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DISCUSSION PAPER 2009 / 1

Standing on the shoulders of science:

Getting more value from the innovation ecosystem

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The New Zealand Institute

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Standing on the shoulders of science identifies opportunities to lift New Zealand's economic prosperity through improving performance of the innovation ecosystem. Innovation is the key driver of prosperity of advanced economies.

ACKNOWLEDGEMENTS

The conclusions reported in this discussion paper are the result of desk research and interviews conducted by New Zealand Institute staff. Participants in New Zealand's innovation ecosystem have shared their experiences and opinions generously. Emerging conclusions were shared with and reviewed by innovation ecosystem participants, government agencies and New Zealand Institute members, and the paper has been enhanced by their very useful feedback. Several New Zealand Institute staff contributed to the research, development of conclusions, and preparation of the paper.

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EXECUTIVE SUMMARY

New Zealand's economic performance needs a step change improvement. Although economic prosperity as measured by GDP per capita has grown, on average, by about 2% per annum since 1990, New Zealanders earn 16% less than the OECD average and are not catching up.

The drivers of recent economic growth cannot be relied on to ensure future prosperity. Two important challenges are to increase productivity per hour worked and to reverse the decline in export performance.

The prosperity of advanced economies like New Zealand is driven by innovation performance. Innovation contributes to improvement in productivity per hour worked and to the formation of new businesses that can improve New Zealand's export performance and wealth.

New Zealand's innovation ecosystem is already contributing. The Technology Investment Network's TIN100 estimates that the top 100 technology companies produced overall revenues of $6.6 billion in 2008, with $5.1 billion exported. These companies contributed over 23,000 jobs with average revenue per job of $280,000. They are growing.

However the innovation ecosystem could contribute much more.
New Zealand's R&D spending per capita is well below average for the OECD. Despite the increase in effort over the last decade, New Zealand has a relatively poorly performing innovation ecosystem and is not making as much effort as other small countries that are seeking advantage from innovation.

Science provides the foundation of an innovation ecosystem. Skilled graduates, research contracts, technology licenses, and launch of new businesses all flow from an effective science infrastructure.

Commercialisation is not the only purpose of science. Science also provides public good research that improves health and safety, and science provides innovations that improve the competitiveness of industries via non-commercial dissemination of results. Many results that form the foundation for valuable new businesses arise from serendipitous discoveries made doing basic research.

The improvement opportunities identified in this paper emphasise improving commercialisation outcomes. A wider lens than used here is required to improve science performance. Three directions for development of the science system would help provide more valuable commercial outcomes. These are to focus research efforts more on sectors where New Zealand has commercial potential, to evolve research institutions to form well-resourced at-scale units, and to ensure that New Zealand is attracting, developing, and

retaining the world-class talent needed to deliver top quality output. Others have more detailed proposals for development of the science system which can further increase the benefits to New Zealand.

An innovation ecosystem includes the research facilities that produce the scientific output and the business organisations that develop the products and launch them in international markets. The performance of the whole is only as good as the performance of the weaker part. Increasing the output from research units will not be enough to deliver a large economic performance lift because commercialisation performance is not consistently world class.

In recent years, institutions that support commercialisation have been established: commercialisation units, incubators, angel networks, and venture funds. At best, the commercialisation part of New Zealand's innovation ecosystem is performing well so it is possible to point to successes and exemplars of best practice. On average though, there is a long way to go before the commercialisation system is sufficiently large and high quality to provide confidence that an increased flow of research will lead to a corresponding increase in commercial and economic success.

The emphasis in this paper is on commercialisation efforts that increase the rate of development of successful international firms based on scientific and other innovation. The focus on go-global firms is because large successful firms provide the most valuable economic benefits and because the improvements required to make go-global firms successful will also lift the performance of other commercialisation pathways.

The research has identified valuable opportunities for improvement of the innovation ecosystem. In summary these are:

- Ensure earlier assessment of market needs
- Lift the productivity of science and commercialisation institutions
- Ensure availability of talent and expansion capital
- Establish a more supportive culture
- Manage the innovation ecosystem as a whole

These specific changes will lift the performance of New Zealand's innovation ecosystem much closer to potential but there are two other things Government can and should do that will ensure a positive trajectory is maintained.

First, Government should highlight the importance of the innovation ecosystem to New Zealand's future economic prosperity. Ensuring people understand the importance and potential will help reduce resistance to change and will encourage talented people to work in the sector.

Second, Government should establish a plan to lift spending on R&D to at least world class levels. New Zealand can and should try to develop the innovation ecosystem as cost-effectively as possible but it would be unrealistic to hope to do so without increasing spending.

The challenge is to improve performance and grow spending; growing spending alone will not be enough. Benefits from increased R&D spending will result only if research is focused where there is real commercial opportunity, and if there are mechanisms and resources to convert the research into new products or services, competitive gains, licence or contract revenue, or to form successful international businesses.

New Zealand needs to move quickly. The economy needs another growth pillar urgently. It will take time to change the innovation ecosystem settings to improve performance, time to gain the benefits from the changes, and time to complete research and develop commercial opportunities. We are in a race.

Finally, although the need for improvement is urgent, it is important to be patient. It takes a long time to grow a scientific innovation into a successful global business and it takes a long time to establish an effective innovation ecosystem. To ensure success New Zealand needs to take action, measure results, monitor progress, and adjust where needed.

GLOSSARY

Research and Development

"Research is about creating something completely new while development generally modifies or improves that new innovation or an existing product or service."

– Ministry of Research Science and Technology

Development of an idea can involve science, such as improving a new food ingredient so that it tastes better or lasts longer on the shelf. Or development may involve a business focus, for example testing the new ingredient with consumers, or securing IP rights and distribution channels.

Intellectual Property (IP)

Ideas and discoveries that are generated through research are known as IP once ownership is established. Ownership and value-creation based on IP can be established and protected through various legal mechanisms like copyright and patent.

Commercialisation

Commercialisation is the process of creating commercial (monetary) value from ideas, research results or IP. Revenue can be generated by applying the IP to provide services or products to an end-user, by owning and licensing IP to others for application, or by conducting applied research for an IP owner to further develop that IP.

Innovation

"Innovation is the dynamic process of creating and introducing new ideas and new ways of doing things. Innovations may be incremental (small, stepwise improvements), major (substantial improvements), or radical (new lines of business, paradigm shifts)."

– Ministry of Economic Development

Innovation ecosystem

In this paper the term *innovation ecosystem* refers to the institutions that conduct and support innovation and the connections among them. In the innovation ecosystem the participants include: researchers and research institutions including university, government owned and independent organisations; Technology Transfer Offices (TTOs) which are designed to support the commercialisation process; government policymakers and funders of innovation activity; and industry groups, industry, entrepreneurs, business schools, business incubators, advisors, investors; and investment funds.

Science

In the context of this paper, the meaning of the term science is intended to be broad, encompassing 'basic' science, 'applied' science, 'experimental' science, and technology.

INTRODUCTION

Previous work by the New Zealand Institute has highlighted the importance of increasing New Zealand's exports and overseas investments, developing economic strengths based on knowledge, and building go-global companies.

This paper builds on that prior work to show how improving the performance of New Zealand's innovation ecosystem can make an important contribution to commercial outcomes for businesses, to improved productivity, and to economic performance.

An innovation ecosystem comprises the actors and relationships that turn an idea into a process, product, or service offered to customers. The paper emphasises improving the commercialisation of science and ensuring the success of business efforts to sell products and services based on innovation in international markets.

The first section begins with a review of the economic importance of innovation then examines economic options for New Zealand, arguing that strengthening the innovation ecosystem is a core requirement for long term prosperity. The following section describes New Zealand's current innovation ecosystem.

Section 3 describes important features of innovation ecosystems and implications of those features for improvement efforts.

In Section 4, specific deficits of New Zealand's innovation ecosystem are described and proposals are made for improving performance.

The conclusion is that lifting innovation ecosystem performance is valuable and achievable.

Future New Zealand Institute work will develop proposals for implementing recommendations in this paper and will assess government's progress.

1 STRONG INNOVATION ECOSYSTEM PERFORMANCE IMPROVES ECONOMIC OUTCOMES

INNOVATION DRIVES ECONOMIC GROWTH

Innovation is the most important driver of economic performance for advanced economies. The World Economic Forum (WEF) produces a Global Competitiveness Index (GCI) that assesses the relative position of over 130 nations on the factors identified as drivers of productivity. Productivity in turn drives economic prosperity.

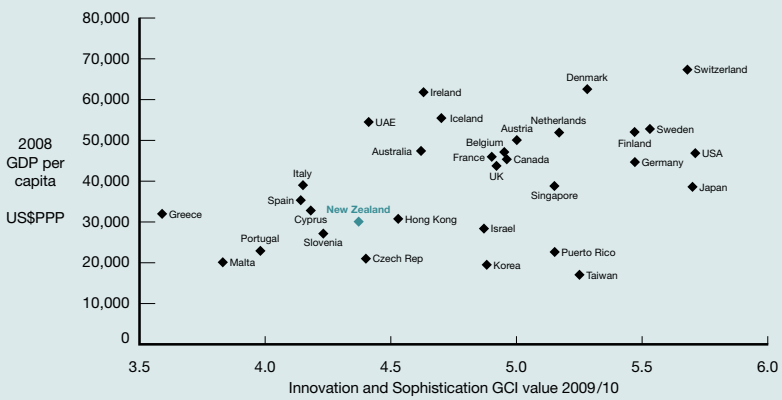
For advanced economies that, like New Zealand, have good basic regulatory settings and relatively efficient markets, what matters most for relative economic competitiveness is what the WEF calls 'innovation factors'. Innovation factors include measures of business sophistication such as availability of scientists and engineers, company spending on R&D, value chain participation, and the state of cluster development.

Figure 1 shows that strong performance on the innovation factors correlates with high per capita incomes.

The Organisation for Economic Cooperation and Development (OECD) has found evidence that strong innovation ecosystems cause GDP growth, not the other way around. Specifically, OECD studies have found evidence that:

- Government and university-performed research, and business R&D, have positive and significant effects on productivity (Guellic & van Pottelsberghe de la Potterie, 2001).
- The impact of business R&D on productivity has been increasing over time (OECD, 2000).
- Stocks of domestic business R&D, public R&D and foreign R&D all have positive and significant effects on productivity growth, as does the stock of human capital (Khan & Luintel, 2006).

FIGURE 1: GCI INNOVATION AND SOPHISTICATION INDEX AND GDP PER CAPITA



Source: World Economic Forum Global Competitiveness Report 2009/10.

Furthermore, a system that supports the effective commercialisation of scientific innovation is an increasingly important way to generate growth and productivity benefits from innovation:

- The innovation system increasingly depends on a sufficient degree of interaction among firms, universities, research institutions, and regulators (OECD, 2000).
- With science exerting a more important and direct influence on innovation, especially in fast-growing new industries, the intensity and quality of industry-science linkages play an increasing role in determining returns on investment (OECD, 2002).

Publicly funded science is an important foundation of an innovation ecosystem. Universities and government funded research institutions provide trained graduates, consultants, and staff for industry, along with contracted research and a stream of innovations that can be commercialised.

COMPETING SMALL COUNTRIES ARE INVESTING

In OECD's 2009 stocktake of existing research, it is noted that all "OECD governments have put in place specific measures to encourage innovation" (Box, 2009, p9). A 2008 OECD review found that the 12 countries offering R&D tax incentives in 1995 had increased to 21 in 2007, along with an increase in the generosity of the incentive. The OECD notes further evaluation of these incentives is required, and that there is a risk of R&D tax competition among countries (Box, 2009). New Zealand's proposed R&D tax incentive has been removed.

The increase in participating countries indicates many perceive potential benefits. Some small advanced economies have developed cohesive, bold strategies to improve their science commercialisation systems, have set concrete goals, and have mobilised resources to implement those strategies.

The levels of aspiration, commitment, and activity in these competing countries highlights that in seeking to remain competitive New Zealand is aiming at moving targets, as countries seek to improve their productivity and prosperity by leveraging the economic potential of science and innovation.

Australia too, is moving towards a cohesive strategy for investment in science and innovation. This year, Australia's Ministry for Innovation, Industry, Science and Research released a report "Powering Ideas: An Innovation Agenda for the 21st Century" that proposes an Australian innovation strategy, and the last Australian Budget boosted government science and innovation expenditure by about 25% (MIISR, 2009).

TABLE 1: SCIENCE-BASED INNOVATION STRATEGIES OF OTHER COUNTRIES

	Denmark	Singapore
STRATEGY Cohesive, widely understood national economic strategy, with the role of science commmercialisation clear and paramount	• National Globalisation Strategy. Developed by formation of Globalisation Council of 26 members from across sectors and recommended significant changes aimed at substantially improving innovation performance	• E 2000 long range economic plan by Economic Development Board
GOALS Both high-level outcomes and low-level outputs	• Lift Gross Expenditure on R&D to 3% of GDP by 2010 • By 2010, ensure that 45% of Small, 55% of Medium, and 75% of Large enterprises are innovative (in manufacturing or high-tech service)	• Lift Gross Expenditure on R&D to 3% of GDP by 2014 • Double manufacturing value-added and output by 2018 • Fund the offshore training of 1000 science and technology PhDs and repatriate them to Singapore by 2010
RESOURCES	• Innovation Denmark budget approximately NZ$800 million over 2007-2010	• Large-scale investments in innovation infrastructure e.g. Biopolis biotechnology campus • Funding for 1000 PhDs goal at about NZ$1 million per PhD

Source: Singapore ASTAR, Singapore EDB, Innovation Denmark, Globalisation Council Denmark.

