeable in Finnish public sector decision-making, in which the Prime Minister heads a Science and Technology Policy Council that is responsible for setting the national agenda. With representation from both the government and private enterprises, this Council is more than just a bureaucratic think tank or committee. It is a major force in decisions about how to best grow the industry and the economy. No such situation exists in Australia.

CONCLUSION

The responsibility for improving a nation's level of innovation, with the consequent benefits it brings to global competitiveness, jobs and enhanced productivity, is a task that governments share with private enterprise and all the other players engaged in economic endeavours.

The development of successful national innovation systems by Finland and Sweden demonstrates how vital it is to give priority to innovation and technology policy as a key driver of a country's economic growth. It is also vital that investment in innovation and technology policy is applied optimally to all elements, from industry clusters and incubators to research capability and educational institutions to marketing, finance and technology transfer infrastructure.

Further, policies on innovation and technology must be focused on deliberate and coherent actions that capitalize and build on the nation's advantages and specific circumstances to create self-sustaining innovation capabilities in its firms, that provide them with an enhanced ability to compete internationally.

Within this framework and focus, nations can make the choices about where to allocate resources in a way which most potently enhances their industrial capability, their economic prosperity and their social wellbeing.

The broad, but nonetheless desirable outcome for Australia, involves a commitment by government, research institutions and universities to actions that will address the gaps between research and commercialisation. Equal attention must be paid to helping firms create, difuse and use knowledge and technology, thereby boosting innovation at the enterprise level. To some extent, the strengthening of the linkages within the Innovation System will assist in this process, but this area requires specific strategies for improvement.

Benchmarking informs policy, but it cannot substitute for a democratic process of decision making. The challenge for Australia is not to copy the best performers, but to define their own original innovation policy, taking into account specific strengths, weaknesses, priorities and cultural and institutional traditions. This supposes a broad political debate among stakeholders (business, professional associations, unions, and academia) to explore the acceptability of the policy options available.

FOOTNOTES

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APPENDIX 1

Theme	Policy aim	Means	Country example
Securing appropriate framework conditions	To develop human resources in S&T.	Reforms to post-secondary education.	Austria – *Fachhochschulen study courses.*
		Increased government and industry support to professional education.	Finland – *Public/private partnership programme.*
	To close market gaps in the financing of innovation.	Establishment of a legal framework for venture capital.	Hungary – *Venture Capital Act.*
Building an innovation culture	To reduce asymmetry in information.	Internet-based business information network.	Canada – *Strategis Initiative.*
	To diffuse best practices in innovation management.	Funding greater use of benchmarking and diagnostic tools.	Norway – *BUNT programme.* Spain – *MINER scheme.*
	To promote the creation of innovative firms.	Public investment in venture capital.	United States – *SBIC programme.*
Enhancing technology diffusion	To increase firms' absorptive capacity.	Co-financing of consultants to upgrade firms' organisational ability.	Norway – *BUNT programme.*
	To improve linkages between SMEs and public research.	Co-financing of technology uptake via public/private partnerships.	Spain – *CDTI Centre.*
Promoting networking and clustering	To stimulate the formation of innovative clusters of firms.	Brokering and procurement policies.	Netherlands – *Clustering policies.*
		Competition among regions for funding of cluster initiatives.	Germany – *BioRegio Initiative.*
	To ensure a better match between the S&T infrastructure and industry needs.	Co-funding of centres of excellence to facilitate university-industry interactions.	Sweden – *NUTEK Competence Centre Programme.*
		Building networks between public research actors and firms.	France – *Réseaux Nationaux de la Recherche (RNS).*
Leveraging research and development	To sustain technological opportunities in the long run.	Increased government spending on basic R&D.	Japan, Korea.
		Increased public support to R&D.	Finland.
	To increase economic return from public research.	Public/private partnerships.	Australia – *CRC Programme.* Austria – *CD Society and Laboratories.*
		Technology foresight for policy setting.	New Zealand.
		Regulatory reform (university-industry interface).	Japan.
Responding to globalisation	To increase linkages between domestic and foreign-owned firms.	Building networks of competitive domestic firms.	Ireland – *National Linkage Programme.*
	To increase country's attractiveness as a location for knowledge-based activities.	Building innovative clusters (see above).	See above.
		Systemic upgrading of the S&T infrastructure.	Mexico.
Improving policy making	To enhance policy co-ordination.	Raising the co-ordination function to the highest policy level.	Korea – *Science and Technology Council.*
	To improve policy evaluation.	Making evaluation obligatory.	United Kingdom – *ROAME-F model.*
		Developing new methodologies.	Switzerland.

This sample typology of good innovation policy practices draws on the OECD's 1999 report, "Managing Innovation Sytems".

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