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DISCUSSION DOCUMENT

PROSPERITY THROUGH PRODUCTIVITY

A PLAN OF ACTION

IPENZ
Engineers New Zealand

PROSPERITY THROUGH PRODUCTIVITY – A PLAN OF ACTION

DISCUSSION DOCUMENT

FOREWORD

1.THE INSTITUTION OF PROFESSIONAL ENGINEERS NEW ZEALAND INCORPORATED (IPENZ) is the non-aligned professional body for engineering professionals in New Zealand. It seeks to contribute to the public good in matters of national interest or importance. One part of its contribution is to publish written papers, independently of any commercial interest, which give an informed view on important issues. Such papers are not consensus papers of the Institution Membership. Rather, they explore issues and describe possible outcomes and/or scenarios that could develop.

As part of this programme, IPENZ published a public policy discussion document entitled *Growing Smartly: A Review of National Policies for Fostering Research, Development, Innovation and Entrepreneurship in New Zealand* (*Growing Smartly*[1]). *Growing Smartly* proposed a number of initiatives to grow New Zealand's prosperity. This paper complements that discussion by addressing the issues raised in more detail.

EXECUTIVE SUMMARY

2.

The performance of the New Zealand economy and those of other countries are analysed to establish the factors influencing the rate of future economic growth. The factor most limiting our ability to increase the rate of growth is labour productivity (gross domestic product/hour worked). It is demonstrated that our low rate of growth in labour productivity is a result of poor performance in a number of areas.

Firstly, the benefit:risk ratio for investment has favoured private sector financial capital investment in property over investment in physical capital and innovation which could result in the creation of products and services for sale.

Secondly, the public sector funding of R & D has not been sufficiently directed towards the creation of intellectual capital value (ICV) in areas where there are realistic opportunities to attract private sector capital to pick up and use the research results.

Thirdly, our investment in human capital (in both tertiary education and ongoing professional development) has been overly directed into less productive areas of the economy. We have failed to adequately and appropriately skill our workforce as a whole to deploy and derive benefits from any physical capital investment made. Our private sector workforce has inadequate capability to effectively use R & D.

Additionally, there are concerns that shortfalls in our national infrastructure are affecting our economic efficiency to the extent that the international competitiveness of some industries may be at risk.

Finally, the compliance costs of doing business and the risks associated with planning and getting approval for major projects are impeding development, and may be impacting negatively on our economic efficiency.

It is concluded that the relatively piecemeal and unconnected actions in the present Growth and Innovation Framework (GIF) will not bring about the substantial increase in growth rate required to return New Zealand's economic performance to the top half of the Organisation for Economic Co-operation and Development (OECD). A concerted, bipartisan approach led by government to adopt and implement the following recommendations in their entirety is required:

- Measures to improve the relative benefit: risk ratio of investment in productive plant and machinery compared to property investment must be introduced to encourage the private sector to redirect its capital.
- The funding of Crown Research Institutes under the economic goal of Vote Research, Science and Technology must be determined against key performance indicators related to lifting private sector innovation capability, such as private sector co-funding commitment and transfer of R&D-literate personnel to industry.
- Public sector R&D investment under the economic goal should be directed towards activities creating ICV in areas where private sector capital is more likely to be attracted for follow-through to commercialisation.
- The capability of our workforce to use physical capital must be built through assertive action to increase participation in critically important disciplines. This can be achieved by reshaping qualifications so that graduates in technical disciplines can work better at the nexus of engineering, technology, creative design and business.
- The unique difficulties faced by small- to medium-sized enterprises (SMEs) in undertaking or using innovation must be addressed by government preparedness to co-invest with the owner to develop in-house capability.

In addition, government must demonstrate leadership and articulation of the plan and must be a role model in its own activities. The increasing need for sustainability will be supported by the plan because innovation, investment and improved technical capability are vital to achieving to that goal.

Other actions that will achieve the goal of returning New Zealand's economic performance to the top half of the OECD include the continuation of increased public sector capital investment programmes in key infrastructure and the development of high quality systems to allocate limited resources between potential users. It is also recommended that our regulatory and compliance framework is reviewed with the aim of reducing unwarranted risks to private sector investors in infrastructure or innovation-based projects. Government should also ensure that the compliance costs imposed on New Zealand businesses do not create undue penalties compared to international competitors.

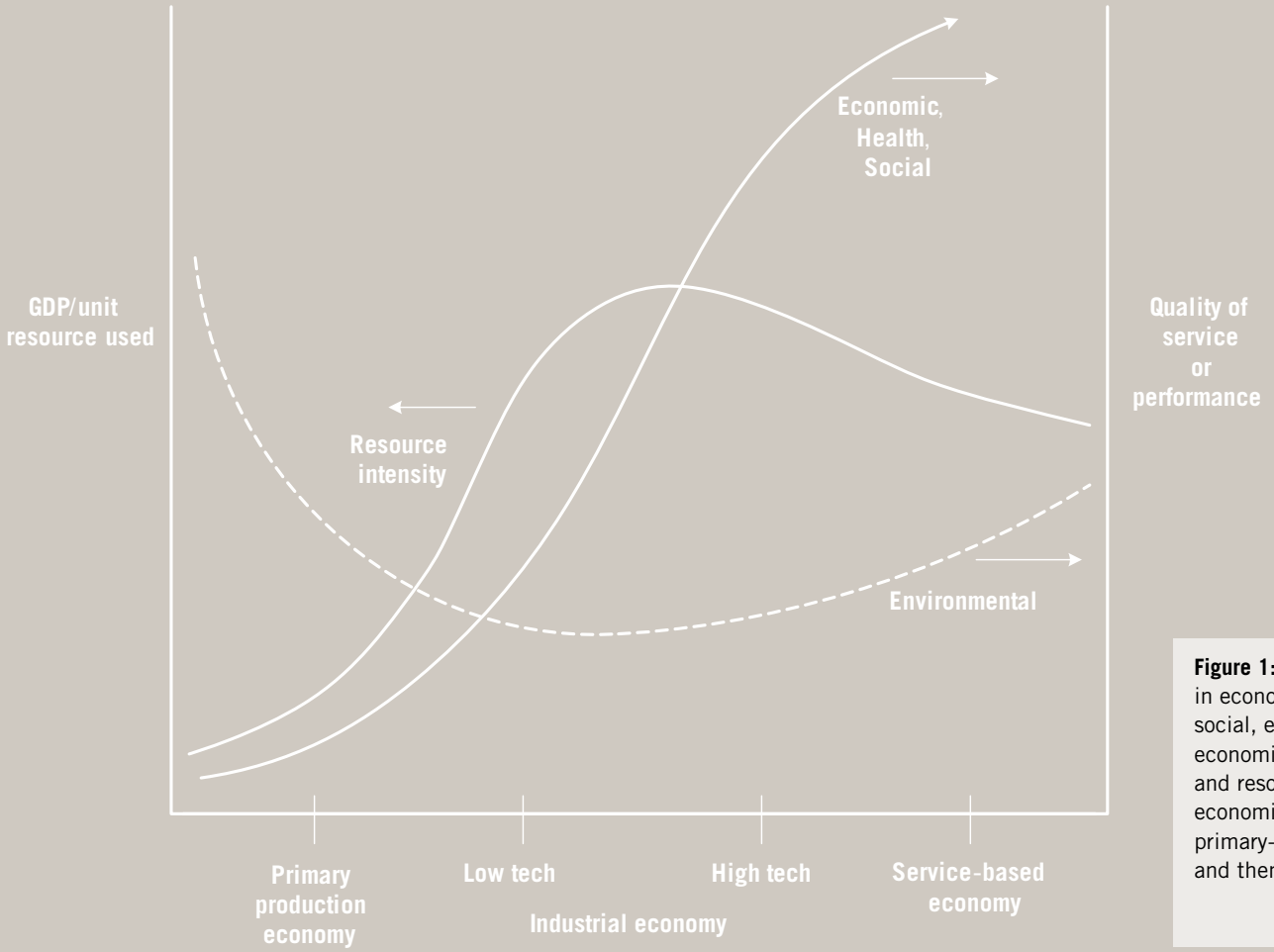
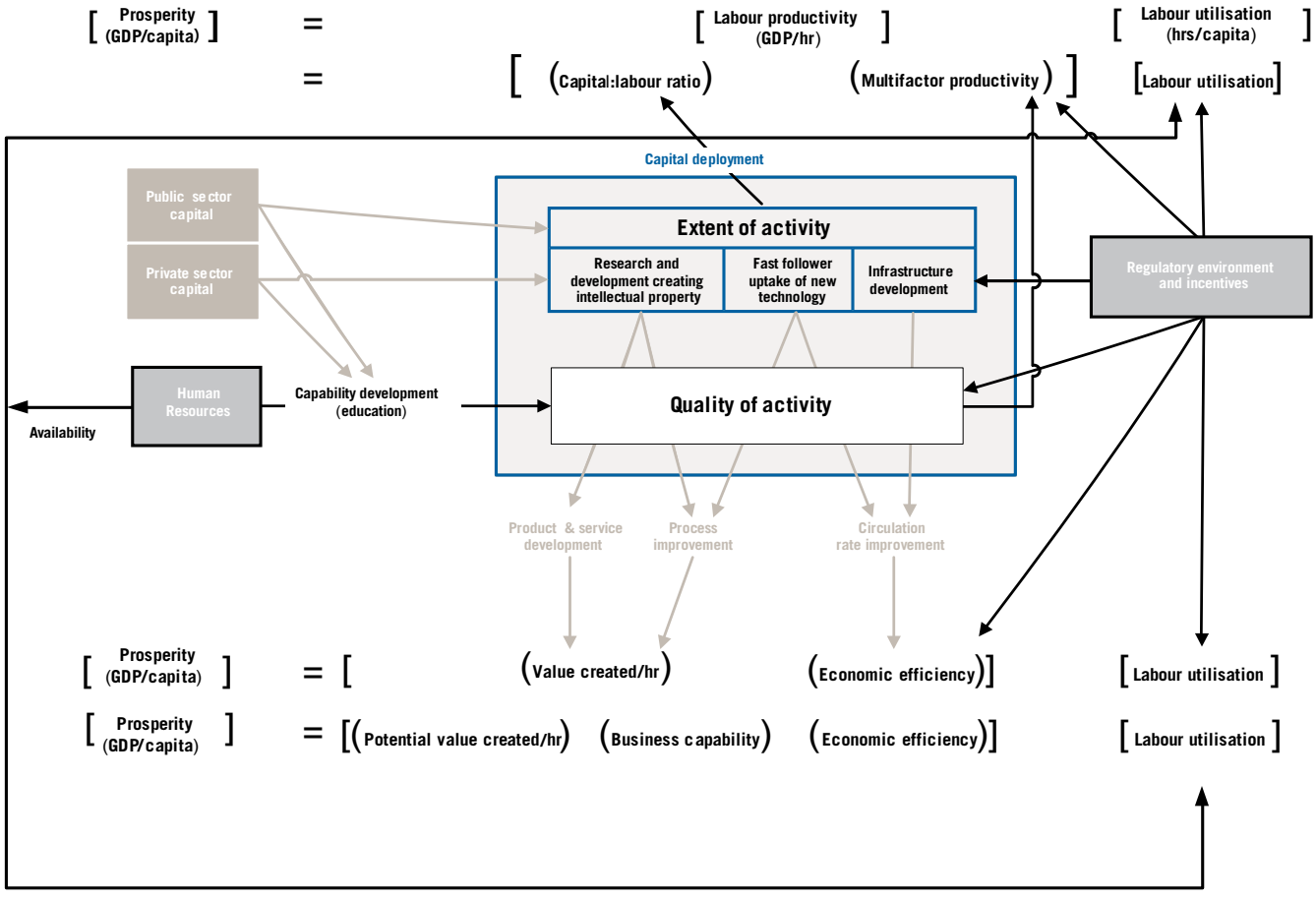


Figure 1: Relative changes in economic, health, social, environmental and economic performance and resource intensity as economies move from being primary-based to industrial and then to service-based.

Figure 2: Conceptual model of an economy from the perspectives of an economist and a business owner.



3.1 Economic Background

Economic growth is fundamental to raising living standards and providing social, environmental and economic well-being. Economic well-being, or prosperity, is measured by economists using gross domestic product per capita (GDP/capita) as the proxy. GDP/capita is the gross economic value of all goods and services produced per person. In order to take account of the different costs of local resources and labour, comparisons between nations are determined on a purchasing power parity (PPP) basis.

There is wide debate that in the future a different marker such as the genuine progress indicator (GPI) will be adapted as a better proxy because it considers progress towards sustainability. GDP measures economic performance based on the flow of goods and services over time, whereas the GPI also factors in social and environmental costs and benefits. Similarly, gross national income might better account for money flows in and out of the country. In our view it is important to make progress both in a traditional economic sense, and towards sustainability. We have used only the more traditional proxy in this study.