NEW ZEALAND NEEDS TO LIFT ECONOMIC PERFORMANCE

New Zealand's economic performance needs a step-change improvement. Although economic prosperity as measured by GDP per capita has grown, on average, by about 2% per annum since 1990, New Zealanders earn 16% less than the OECD average and are not catching up. Currently New Zealand's GDP per capita is only about 70% of Australia's in real purchasing power terms (OECD, 2009).

Previous New Zealand Institute reports have shown that raising labour productivity growth is critical. New Zealand falls down most dramatically in the value produced per hour worked. In 2008 output per hour was the lowest in the OECD and only 70% of the OECD average. Improving output per hour worked is essential to improve economic prosperity (Skilling & Boven, 2005). This argument can be reviewed in the New Zealand Institute publication *No country is an island: Moving the New Zealand economy forward by taking it to the world.*

Improving relative economic prosperity is important because it affects where New Zealanders will want to live, work, and bring up their children. How New Zealand's economy compares with other advanced economies will also affect New Zealand's ability to retain and attract the talented people and business opportunities needed to maintain and improve standard of living.

New sources of economic growth are needed

New Zealand will need to develop new sources of growth to provide income levels that are competitive with those of other advanced economies. The main sources of recent economic growth – working more hours, a debt-fuelled property boom, tourism growth, and favourable agricultural commodity prices – should not be relied upon in future.

Working ever more hours is unsustainable. One important source of economic growth since 1990 has been working more hours. Since 1990, about 2/3 of New Zealand's GDP growth has been from increasing hours worked, with only 1/3 attributable to increases in the value of output per hour worked (Skilling & Boven, 2005). New Zealand cannot rely on forever driving upward hours worked. Before the recession, compared to other OECD countries New Zealand's unemployment rates were low, and labour force participation high. Working hours per capita in 2008 were 10% above the OECD average (The Conference Board, 2009).

Relying on a property boom is unwise. Nor should New Zealand rely on a renewed property boom to keep driving growth. The growth in GDP per capita in New Zealand since the 1990s has been mainly in the services sector, and within the services sector property services has been an important contributor. But the property boom has been underpinned by increasing household debt levels. Since 1990 household debt has increased from around 60% to 160% of household disposable income (RBNZ, 2009). Relying on lenders to fuel further growth of leveraged housing investment would be an unwise strategy.

Tourism is important but the potential for transformational impact is uncertain. Tourism has also been an important source of growth in recent years with receipts growing from $14 billion in 2000 to $22 billion in 2009 (Statistics New Zealand, 2009b). Further growth is targeted, but the potential for the transformational economic growth that the economy needs to be driven by the tourism sector is somewhat uncertain because climate concerns may translate into higher travel costs and changed destination choices, because of local environmental constraints, and because many tourism jobs are not well paid.

Relying on favourable agricultural commodity prices is risky. Depending on favourable future agricultural commodity prices to drive economic growth would also be a risky strategy. Recent overall export performance has been underpinned by increases in primary sector prices. Those price increases were halted by the recession. They may return as world population and wealth grow but New Zealand should do more than rely on favourable commodity prices to assure future prosperity; not least because the size of the GDP per capita gap between New Zealand and Australia is three times the value of our agricultural exports.

MAF estimates that around 90% of potentially available agricultural land in New Zealand is now in production. Efforts to get more production out of land already in use may be limited by environmental constraints such as water availability and nutrient pollution. Other risks to the sector include increasing competition from other producers; higher supply chain costs as energy prices increase; potential consumer preference changes reflecting 'food mile' concerns; and post-Kyoto carbon emission regulation.

2 NEW ZEALAND'S INNOVATION ECOSYSTEM

BENEFITS OF AN INNOVATION ECOSYSTEM

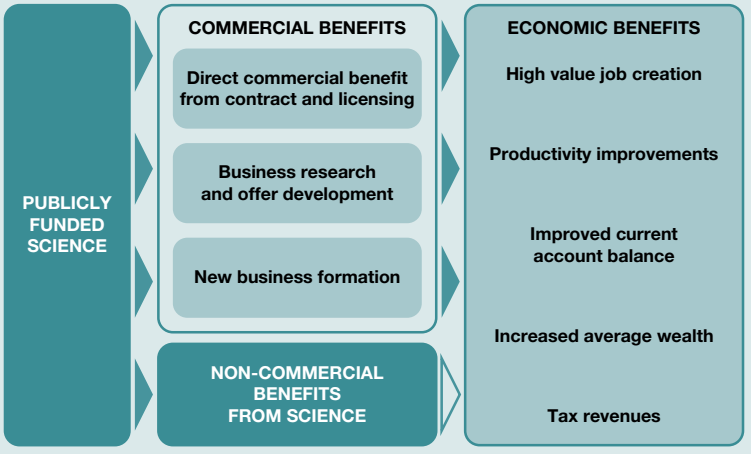
An innovation ecosystem provides many kinds of benefit to a country. Research or a serendipitous discovery may provide a direct commercial benefit for the research institution in the form of contract or license revenue or a stake in a new business. There are benefits for the wider economy too, depending on the jobs created, other inputs used, export outcomes, foreign direct investment, tax paid, and wealth outcomes.

Having a strong science system helps provide a country with the skilled population and capable businesses that are the primary direct sources of innovations for commercialisation. Innovations may be developed by individuals working in their basement or by firms developing offers for their customers. Both these additional sources of innovation rely on the availability of education, advice, and services that are built upon the scientific foundations.

More recent research on deriving benefits from science has focused on innovation as a systemic phenomenon, with success dependent on a sufficient degree of interaction among various participants including firms, universities, research institutions, and regulators (Box, 2009). Review of the New Zealand innovation ecosystem indicates that the building blocks are in place.

This paper is focused on increasing overall economic benefits which, as shown in Figure 2, requires improvement of commercial benefits.

FIGURE 2: BENEFITS FROM SCIENCE



New Zealand's current account and wealth challenges motivate the emphasis in this paper on growing international business success. The proposals for improvement presented later in this paper target improved production of research suitable for commercialisation, more effective transfer of research results to businesses, and improving business success.

The focus on improving commercialisation outcomes does not imply that commercial imperatives should be introduced across the science research system. The science system needs to protect opportunities for strong basic and fundamental scientific research to be conducted, with scientists allowed and supported to investigate and experiment with no end application necessarily in mind.

Basic and fundamental science is important:

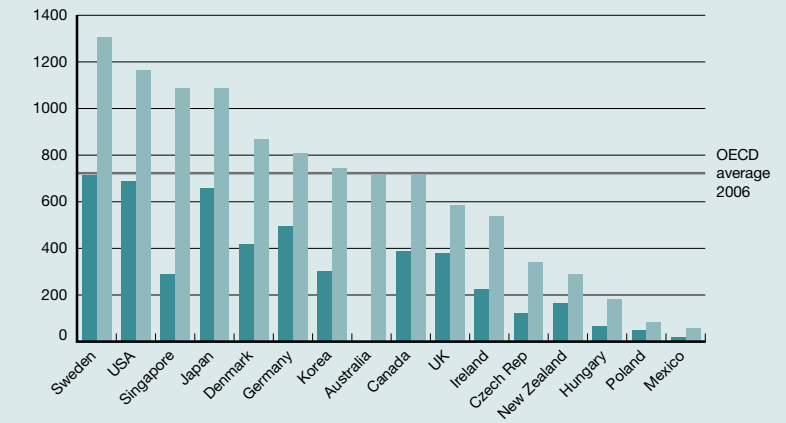
- Research in pursuit of fundamental understanding enthuses many scientists and attracts them to the field of scientific endeavour. It fosters the training of scientists and development of skills that can support the 'applied' science done in public research institutions and in businesses.
- New knowledge may be a public good, with understanding being valued in its own right, or providing non-commercial public benefits such as protecting the environment, managing hazard risks, or developing health strategies.
- Research conducted in pursuit of understanding rather than commercialisation can lead to unexpected discoveries and innovations with commercial benefits.
- Research may provide valuable competitiveness benefits for New Zealand industries if results are made available to businesses without any attempt at commercialisation.

NEW ZEALAND'S CURRENT INNOVATION ECOSYSTEM

This section provides a brief overview of the New Zealand innovation ecosystem. First, Figure 3 shows the money New Zealand invests in R&D compared to other countries.

New Zealand's expenditure on R&D per capita was less than half the OECD average and less than a quarter of Sweden's in 2006. In 2006 New Zealand spent $1.8 billion on R&D, representing 1.2% of GDP; the average OECD country spent 2.2% of GDP in 2006. In 2008, New Zealand R&D expenditure remained at 1.2% of GDP. In addition to New Zealand's low total investment in R&D, it is notable that public expenditure on R&D makes up a relatively large proportion of New Zealand's R&D spend.

FIGURE 3: GROSS EXPENDITURE ON R&D PER CAPITA



Note: Australia 2006 only. New Zealand, Mexico values are for 1995 and 2005.
Source: OECD Main Science and Technology Indicators, 2008.

New Zealand has a very low rate of business research and development activity. Business expenditure on R&D is 0.5% of GDP, only one-third of the average for OECD countries. Public investment in R&D in New Zealand is about the OECD average, with both just below 0.7% of GDP (Statistics New Zealand, 2009a). If New Zealand is going to use innovation to improve economic performance these investment numbers must grow. Increasing spending alone is not the answer though; the spending must deliver research that has strong commercial potential and there must be an effective innovation ecosystem to convert the research outputs into commercial and economic benefits.

Participants in New Zealand's innovation ecosystem

The innovation ecosystem is complex, comprising many different institutions. Some of the participants are:

Government agencies including the **Ministry of Research Science and Technology (MoRST), Ministry of Economic Development (MED), Treasury,** the **Tertiary Education Commission (TEC)** and the **Ministry of Education** all play roles in developing and implementing policy that affects innovation.

TABLE 2: COMPARISON OF EXPENDITURE ON R&D AS A % OF GDP

	New Zealand 2008	OECD 2006 (trend increasing)
Business	0.51	1.56
Government	0.33	0.26
Higher Education	0.36	0.39
Total	1.20	2.21

Source: Statistics New Zealand.

The **Foundation for Research, Science and Technology (FRST)** is the government's primary agency for allocating funds for public good science and technology. The 2009 budget for FRST is $529 million (FRST, 2009).

The Crown Research Institutes (CRIs) are AgResearch, Plant and Food Research, Institute of Environmental Science and Research Ltd (ESR), Scion, Institute of Geological and Nuclear Sciences (GNS), Industrial Research Ltd (IRL), Landcare Research, and National Institute of Water and Atmospheric Research (NIWA). As of 30 June 2008 they had "total assets of $669.2 million and employ 4,235 staff members, of whom 3,478 are engaged in research and research support" (CCMAU, n.d.).

New Zealand Trade and Enterprise (NZTE) is the trade and economic development agency. It aims to boost export earnings, strengthen regional economies, and deliver economic development assistance. NZTE spent $231 million in the year to June 2009, including $52 million in grant expenditure (NZTE, 2009).

Existing private **Industry** can be purchasers of R&D undertaken in public institutions like the CRIs and Universities or may undertake R&D separately.

Universities. The vast majority of research in the higher education sector is undertaken by the eight New Zealand universities: University of Auckland, Massey University, Victoria University of Wellington, University of Canterbury, University of Otago, University of Waikato, Lincoln University, and Auckland University of Technology (AUT). Universities account for $643 million – about 30% – of the gross expenditure on R&D in New Zealand (MoRST, 2006).

There are currently seven **Centres of Research Excellence (CoREs)** funded by the TEC. They are primarily, but not exclusively, inter-institutional research networks, with researchers working together on a commonly agreed work programme. The CoREs are currently all hosted by a university and in aggregate receive about $35 million per year in funding (MoRST, n.d.).

Commercialisation Units are designed to facilitate the flow of research results from universities and CRIs to businesses. The Universities each have an associated **Technology Transfer Office (TTO)** which serves as a commercialisation unit. The estimated combined business worth of the activities of these TTOs was $350 million in 2008 (UCONZ, 2008). There is a wide diversity of scale and approach in these offices.

Business Incubators assist start-ups to develop into viable businesses. Currently there are more than a dozen incubators in New Zealand assisting more than a hundred companies. In 2001 there were only two incubators in New Zealand. The industry association of business incubators reports that the total capital raised by incubated companies in 2007 alone was over $25.3 million (UCONZ, 2008).

Investment Funds exist to take equity stakes in businesses, hoping to generate dividend or capital gain return. **Government Investment Funds** such as the Venture Investment Fund (VIF) and Seed Co-Investment Fund (SCIF) have been established to invest matching funds alongside **Private Investment Funds.**

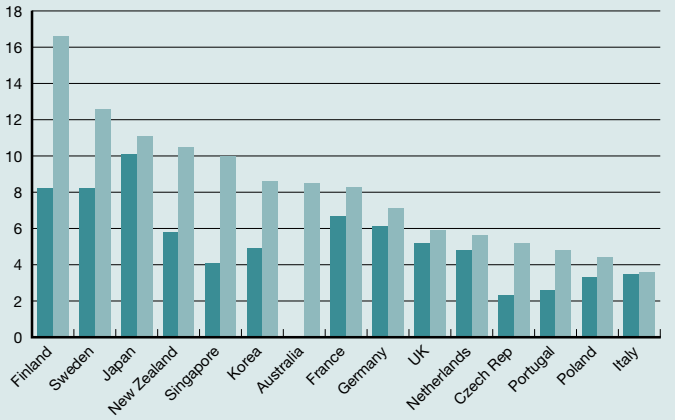
INVESTMENT IN SCIENCE HAS INCREASED

It is generally understood that much of the scientific research that takes place in New Zealand is high quality, and the systems that support that research, while not perfect, are generally sound. The OECD review of New Zealand's innovation system praised the research skills and capabilities that have been developed over time in the public sector, leading to "world class competencies in many areas" (OECD, 2007). Despite these strengths there are opportunities to improve the scientific foundation. The OECD review cited above noted that the scientific research infrastructure in New Zealand could be strengthened by, for example, increasing funding for research in pursuit of government's strategic objectives.

New Zealand has increased investment in research related employment. Figure 4 compares New Zealand with selected OECD countries on researchers as a share of total employees. In 1995 New Zealand was ranked 15th in the OECD. Since then it has more than doubled the number of researchers per thousand employees and New Zealand is now 4th out of the 25 OECD countries reporting since 2005.

Patents are one way of assessing the performance of an innovation system because they are a key tool for capturing the commercial benefits of research. Patent filing requires investment and implies expectation of commercial value.

FIGURE 4: RESEARCHERS PER THOUSAND EMPLOYEES



Note: Australia 2006 only. New Zealand values are for 1995 and 2005. New Zealand 1995 value adjusted for definition change to 1 full FTE per Phd and Masters student in 2000 to allow comparability.
Source: OECD Main Science and Technology Indicators, 2008; New Zealand Institute calculations with MoRST and Statistics New Zealand.

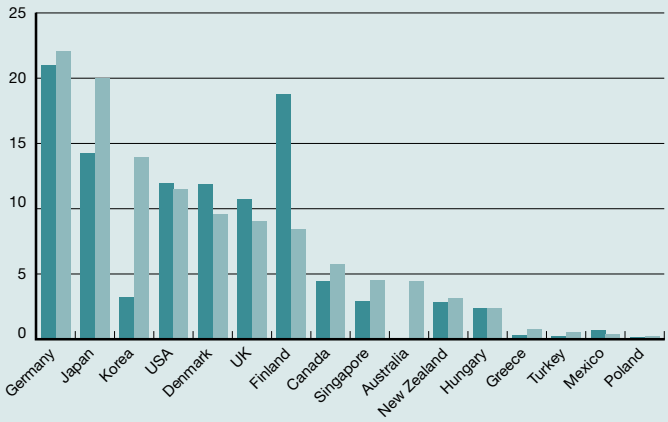
The OECD tracks the patent family unit, which is defined as a set of patents taken in various countries for protecting a single invention. The patent data shown here and used elsewhere in this paper is for triadic families, meaning that the patent has been filed in Europe, Japan, and is granted at the US Patent and Trademark Office.

Measuring the success of an innovation system is challenging and every metric has drawbacks. Patents emphasise commercial potential so they do not capture the non-commercial benefits from the innovation ecosystem. The use of metrics for performance assessment may affect comparisons as staff work to maximise their compensation. The number of patents achieved per dollar spent varies across industries; for instance patents on average require greater investment in the pharmaceutical industry than in electronics. And the fact that an idea is novel enough to secure a patent says nothing about whether or not that idea might ever be commercially viable. Despite these drawbacks, patents provide an indication of relative performance and can be used to make cross-country comparisons over time.

As Figure 5 shows, New Zealand was generating about the same number of triadic family patents per thousand researchers in 1995 as was achieved in 2005. During this period the number of researchers increased at an average rate of around 8% each year, more than doubling from a base of less than eight thousand.

The number of triadic patent families produced has increased from 21 in 1995 to 54 in 2005. Any increase in research capacity and intellectual property output must be matched by increased capacity for commercialisation.

FIGURE 5: PATENTS PER THOUSAND RESEARCHERS



Note: Australia 2006 only. New Zealand, Mexico values are for 1995 and 2005. New Zealand 1995 value adjusted for definition change to 1 full FTE per Phd and Masters student in 2000 to allow comparability.
Source: OECD Main Science and Technology Indicators, 2008; New Zealand Institute calculations with MoRST and Statistics New Zealand.

COMMERCIALISATION OPTIONS

Figures 6 to 8 are simplified diagrams that depict three ways in which research can be commercialised.

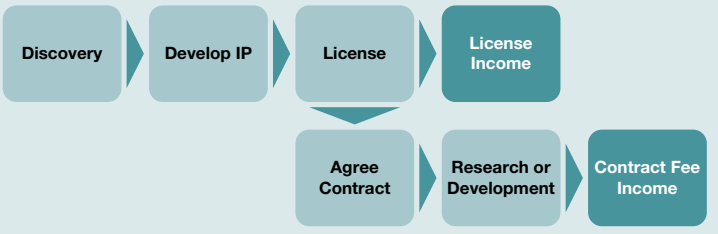
In Figure 6, a firm starts with IP or an idea that it seeks to develop. Development can be done by the owner, in-house, or it can be contracted out through contracts that specify research to be completed. The firm agrees a research contract with a provider, the research is conducted, and the organisation conducting the research earns income.

FIGURE 6: CONTRACT FEES FOR SPECIFIED RESEARCH

Contracting generally involves a fixed payment, with limited downside risk and limited upside potential. There are several benefits from contract research over other research activities. Revenues are more reliable, and income is often received quickly. An organisation that conducts contract research gains experience, developing skills that can be applied in other research.

When a potentially useful discovery is made by the research institution, there are other avenues available to generate income. The discovery, whether made intentionally through basic research, via serendipity, or from applied research seeking a particular solution, can be developed into IP. The IP owner may then choose to follow the path depicted in Figure 7, which involves licensing the IP for use by another party. Licensing arrangements often lead to contract research as well as the license fee, so there may be two forms of income from pursuing this route.

FIGURE 7: LICENSE AND (LIKELY) CONTRACT INCOME



DEVELOPMENT PATHS MAY BE COMPLEMENTARY

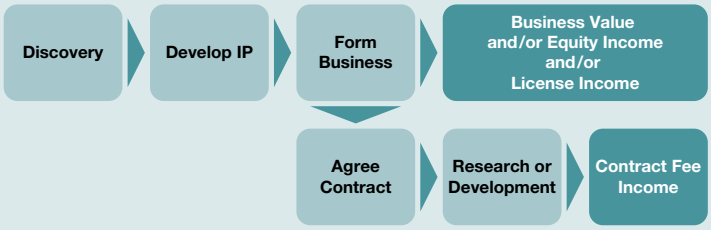
Induction power technology, the ability to transfer power wirelessly without contacts, was first licensed in 1991 for the field of materials handling to Daifuku in Japan and in 1996 to Wampfler in Germany. Both of these licenses included royalty payments and ongoing commitments to contract research at the University of Auckland. This increased research investment enabled increased IP output which led to the development of a number of new licenses being granted to innovative New Zealand start-up companies in applications as diverse as specialised tunnel lighting, biomonitoring, children's shopping carts, stage lighting, and agricultural actuators and switchers. A new New Zealand company is also being formed with venture capital firms at present to develop IP for the emerging electric vehicle market. None of this would have been possible without the original license and contract research.

Licensing has the advantage of leveraging the established resources and relationships of existing organisations. Licensing might provide the fastest route to high income levels as the resources and networks required to produce at high volume and distribute to many end-users can take years to establish. One drawback is that the IP owner who licenses is less likely to establish customer and end-user relationships, which are often fertile ground for generation of further ideas and IP.

The third way to realise value through R&D activities is shown in Figure 8. Once developed, the IP is applied through a business formed to provide new or improved products or services. The IP owner usually exchanges the IP for an equity stake in the newly formed business. Income is earned by the new business and value is realised by the business owners through increases in the value of their equity stake in the company and from dividends. Again, contract income may be earned.

The owners of IP may have a choice between licensing or forming a business. The option of forming a business is commercially attractive when there is no company suitable for licensing available or there is potential for a valuable capital gain.

FIGURE 8: BUSINESS FORMATION



The owners of a business gain benefits from value growth and from dividends and if the business is successful these are likely to be much greater than what would be earned from licensing the IP. On the other hand, capital is needed to develop the business and it takes a long time to become successful.

The business formation route offers much greater control over the destiny of the IP because the business should have strong relationships with customers and end-users and may also retain control over how and when the IP is further developed and applied.

The benefits from even a small ownership stake in an IP owner that successfully applies IP can be substantial: Nokia's remarkable success assisted Finland in improving its innovation system, largely through a block of shares that Sitra, the Finnish National Fund for Research and Development, acquired in return for support of Nokia's cell phone enterprise in its infancy (Innovation gives Finland, 2005).

The commercialisation process in practice may be more convoluted than shown in Figures 6 to 8. Related ideas and IP can progress through the process independently, which is advantageous as sometimes one element can be licensed to fund further development of other outcomes from a discovery. Those responsible for decision-making may have choices to make in some instances, for example between licensing and business formation, but in other instances there will be only one feasible option.

An innovation ecosystem that is functioning well has all three publicly funded science commercialisation routes active.

Simply increasing the volume of research commercialised is not sufficient. If New Zealand sought only to increase the volume of commercialisation activities, such a goal could be met solely through increasing contract research services. A country that relied only on contracting to commercialise its science outputs, would be positioning itself as a commodity provider of scientific research and innovation.

With that strategy, continued competitive advantage would be based on being able to continue to do scientific research and sell scientific IP for prices that are attractive relative to competitors. That positioning would be threatened as the workforces of developing countries become more skilled and their supply of scientists increases. Countries such as India and China are actively pursuing this strategy today (Bound, Leadbeater, Miller & Wilsdon, 2006). Conducting contract research and selling scientific IP to existing industry is a lower-value added method than licensing and business formation, and New Zealand must form and grow more successful international businesses if it is to extract the maximum commercial and economic value from its publicly-funded scientific research.

Many of the recommendations this paper makes to improve the success rate of producing globally engaged, successful New Zealand companies from New Zealand scientific innovation would also strengthen other routes to commercialisation. Creating new New Zealand companies based on scientific innovation would strengthen and deepen the pool of domestic science and technology based industry. New industry participants would be potential purchasers of research or IP from public research institutions. These new science-based participants would also invest in in-house R&D, strengthening the skills base and innovation absorptive capacity in the ecosystem. The higher rate of innovation would lift productivity and improve the competitiveness of the export sector.

BENEFITS DIFFER DEPENDING ON DEVELOPMENT PATH

WaikatoLink, the technology transfer office for University of Waikato, approached two multinational leaders with an offer to license new technology developed by university researchers at a low price to fund further research. The offer was refused as the existing industry participants did not see the value in the innovation.

So WaikatoLink used another path to commercialisation. WaikatoLink founded a company to develop and commercialise the IP. The company secured a $1 million investment from a domestic VC firm which allowed it to further develop the product, attract customers, and begin to create market noise. Customers started to demand the same technology from the two multinational industry leaders, motivating one to source the technology from another start-up, while the other's customer base started to suffer.

Just 18 months after WaikatoLink had first approached the multinationals with an offer to sell the underlying communications IP for the smaller amount, the second multinational realised it needed the technology to compete, and offered much more to purchase.

Even though starting the company and investing in business and product development required upfront investment, the net return to the shareholders was much greater than they would have earned from simply selling the underlying IP to the existing industry players.

3 NEW ZEALAND'S INNOVATION ECOSYSTEM CAN DELIVER MORE

The previous section reviewed New Zealand's investment in R&D, participants in the innovation ecosystem, and commercialisation options. This section assesses how well New Zealand's innovation ecosystem is performing, how well it may perform, and factors relevant to improving performance.

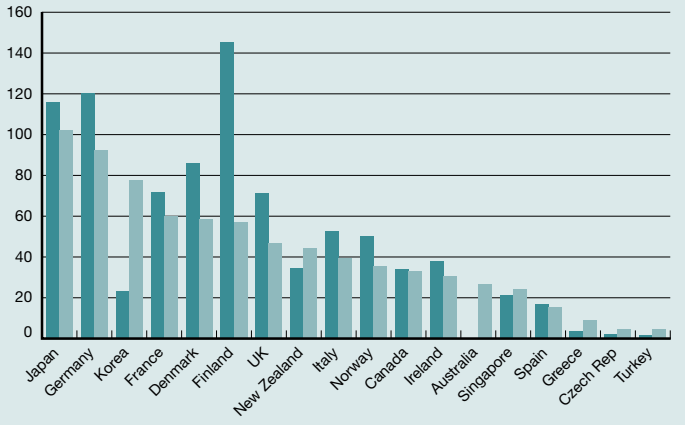
New Zealand has the basic ingredients to be great at commercialising science, but has not yet devoted the attention, planning, and resources needed to tap the full potential of this source of economic prosperity.

New Zealand performs well above the OECD average in production of scientific articles but well below the OECD average on patents (OECD, 2007). That suggests that the balance between seeking academic outcomes and commercial outcomes in New Zealand is tilted more towards academic outcomes than it is in other OECD countries. That may be in part because the Performance-Based Research Fund (PBRF) system used for evaluating university staff places a high weighting on academic papers but provides little incentive for commercial contributions (OECD, 2007; NZbio, 2009).

Figure 9 shows the number of patents acquired per gross expenditure on R&D (GERD) for selected OECD countries in 1995 and 2006. New Zealand's innovation system delivers a middle of the pack performance, ranked 13th out of the 27 countries in the analysis. Over the period, the performance of many countries declined, but New Zealand managed a slight increase. New Zealand's rank improved from 17th in 1995.

The rise in the rankings indicates that New Zealand's innovation system is improving. But with less than half the patents per billion dollars of GERD spend

FIGURE 9: PATENTS PER GROSS EXPENDITURE ON R&D SPEND, $B



Note: Australia 2006 only. New Zealand values are for 1995 and 2005.
Source: OECD Main Science and Technology Indicators, 2008.

of Japan, there is still room for improvement. Korea's improvement over the last decade, rising from the bottom third to fourth from the top in the OECD, shows that improvement can be achieved quickly.