Although in the 20 years after World War II New Zealand held a top-five ranking, we are now 21st out of 25 nations in the OECD with a GDP/capita of US$22,000 on a PPP basis. During the last 10 years our GDP/capita has been roughly 80% of the OECD mean.

There is a viewpoint that a nation can bypass the development of prosperity measured by GDP/capita and instead focus on excellent health, education and environmental services for its people. However, western democracies all tend to spend about the same percentage of their GDP on health and educational services. Many components of these services (such as medical and scientific equipment, university staff and health professionals) are subject to international market forces, and therefore to access the best a nation must be able to afford them.

Figure 1 demonstrates changes in resource intensity (GDP created/unit resource used) of an economy and the quality of economic, health, social and environmental performance that is possible as an economy changes.

Developing countries tend to have a primary production-based economy with traditional agricultural systems that support low population densities allowing high environmental quality. In the first phase of industrialisation resource-intensive industries with low levels of technology are normally introduced. Workforce quality and the low price of labour mitigate against sophisticated clean technologies at this development stage. As workforce skills increase, the transition to a higher technology, less resource-intensive, industrial economy starts to show benefits. With higher incomes, cleaner technologies are afforded so environmental performance and commitments to sustainability tend to improve.

As economies move to service-based (that is, adding value through cutting-edge service provision based on intellectual property [IP]) they can afford better environmental standards in addition to excellent health and education services. They will often choose to fully embrace sustainability in their decision making. Service-based economies require very high levels of education to create internationally-competitive knowledge-based services which they can trade. The service-based economies that are emerging in Western Europe have the highest standards of prosperity (GDP/capita) with the highest environmental standards. They can afford to pursue sustainability and have excellent health and education services. Therefore, to move to a prosperous, environmentally-sound, service-based economy, New Zealand must build its prosperity in parallel with improving the sustainability of our activities.

Figure 2 outlines a conceptual model of an economy from the perspectives of an economist and a business owner. The economist's view of an economy (as illustrated in the top half of Figure 2) is:

"To move to a prosperous, environmentally-sound, service-based economy, New Zealand must build its prosperity in parallel with improving the sustainability of our activities."

Prosperity (GDP/capita)	=	**Labour utilisation** (Hours worked/capita)	x	**Labour productivity** (GDP/hour worked)
where:				
Labour productivity (GDP/hour worked)	=	**Capital:labour ratio** (Capital deployed/unit labour)	x	**Multi-factor productivity**

An alternative view of an economy from the perspective of a business owner (as presented in the bottom of figure 2) is:

Labour productivity (GDP/hour worked)	=	**Value created** (GDP/hour worked)	x	**Economic efficiency**
where:				
Value created (GDP/hour worked)	=	**Potential to create value** (GDP/hour worked)	x	**Business capability**

In both models the concept of the quality of activity arises, as illustrated in Figure 2. For example, education lifts the capability of the workforce, so that the quality of the various activities undertaken is improved. Figure 2 also shows the impact of regulatory processes as a potential dampening or barrier-removing mechanism and the role of infrastructure investment to assist the circulation of goods and services.

3.2 Use of Capital

The deployment of capital has an important influence. Investing in new capital introduces new technology and increases the amount and quality of plant and infrastructure, increasing the capital:labour ratio.

Capital investment in infrastructure such as transport, utilities and telecommunications is critical to improve overall economic efficiency by ensuring that goods, service and information flows are not impeded.

Capital investment in the "fast follower" adoption of proven technology to reduce costs is vital to retain the efficiency of doing business, specifically maximising business capability. This is simply about businesses and organisations evaluating and using the best technologies to keep their business processes efficient in international terms. This in turn requires a skilled workforce to make the evaluations.

However, capital has a greater role in increasing value created per hour worked. Capital investment in the fast follower adoption of proven technology for process improvement in industrial and primary production is vital to maximise the value created per hour worked. Such capital is normally used for greater automation, meaning that revenue per employee increases. The mean skill level in a business must be improved to maximise the benefit of capital labour investment. The bulk of private sector capital investment in an economy is used in this way. Economies can make major gains without high risk of failure by being excellent fast followers rather than relying on pioneering unproven technologies.

Capital investment in R&D for process improvement, and implementation of these improvements, is vital to maintain the viability of existing business. Improving existing practices leads to greater output per hour worked.

Capital investment in developing and applying innovative products or services based on new IP expands the pool of potential value available in our economy. The new IP is a product or service that can be sold competitively in local and offshore markets.

3.3 The role of education

The education and skills level of the workforce is important. Moving to higher labour productivity requires people who can work with higher levels of technology, introduce process improvements and make innovations. Indicators of skills include educational attainment, literacy and numeracy. New Zealanders have high basic literacy levels.

3.4 Innovation, research and development

Innovation is often considered to be measured by such things as investment in R&D, patenting new processes and technologies, and the rate of adoption of available technologies. However, for a modern economy, the ultimate measures of the potential for value creation to lift labour productivity are the skills of the people available and the obtainable capital. If capital is given to skilled people they are more likely to generate the right types of world-class IP where it is needed; make wise choices about which IP belonging to others they wish to pay a fee to access (whether by purchase of new technologies, licensing or other means); complete the technology transfer and commercialisation work involved; and roll out internationally competitive products and services to market.

3.5 Objectives of this plan of action

The government's publication *Growing an Innovative New Zealand*[2] identified growth and innovation as the key to return New Zealand's per capita income to the top half of the OECD rankings, and maintain that standing. A target of 2011 was proposed. Achieving this goal requires sustained economic development rates in excess of our historic performance and above that of other OECD economies.

The focus of this paper is to identify the critical elements needed to drive economic development, so that the stated goal can be achieved. It examines the effectiveness of public policies in place for creating an environment that will sustain growth on the scale required. The factors that will generate sustained growth are identified and the role that engineers can play in supporting this growth is outlined.

"If capital is given to skilled people they are more likely to generate the right types of world-class IP where it is needed; make wise choices about which IP belonging to others they wish to pay a fee to access; complete the technology transfer and commercialisation work involved; and roll out internationally competitive products and services to market."

Labour utilisation
measures directly the average hours worked per person. It increases as unemployment drops and as participation in the workforce increases. Both delaying retirement and increasing the incentives for parents of young children to remain in the workforce would increase labour utilisation. By international standards New Zealand has a high level of labour utilisation – we work hard as a nation.

Labour productivity
measures the amount of output produced per unit of labour input. Labour input may be measured by persons employed or the number of hours worked, although the latter is normally used. Labour productivity is low in New Zealand.

Capital:labour ratio
measures the amount of capital (e.g. plant and machinery) deployed per hour worked. In recent years New Zealand has had a low capital: labour ratio. That is, the amount of capital deployed per worker in our economy is low by international standards.

Multi-factor productivity
is an overall efficiency or "quality of use" term that measures the amount of output in relation to both capital and labour. This means a change in multi-factor productivity reflects the change in output that cannot be accounted for by increases in inputs (from labour and capital). For instance, MFP may be low, even after significant amounts of capital and labour have been deployed, suggesting an inefficiency exists. New Zealand has a relatively low multi-factor productivity.

Value created
in this context is the result of ownership of competitive advantage, increasingly in the form of empowering intellectual property (IP). Value created per hour worked is generally increased by a better educated workforce, capital investment in research and development to create new products or services, capital investment to implement new intellectual property in a tangible way and capital investment to utilise externally available new technology (intellectual property of others). Value created by export sales tends to have a greater effect on GDP/capita than value created by internal economic activity because export earnings tend to create greater consequential internal economic activity. Another way to view the value created is via the model used by production companies – value is only created when something is made and sold to someone else at a profit.

Potential value
is the maximum value that could be derived from using IP or competitive advantage efficiently and to full effect in an economic sense.

Economic efficiency
measures the more general status of the economy relative to other economies for economic activity. It includes the ease of transport of goods, services and information around the nation and the compliance costs of doing business.

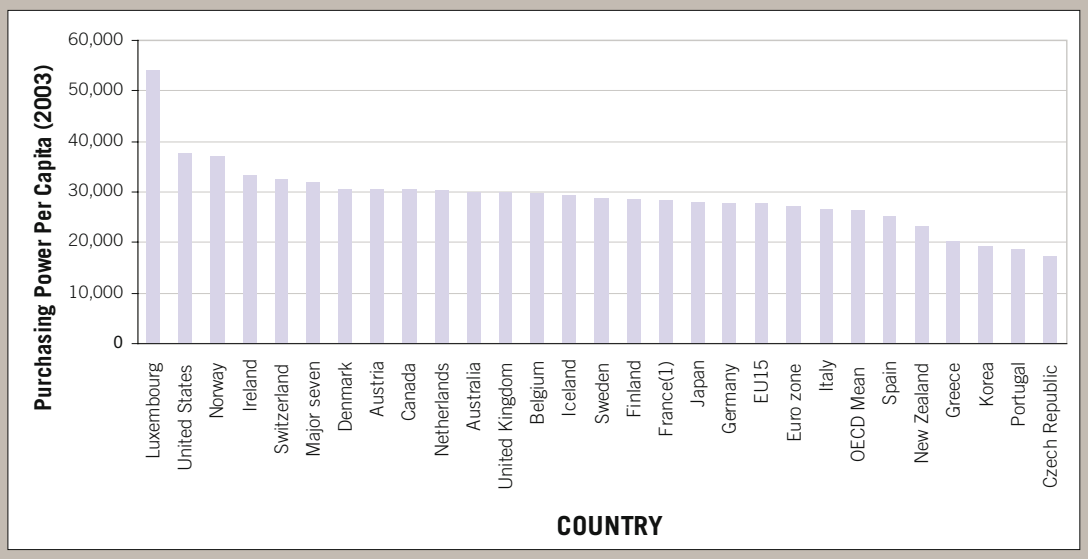


Figure 3: GDP/capita for OECD countries on a US$ PPP basis (2003). *Source: OECD*[7]

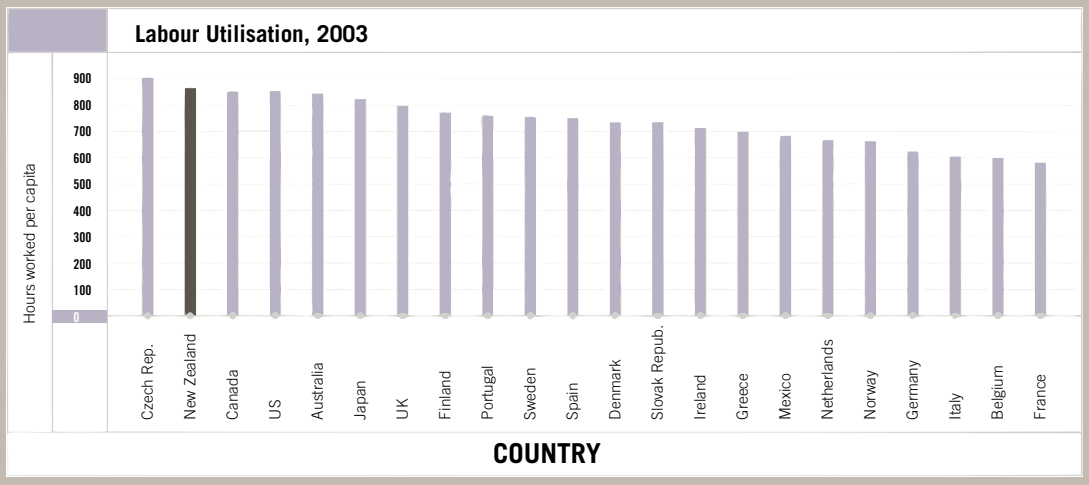


Figure 4: Comparison of labour utilisation between OECD countries (2003). *Source: Economic Development Indicators 2005*[4]

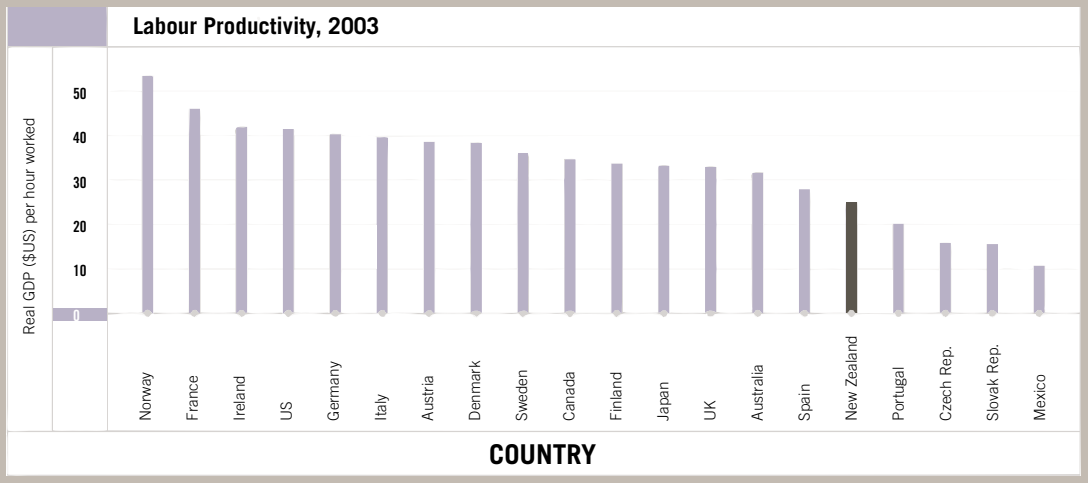


Figure 5: Labour productivity (2003). *Source: Economic Development Indicators 2005*[4]