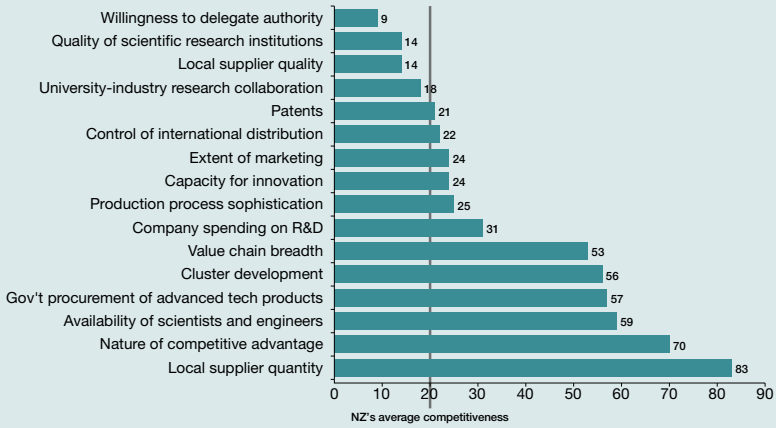
The WEF GCI shows that New Zealand scores well on the basic requirements of an economy such as institutions, infrastructure, macroeconomic stability, health, and primary education. New Zealand also scores well on efficiency enhancers such as higher education and training, market efficiency, and technology readiness (Schwab, 2009).

Figure 10 shows New Zealand's ranking on the WEF innovation and business sophistication factors, considered the critical drivers of economic performance for advanced economies (Schwab, 2009).

Thirty-seven of the economies ranked in the GCI are classified as advanced economies. New Zealand is ranked 20th overall, making it middle of the pack among the advanced economies. However as the chart shows New Zealand ranks quite poorly on innovation competitiveness, which is the differentiator of economic performance among advanced economies.

New Zealand's small size and isolation are obvious sources of economic disadvantage that have been well-documented elsewhere. They limit the scale of the innovation ecosystem and make it more challenging to connect with highly specialised or capital intensive supporting services. They are a direct driver of the 'local supplier quantity' metric, where New Zealand performs most poorly.

FIGURE10: NEW ZEALAND'S INNOVATION COMPETITIVENESS
Rank among 133 Countries for innovation factors



Source: World Economic Forum Global Competitiveness Report 2009/10

Government policy affects several of the other factors where New Zealand performs most poorly. Availability of scientists and engineers is influenced by education policies, retention of graduates in New Zealand, and relative pay and conditions for scientists. Cluster development and government procurement are influenced by policy too. Control of international distribution and value chain participation are impeded by small scale and isolation but can be improved via effective support from a trade development organisation.

The next group of factors including product and process based advantage, company spending on R&D, production process sophistication, capacity for innovation, and extent of marketing are largely firm specific. They indicate relatively poor performance of New Zealand firms as innovators and international marketers.

In response to these results one could conclude that New Zealand will not be able to compete effectively in innovation so should be resigned to being an exporter of agricultural and other commodities, and a provider of tourism. Or, one could conclude that if New Zealand aspires to be a successful advanced economy it must have a strong innovation ecosystem despite the obstacles. To take the second path one must have some prospect of success.

Imagine Singapore deciding whether it can become a great exporter of minerals or develop an economy based on agricultural exports. Natural endowments make those strategies impossible.

New Zealand is not in that situation when assessing the potential for the innovation ecosystem to make a huge contribution to future prosperity. Research facilities exist along with the other important institutions required for an innovation ecosystem. Transport and communication links are not perfect but access to international suppliers and markets is feasible. Many of the innovation measures where New Zealand performs poorly could be improved over time, some by economic development policies and some by business effort.

Furthermore, there have been some New Zealand successes in commercialising science, and recent progress demonstrates that improvement is possible. Economic returns from the commercialisation of science are evident, for example:

- New Zealand's agricultural sector is internationally competitive because of biosciences. Productivity increases over the last 30 years have been dramatic, and many of these stem from the development and application of biological science discoveries made 20 years ago or more.
- There are pockets of significant value for the country being developed by the application of science to commercial efforts. The bioactives sector, for example, was valued at $760 million in 2007 up from $350 million in 2004. The OECD Review of Innovation Policy in New Zealand stated that the country is developing "pockets of excellence in new industries such as software" (OECD, 2007).

Efforts in recent years to improve the rate of success have gained some traction. Almost a decade ago, there was a large increase in efforts to use innovation to boost New Zealand's economic performance. The Knowledge Wave conferences in 2001 and 2003 helped focus attention on the importance of knowledge in a modern economy. The increase in perceived importance of knowledge encouraged establishment of science funding programmes and institutions to convert science and other innovation sources into successful go-global businesses. Action was taken, for example:

- Commercially focused science funding programmes such as the New Economy Research Fund, budgeted at over $70 million in 2008/9, and the Pre-seed Accelerator Fund, budgeted at about $9 million in 2008/9, were established.
- Business incubators were established in the major cities along with University Technology Transfer Offices.
- Government established the Venture Investment Fund to provide a flow of risk capital to emerging businesses and angel networks were established to access the capital and skills of high net worth individuals willing to support and invest in go-global businesses. NZVIF has since invested $71 million in 48 firms (Lerner & Schiff, 2009).
- NZTE helps businesses establish international linkages, supports the marketing efforts of companies selling overseas, and helps increase the success of emerging go-global companies, for example with the Beachheads programme.
- The Kiwi Expatriates Association (KEA) was formed in part to better leverage the skills, opportunities, and networks that offshore New Zealanders provide.

But was this action enough? Consider the primary input gap for New Zealand's innovation ecosystem: Business Expenditure on R&D (BERD). Figure 11 shows New Zealand's BERD as a percentage of GDP is comparatively low for both 1995 and 2005. Whereas New Zealand's overall investment in R&D per capita

was about half the OECD average, New Zealand's businesses invest less than a quarter of the OECD average.

It does not appear that innovation is considered a sufficiently attractive prospect to merit business investment at a level comparable to other countries. This raises the question of what can be done to manage New Zealand's ecosystem for better performance.

New Zealand will not gain the economic benefits available from science and innovation unless existing businesses are encouraged to innovate more, and supported to improve their ability to launch new products and services in international markets.The next section describes New Zealand's innovation system and considers the characteristics of a successful innovation ecosystem.

FEATURES TO CONSIDER IN MANAGING INNOVATION ECOSYSTEM PERFORMANCE

New Zealand's spending on the research and development that provides the feedstock for commercialisation is low. The natural response would be to increase spending rapidly. That would have a positive effect provided the increased research output could be commercialised effectively.

One reason that improving the commercialisation of science is challenging is that the process of commercialising science is complex, involving numerous connections and relationships among participants and institutions. That is why it is referred to as an 'innovation ecosystem'. This section describes relevant features of the innovation ecosystem and explores some implications for success requirements.

FIGURE 11: BUSINESS EXPENDITURE ON R&D PER CAPITA

Note: New Zealand, Mexico values are for 1995 and 2005.
Source: OECD Main Science and Technology Indicators, 2008.

Diverse inputs required – The inputs required in the ecosystem are varied and usually are not substitutable. They may include specialised equipment, scientific information, or market input. People in research units and businesses need to be able to access local and international networks to secure those inputs.

Many steps from research to international commercial success – The business must succeed at every step and the kinds of inputs and skills required change several times.

High risk – The business must introduce a new product into a new market, which is normally regarded as an unwise business strategy. Success requires an offer that fits with customer needs and a viable channel to market. Being distant from markets makes the challenge even greater and failure usually means loss of the entire investment.

Specialised skills required – The skills required for successful commercialisation are quite specialised and take a long time to develop.

Speed is important – Competitors may beat the business to exploit the market opportunity, and the business consumes cash until it is established.

Many commercialisation options, with the best undetermined at outset – The route for commercialisation must be chosen. Sometimes there is only one feasible route but in other cases choices must be made.

Increasing returns for the innovation ecosystem – The OECD has noted that there are increasing returns to R&D on economic output and that the impact of increasing business R&D on productivity was greater in countries where more R&D was undertaken to start off with. The importance of accumulating experience, growing networks, and developing a population of skilled people means that the performance of the ecosystem increases as it gets larger and has been around for longer.

These seven features have important implications for developing an effective innovation ecosystem.

The need to access diverse specialised inputs means networks are very important. Networks within and around the business may be relied upon early in the development process but easy access to wider networks, including international networks and linkages will be required too. The more remote the ecosystem is the harder and more expensive it is to establish and maintain those international linkages and networks.

The number of steps from research to commercial success means each resource must be available in the required quantity when it is needed. The business must be able to access research infrastructure and funding, suitably skilled researchers, business founders, directors, capital, and advisors. If no business leader is available the commercial manager is unlikely to be able to step up successfully. If a skilled director cannot be found, a less skilled one is not an adequate substitute. At each step there may be a rotation of people; the team that initially forms the business is unlikely to be the team that makes the step to international sales.

The challenge of entering a new market with a new product means that a high level of skill is needed for success. Second best will mean delays and possibly failure of the businesses.

The requirement for specialised skills means that appropriately trained and experienced leaders, staff, contractors, advisors, and directors must be available in sufficient quantities to ensure that each venture with international potential has a team capable of developing the business successfully.

The importance of speed means that delays due to not getting the product-market strategy right first time are expensive in time and money, and may make the difference between having an advantaged or disadvantaged position relative to competitors.

The different options for using research results combines with the difficulty, and importance, of getting the product-market strategy right to create a requirement for governance that increases the likelihood of success. Those making decisions about whether to commercialise or publish, which commercialisation route to follow, or which product-market strategy to adopt must be sufficiently skilled to make good choices and, where public funding is involved, should decide within governance frameworks that recognise economic contributions from go-global business development.

The need for networks, specialised skills, and successful strategic decision-making combine to encourage focus of effort in areas where networks and skills can be developed to reach critical mass. With critical mass New Zealand's researchers and business developers may be able to access skills and knowledge as easily as competitors in other countries. Small and isolated research and commercialisation activities are much less likely to be successful.

IMPLICATIONS FOR IMPROVING AN INNOVATION SYSTEM

Lifting innovation ecosystem performance to the world-class level requires four parts of the ecosystem to perform really well. Public research must produce an increased flow of research results with high commercialisation potential. Research results must be passed successfully to existing and newly formed businesses for commercialisation. Existing businesses must increase their R&D expenditure and successfully commercialise the results. New businesses must develop competitive offers and succeed internationally. The dependencies and connections among the four parts mean that one weak part will limit the economic benefits from improving the others.

The analysis above implies that New Zealand is not likely to have sufficient availability of inputs for commercialisation, especially skills and networks, and that the market is unlikely to supply sufficient skills quickly enough. Furthermore, while New Zealand can supplement those inputs from international sources, it is more difficult and costly for New Zealand organisations to do so than it is for competitors in larger, less distant economies.

The innovation ecosystem improvement strategy must meet three requirements:

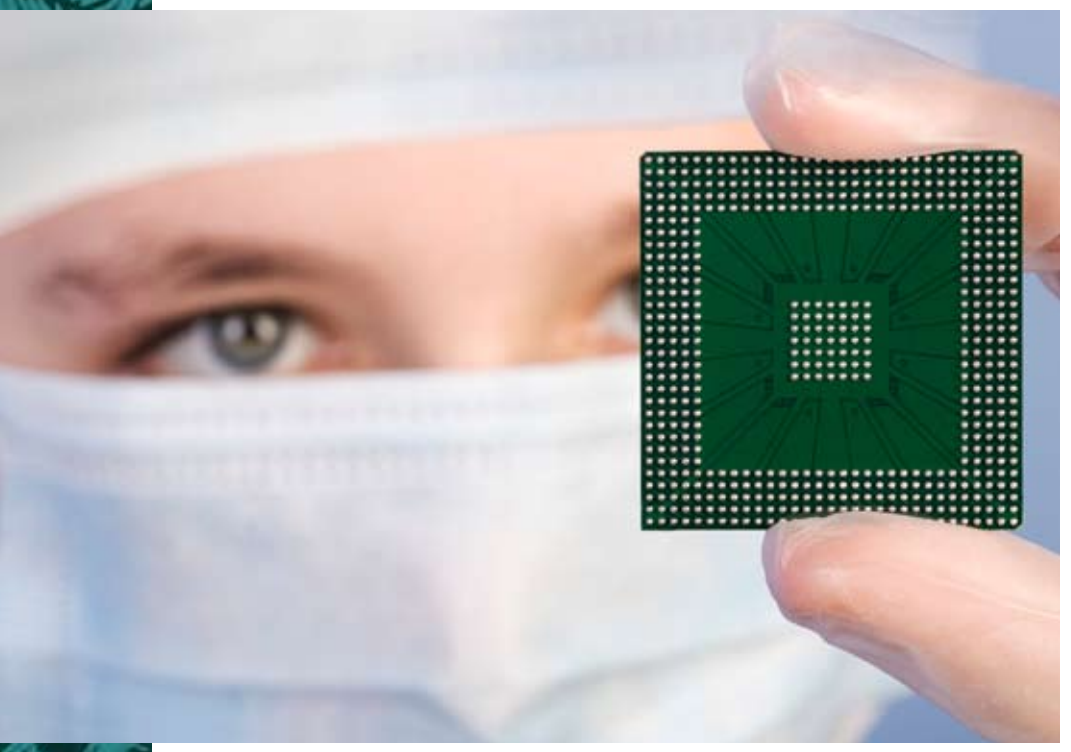
First, the need for the right quantities of specialised inputs means a *comprehensive and cohesive strategy* that covers all parts of the innovation system is needed. Because the system requires many kinds of inputs and is so highly interlinked, all parts must be healthy for the best possible performance. There is no silver bullet; a series of coordinated actions is required. The system must be managed as a whole.

Most of the emphasis in the current national discussion about how to better commercialise New Zealand science is on increasing the availability and flow of commercialisable science. The implicit assumption is that the business end of the science-commercialisation system is functioning well and will respond effectively when the supply of research output is increased.

New Zealand must pay at least as much attention to ensuring sufficient high quality resources for commercialisation by new and existing businesses as to increasing the supply of research results for commercialisation. It is necessary to dig beneath the superficial observation that the required support institutions are in place to consider the quality of the institutions and the available quantities of the required skills and other inputs.

Second, the strategy needs to be *sufficient*. The economic prize for success is large. There are already shortages of key inputs and there are increasing returns to scale. If New Zealand aims to be a leading innovation-based economy then substantial intervention will be required.

Finally, *a long-term strategy and patience* is needed. Although the need for improvement is urgent, patience is required. Just as it takes a long time to develop a research result into a successful international business, it takes a long time to establish an effective innovation ecosystem.



4 OPPORTUNITIES TO IMPROVE THE PERFORMANCE OF NEW ZEALAND'S INNOVATION SYSTEM

Identification of opportunities for improvement should not be taken as an indication that New Zealand's innovation ecosystem is performing poorly everywhere. At their best New Zealand institutions, firms and individuals perform very well in each of these areas. The existence of opportunities for improvement for the ecosystem as a whole is not intended to be a criticism of individual institutions or individuals.

The opportunity is to consistently achieve the best performance possible. The proposals are to ensure structures that will be successful, useful incentives, availability of important resources and more support for those working in the ecosystem.

Our research reveals five directions for improvement of New Zealand's innovation ecosystem to make it closer to what is done in world class innovation ecosystems and to overcome obstacles to commercialisation:

- Ensure earlier assessment of market needs
- Lift the productivity of science and commercialisation institutions
- Ensure availability of talent and expansion capital
- Establish a more supportive culture
- Manage the innovation ecosystem as a whole

The obstacles and opportunities identified are interwoven so that each shortcoming increases the deficit in other areas. For example, if a go-global business lacks skills it may not get market input, and if it lacks market input it is less likely to be able to attract expansion capital. Lack of capital means it cannot afford skills. There are many of these interactions.

Some of the proposals for improvement imply government policy initiatives while others should be implemented by government agencies. A few could be done by non-governmental organisations (NGOs) or by businesses. However, NGOs and businesses cannot be relied upon to act as they should because they pursue their own goals, which may or may not align with what is best for the innovation ecosystem or for New Zealand's economy. Government is accountable for innovation ecosystem outcomes and for establishing the policies that ensure NGOs and businesses play their part. For example, business R&D spend needs to be much higher but businesses may not increase their R&D spend just because that is economically important for New Zealand. It is government's responsibility to ensure that the right conditions and incentives are in place to encourage investment and enable successful commercialisation.

ENSURE EARLIER ASSESSMENT OF MARKET NEEDS

Developing products successfully from scientific or other innovation depends on talking to markets early and often to understand what customers need and how they want to be served.

It was striking how often market engagement and understanding customer needs were mentioned in the brief explanations of why each company was succeeding and had been chosen as a finalist for the 2009 New Zealand International Business Awards. The award contenders demonstrate that there are many New Zealand companies who do engage with markets and reinforce the importance of doing so. An attendee at the awards ceremony might conclude that New Zealand firms are good at acquiring and using market input.

Scientists and other innovators are often motivated by the challenge of completing the research or the development rather than the commercial and economic benefits that flow from their efforts. They are not usually well-connected with the potential end-users of the products that will result from their research and may see no reason to consult with markets at such an early stage.

Because offshore markets are difficult to reach, the temptation is for New Zealand businesses to look to domestic markets to test products. Entrepreneurs with international experience know local testing is an insufficient substitute for testing products offshore, because New Zealand is a small, distinct, and relatively homogenous market. Customers in other countries may have very different tastes and requirements, and lack of in-market testing can lead to misdirecting offer development.

Poor market engagement may result from a reluctance to expose developments to others based on the fear that they will steal ideas. There are sometimes reasons to be concerned about giving away commercial secrets but the fear is overblown and there are many ways to manage these risks. The costs of not testing with the market are much greater than the risks from someone stealing ideas.

New Zealand Investors from angel groups and those responsible for making funding decisions for business assistance support programmes have noted that the ‘product push’ approach taken by many New Zealand start-ups hampers success. They report seeing hundreds of proposals where an entrepreneur or scientist has developed a product but has done no research to confirm whether or not there is a market for that product. Some scientist-founders of start-ups try to blind potential customers with science or think that because they think they have a fantastic innovation the value will be self-evident to customers.

The results of lack of early engagement to gain market input were highlighted in a 2007 NZTE study of how New Zealand businesses are perceived in overseas markets. The interview survey was carried out in Australia, India, South Korea, China, Japan, the US, and the UK. A strong theme among responses was that New Zealand businesses exhibit a lack of preparation and research into a country's culture and specific market characteristics e.g., a 'what can we sell' approach rather than asking 'what does the market want?'. Specific findings included that: in China "lack of consumer understanding… lets New Zealand businesses down"; in India, respondents commented on the lack of New Zealand engagement with markets at trade shows, conferences, and networking events; in Japan, New Zealand businesses fail to understand the market emphasis on aesthetics and quality; and in Korea, "many New Zealand companies show little concern about Korean consumer preferences" (NZTE, n.d.).

The tendency of many New Zealand start-ups to develop products without talking to markets also lengthens the time it takes for innovations to reach market from New Zealand, because the next round of development begins when the start-ups do start talking to markets.

Three general solutions have been identified. Market and commercial assessment should be completed before commercially-motivated research is funded, and at every step along the development path where public funds are committed. As an example, the National Institutes of Health in the US require a letter accompanying grant applications from a commercial organisation saying that the results of the research can be commercialised.

Second, get in-market resources such as NZTE involved earlier in the offer development process. Companies that lack market input develop their offer and then use in-market services to get connected to the market they choose to serve. Sadly what those companies often find is that their offer does not suit the market so back they go for another round of development.

NZTE should be engaged earlier with these companies, when they really need help establishing international networks and relationships. Products and services would be better suited to markets and so would be easier to sell, and the relationships with channels and customers would be more mature so it would take less time and transaction cost to establish successful commercial agreements.

The third opportunity comes from ensuring skilled and experienced commercial governance of developing ventures. Directors who have 'been there and done that' will insist management takes the required steps to ensure product development is guided by market input.

ENSURE EARLIER ASSESSMENT OF MARKET NEEDS
Ensure participants in the innovation ecosystem in New Zealand understand the benefits from assessing market needs early and explicitly assessing commercial potential
Ensure public funders of research and commercialisation receive commercial and market input before funds are committed • Required when commercialisation potential is the justification for funding • Informational but potentially still valuable when other rationales drive the research
Refocus trade development efforts so international connections are made earlier to guide offer development and secure channels to market
Build networks with overseas New Zealanders, including via KEA, to allow commercialisation units and businesses to extend their market input reach • Develop for market input and as a source of international advisors, business relationships and international directors

LIFT THE PRODUCTIVITY OF SCIENCE AND COMMERCIALISATION INSTITUTIONS

In New Zealand the research infrastructure comprises a relatively large number of small units that compete for resources such as skilled researchers and funding. The model of many units competing was established in the early 1990s when the Department of Scientific and Industrial Research was divided to form eight Crown Research Institutes. That split was consistent with a business trend at the time to break up large organisations to gain benefits from focus and accountability and to reveal opportunities to remove unnecessary costs. The trend led to more and smaller entities competing in many industries.

Decentralisation allowed an increase in competition for funding which was a useful way to increase performance. At the same time, commercial performance incentives were introduced, most notably a requirement to earn a return on investment for the CRIs.

The logic for competing units is much weaker today for four key reasons: benefits from being small and focussed are transitional; the real competitors are overseas, not domestic; there are valuable benefits from bulking up units; and performance can be assured using other methods.

When business units are first decentralised and exposed to competitive pressure there is a worthwhile improvement in performance but the improvement is a result of the transition. Once an organisation has introduced the accountabilities, removed the cost, and improved performance something more must be done to gain further benefits. Longer term, there are costs from running smaller units. Each establishes its own infrastructure, which impedes opportunities from sharing, and when they compete intensively for small funding opportunities there are high transaction costs.

When the competitive funding model was established the most important markets for research were domestic. Today, globalisation, the importance of innovation ecosystem competitiveness, and the imperative to grow go-global businesses mean competitors are overseas. The challenge now is to work together to ensure the best possible performance from research and commercialisation units so go-global and other businesses can compete successfully in international markets.

International best practice and experiences in New Zealand provide strong evidence that large specialised institutes perform more effectively than small isolated research units. Larger specialised institutes have worthwhile advantages:

- They can afford, attract, and retain the world class leadership that is so important to success
- They have stronger internal and external networks and communications that make research efforts more productive and more likely to be commercially successful
- They are more sustainable because they can establish succession and positive internal cultures
- They can attract more high quality specialist support ranging from specialised technical staff to skilled governance

Others are advocating concentration of science investment for commercial or economic benefit on sectors where New Zealand has or can develop competitive advantage. Focusing investment where research output has potential commercial and economic benefit is good strategy.

If a small country like New Zealand is going to evolve towards larger scale specialised research institutes focused on key sectors of the economy then it will not be possible to continue to use competition for funding at the research project level as the key mechanism to ensure performance.

The solution to this restriction is emerging in New Zealand and is in place in other countries. It is to shift the funding mix towards longer term, larger scale investments. The Centres of Research Excellence are funded in bulk for longer terms and they become the decision-making bodies for allocating funds to specific projects.

In some other countries, institutes are bulk-funded for longer terms and subject to external performance review. For example, Swiss National Centres of Competence in Research (NCCR) are funded for multiyear periods. An external review panel assesses scientific, administrative, and financial performance. The review panel includes international researchers and representatives of public and private sectors served by the NCCR. Informed by recommendations from

the review panel, the NCCR's funding is increased or decreased. NCCRs are expected to develop their own revenue streams (SNSF, 2009a).

The external review and funding processes provide incentive for institutes to perform effectively without the disadvantages of fragmentation. A Swiss National Science Foundation review of the NCCRs concluded that "Our high expectations have been met to a greater extent than anticipated" (SNSF, 2009b, p4) and a 2007 comparative review concluded that Switzerland was one of the European leaders in innovation.

Establishing at-scale research institutes implies a reorganisation of existing research institutions. An institute structure that had one institute for high technology industries and one for the biological economy would result in institutes that are too broad. At the other end of the scale is a small research laboratory in one of the smaller universities. The ideal research institute scale lies between these sizes. The biological economy is too large a topic to be covered by a coherent research institute whereas the small isolated laboratory is too small to capture the benefits from scale.

When deciding how to rearrange the institutions government should begin by identifying strong, or potentially strong, sectors within the economy and matching them with existing strong research units. An institute should be sufficiently coherent that it can have a common mission and can attract a leader with the breadth of knowledge to contribute across the range of activities. Researchers within the institute should see the relevance of work of other researchers in the same unit, and where internal networks are valuable.

Having identified the core of a research institute based on existing strengths, related research units should be reviewed for suitability to be included as part of the institute. The small isolated laboratory referred to above might be included at this step. The result will be institutes that are geographically dispersed, although over time co-location is desirable.

World class institutes are led by world class leaders. It may be attractive to assemble institutes around a world class leader or leaders, perhaps New Zealanders attracted from overseas. That approach is used by some other small countries. Critical leadership mass to allow collegiality and succession is important and that implies internationally competitive remuneration.

To ensure research and commercial success, each of the institutes must have a board of directors capable of governing high quality decisions about which research efforts should be supported by the institute. These decisions should be informed by market and commercial input along with research and IP potential. That implies a mix of scientific and business skills on the board.

Commercialisation Units

Commercialisation units have been established in Universities and within CRIs to facilitate the conversion of research outputs into business opportunities. The units help arrange contracts between research units and firms to carry out research, they facilitate licensing the use of IP based on planned or serendipitous discoveries, and they may form businesses that can take products and services based on scientific innovations to international markets.

The result of this typical one-to-one connection between research institutions and commercialisation units is that some of the commercialisation units lack the critical mass required to operate successfully.

Successful commercialisation requires a diverse range of skills and capabilities. Staff should understand the science, the market, and the commercial opportunities. They need to be able to manage intellectual property issues, licensing requirements, and business formation approaches. They need relationships with advisors who can help ensure the commercial arrangements are sound and legally robust. Commercialisation units need sufficient staff that relationships are not lost if one or two people leave.

There are also benefits from specialisation of commercialisation units. Understanding of the scientific and market domains is important for successful commercialisation so it would make sense to align commercialisation units with research institutes or other institutions such as universities provided there is sufficient critical mass in the commercialisation units to do so.

However, where there is not sufficient scale in the research institution or university the commercialisation units should be aggregated. Larger units can deploy the full range of skills required and be more sustainable. They will attract more highly skilled leaders and stronger governance. That logic lies behind the establishment of consortiums. For example, Unicom has enabled AUT University, Canterprise, Lincoln University, and WaikatoLink to collectively apply for and receive $4.9 million of government pre-seed funding from FRST. Allocation of these funds will now be made under the guidance of experienced directors including a former Minister of Finance, an Ernst & Young New Zealand Entrepreneur of the Year winner, and the holder of the Chair in Science and Technology Entrepreneurship at a leading university who also has experience leading and directing NASDAQ companies. Individually these organisations would not all have been able to assemble such a Board.