Figure 6: Growth in labour productivity. *Source: Economic Development Indicators 2005*[4]

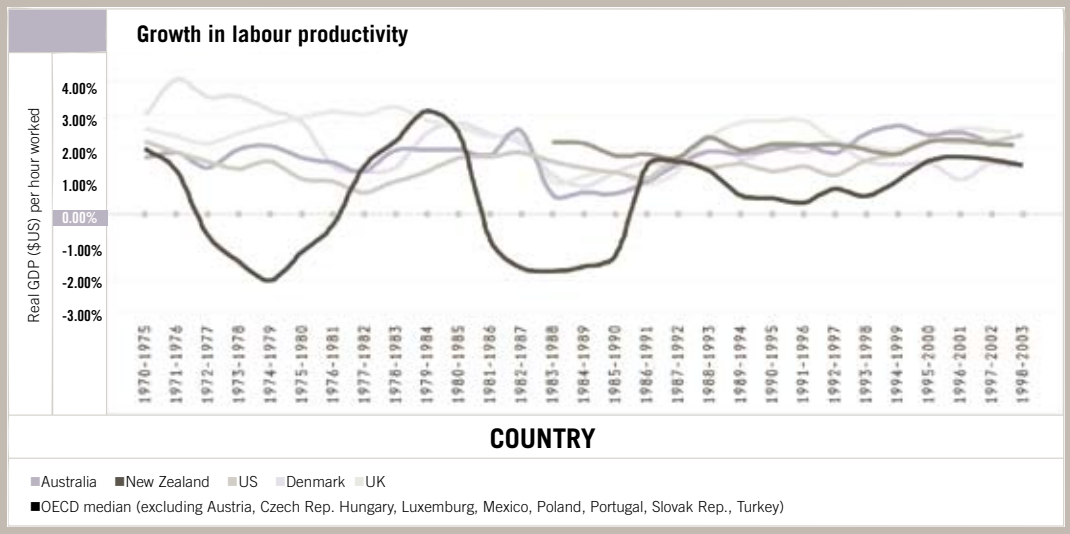


Figure 7: Multi-factor productivity (2002). *Source: Economic Development Indicators 2005*[4]

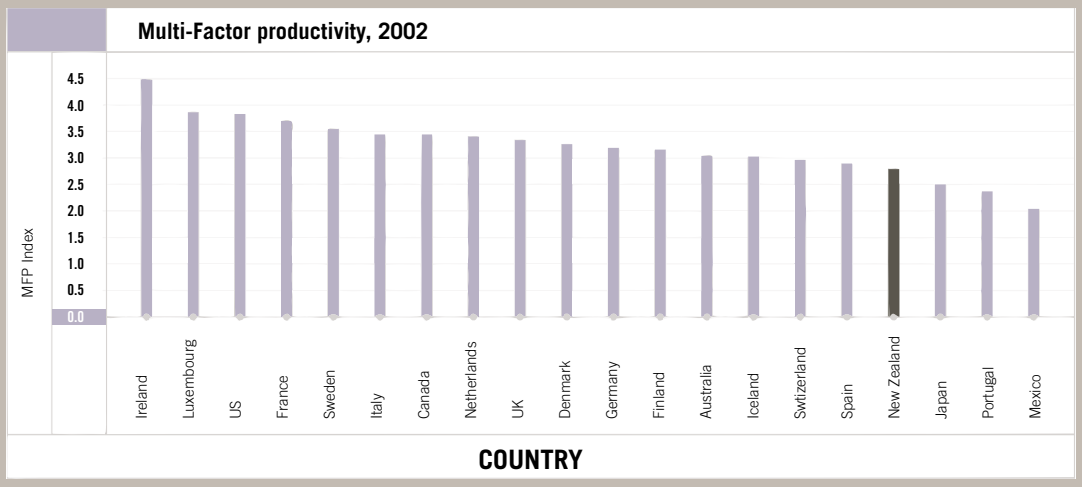
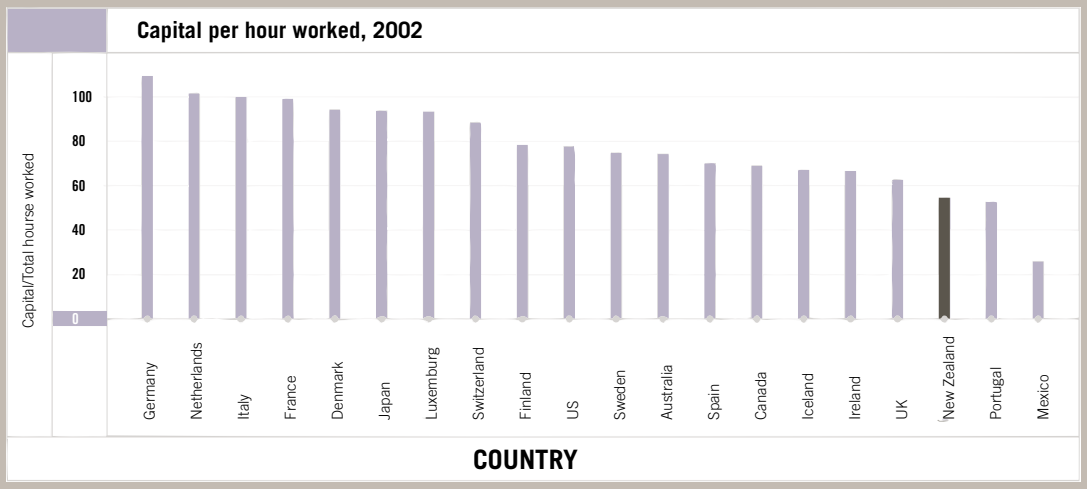


Figure 8: Capital per hour worked (2002). *Source: Economic Development Indicators 2005*[4]



NEW ZEALAND
PRESENT PERFORMANCE AND FUTURE PRODUCTIONS

4.

4.1 GDP/CAPITA

The December Economic and Fiscal Update 2004[3] outlines the current economic outlook. It confirms that New Zealand's economic growth has outperformed the OECD average over the past five years, with annual real GDP growth averaging 3.7% per annum compared to the OECD's average of 2.4% per annum. However, the Update forecasts a slowing of economic growth. Real GDP growth is predicted to range from 2.4 to 3.1% between 2006 and 2009 compared with forecast growth rates for our major trading partners averaging 3.4% over this same period.

Economic Development Indicators 2005[4], produced by the Ministry of Economic Development and The Treasury, shows that our recent GDP/capita growth has been above the OECD average. New Zealand's annual GDP/capita growth averaged 2.6% from 1998 to 2003, compared with the OECD average of 2.1%.

These same forecasts project that growth expressed as real GDP/capita will slow from an annual average growth rate over the past decade of 2.5% to between 1.5 and 2.1% between 2006 and 2009. The most recent economic and fiscal update confirms these predictions[5].

Deutsche Bank Research[6] has developed a model for predicting economic growth that can be used to corroborate the above estimates. The purpose of the model is to look for countries posting high absolute growth rates (GDP and income) as well as on a per capita basis. This identifies countries with a high level of GDP/capita and a history of low growth volatility as attractive locations for exports and investments. They have used their model to predict growth in 34 economies.

According to their model, India (5.5%), Malaysia (5.4%) and China (5.2%) will post the highest GDP growth rates from 2006 to 2020. Ireland (3.8%) is predicted to be the fastest growing OECD economy. New Zealand (2.1%) is predicted to be the 18th fastest growing economy out of the 34 economies studied with a real GDP/capita of US$26,000 (1995 PPP) by 2020. The prediction is for no change in New Zealand's relative ranking in the OECD on the basis of GDP/capita. This is in line with the Ministry of Economic Development and Treasury forecasts which suggest we will remain at about 80% of the OECD mean GDP/capita, and at about 20th place in the OECD league table.

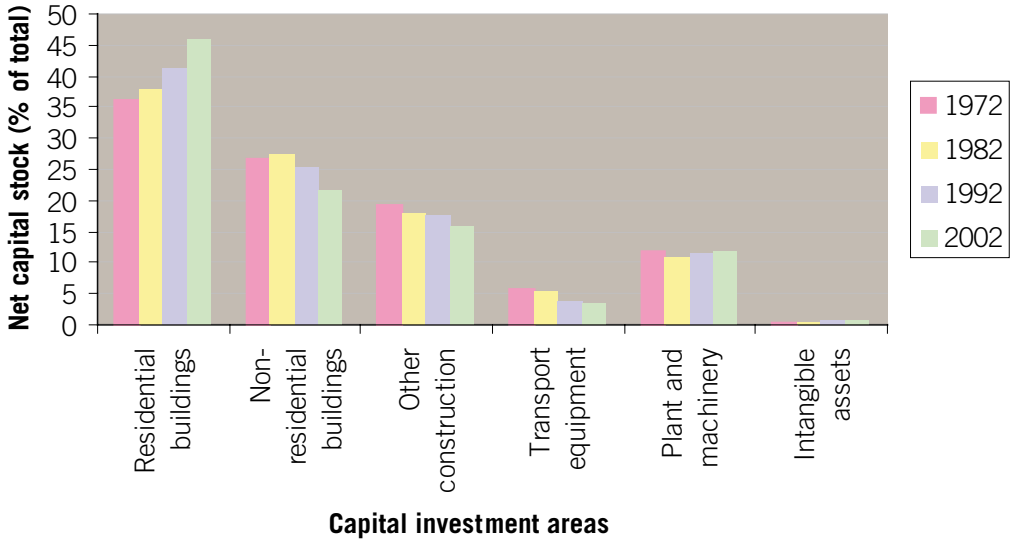


Figure 9: Changes in the distribution of gross fixed capital formation in the New Zealand economy between 1972 and 2002. *Source: Statistics New Zealand*[9]

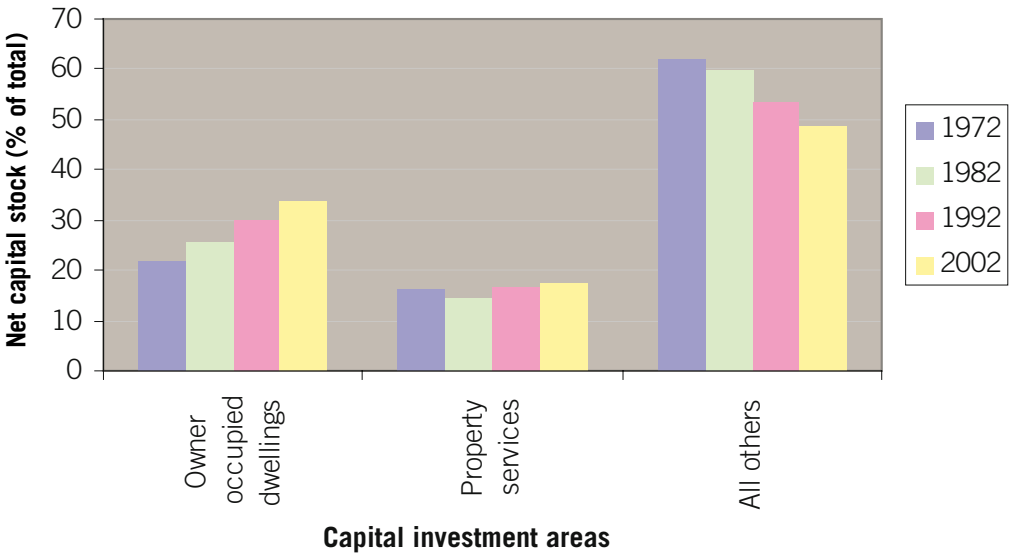


Figure 10: Changes in the nature of gross fixed capital formation (excluding land improvements) in the New Zealand economy between 1972 and 2002. *Source: Statistics New Zealand*[9&19]