One impediment to aggregation of commercialisation units is the requirement for very strong connections between the commercialisation professionals and researchers. That requirement implies co-location of the research with commercialisation, which would prevent increasing commercialisation unit scale. The solution is to have a hub and spoke approach where the commercialisation unit itself is at scale and centralised but has field staff building relationships with researchers, trawling for opportunities, and facilitating interactions as opportunities develop.

Industry interviews indicate that when entrepreneurs and others search university and CRI output for results with commercial potential there is little found that is ready for commercial development. The difficulty seems to be, at least in part, due to a gap between the research output and the input that is required for commencement of commercialisation effort. The gap is in the value-adding activity of qualifying and packaging research results so they are ready to be considered as commercial opportunities.

Researchers may lack the resources, skills, or motivation to take the results to the next stage. Commercialisation units and entrepreneurs have limited resources and their commercial imperatives mean they focus on the most attractive looking opportunities, meaning others with potential may remain undeveloped and unexploited.

Four distinct activities should be expanded to increase the flow of completed but unexploited science towards commercialisation.

The first is to describe the research output in a standard way: the result, status of intellectual property protection, market application, and commercial potential.

The second activity is taking the results judged at the governance step to have potential, testing that potential further, and further packaging the output so a decision can be made to pursue a commercial route further, or not. The third activity that needs to be increased is the commercialisation effort itself. Commercialisation effort is limited by budgets available to the commercialisation units of the universities and by the limited commercialisation capacity and focus of the CRIs.

The final activity is disclosure of available research results identified in the three steps above that are not actively being progressed by commercialisation units or search for a commercial partner; i.e. the results that do not yet have a place to be developed. Many of the results not being progressed will have no potential. One person or group might conclude that a research result has no commercial potential but another group may find potential based on application in novel situations previously unconsidered.

Encourage formation of go-global companies

A go-global company is one that is formed with the intention of selling into international markets, recognising that the New Zealand market will be too small to sustain the business long term or to allow it to reach potential.

Go-global companies like Research in Motion or Google can deliver large commercial prizes. While contract research provides immediate fees for service and licensing IP provides revenue when the product or service is launched, a successful go-global business creates wealth for investors.

Think of the creation of a go-global company as a way to ‘add value’ to a ‘raw’ research output. Just as making wine adds value to grapes, building a business around research results adds value to those results.

The New Zealand Institute has argued in *Flight of the kiwi: Going global from the end of the world*, that New Zealand must grow more successful internationally engaged businesses to increase productivity and economic performance. Successful New Zealand based go-global businesses would contribute to exports and reduce the trade account deficit. Overseas operations or subsidiaries would contribute via growing outward foreign direct investment and reduce the investment account deficit. Many existing New Zealand based go-global businesses manufacture offshore so more go-globals would help shift the mix of the economy towards the ‘weightless economy’ and reduce the adverse effects of distance from major markets.

And success will breed success: visible wins will lift aspiration levels and support an entrepreneurial, success-driven culture.

Successful businesses sold to overseas investors would also make a worthwhile contribution. If the owners remain in New Zealand they might invest or spend the proceeds in New Zealand. The jobs created in go-global businesses are likely to be high value, as indicated by the average revenue of $280,000 per employee within the 100 largest technology firms in New Zealand (TIN, 2009).

Even unsuccessful attempts to grow go-global businesses provide benefits as these firms offer relatively high value jobs before the failure, and the staff develop experience that is valuable for the next attempt.

The decision about how to derive the greatest net commercial return from a scientific discovery must be made on a case-by-case basis. Very broadly speaking, of the choices available for creating value out of a scientific innovation with commercial promise, the route of creating a start-up and taking it global is the one that requires the highest upfront investment, is most risky, and takes the longest to deliver commercial returns. However, as argued above, a successful go-global business is likely to provide the highest commercial and economic value, so that path should be available if there is a sufficient chance of success.

Some commercialisation units are funded by Universities and CRIs from operating budgets and, in general, their performance is measured based on current operating returns. Therefore if they successfully conclude a licensing arrangement they improve their measured performance directly and relatively soon but if they spend operational funding to progress a business formation option they will erode current results in the hope of some long term future benefit that may well show up in the performance measures for a later generation of managers.

RESEARCH IN MOTION

Research in Motion provides an example of how large commercial prizes can result from innovation. The story began in 1984 with a tech student dropping out a month before graduation. The founders spent several years as computer science consultants before recognising in the early 1990s that email and personal communications could be combined into the product they developed: the Blackberry. Prior to public listing in 1997, $30 million Canadian dollars were raised from institutional and venture capital investors. The IPO raised another $115 million. Within a decade of releasing the Blackberry the company was valued at almost $80 billion. Even after the market meltdown the company today is valued at over $30 billion, with revenue of $11 billion and profit of almost $2 billion.

Source: Fortune, 2009; www.rim.com

The incentives encourage choices that are rational for the commercialisation units given the performance measures and resources they have, but which are not optimal for New Zealand. In practice, the leaders of the commercialisation units understand the value from go-global businesses and will go after longer term opportunities when they can. However, that behaviour should be encouraged not discouraged by the performance measures.

Go-global business formation would be encouraged by revising the incentives and performance measures of commercialisation units to ensure there is sufficient incentive to form go-global businesses when that is a commercially attractive option. Further, commercialisation units should have sufficient operational and capital funding available to allow them to form businesses.

LIFT THE PRODUCTIVITY OF SCIENCE AND COMMERCIALISATION INSTITUTIONS
Evolve towards at-scale research institutes • Focus where New Zealand can have economic strength • Base the institutes where there are existing strengths • Connect smaller, related units to the institute via funding and governance to access scale and encourage collaboration • Hundreds not dozens of people
Build around or attract world-class leadership
Assess performance via international peer review teams
Fund for long term – 5 or 6 years Adjust funding based on peer review and potential Expectation that Institutes will develop revenue streams
Aggregate commercialisation units to ensure all are at scale • At-scale means at least 8 – 10 people • Larger units may be better but keep several New Zealand units • Where possible, combine units in related fields to maximise benefits from networking and specialisation
Ensure local presence of commercialisation units at research units • Use a hub-and-spoke structure when research units served are not co-located
Describe research results with commercial potential in a standard way and make results available more widely Ensure commercialisation units have operational and capital funding available to form go-global businesses Ensure commercialisation units also have performance measures that encourage development of go-global businesses when there is sufficient potential

ENSURE AVAILABILITY OF TALENT AND EXPANSION CAPITAL

Sufficient talented people

There are many people who have skills and a track record in commercialisation of scientific and other innovations. But there are not enough skilled people to properly develop the science and innovation opportunities available now. It follows that there are not enough to deliver the larger economic contribution required from New Zealand's innovation ecosystem.

One reason there are not sufficient skills is that the innovation ecosystem is expanding and there has not yet been time for a large number of people to accumulate sufficient experience to develop the specialised skills needed. The other reason is that there has not yet been enough effort to develop a large enough population of entrepreneurs, managers, and directors with the skills required to commercialise innovations and take the resulting offers into international markets.

It takes skilled, world-class leaders to grow successful world-class businesses. Launching a new product into a new market is very difficult and there are many failed attempts. The potential to improve results by fielding highly skilled business teams is high.

Which skills?

When a discovery or innovation is identified it is usually necessary to match the opportunity with a leader and a team of managers. In some cases the opportunity will be licensed to an existing company which may have sufficiently skilled leadership and management in place. In other cases a new venture will be formed to take the product or service to market.

Even when scientists do want to commercialise their discovery few will have the range of skills required, and they are usually eventually replaced as leaders. Nevertheless it is worthwhile to have scientists more knowledgeable about business so they can make stronger contributions to business development. Current initiatives to include business training in science degrees are a helpful step and should be extended further, and quickly. Increasing opportunities for established scientists to learn about business would be helpful too.

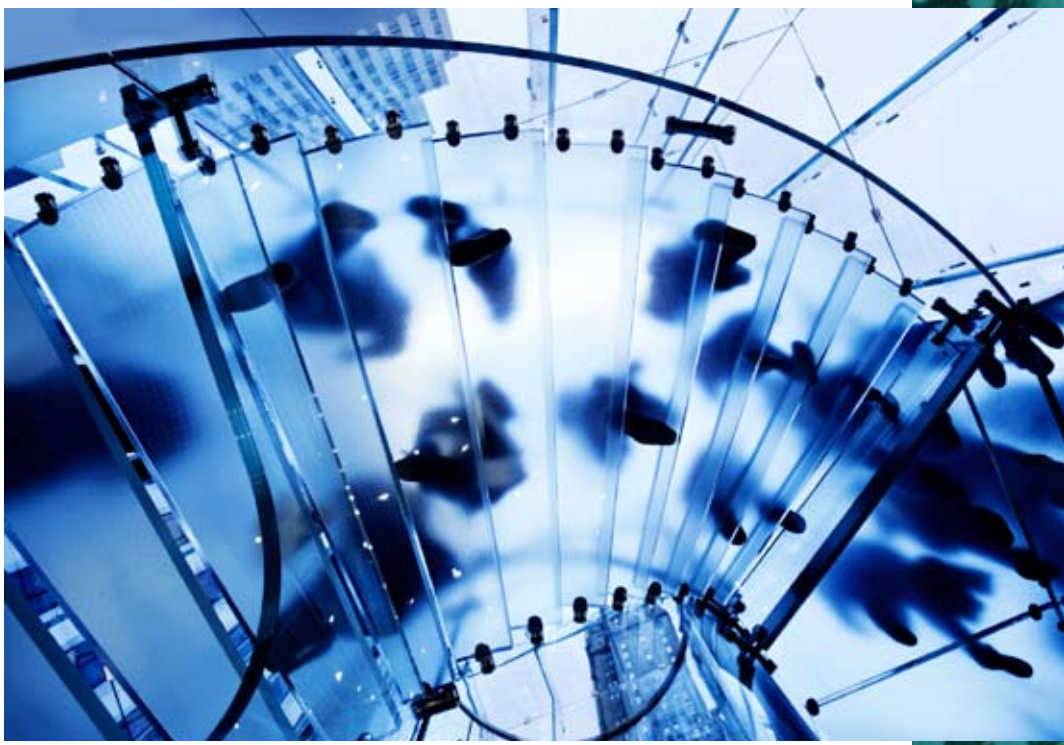
The most important role when launching a go-global business or entering a new market with a newly developed product is leadership of the venture. Some ventures are led by an entrepreneur who provides both leadership and risk capital. Others are formed by a group of investors who will form or appoint

a board of directors. A chief executive is appointed from within the group or recruited. As the business develops and grows there will usually be changes in the leadership team.

These considerations imply the need for a supply of suitably skilled leaders to develop offers from innovations and launch those offers into international markets. The talent required to be successful should not be underestimated.

Successful businesses are developed by teams. Effective leaders work with two teams; the management team and the board of directors. They might be distinct teams by the time the business is launched internationally, perhaps with a staff of 10 or 20 people, but the whole business might comprise only a handful of people when it is initially formed, so the boundaries among these groups are not yet distinct.

A successful international business needs to win in two competitive arenas: market and commercial. In the market arena the business must have an offer that meets the needs of customers and does so in a way that makes the business a preferred supplier. In the commercial arena the business must command a price and deliver at a cost that leaves enough margin to cover the overheads of the business and delivers an attractive return to the providers of capital.



The commercial skills required to ensure a business is able to operate at a profit are relatively similar for international businesses and domestic businesses and those skills are not usually an impediment to the growth or success of go-global companies. However, the marketing skills required to launch a new product in an overseas market are very different from those required to succeed managing an existing product in an existing market, and those go-global marketing skills are scarce in New Zealand.

The board of directors of a go-global business governs the venture, making decisions about direction and committing resources to implement strategies. The importance of governance is often underestimated; the work of boards is usually invisible until something goes wrong, and directors' contribution is difficult to understand for people without experience in the boardroom.

A high quality board for a go-global venture will be led by a chairman who manages the board, worries about ensuring that everything is important is being covered, makes sure there is good process, and sees that compliance requirements are met. Other members of the board bring specific skills such as product or market insight, fundraising, business development etc. As a team the board is able to assess the potential of proposed strategies, whether developed by them or by the management team, or both, and deliver the judgment calls that will ultimately result in success or failure. Those calls may be about the market opportunity, the market entry strategy, the form of the market offer, the production process, or the management team, for example.

Three critical skills required for successful go-global businesses are in short supply in New Zealand's innovation ecosystem; entrepreneurship/leadership, go-global marketing, and governance.

Entrepreneurship / leadership

"We all know that New Zealand produces many hard-working and visionary innovators and entrepreneurs. But… many of these founders lack the skills to grow large and successful companies" *– A senior industry observer*

The shortage of entrepreneurs is acute for newly formed businesses, when a research result needs to have a business proposition and plan wrapped around it. One university commercialisation unit officer noted that at prestigious US universities, every research idea has 10 entrepreneurial suitors clamouring for the chance to explore whether or not it can be commercialised, yet a large part of his job in New Zealand is to 'beg' entrepreneurs to take on promising ideas. It is reported by some industry participants that some research results that could be the basis for a go-global business are licensed, or sit idle, because of a lack of entrepreneurial interest.

Many leaders of new go-global ventures are leading such ventures for the first time. Several symptoms and results of this inexperience were highlighted in interviews including:

- Long development times for New Zealand innovations
- Entrepreneurs chronically under-resourcing their ventures because they lack understanding about the time and resource required
- Founders without business knowledge creating strange and complicated business structures that hamper performance
- Overseas venture capitalists being uninterested in investing in New Zealand businesses because they only want to back ventures run by skilled, astute businesspeople

To some extent, entrepreneurs are born not made – the stereotype is of a particular kind of person who is driven to prove something, to achieve something, to make a difference. But in fact entrepreneurs come from many different sources. The common feature is that they need more than the inclination and drive; they also need knowledge and skills.

Internships are not as widely used in New Zealand as they are in some other countries and are an underdeveloped option to accelerate growth of the population of entrepreneurs. Academic courses tend to teach people about subjects such as entrepreneurship. That provides a useful foundation but does not deliver the practical skills and knowledge required to succeed. Internships provide practical experience for the learning entrepreneur while the business gets low cost labour during the internship, and potentially a new recruit afterwards.

Another means of increasing the entrepreneur population is to attract successful entrepreneurs from abroad. Immigration and taxation policies could be used to create an attractive environment here for entrepreneurs. For example, royalty income is relevant to successful participants in research and business development and merits review as New Zealand currently captures limited tax income in this category.

The key to success is to understand the gap between the entrepreneurial resource New Zealand needs and the supply available, and to apply effort and resource until that gap is closed. That implies quantifying the gap. Otherwise there is a risk that the usual approach will prevail – identify an issue, find a solution, deploy that solution, claim credit, and move on to the next problem without waiting to confirm whether the issue is addressed. That process is flawed because until the gap is quantitatively closed the problem has not been truly solved.

Marketing

Start-ups are almost always short of cash and even if they are not they know cash is a valuable and limited resource. So why would you spend money on marketing when you have not yet got a product and you could focus scarce resources on completing product development? When product development is complete then you can get marketing and sales resource.

That thought process is understandable but wrong.

As an industry participant and consultant who reviews over 200 investment proposals per year observes, “New Zealand innovators are often ‘product developers’ rather than ‘commercialisers’ or ‘marketers’… they spend two or three years developing products without knowing what market pain it solves and this is our greatest weakness: spending a lot of time and money solving ‘the world’s problems’ without actually knowing or asking what the world’s problems are”.

Marketing and sales skills required for go-global ventures have some features in common with the skills required for stable domestic ventures but there are very important differences. Developing overseas markets where channels are not established, needs and tastes are different from those in New Zealand, and the product is new is a challenging proposition.

The solution is the same as for leaders and entrepreneurs: increase resource and effort to grow the supply until the problem goes away.

There is a deeper issue that must be addressed too. There is no 'textbook' available to guide international marketers as they decide how to enter new markets. As a result, each company works out how to enter new markets for itself and most try several options before they succeed. The choices among options such as working with an agent, flying in the CEO or salesperson or establishing a sales office are important and depend on the opportunity and the circumstances of the company. Developing and disseminating the algorithm that would help companies develop market entry strategy would be a valuable step forward.

Governance

Being a company director requires a lot of experience, knowledge, skill, and wisdom, and it brings with it reputation and legal risk. The rewards are modest. Being a director of a go-global company requires somewhat distinct skills and increases the risk, but it may increase the rewards dramatically too, if the director is also an investor.

There are many suitably qualified directors here but not enough. When founders bring in outside expertise at management or board level, it can often be the wrong kind. Boards may become overpopulated with professional services advisors who may be helpful for risk and compliance matters but lack strategic capability or experience in growing go-global companies. Partly as a result, go-global boards do not always have the best skill mix. According to one angel investor interviewed, "The bulk of our boards are comprised of accountants and lawyers. Those are the last two people you want on a board of directors unless you're a bank or a property company or an insurance company, where governance and legal compliance is an issue".

Increasing availability of directors is an important challenge and opportunity. There are three general directions that would help. First, wider communication of the economic imperative to grow international trade by increasing the number and success of go-global and other exporting companies would motivate more qualified people to participate as directors.

Second, professional development opportunities for directors and aspiring directors of go-global companies should be established. The Institute of Directors in New Zealand provides a range of professional development courses for aspiring and current directors, including one on governing not-for-profits. The Institute of Directors or another organisation should offer a programme for developing go-global directors.

Third, establish a director broking service where people who are willing to be directors and/or investors in go-global companies can be connected with companies that need their skills. Use the broking service to set a standard for go-global director skills and board competencies; not one that prevents appointments but one that describes the skills directors are expected to deliver so directors know what skills they need to develop, and companies have a basis for assessing candidates and developing strong governance teams.

International linkages

Important skills are in short supply in New Zealand but may be available overseas. Having sales and marketing staff or directors who are located in-market can bring huge value provided the right people and engagement model can be found. There are challenges due to different remuneration expectations, distance, and time zones, but a company cannot be international if all activities are done in New Zealand.

Connecting with New Zealanders overseas may be worthwhile or it might be best to find a local; each situation will have its own best solution. The Beachheads programme already provides a commercial introduction service but the focus is on companies that have already established international revenues. The KEA network may have an important role to play too. Earlier development of networks and earlier engagement with markets will increase the ability of go-global business to supplement New Zealand based skills.

Sufficient expansion capital

Some companies are able to grow without introducing expansion capital but that is not always possible. Even when it is possible it may not be desirable because rapid expansion may be valuable to increase profits, and speed is strategically important to avoid falling behind competitors.

The international expansion stage usually requires substantial investment, several million dollars is typical, and the pitch for expansion capital is often made to international investors who may be from the industry offering channel access, or may be overseas venture capital or investment firms who can provide guidance and introductions along with their capital.

Sometimes these relationships formed to secure expansion capital or channel access result in sale of 100% of the company to overseas interests. Seventeen of New Zealand's largest 100 internationally focused technology companies, the TIN100, were wholly foreign owned in 2009, up from 13 in 2006 but down from 22 in 2008 (TIN, 2009).

In some cases international equity sale is necessary to secure distribution or high quality business guidance. However these inputs would more often be available without equity sale if the local innovation ecosystem was larger, more skilled, better connected, and better capitalised.

An important reason why go-global businesses are sold is that there are few sources of later stage risk capital available to growing go-global businesses in New Zealand so they must sell to international investors to expand or cash out. There is nothing inherently wrong with overseas ownership of these firms. However, all other things being equal, it is better for the ownership of a successful international business to remain in New Zealand hands so the wealth, trade account, and investment account benefits are secured.

NZVIF and partner funds invested $218 million in the seven years between 2003 and 2009. Of that, 49% was for expansion, which corresponds to an average of $15 million per year. The emphasis of the NZVIF expansion funding has been on early expansion so much of that expansion investment would be for domestic development prior to launching in international markets (Lerner & Schiff, 2009).

Retaining ownership of go-global companies in New Zealand will only be possible if there are investors in New Zealand willing and able to fund the international expansion. Investment of expansion capital to grow a go-global business is risky.

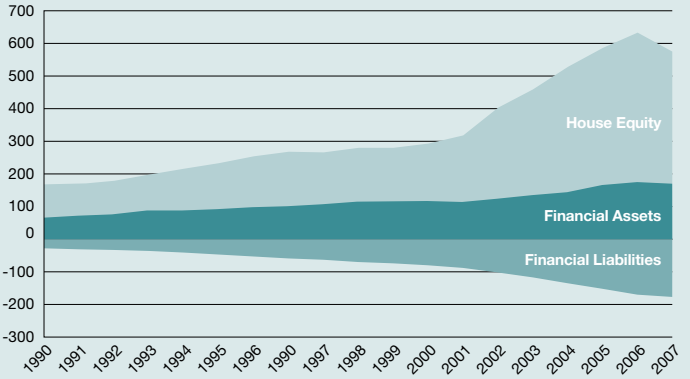
Banks are usually unwilling to provide structural debt finance for go-global companies because of the inherent risk of the sector and the uncertain value of the security available. It may be possible to get debtors factored, though the amount of funding available is likely to be limited and the terms will be tough. Finance companies are not active and are generally weak at present.

The New Zealand Super Fund has recently indicated that it will co-invest $30-$60 million with private equity funds that provide expansion capital to young firms (Super Fund may put, 2009). That is a valuable step, especially given the overall goal of the fund to increase both investment in New Zealand and private equity investment substantially.

Three broad directions for development would help further improve the supply of expansion capital. First, shift investment incentives in New Zealand to encourage investment in assets that will contribute to the productive economy and assist with the current account balance.

The recession and end of the property bubble have changed the prospects for property investment. However, residential property has attracted billions of dollars of private investment while go-global ventures are hard to fund domestically. One result of that imbalance is shown in Figure 12.

FIGURE 12: TOTAL HOUSEHOLD WEALTH, $B



Source: Reserve Bank of New Zealand; Statistics New Zealand.

New Zealanders on average have almost zero net financial worth outside the housing sector. That pattern is not in New Zealand's long term interest.

Second, reduce the risks of providing expansion capital to go-global ventures. Some improvement in potential returns will be available from improving the business opportunities themselves, via ensuring that offers suit markets, and that businesses have the skills available that are needed for success. There is little benefit from interventions that would increase the upside further because there is already large upside if the venture is successful. What is required is something that reduces the losses should the venture be unsuccessful. The principle of reducing the losses given failure could be applied to equity investments as well as to debt funding for expansion. In some countries capital losses on venture investments are deductible but they are not in New Zealand.

Third, make it easier for individuals to invest in the go-global sector if they want to. Investor protection rules mean that fundraisers must target individuals who have very high incomes, are wealthy, or are expert in the industry being funded. Larger scale offers require preparation of a prospectus. These rules are prudent given the risk involved and the incentive investment promoters have to present their offers with an optimistic spin.

An investor who would like to invest in go-global businesses may not qualify, or may not be presented with an attractive opportunity because the offers are not widely circulated. However, there is an even more important obstacle; the potential investor probably does not have the skills to evaluate the offer. In a risky sector that lack of skills is likely to be disastrous and is a key reason why people stay away from go-global investment opportunities.

Generically, the solution to this obstacle is to link the 'smart money' with the 'dumb money'. SCIF does this already when it invests public funds to support earlier stage go-global investment. It co-invests only when a group of angel or similar investors do, free-riding to some extent on their skills. The AngelLink model, launched in September of 2009, was designed to exploit this logic. The national network of private investors is meant to facilitate early stage investment with a group of skilled investors reviewing opportunities and taking the best ideas to a wider group of investors (AngelLink, n.d.).

There are additional benefits to be found from this approach as the base of investors who have experience with such companies will grow, and that experience will be gained with the support and guidance of more experienced investors. Growth of the experience base would accelerate as more investors participate because they are not required to go it alone.

ENSURE AVAILABILITY OF TALENT AND EXPANSION CAPITAL
Monitor key skills demand and supply via linkages with go-global leaders and agencies and continue to add supply until the gap is closed • Review immigration strategy and policy to encourage world-class scientists, entrepreneurs, and marketers to move to New Zealand • Systematically connect successful New Zealand based and returning entrepreneurs with networks that can leverage their skills • Expand internship opportunities for science and business students to work in go-global companies
Ensure macroeconomic settings encourage investment in productive assets, especially traded sector and go-global businesses
Target increased business R&D expenditure as innovation ecosystem strengthens • Introduce incentives for business to increase R&D expenditure
Ensure availability of working capital funds for expansion via debt instruments, if necessary underwriting a share of the risk
Create opportunities for unskilled passive investors to co-invest with skilled investors who have skin in the game

ESTABLISH A MORE SUPPORTIVE CULTURE

A recent Economist article on entrepreneurial success stated that:

> David Landes, an influential economic historian, has argued that "if we learn anything from the history of economic development, it is that culture makes all the difference." You can build as many incubators as you like but if only 3% of the population want to be entrepreneurs, as in Finland, you will have trouble creating an entrepreneurial economy.
>
> *– The secrets of entrepreneurial success, 2009, p9*

While culture might seem to be a soft and unmanageable factor, over long time periods it can make a substantial difference. From the interviews and other research for this report several cultural characteristics that impede translation of research outcomes to commercial success have been identified. Many of the practical implications of these cultural attributes have been discussed in previous sections and proposals to compensate for them have been made. In this section the cultural issues themselves are discussed and proposals to promote a culture that better supports the innovation ecosystem are offered.

By their nature assertions about culture are generalisations and there will always be many individuals who are exceptions. The test of a culture opportunity should be to ask if there were more of the positive cultural attributes would New Zealand's innovation ecosystem perform better?

The first cultural attribute is insufficient desire to succeed economically by building go-global businesses. Do New Zealanders recognise how important building new go-global businesses will be to future economic prosperity? Can New Zealanders name three successful builders of international businesses? Do many New Zealand children want to be go-global entrepreneurs? Do leaders call for increased innovation and entrepreneurial performance?

New Zealanders are good at inventing and making things. We used to maintain our own cars a lot and now we are avid do-it-yourselfers. We like to produce.

New Zealanders are perceived to be less keen on marketing and sales, which is sometimes regarded as a slightly distasteful activity. Those cultural biases result in sometimes not getting the offer developed so that it meets market needs.

The interventions proposed above to get market input sooner will help with these symptoms but the underlying problem is that our culture does not equip us well to be customer oriented. We have a 'production mindset'.

That affinity for production is a cultural advantage because it means New Zealand can rely on a steady stream of opportunities. If we could also become more customer-oriented our go-global and exporting efforts would be much more successful.

New Zealanders are known internationally for not preparing proposals well and for not presenting ourselves well. We may not like it but it is the truth. There are many exceptions.

Underlying our lack of care about presentation is an important value; we tend to think that substance matters and that the gloss put on via our presentation of the substance is not so important. We prefer to be understated and genuine.

Unfortunately others do not see it the same way so we can be perceived as unprofessional and unprepared. The quality of our offer or the relationship we establish may overcome the initial disadvantage, provided we get that far.

The preference for substance over form and understated style is very deep in the culture and probably hard to move in a short time, even if we wanted to. However we can and should learn to present ourselves more effectively; generally by more focus on individual presentations at secondary school, and specifically by systematically training staff in go-global and exporting businesses to develop and deliver proposal presentations. The issue is well-recognised and training opportunities exist but we need to do more. As part of the training we need to get across to people that the way we present ourselves matters. Once business leaders recognise the importance of presenting well and demand a high standard, performance will improve.