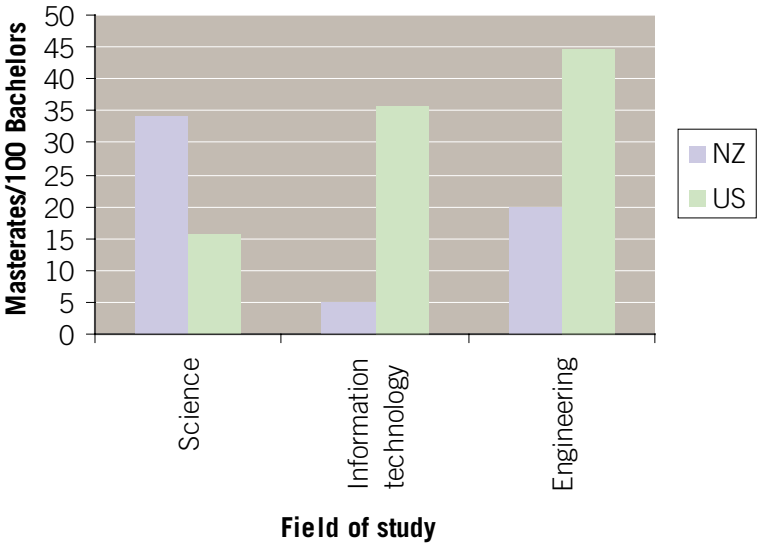


Figure 11: Masterates completed per 100 Bachelors degrees in the same field of study in New Zealand and the United States (2001/2002). *Source: Ministry of Education[10] and National Science Foundation[11]*

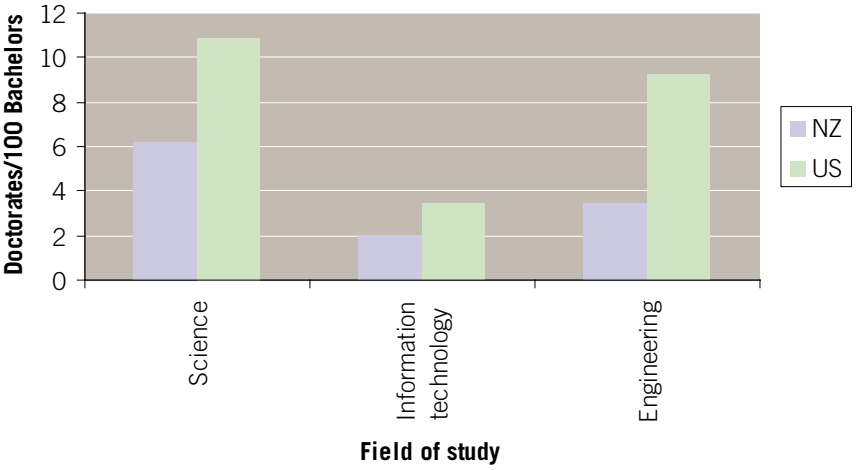


Figure 12: Doctorates completed per 100 Bachelors degrees in the same field of study in New Zealand and the United States (2001/2002). *Source: Ministry of Education[10] and National Science Foundation[11]*

4.2 Labour utilisation

New Zealand has one of the highest labour utilisation rates (hours worked per capita) in the OECD (Figure 4), reflecting a combination of high labour participation, low unemployment, and a high average number of hours worked[4]. It is hard to envisage that we can attain further significant growth in this parameter. In fact, most of the growth in GDP/capita in 1998–2003 was in labour utilisation, reflecting the drop in unemployment and the fact that the average New Zealander worked longer hours.

4.3 Labour productivity

Low GDP/capita and high labour utilisation inevitably leads to low labour productivity and OECD data confirms that New Zealand's labour productivity is low by OECD standards (Figure 5). The rate of growth in labour productivity has been low since the 1970s, but in the six years to 2002 it was as high as 1.7% compared to 0.5% in the previous five year period (Figure 6). As this parameter was a negative figure in the 1980s, the recent past has been encouraging. However, given that New Zealand's overall GDP/capita growth is forecast to be low by OECD standards in the next decade, growth in labour productivity will also be low unless labour utilisation was to fall, which is unlikely. This is a concern.

The Treasury[8] has predicted that labour productivity growth will increase to around 2% per annum in the year to March 2007 as recent entrants to the labour force become more productive and as continuing business investment leads to an increase in the capital: labour ratio. By the end of the forecast period, labour productivity growth is expected to be around the trend productivity growth of 1.5%. Real wage growth (measured by the unadjusted Labour Cost Index deflated by the Consumers' Price Index) has been positive over the past six years and has broadly reflected productivity growth.

4.4 Multi-factor productivity

Multi-factor productivity (MFP) has also been low by OECD standards (Figure 7). In the view of many economists, MFP and the capital: labour ratio do not act completely independently of one other. A rise in MFP tends to lead to improved capital investment at a later time.

4.5 Capital:labour ratio

In recent years New Zealand's capital:labour ratio has been low compared to other OECD countries (Figure 8). Other OECD countries that New Zealand likes to compare itself with are making a greater capital investment per worker than we are. According to Treasury analysis[8], this factor was a negative contributor to labour productivity change during much of the 1990s, but since 2001 there has been increased investment, and some improvement in this parameter. Nevertheless we are still low.

The trends in the use of capital in New Zealand can be identified in work by Statistics New Zealand which compared the capital stock (excluding land improvements) in New Zealand between 1972 and 2002. The major change in the distribution of capital was an increasing investment in residential property, with decreases in other

components, as shown in Figure 9. This may in part explain why the capital: labour ratio did little to improve labour productivity during the 1990s. Capital investment in plant and machinery is more likely to raise productivity than investment in property.

Additionally, Figure 10 shows that property services (non-owner occupied property rather than investment in productive assets) has been increasingly favoured in recent times by those investors not wishing to invest further in their own home.

4.6 Potential to create value

Measuring the total potential to create value in an economy is very difficult. However, useful proxies include the capability of the New Zealand workforce to undertake R&D, and investment in this area.

New Zealand R&D expenditure grew by 13.1% between 2002 and 2004, increasing private sector expenditure to 0.47% of GDP. However, this was partly due to increased operating costs and New Zealand's R&D expenditure is still substantially below that of other countries. In 2002 New Zealand spent 1.15% of its GDP on R&D while the OECD average for the same period was 2.26%[12]. These facts suggest that the amount of potential value being created in New Zealand in the form of IP is low.

The number of people entering the workforce with higher degrees in science, engineering or technology is also a useful proxy for the potential to create ICV. The data for New Zealand are low by international standards. Figures 11 and 12 compare the numbers of higher degrees in New Zealand and the United States in relation to Bachelors degrees. There are high numbers of Masterates in science, probably indicating that employment with only a Bachelors degree is difficult to obtain. However, New Zealand educates relatively few higher level graduates in information technology and engineering.

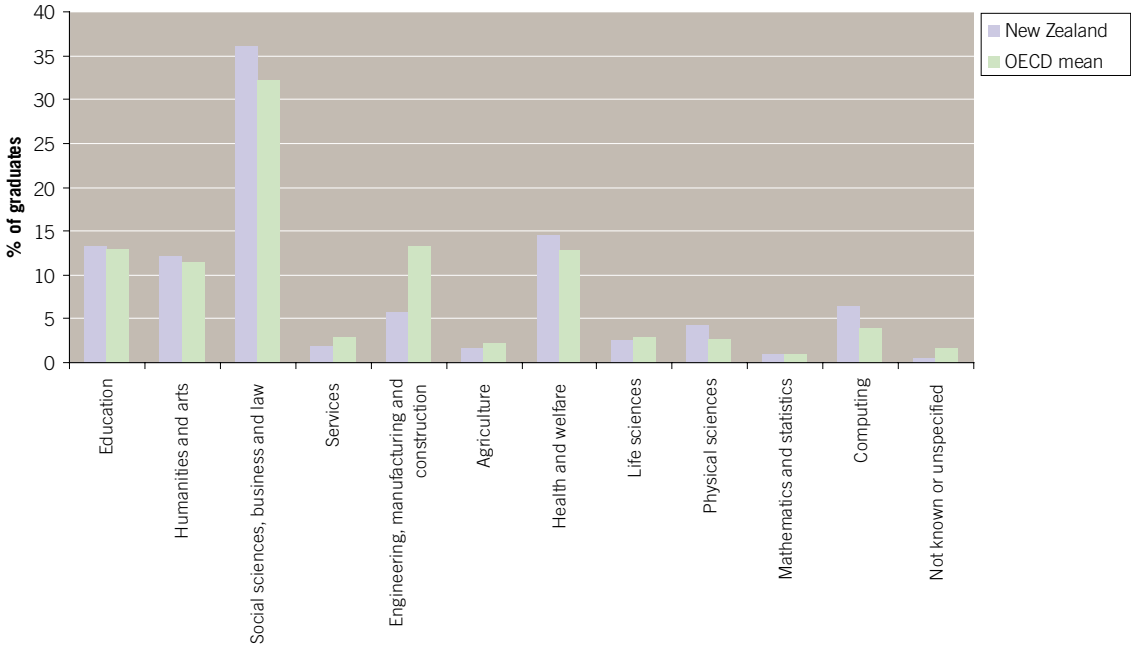


Figure 13: Comparison of graduates of Type A qualifications in New Zealand with the OCED mean by field of study (2002). (Type A qualifications are typically Bachelors degree or above.) *Source: OECD*[14]

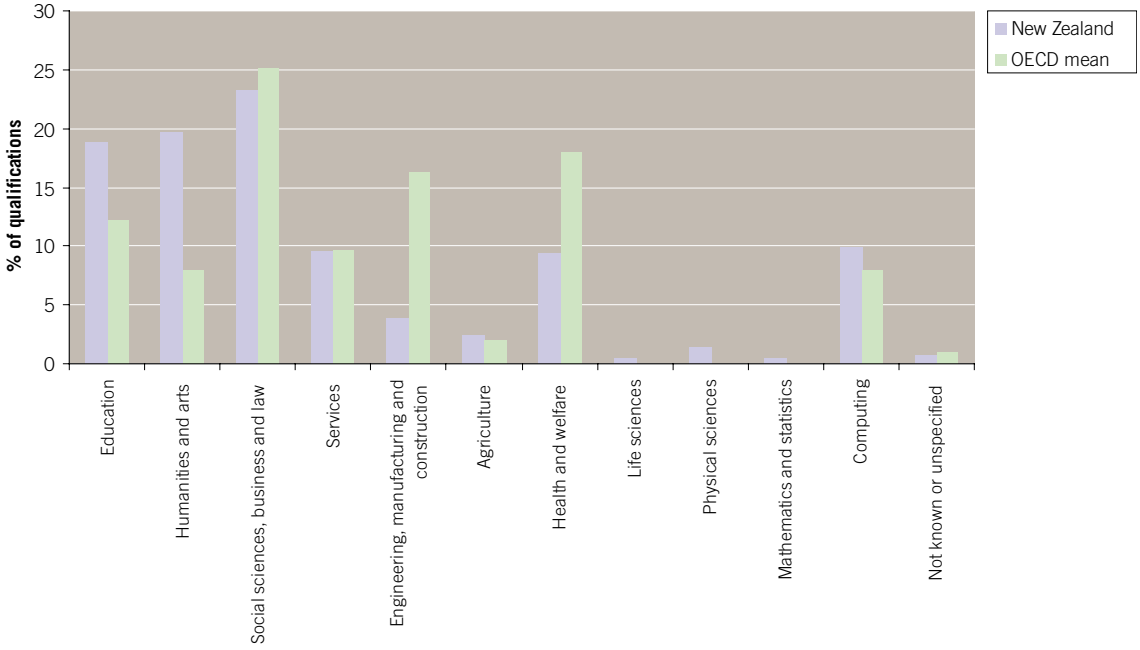


Figure 14: Comparison of graduates of Type B qualifications in New Zealand with the OECD mean by field of study (2002). (Type B qualifications are typically sub-degree.) *Source: OECD*[14]

4.7 Workforce education

A recent Deutsche Bank research paper[13] concluded that a good comparative measure of human capital is the average number of years of education per capita within the 25 to 64 age group. The research, using OECD calculations ranks Germany (13.5 years of education), Switzerland (12.9 years) and Canada (12.9 years) at the top of the list. Australia (12.1 years) is rated fifth. New Zealand (11.9 years) rates well in 12th place out of 33 countries surveyed.

The distribution of our graduates in terms of field of study is broadly similar to the OECD mean, although well out of kilter in engineering-related activities (Figure 13). For lower level qualifications the disparities from the norm are greater (Figure 14). Engineering and health are both low yet education and humanities are high.

With our difficult geography and low population density we have particularly challenging infrastructural engineering issues, so the low number of Bachelors degrees and lower level qualifications in engineering as well as the paucity of higher level qualifications is a real concern.

4.8 Business capability

There is no evidence that New Zealand companies are intrinsically less profitable than companies elsewhere. There are no regulatory impediments to foreign direct investment (FDI) flow into the country and FDI seems to be attracted. Therefore the business capability of companies must be competitive. Figures 13 and 14 show that we produce slightly more graduates in business and related fields than the OECD norm. Outwardly, therefore, New Zealand appears to be around the norm for educating our people in general business capability.

4.9 Economic efficiency

The World Bank Development Report 2005[15] states that government policies and behaviours play a key role in shaping the investment climate. Government needs to improve the security of property rights, approaches to regulation and taxation, the provision of infrastructure, the functioning of finance and labour markets, and address broader governance features such as corruption in order to improve growth.