New Zealand is known as a nation of small businesses, with independent and self-reliant people. The farmer trudging across his farm is an iconic example. We would prefer to work things out ourselves and avoid asking for help.

That desire for independence sometimes takes the form of what has been called ‘founders disease’, the unwillingness of the founding entrepreneur to give up a share of the ownership or control to access partners who could greatly improve the value of a business.

A related trait is that we sometimes tend not to trust people who seem to want to help us. We worry that if we share our thinking our ideas will be stolen.

All this adds up to mean that we do not partner as well as we might, both within New Zealand and with overseas companies. There is a paradox here because at the same time we are usually good to work with. We are just less willing than we might be to find and pursue the win/win opportunity to work with others. In some cultures, especially Asian ones, that tendency to avoid engagement and relationship building in favour of independence and a transactional approach to doing business puts us at a disadvantage.

Networks of relationships are intangible, personal, and often informal, which makes them hard to manage. But they are vitally important to the success of international businesses. Networks take many forms, for example:

- Networks among researchers who know what has been done before and how best to take the next step
- Links between developers and potential customers to ensure the offer meets market needs
- Connections board members have that are used to find other directors, management, and investors

Experienced people are very conscious of the value of networks and are more willing than novices to invest in developing and maintaining them.

ESTABLISH A MORE SUPPORTIVE CULTURE
Create excitement around go-globals and motivate talented people to join the sector
Ensure participants in the innovation ecosystem understand the importance of early market input and of marketing, and are encouraged to improve performance
Expand opportunities for go-global leaders and sales staff to learn how to develop and present winning commercial proposals • Test of sufficiency based on skill levels of leaders making their first international foray
Renew effort and increase investment in building networks • Emphasise focused commercial introductions and support, not meet and greet

The small size of the New Zealand economy means that many of the people we need to network with are in other countries. Remoteness from those countries makes networks more difficult to establish and develop. Those physical obstacles are compounded by cultural tendencies to think we can do things well ourselves, to fear that others may steal our ideas, and social reticence.

On the other side of the ledger there are many New Zealanders and others offshore who would be willing to help if only we would reach out more. For example, in the course of this project we spoke with one world-leading scientist who in more than 30 years as an overseas New Zealander has been contacted only once from New Zealand, with a request for a donation to his university. The individual was keen to help New Zealand succeed but has not had the opportunity.

The issue is well-recognised. NZTE links New Zealand companies with international markets. The KEA network has been established to link offshore New Zealanders and there are several initiatives designed to facilitate networks and networking.

That is all good but we need more. The performance of the network support organisations would be improved if they were engaged earlier in the development process and if they provided stronger support to the formation of commercial arrangements.

Establishment of at-scale research institutes would also make a worthwhile contribution, especially if the internal cultures of those institutes are developed to encourage collegiality and collaboration. Each individual brings his or her own networks to the organisation and those networks can become institutional assets if they are shared. Recruiting internationally for world class leaders to work in the institutes will extend the networks further.

MANAGE THE INNOVATION ECOSYSTEM AS A WHOLE

The emphasis in this paper is on improving New Zealand's performance at producing and commercialising science and developing go-global businesses. But the performance improvement opportunities identified would lift economic prosperity more widely. Stronger performing research institutions and commercialisation units would lift contracting and licensing outcomes too. Further, if businesses were more focused on opportunities from innovation, and innovation processes worked more effectively, then more businesses would identify and pursue opportunities to export.

Identifying the opportunities is the easy part. Many of the proposals have been made before. The real challenge is to get beyond stating what should happen to make sure it does happen.

There is an understandable tendency to identify an issue, take some step to improve the situation, and assume the problem has been fixed. Applying this 'tick the box' approach to the innovation ecosystem would reveal the required institutions are in place, there are examples of excellent performance, there is a lot of effort to develop skills, there are moves to increase market input, and many other required features are present.

It is only when the amounts required are compared with the amounts in place that the gaps are revealed. However the evidence for gaps is anecdotal and not quantitative because there are few of the metrics required for management; e.g. the number of potentially valuable discoveries not being developed and the number of skilled roles that go unfilled are unknown. In contrast there is a vast array of information about the agricultural sector.

Having the right quantitative measures in place is important, but even more important is effective management of the innovation ecosystem as a whole; monitoring performance, identifying gaps, and taking steps to ensure that the gaps are closed.

Government's engagement with the innovation ecosystem is via several entities including MoRST, FRST, MED, NZTE, the CRIs, TEC, and the universities. Imagine the innovation ecosystem as a large industrial plant where the flows among parts of the plant must be balanced to get the best possible output. The innovation ecosystem is like such a plant where each department has a manager optimising the performance of that department and coordinating with some other departments. But there is no one ensuring that capacities are balanced across the plant so bottlenecks do not emerge. An overall system view is required and government needs to ensure it is provided; whether by a government agency or an innovation council.

There are many things that government can and should do to ensure a high-performing innovation ecosystem and there are also things government can encourage that must be done by others. Institutional and other changes required to lift ecosystem performance will be unpalatable for some. Communicating the importance of innovation ecosystem effectiveness and export success to future economic prosperity is a very important opportunity and challenge for government.

Business leaders and media can make valuable contributions by highlighting opportunities and celebrating successes. In any society talented individuals are attracted to opportunities for success. If successful entrepreneurs and exporters are honoured in New Zealand society then talented people are more likely to consider science or go-global business opportunities when making career decisions.

Businesses might respond to encouragement by having another look for potential opportunities from innovation and exports. That might mean developing relationships with relevant research and development providers and searching systematically for opportunities. That might seem a very soft proposal but many businesses are not currently searching for science or innovation-based opportunities.

Individuals can help too. Opinion-leaders can communicate the importance of science and commercialisation for future prosperity and encourage talented people to explore science or commercialisation opportunities when making career decisions.

MANAGE ECOSYSTEM AS A WHOLE
Assign accountability for overall innovation ecosystem performance to a single agency or public-private council
Review innovation ecosystem measurement and ensure appropriate measures are defined, collected, and monitored
Manage improvement performance by closing identified gaps; avoid a ‘tick-the-boxes’ approach

CONCLUSION

Lifting the performance of New Zealand's innovation ecosystem presents a substantial opportunity to enhance economic prosperity. The productivity and current account gains available mean there is potential to improve economic outcomes for the country as a whole, while providing commercial gains for existing and new businesses.

The economic importance of innovation is not as well nor as widely recognised as it should be in New Zealand. Commodity prices, exchange rates, and interest rates affect short term economic performance. Focus on these metrics, which are not easily controlled, encourages a view that economic performance is something that happens to New Zealand, rather than an outcome of strategies and actions. Successes of go-global companies are celebrated as successes for those companies but the average New Zealander is not as aware as he or she should be that future prosperity depends on collective performance at developing and selling goods and services that are competitive in other countries.

If New Zealand is to succeed as an advanced economy then disadvantages in innovation must be turned into advantages. Government's aspiration is to equal Australia's economic prosperity by 2025. Australia's GDP per capita is well above the average for the OECD and Australia aims to be fifth in the OECD by 2025.

One strategy option for New Zealand would be to focus on agriculture as the main engine for improved trade performance. Increasing affluence, population growth, agricultural land constraints, and climate change may combine to further increase global agricultural prices and provide a worthwhile lift in New Zealand's prosperity. When considering the agricultural option, strategists should acknowledge that agricultural successes over the past three decades have been possible only because New Zealand has lifted agricultural productivity by developing and deploying innovations that have improved competitiveness.

Pursing an agricultural strategy with continued and increased focus on innovation must be a better option than a low innovation strategy that relies on commodity price increases. A successful agricultural innovation strategy requires an effective innovation ecosystem. Given that New Zealand must have an advantaged innovation ecosystem to lift agricultural performance, that advantaged innovation ecosystem capability can be used to make gains in sectors beyond agriculture.

There is no need to make a choice. There is capacity to shift resources from the fragmented and low productivity service sector into innovation-based go-global businesses in sectors where New Zealand can be advantaged.

If agriculture and innovation are important pillars of the strategy for future economic prosperity then New Zealand needs to make the policy changes and

investments required for success. Given that New Zealand intends to shift from being disadvantaged to being advantaged, the changes required are substantial. Research and development spend is only one of the drivers of innovation ecosystem success but the scale of the change required is illustrated by R&D spending in New Zealand relative to that in small innovation-led economies. Both Singapore and Denmark are targeting R&D spend of 3% of GDP; New Zealand's is less than 1.5% and no specific target is set. The spending emphasis needs to be on growing business R&D, because that is where New Zealand is furthest behind and it offers the best economic payback.

It would be easy to conclude from the statistics on relative R&D spend that the innovation system is not working well because spending is too low. However, causality works strongly in the other direction too; New Zealand is not spending enough because the innovation ecosystem is not working as well as it could be working. The challenge is to improve performance and grow spending; growing spending alone will not be enough. Benefits from increased spending will result only if research is focused where there is real commercial opportunity, and if there are mechanisms and resources to convert the research into new products, competitive gains, licence or contract revenue, or to form successful international businesses.

In this paper many opportunities to lift innovation ecosystem performance have been identified. At a high level they are categorised as: ensure earlier assessment of market needs; lift the productivity of science and commercialisation institutions; ensure availability of talent and expansion capital; establish a more supportive culture; and manage the innovation ecosystem as a whole. All must be progressed successfully to achieve world class performance.

New Zealand needs to move quickly. The economy needs another growth pillar urgently. It will take time to change the innovation ecosystem settings to improve performance, time to gain the benefits from the changes, and time to complete research and develop commercial opportunities. We are in a race.

Finally, although the need for improvement is urgent, it is important to be patient. It takes a long time to grow a scientific innovation into a successful global business and it takes a long time to establish an effective innovation ecosystem. To ensure success New Zealand needs to take action, measure results, monitor progress, and adjust where needed.

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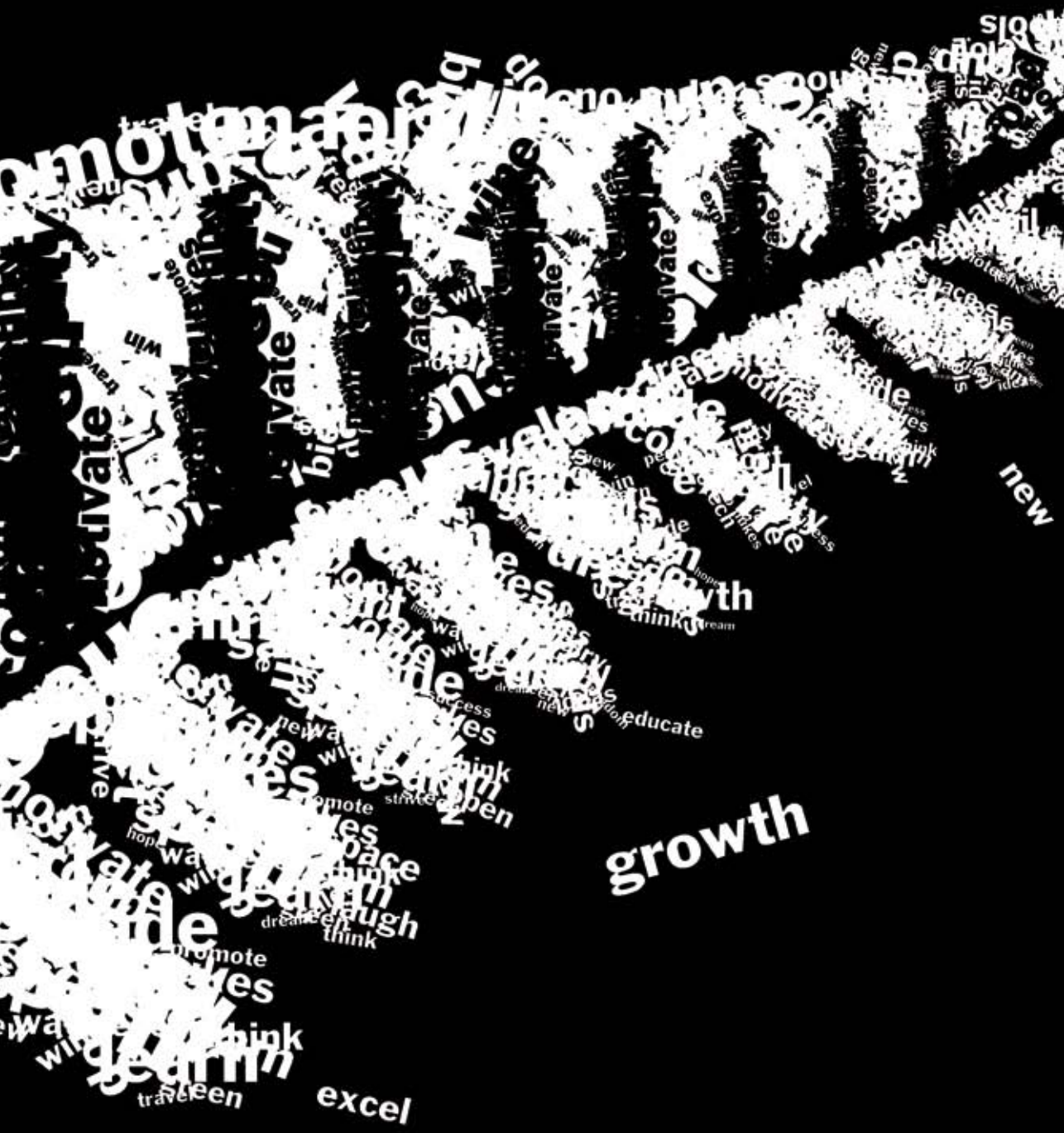

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