This view is further supported by the OECD's document *The Sources of Economic Growth in OECD Countries 2003*[16]. The foreword by its chief economist states in part that institutions and regulations play a crucial role in determining the path of growth. But if the "rules of the game" start being perceived as blurred and non-transparent, capital deepening (increasing the capital:labour ratio) and productivity enhancements can suffer. More generally, macroeconomic stability and well-functioning markets cannot be taken for granted even where they have best served the cause of economic growth in the last decades.

The general economic framework in New Zealand is regarded as reasonably efficient as measured by the Economic Freedom Index[17]. This index measures economic freedom by analysing five major areas, including the size of government (expenditure, taxes and enterprises), the regulation of credit, labour and business, and the freedom to exchange with foreigners.

A number of factors may well have lowered economic efficiency in recent years:

- changes to the Holidays Act and other employment law have driven up the costs of labour without creating any compensating labour productivity gain
- the increasing plethora of socially-oriented grants and subsidy schemes may have high transactional costs relative to the benefits obtained, and have increased the size of government as a percentage of GDP
- a relatively expensive and time-consuming resource management approval process was recently reaffirmed
- a lack of adequate investment in key infrastructure such as transport and energy
- corporate and personal taxation rates, including treatment of R&D expenditure, are less favourable than those in competing economies

In a recent report the International Monetary Fund noted that it is a cause for concern that warnings are being issued by some international experts[18].

However, one recent positive move was announced in the 2005 Budget. Changes to depreciation rates will allow businesses to recover their capital more rapidly when they invest in technologies that become obsolete before they physically wear out. Businesses can therefore reuse their recovered capital sooner.

"With our difficult geography and low population density we have particularly challenging infrastructural engineering issues, so the low number of Bachelors degrees and lower level qualifications in engineering as well as the paucity of higher level qualifications is a real concern."

RETURN TO THE TOP HALF OF THE OECD

5.

So what GDP/capita growth rate is required to return New Zealand to the top half of the OECD over the next five to 15 years?

In 2003, New Zealand's GDP/capita was ranked 21st in the OECD at US$22,000 (PPP) per capita[4]. To be in the top half of the OECD, New Zealand's GDP/capita would have needed to be greater than US$28,000 (2003 dollars).

If the economies in the top half of the OECD continue to grow at the current average GDP/ capita growth rate of 2.1% per annum, then New Zealand would need to have a GDP/capita of US$33,000 by 2011 to be in the top half. This equates to a compounded annual growth rate of 5.2% per annum, well above the growth of recent years, over twice that of the OECD average, and significantly above the growth forecast over the next few years. If we do not choose to work harder, the 5.2% growth must come from improved labour productivity, a parameter we have failed to get much above 1.5% in the past (Figure 6).

New Zealand's 2003 GDP/capita of US$22,000 equates to a GDP of US$88 billion (based on a population of four million). To put the scale of the task into perspective, a GDP/capita of US$33,000 over eight years equates to a massive 73% expansion of the economy to a GPD of US$152 billion (based on an unchanged population of four million), a rise of US$64 billion (US$8 billion of new GDP per year). These data are on a PPP basis. As economies grow via productivity gain, the salaries and wages paid to workers grow and the economy becomes higher cost. Hence, the PPP exchange rate changes, and even higher rates of growth are probably needed. New GDP in the order of NZ$12 billion per year is an enormous task for an economy of our size. Further, a good proportion of this would need to be export industries.

The scale of the task should not be underestimated. To achieve a growth of anything approaching NZ$12 billion of new GDP per year would require enormous growth in high salary/high productivity jobs in our economy. We would need annual growth equivalent to adding about one Fonterra to our economy each and every year. Knowledge-based service industries have a much higher turnover per employee than other industries. Nevertheless, to create $12 billion of new GDP, every year we would need to create tens of thousands of knowledge-based jobs for highly-skilled workers in new industries. This is beyond anything that the venture capital industry can achieve via start-ups of new ventures. Growth of this quantum must be fully contributed to by existing businesses, including major primary exporters and the manufacturing and the service sectors.

GOVERNMENT GROWTH AND INNOVATION POLICIES

6.

The government's GIF is set out in *Growing an Innovative New Zealand*[2], published in February 2002. The New Zealand government is implementing policies with more emphasis on:

- enhancing our innovation framework
- developing our skills and talents
- increasing our global connectedness
- focusing innovation initiatives in those areas which can have maximum impact

The broad framework set out by the New Zealand government is similar in concept to that in other countries such as Australia, Norway, Canada, United Kingdom and Taiwan[20]. However, some of these countries have stated their objectives more directly than us. For example, the United Kingdom innovation strategy identifies seven critical success factors for innovation performance:

- sources of new technological knowledge
- capacity to absorb and exploit new knowledge
- access to finance
- competition and entrepreneurship
- customers and suppliers
- the regulatory environment
- networks and collaboration

A significant budget has been allocated to GIF initiatives since 2002. The multitude of work streams is set out on the Ministry of Economic Development's website[21]. When IPENZ spoke with a number of these responsible agencies they seemed unaware of the work of other agencies, and there did not seem to be sufficient ownership of a large-scale plan. It seems that resources are being used to support a large number of initiatives, each of which is useful when viewed from a low level, but insufficiently connected to create a collective change of the required magnitude to reach the overall target.

To get a 5% compounded growth rate – two to three times what we have achieved for the last two decades – we need to put the bulk of our effort into doing things in a fundamentally different manner, not creating a range of disconnected small initiatives around the fringes of a "business as usual" juggernaut.

The government's own labour productivity projections for the next five years, and those of external commentators, are for business as usual, meaning no gains on the rest of the OECD. Why should we be surprised? There is nothing on the horizon that suggests that as a nation we are prepared to do enough of the "big things" required to create change.

7. INTERNATIONAL COMPARISONS

Comparisons with other countries are frequently made, but the consensus view is that they must be interpreted with care. We consider that it is important to learn from others, but we have to see our own situation as unique. For this comparison five nations were selected: three of similar size, although with distinct other differences (Finland, Singapore, Ireland) and two of similar culture (Australia, United Kingdom) but of different size. A number of metrics were observed for all five nations and New Zealand.

7.1 Change in GDP/capita

Figures 15 and 16 show the recent trends in GDP/capita and labour productivity change in the six nations. Singapore grew very fast until the late 1990s when it suffered considerably as a result of the Asian crisis. Ireland grew very fast until about 2002. Finland, the United Kingdom and Australia have enjoyed steady growth.

Figure 16 illustrates that New Zealand has experienced relatively low labour productivity growth. All of the other five nations have increased their labour productivity from a position lower than New Zealand (in 1993) to a position above New Zealand (in 2002).

Figure 15: GDP/capita on a US$ PPP basis for six selected countries (1990–2004). *Source: OECD*[7]

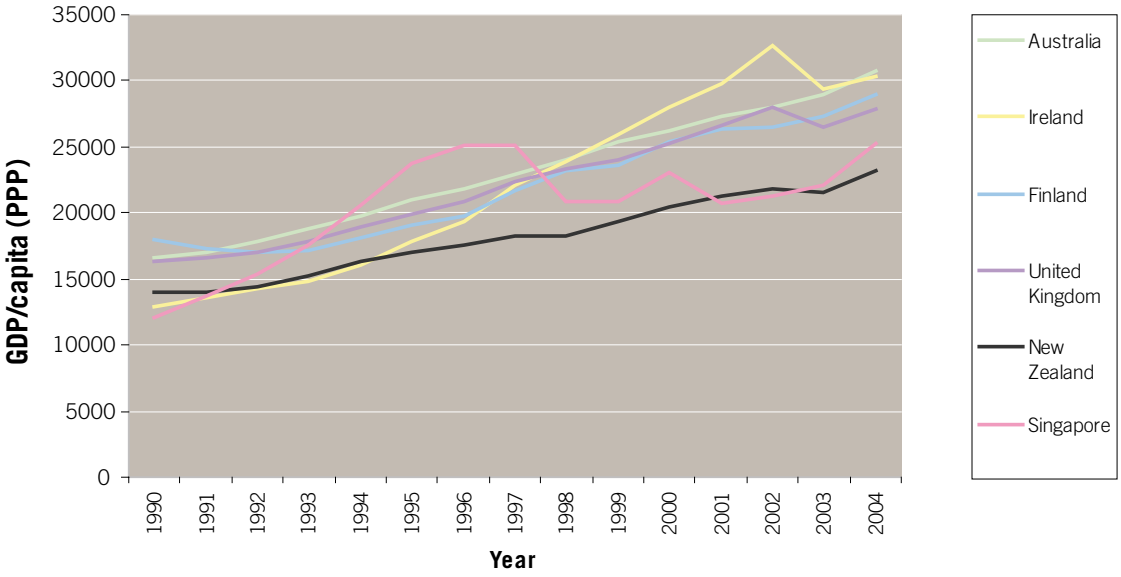
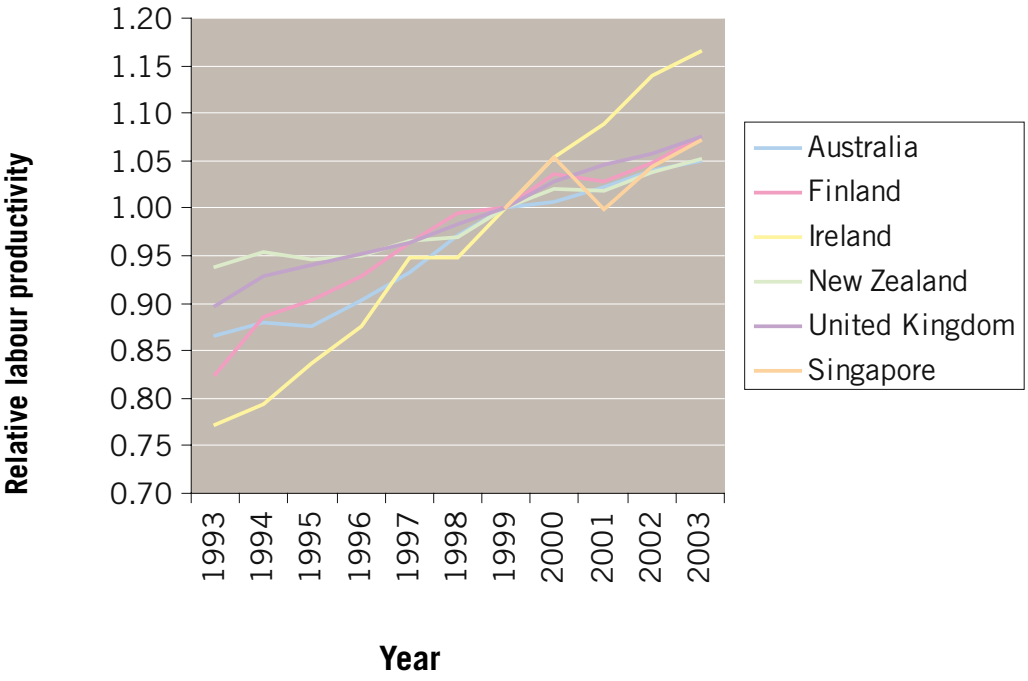


Figure 16: Changes in labour productivity relative to 1999 levels for six selected countries (1993–2003). *Source: OECD*[22] *and Statistics Singapore*[23]



7.2 Capital deployment in the economy

Figure 17 shows 1995 and 2004 data for deployment of capital in each of the economies. Finland and the United Kingdom are well advanced towards service-based economies, which may be less capital-intensive than production-based economies. Finland, with its high reliance on the information technology sector, would be expected to have low capital requirements for a nation of its size. The United Kingdom also enjoys a high population density which assists. Ireland enjoyed significant capital investment during the period under study and this is identified by many commentators as a significant contributor to its rapid growth over this period. Australia also has invested much more significantly than New Zealand in underpinning infrastructure. If the difference in GDP/capita between the nations is taken into account it becomes clear that the average total capital invested per person is much lower in New Zealand. Many capital items must be bought at international prices so the low capital deployment per person in New Zealand in absolute terms is a concern.

Figure 18 shows the changes in gross capital formation in New Zealand over the last 10 years. New Zealand would be expected to need a high level of public capital formation – our low population density and our distributed housing systems require more capital to service the population. Some gains have been made recently. As shown earlier, our private capital investment has moved towards buildings and not industrial assets.

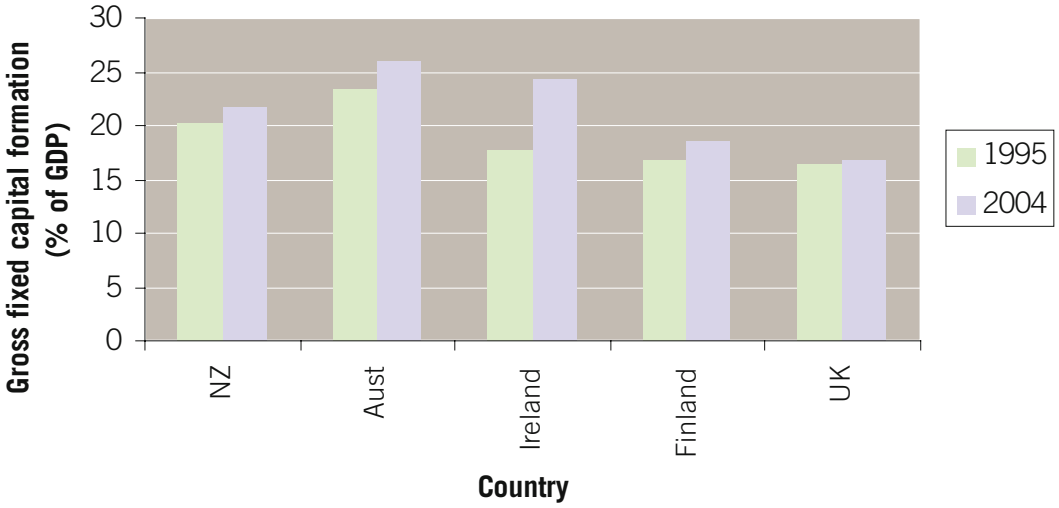


Figure 17: Gross fixed capital formation (excluding land improvements) in six selected countries (1995–2004). *Source: OECD*[7]

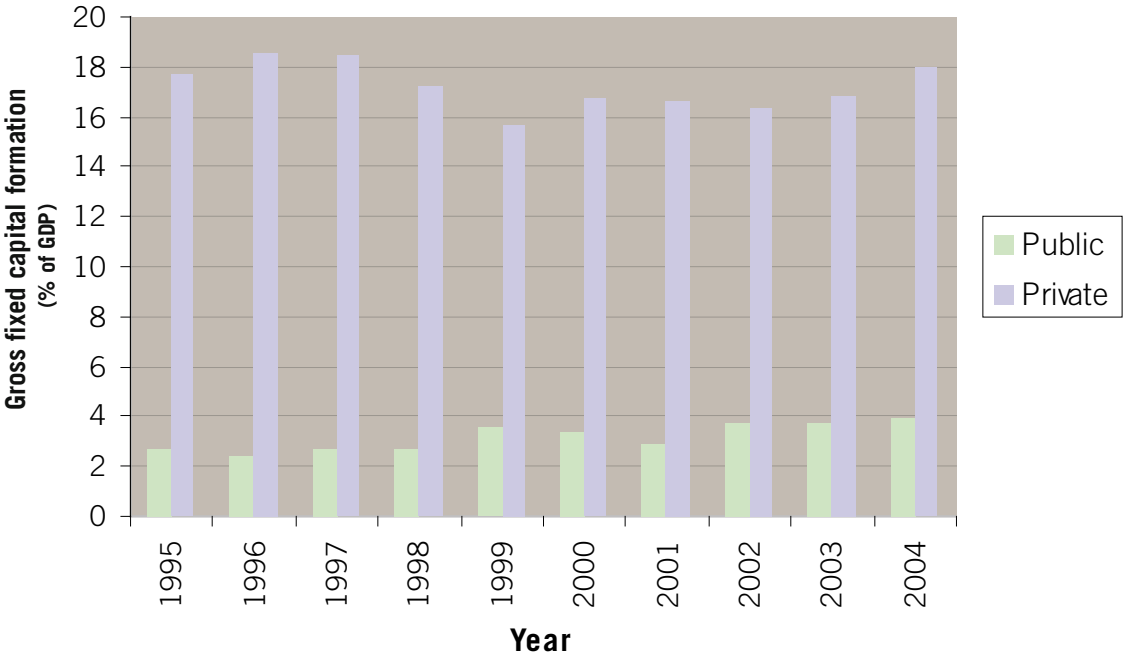


Figure 18: Gross capital formation (% of GDP). *Source: Statistics New Zealand*[9]

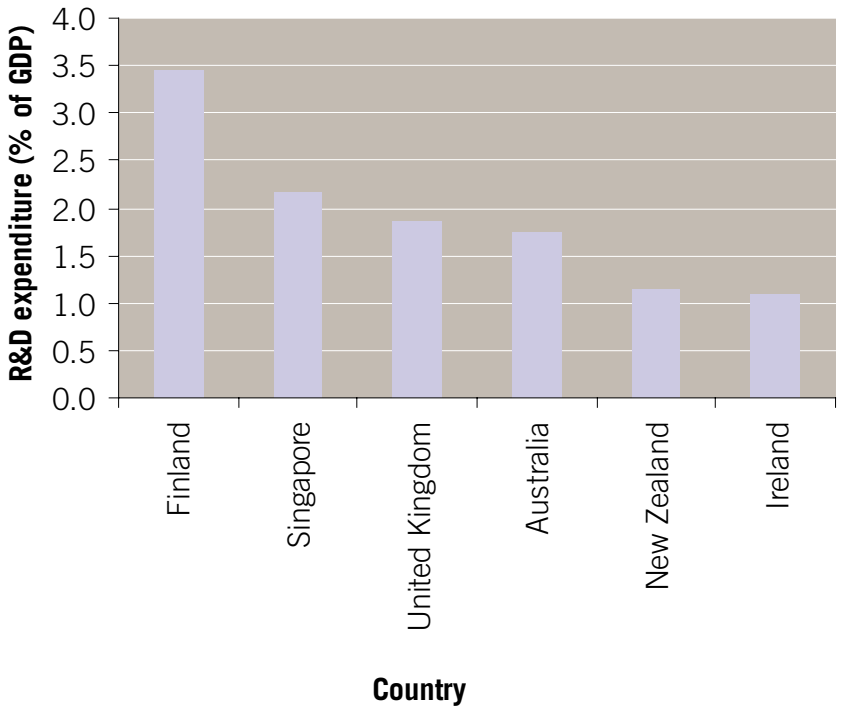


Figure 19: R&D expenditure as a % of GDP (2002). *Source: Eurostat[24], Statistics New Zealand[25] and Australian Bureau of Statistics (2005)[26]*

7.4 Business capability

As has been discussed, the ability to deploy capital and R&D funds wisely is an important factor. Figure 20 compares the educational outputs of five of the six economies in terms of the proportion of all graduates from the disciplines of business, law and social sciences. Other than Finland, the countries are not too far from the OECD norm (of about 33 and 25% for types A and B respectively) in terms of the proportion of graduates in the business area, although Australia is the highest and New Zealand next highest.

Figure 21 presents the equivalent data for engineering which shows New Zealand lags considerably behind the other countries and the OECD mean of 12.9% in Type A and 12.2% in Type B. Although equivalent data for Singapore are not shown, it is well-established that for the same population base as New Zealand it graduates at least three times as many engineers as we do.

Figure 22 shows estimates of the number of engineers per 1,000 of population. New Zealand is the lowest which is in line with the graduate statistics.

As shown earlier, capital deployment is significant in all the economies. In New Zealand we seem to deploy capital with less engineering expertise than the other economies. Finland has a very strong engineering skill base and Ireland has a strong engineering technician capability which was attractive to enterprises looking to transfer in.

The Engineering and Technology Board in the United Kingdom examines qualifications of chief executives and directors in the United Kingdom. Their survey[27] confirmed that 16% of directors of Financial Times Stock Exchange 100 companies (both executive and non-executive) with a first degree had studied engineering. Of these 100 companies, 17 top or chief executives held an engineering degree. Within the industrial companies, 41% held engineering degrees. Equivalent data is not available for other countries, but anecdotal evidence suggests that European industry has a strong engineering and scientific presence at senior levels as does Asian business. In New Zealand, participation of the engineering profession at senior level is thought to be low.

Absorptive capacity is the ability to find innovative solutions to remain competitive. Tullet et al.[28] demonstrated that New Zealand is characterised by poor absorptive capacity in our private sector. Absorptive capacity is especially important for the economic transformation of small countries like New Zealand that don't produce much of the technology they exploit. New Zealand's private sector has a low capability to use R&D.

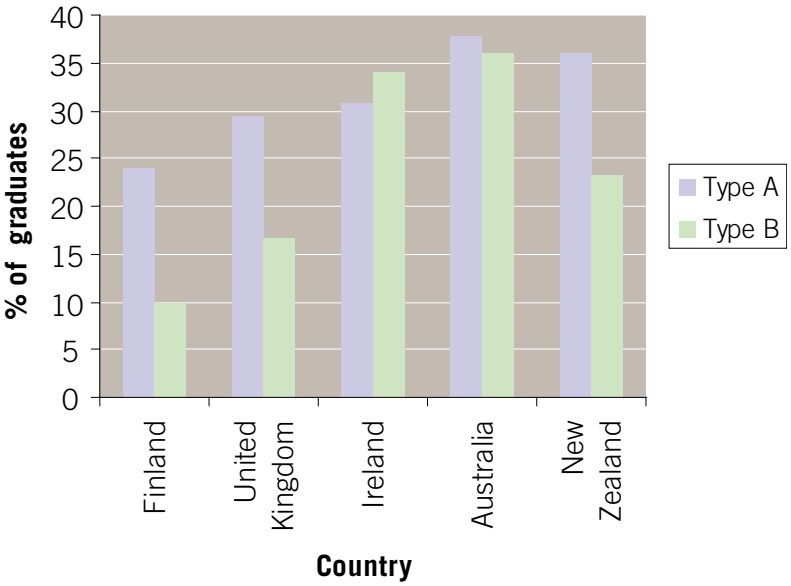


Figure 20: Proportion of graduates (Types A and B as defined in Figures 13 and 14) in the fields of social science, business and law as a % of total graduates from five selected countries (2002). *Source: OECD[14].*

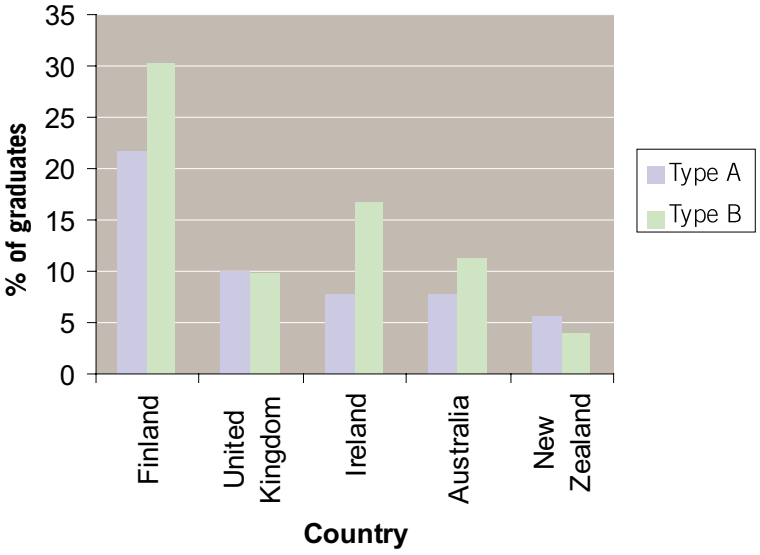


Figure 21: Proportion of graduates (Types A and B as defined in Figures 13 and 14) in the field of engineering as a % of total graduates from five selected countries (2002). *Source: OECD[14] and Statistics Singapore[23]*

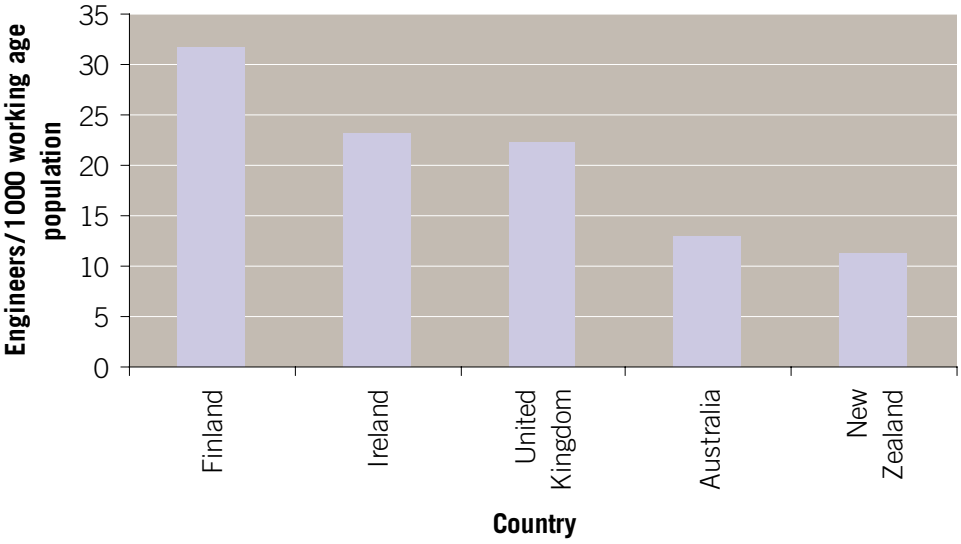


Figure 22: Proportion of engineers of selected countries. *Source: Eurostat[24], Statistics New Zealand[25] and Australian Bureau of Statistics (2005)[26]*

7.5 National strategies

It is worth reflecting on the effect of national strategies. The United Kingdom and New Zealand have taken the least interventionist approach and allowed markets to determine economic events. Neither seeks to promote R&D to any particular extent from an economic perspective. Australia has intervened more by creating positive incentives for private sector R&D through 150% write-off of relevant expenditure, and taking an active approach to investment in infrastructure using both capital and private sector money. It has adopted strong industry/research provider models to build industries. Finland has sought to build strong industry/research sector linkages[29].

Ireland built a strong national plan to bring enterprises to Ireland. It did this through a combination of low company tax, maintaining a highly educated workforce – particularly in the technician area – and investing in supportive infrastructure to make conditions attractive for new technology-based businesses. It was aided by capital from the European Union, but that capital alone would not have been enough.

Singapore probably had the strongest central planning of the six nations. It decided to build particular capabilities, and invested heavily in high-technology capability based around leading edge engineering and technology, supported by excellent infrastructure, and clear business rules. It strongly articulated its vision to its people.

Other countries that have grown rapidly (such as Korea, Taiwan, and Japan) have all taken similar approaches to Singapore and created high-technology capability through targeted education and industrial support. One-third of all university graduates in Korea are in engineering, and not by chance. China is following a similar pathway. China has 1.4 million students entering engineering this year and one-third of its graduates are in engineering.

A study by Deutsche Bank released in August 2005[13] examined the role of human capital in relation to growth. The analysis showed that countries which have invested heavily in education have made the largest gains on the rich nations. Deutsche Bank states that this is a long-term process without a quick turnaround in performance, but the benefits are evident in a number of nations, especially India, China, Thailand and Spain.

The study shows that life-long learning is as important as initial education. Increased physical capital formation will not succeed in accelerating growth unless there is upskilling of the workforce to use sophisticated technology effectively. The extent of R&D and educational achievement are correlated; better human capacity is needed to both undertake and utilise the benefits of R&D. These findings are consistent with the work of Tullet et al.[28]

8. SHORTCOMINGS OF THE NEW ZEALAND APPROACH

8.1 Self-audit against the United Kingdom success criteria

So what is wrong in New Zealand? It is salutary to check ourselves off against the United Kingdom's seven critical factors:

- Sources of new technological knowledge. In New Zealand we have concentrated too much on developing world-class scientific knowledge ("know-what") and paid too little attention to wider technological knowledge ("know-how") in the last decade. For a small country this does not make sense. We have limited resources to undertake the work to bring research to market, and in general know-how is cheaper to commercialise than know-what. Where we have grown industries this has been around a platform of international quality know-how from which product ranges can be derived. The information and communication technology (ICT) industrial cluster in the Canterbury region is a good example – with world class confidential know-how at its core. The study by Tullet et al.[28] for the Ministry of Economic Development, showed that only the ICT, dairy and some parts of the manufacturing industries have sufficient research capability of their own through which they can link market research to the R&D effort.

  In a letter of 29 September 2004 to IPENZ, the Minister of Research, Science and Technology outlined the results of an unpublished study by the Ministry of Research, Science and Technology on public sector investment in engineering research in New Zealand. The total proportion of Vote Research, Science and Technology spent on engineering was about 16% in 2004/2005, of which about 5% was for basic research in engineering (down from 7% two years earlier). The nature of private sector research capability should be more weighted to engineering than the public sector capability, but the former's capability is very low[28]. It is very unlikely that private sector capability can be grown unless public sector engineering research is strengthened.

  We must also question the amount of scientific research in areas where there is no existing follow-through capability, or little likelihood of attracting sufficient capital to create the capability for taking ICV through to marketable products. In these situations, any ICV that results ultimately gets sold or licensed overseas with only a modest return to New Zealand.

  We produce more published papers per research dollar than any other nation[30]. Whilst our researchers are producing published work it is likely that they are not producing enough confidential know-how which is the basis of most industrial development.

  Additionally, in New Zealand our distance to market means that our ICV must be particularly good to justify the greater than normal costs of taking it to market. As demonstrated in *Growing Smartly*[1], much of our innovation in the private sector is not much more than low level improvisation which simply is not good enough to compete in international markets.

In short, we have neglected technological knowledge to our cost.

- Capacity to absorb and exploit new knowledge. As has been stated, Tullet et al.[28] showed that in general New Zealand had what they termed a low research absorptivity in its private sector. There is a lack of senior managers who know how to manage R&D, to commercialise ICV, who can attract capital to ICV-based ventures, and who can persuade their investors that this is good business.

  Figures 11 and 12 add a further dimension to this issue. Using R&D in industry requires consideration of practical implementation issues and the use of capital to bring about change. Research-absorptive staff in industry would ideally hold higher degrees in engineering, technology, or technical aspects of business. The data show that whilst we produce a reasonable number of higher degree-qualified scientists, we do not produce engineers and IT specialists in anything like large enough qualities. In New Zealand we do not have a culture of technical people moving into business, but we badly need it.

- Access to finance. In the open New Zealand market access to capital should not be a problem. It will be attracted to compelling business cases where there is real competitive advantage. As has been demonstrated, our capital:labour ratio has been low, and it is possible that we have not been able to make the quality of business case to bring new capital into our businesses. The question of capital availability for start-up ventures has been addressed to some extent via government-sponsored venture capital funds, but capital investment in existing businesses has been low.

- Competition and entrepreneurship. As has already been discussed, our economic market is largely free-market so we are in reasonable shape although the OECD[31] and International Monetary Fund still express some concerns.

- Customers and suppliers. We do suffer the difficulty of remoteness, but service-based businesses should suffer a lesser penalty than production-based ones in trying to develop new markets. The quality of what we have to sell and how well it meets a market need are key issues. New Zealand Trade and Enterprise is taking steps towards improvement of our connectiveness in international markets.

- The regulatory environment. There are concerns that our regulatory environment, particularly through the Resource Management Act, has become too risk-averse, time-delaying and expensive. This acts as a disincentive to capital investment in New Zealand industry.

"We have concentrated too much on developing world-class scientific knowledge ("know-what") and paid too little attention to wider technological knowledge ("know-how") in the last decade."

- Networks and collaboration. This matter has received some attention over recent years. New Zealanders travel widely and we are learning to build collaborative partnership and joint venture arrangements. Large companies such as Fonterra have learnt how to establish and maintain overseas offices and make connections to international markets. Our SMEs are certainly not as well connected and that may restrict their ability to grow.

8.2 The need for redefinition of business capability

Many commentators are calling for better business skills. We contend that it is not more of the same skills, but more of a new breed that is required.

In business, a major change is occurring in the balance of financial capital investment between physical and intellectual capital. In older style "production" companies financial capital was invested in physical plant and machinery, and depreciation rules to fairly represent its value were developed. This allowed business investment decisions to proceed with a reasonable degree of financial certainty. In a modern ICV-based company, the bulk of the capital exists in a much less tangible form, and not as physical capital. Compounding this are technological advances which may well render plant as technologically obsolete before it either wears out or is fully depreciated.

Valuing of the key IP and the risk management around that form of capital investment are much more complex activities than in a traditional production company. An older company might spend ten times on physical plant what it spends on creating and maintaining ICV (R&D etc). In a modern company that relativity can be reversed. Thus, modern companies might spend 5–15% of turnover (from retained earnings) on R&D, whereas older companies spend less than 1% on R&D but have relatively hefty plant maintenance budgets.

Added to this, an increasing proportion of the value of companies is now in the ICV represented by the aesthetic design of their products, and their brand value. Just as engineering is part of the core of business, so is creative design.

There have been inconsistent messages from government recently. The importance of the creative design sector (that is, the sector focusing on creating products in which the IP is primarily aesthetic rather than functional) has been talked up to some extent. However, government persists in using the word "science" as shorthand for science, engineering and technology. Engineering and technology use science but are fundamentally different from science – they are purposeful activities that occur in a business context. If our leaders do not articulate the difference, and also fail to recognise similarities between engineering and creative design, how will our people understand that engineering and technology are purposeful activities that create wealth for the benefit of all?

The new realities of modern business bring with them new management demands. Understanding the value of both functional and aesthetic IP and its impact on business will be a critical element of the management of growth and innovation. Increasingly sophisticated and more technically aware management is needed to progress sustainability. We suggest that business as a whole in New Zealand has failed to adapt well to these changes. The modern business requires leadership from a team including ICV business experts (more likely to come from the disciplines of engineering, technology and design) as well as more traditional business expertise from disciplines such as accounting. Success will come from the right balance of expertise, not from dominance of one kind over the others.

8.3 Particular risk factors for New Zealand

8.3.1 World trade barriers

While much value adding has occurred in the major primary sector of dairy, meat, wool and wood, these industries continue to be dependent on the export of largely undifferentiated lower value and often commodity products. New Zealand exports form a large part of total production traded internationally across borders, but nevertheless a small part of overall global consumption. Most world production is consumed in the country of production. This brings with it risks such as market exclusion through trade barriers and subsidies that encourage domestic production and consumption, as well as domestic consumer preference.

8.3.2 Reliance on low cost production

New Zealand's competitive advantage has been based on a low-cost production system. We have continued to maintain our international competitiveness by some value adding, but largely through increases in production and processing efficiencies.

It is arguable whether this international competitiveness can be maintained. The production inputs of capital, land, water, energy, labour and environmental compliance costs are all increasing in price, and in some cases we are reaching finite limits of availability. Limits imposed by the need for sustainability are already a reality for some resources. At some point in time as we transition to a service-based economy, New Zealand will cease to be the lowest-cost producer in each sector. For example, a number of South American countries have lower labour and other costs and will eventually close the productivity gap.

8.3.3 Leverage off domestic markets

We have a small domestic market and our manufacturing sector cannot easily fund innovation and export growth from local cash flows to develop international markets. Promotion of products or services with excellent competitive advantage into new markets may not proceed because of lack of capital availability through retained earnings. There are exceptions – businesses have overcome distance from major markets and achieved growth and commercial success through a technological advance which is internationally competitive.

8.3.4 Picking winners

The basis of wealth creation is having knowledge that others don't have and being able to use it commercially to create or fill a market need through competitive advantage. There is an inclination in New Zealand to pick winners and put our resources into the industries expected to do best. However, this flies in the face of the principles that markets decide best, and that innovation comes at the fringes of present activity. Market-led economies will always include declining older companies, companies revitalising and reinventing, and start-ups.

The belief that we must concentrate on building from our present strengths (perceived as biotechnology, ICT and creative design) does not make sense, and is a weakness in our present thinking. We could well end up missing the most important innovation, simply because it was not in our plan. We would be much better to support any private investor prepared to have a go, irrespective of the field, than to restrict ourselves to a few chosen fields. Where would Finland be if Nokia had been restricted to forestry? Would the 3M Corporation still be mining, and would IBM have survived by making only mainframe computers?

8.3.5 Limited follow-through capability in many areas

If New Zealand public sector research investment agencies do want to pick winners they need to support the further development of any ICV that private sector investors see as internationally-competitive, irrespective of the sector it comes from. If some fields are treated less favourably, then it should be those where the country does not have, or cannot fund, the follow-on capability to take new IP to market. If the sheer scale of creating the follow-on capability is too high then we would have to sell or licence overseas the IP rather than further develop it ourselves.

8.4 The primary production sector has key factors in place

One part of the New Zealand economy that has come close to the required level of sustained economic growth is the farming sector which has achieved significant dairy, meat and wool production gains per animal over a long period of time during the last half of the 20th century. The upper quartile of farmers is well in advance of the mean, with some being reportedly 30% more productive than average farmers.

The reasons for this superior performance include:

- A largely well educated sector has made business-savvy investment decisions. The sector has traditionally had a history of sending their children to university for agricultural degrees which mix underpinning science with know-how and business skills.
- The sector has been supported by considerable public sector investment in R&D in research institutes and universities.
- Growth has been driven by the combination of practical production-based research, an effective farm advisory service supporting technology transfer, and innovative family farm owners prepared to invest heavily in production improvements.
- While not cash rich, continuing capital gains have provided the equity to underwrite continuing investment.

When analysed against the model in Figure 2, the primary production sector does appear to have had the key elements in place. There has been considerable investment to lift potential value, and the education and business capability of our farmers is excellent by international standards. By and large farmers operate in sectors of the economy with reasonable infrastructure – they are rarely limited by roads, telecommunications and energy supply – so the primary production sector has good economic efficiency.

Many parts of the primary produce processing and preservation sector are also in good shape when the test of Figure 2 is applied. Organisations like Fonterra and Zespri have linked their R&D effort, marketing/sales and manufacturing/production within sensible business structures. They have also upskilled their workforce in both technical and business terms.

8.5 The special needs of SMEs

Much of the New Zealand economy is SMEs. Many of these have been established on a basis of ICV that is nationally, but not internationally competitive. Many simply do not have the management capability to invest in R&D and innovation to improve the potential value of their business. Even if there is willingness, they do not always have the technical, engineering or creative design capability to invest in the necessary "intellectual capital" development, nor do many have the financial capacity to invest in process improvement and/or new capital plant to increase productivity.

Many established SMEs choose not to expand beyond a certain size. They can face significant hurdles if they do decide to invest in new capital plant. Financial investors may seek personal collateral guarantees such as the business owner's home. Faced with this risk, many SMEs make the risk-averse decision to remain at a size that provides a comfortable living for the business owner without taking on risk to expand the business by further investment in capital plant and processes that may increase the business's productivity.

"Engineering and technology use science but are fundamentally different from science – they are purposeful activities that occur in a business context."

IPENZ'S PLAN OF ACTION

9.

The myriad of detailed reports available on New Zealand all suggest that complex interdependencies between a wide range of factors are responsible for our sluggish economic performance. However, almost everything that has been observed about our economy can be explained by the model in Figure 2. The key success factors are the right balance of human, financial, physical and intellectual capital operating within an effective business and general economic environment. When taken together, all the data, all the international comparisons and all the views of international commentators point to the following explanations for New Zealand's poor economic performance in terms of lifting labour productivity (GDP/hour).

The capital:labour ratio is low in New Zealand because:

- Our financial capital conversion into physical capital has been directed towards property investment rather than towards production of products and services we can sell.
- Our private sector financial capital conversion into ICV is very low, meaning that we do not generate enough potential value in our business sector.
- Our ICV creation through public sector funding of R&D under the economic goal has been too low, meaning that capital has not been attracted to pick up and use the research results.

New Zealand's MFP is low because:

- Our investment in human capital (in both tertiary education and ongoing professional development) has inadequately and inappropriately skilled our workforce as a whole to deploy and derive benefits from physical capital investment.
- Our investment in human capital has not adequately addressed the key issue of developing private sector capability to perform and use R&D (that is, convert financial capital to ICV and physical capital).
- The movement of people, resources, goods and services through our infrastructure is too slow and limits the ability of our businesses to be internationally competitive in distant markets.
- The compliance costs of doing business and the risks associated with planning and getting approval for major projects are impeding development, and may be impacting negatively on our economic efficiency.

It is vital that a bipartisan approach is taken by government and other political parties to show leadership and be a role model in addressing these issues and pursuing improved sustainability.

We now discuss the issues in more detail and suggest means to address them.

9.1 Leadership and national support

Even in a market-led economy, governments must provide leadership as well as regulatory functions. In our view, government has a vital role to explain the issues to all the people of New Zealand and achieve their acceptance of approaches to be followed. All growth-related investments by government must then be used in a cohesive and co-ordinated manner to achieve the outcomes sought.

There is evidence that the people in many nations listen to their leaders on matters deemed to be national issues. The leaders of the Asian tiger economies succeeded in getting people to commit to a clear vision and plan. Even in New Zealand there is evidence of the value of clear articulation of a plan. Up until the 1970s, as a nation we showed clear faith in the national infrastructure development plan. On a more limited scale, some years ago the then Minister of Overseas Trade spoke publicly of the need for value-added food products. The next year the student enrolment in food technology trebled as students and their key influencers responded.

Government must articulate the issues frequently and in a neutral way.

Action 1: National leadership and public support

1

Government has a vital role to explain the issues to the people of New Zealand and achieve their acceptance on a way forward. The issues that people need to understand are the:

- nature of labour productivity and the value New Zealand will derive from increasing it – we need sufficient prosperity to be able to afford high quality social, educational, health and environmental services
- need to apply financial capital effectively to infrastructure, fast follower uptake of external IP and innovation to lift labour productivity
- need to lift our national business capability to manage and grow IP-based business
- need to lift private sector investment in IP-based business development
- national need to develop leading edge technological literacy through strategically-focused tertiary education initiatives in engineering, technology, creative design and their nexus with business
- need to maintain a light-handed regulatory and compliance structure so that the private sector can do what it does best – develop prosperity
- need to progressively increase the sustainability of our activities by implementing sophisticated technically-based strategies
- need to address environmental concerns does not mean discouraging investment in productive capacity – both objectives can be met through encouragement of less resource-intensive service industries

2

Action 2: Boosting private sector capital investment

Government must incentivise the private sector investment through some or all of the following actions:

- lowering company taxation rates to encourage retained earnings for re-investment in business
- continuing modernisation of depreciation regimes to allow the more rapid recycling of capital in business
- consider taxation or other regulatory changes so that the total benefit: risk ratio, including capital gains, for real estate is not perceived to be higher than other investment opportunities
- investing a greater proportion of the New Zealand Superannuation Fund in productive New Zealand businesses and infrastructure to assist their capitalisation and expansion

9.2 Low private sector capital investment in business

The evidence is that in our economy and under our regulatory structure too much financial capital flows to uses other than investment in productive enterprises. There are a number of actions that might be considered to address the issue.

The first of these is lowering company taxation rates to encourage retained earnings to be re-invested in businesses. It is important to have a company taxation rate lower than or at worst equal to similar nearby countries.

Productive investment in new processes and plant will be encouraged through more favourable taxation write-downs on new productive capital. Furthermore, the pace of technological innovation can mean that business capital plant can be superseded by newer technology before existing plant is fully depreciated. A more flexible approach that recognises obsolescence and allows capital to be depreciated at a faster rate may assist growth and innovation by encouraging businesses to more quickly invest in new capital plant that increases productivity.

The relative instability of the exchange rate creates a risk to business investment that does not occur in domestic property investment. This, plus the absence of a capital gains tax, encourages investment towards property to earn a capital gain instead of productive investment in business. A capital gains tax could be considered in specific circumstances such as non-owner occupied buildings.

An alternative that could have wider benefits might be to implement requirements for building upgrades before sale. These requirements might achieve or move towards present day Building Code compliance in respect of safety, sustainability and energy efficiency measures. This would also assist improvement of sustainability in New Zealand as a whole. The requirement could be for all buildings, or just non-owner occupied buildings. We recognise that designing a robust regime that could not easily be avoided would not be easy, but the benefits may justify the costs.

Lastly, the investment of private sector superannuation funds is reputedly a major source of capital in the United States economy. In New Zealand we have now developed a major public sector superannuation fund. Investment of a greater proportion of the New Zealand Superannuation Fund in productive New Zealand businesses to assist their capitalisation and expansion should be considered. The fiscal returns are not the only consideration when investing that fund.

9.3 Low private sector investment in ICV

This matter was studied in detail in *Growing Smartly*[1] and here we summarise the key recommendations.

While we argue that we need to move away from picking winners (see 8.3.4), if we are forced to, we need to pick those with follow-through capability or those that do not expose New Zealand to wildly fluctuating prices, for example those with low dependence on liquid fuels. The particular needs of SMEs (see 8.5), also need to be addressed. The cost of an R&D worker is very high relative to turnover in a SME, which is considered to be too great a risk by business owners. Therefore government co-funding of the initial employment of R&D workers could be worthwhile.

"Our investment in human capital has inadequately and inappropriately skilled our workforce as a whole to deploy and derive benefits from physical capital investment."

3

Action 3: Boosting private sector investment in ICV creation

Government must incentivise private sector investment by some or all of the following actions:

- redefining the role of Crown Research Institutes (CRIs) in their activities under the so-called economic goal within Vote Research, Science and Technology so that their primary measure of success is private sector co-investment, thereby driving up the pressure for CRIs to draw investment from the private sector
- both in the CRIs and elsewhere, moving away from picking winners by allocating public sector R&D investment in predetermined sectors towards co-investment with the private sector in any activity where there is reasonable evidence of follow-through capability to take new ICV to market
- reconsidering the grants/tax relief available to the private sector in general, and SMEs in particular, including considering subsidising initial employment of R&D workers in small companies

9.4 Low levels of public sector ICV creation

The reform of the publicly-owned R&D system in the early 1990s had a number of excellent outcomes, but a number of perverse and probably unintended ones as well. One of these was to shift the emphasis in measuring research quality too far away from the commercial value of the outcomes. Even now, work under the so-called economic goal tends to be evaluated with too high a scientific weighting and too low a weighting given to potential commercial value. Further, over the last 10 years the number of engineering researchers and technologists in our CRIs has been eroded, yet these are the very people that we rely on to build links to industry, and to create private sector research absorptivity.

The 2003 Performance-Based Research Fund round for tertiary institutions placed low value on fitness for purpose as a quality measure of research, so academic engineers were encouraged to publish and let industry links lapse. It appears that some effort is being made in the 2006 round to redress this mistake.

In contrast, the Fonterra Research Centre in Palmerston North, New Zealand's largest private R&D centre, has a balance of engineers, technologists and scientists, some doing basic research, while others are involved in more applied work, co-located with the marketing arm of the company. Fonterra has become almost research self-sufficient except where it chooses to work with other research providers on its own terms. Its staff includes pre-eminent researchers, including Fellows of the Royal Society of New Zealand.

Under the economic goal, research is simply a means to an end. We strongly recommend the implementation of proposals made in Growing Smartly. That is, we should ensure that more ICV is created by measuring CRIs' performance on an outcomes basis for which the key performance indicators are private sector co-investment and transfer of research-capable personnel to industry. Allowing CRIs to vary the co-funding ratio to increase the government component on research that is more "blue skies" would prevent too much short-sighted action.

To improve the quality of the evaluation of engineering- and technology-based bids for project- or programme-based public research funds we need to recognise fitness for purpose as a measure of research quality, put greater value on know-how and industry/research provider linkages, and develop a better understanding of the nature of basic research in engineering. Poor quality engineering research proposals should not be supported. However, provided the technical quality of the proposed research is reasonable, it is sensible to favour proposals in which there is private sector willingness to co-invest.

Lastly, when considering bids for project- or programme-based research investment, the ability to be able to attract capital to build follow-through capability in our industries is important. Good research that exists in a silo will not add much ICV to New Zealand as a whole.

9.5 Workforce cannot realise benefits of physical capital

We have increased participation in tertiary education but, as Figures 13 and 14 show, the proportions of the skills we are producing from our tertiary sector do not in any way meet our needs. Deutsche Bank[13] stated that human capital was the long-term key to increasing labour productivity, by increasing skills for using capital and innovation. Tullet et al.[28] also demonstrated the low capability of the New Zealand private sector to use innovation. Until we take strong and specific actions to raise private sector technological capability we will not succeed in our quests to climb the OECD rankings and become more sustainable.

When financial capital is converted into physical capital, businesses need the capability to select new equipment systems and use them to their maximum potential. The skills required for these activities tend to come from the disciplines of engineering, technology and ICT. The size of the need is staggering: to spend one million dollars of capital per year requires one full-time professional engineer, a technical engineer and engineering tradespeople to install the new plant and make it run. The increased expenditure in national infrastructure over the last year or so alone has created over 800 new jobs in the internationally-competitive consulting engineering sector.

Within the engineering sector the skill levels range from trades to PhD, and include a wide range of disciplines such as civil, mechanical, process, electrical, electronic, software and even multimedia systems. Physical capital purchases require critical skills from carpenters, fitters and turners, instrument technicians, installers of high technology products and IT technicians. We have low levels of participation in our tertiary sector in both Type A and Type B qualifications, as Figures 13 and 14 show.

There are some positive signs. The apprenticeship scheme, which was the basis of training in many engineering-based industry sectors,

Action 4: Directing public sector investment in ICV creation

4

In line with our previous recommendations in Growing Smartly, government must redirect public sector investment in R&D under the economic goal towards ICV creation by some or all of the following actions:

- measuring CRI performance on an outcomes basis for which the key performance indicators are private sector co-investment and transfer of research-capable personnel to industry
- recognising fitness for purpose as a measure of research quality, putting greater value on know-how and industry/research provider linkages, and developing a better understanding of the nature of basic research in engineering

has been rebuilt to some extent. However, the mobility of our technologically-literate workers has never been higher, and many are leaving New Zealand.

It is also hard to escape the conclusion that we have sidetracked too much of our precious talent into studying for careers managing compliance activities and procedural matters resulting from too complex regulatory and legal requirements. Too few students enrol in tertiary engineering or technology courses even though they have studied science, maths and perhaps technology at school to Year 13 level. There is anecdotal evidence that engineering is seen as unattractive and too hard by many school leavers. To create a better balance, we must change the apparent mindset that unduly favours commerce, accounting and law careers over science, technology and engineering.

We must implement specific plans to support programmes building participation in economically-critical disciplines to internationally acceptable standards. The Futureintech programme funded through New Zealand Trade and Enterprise for four years until June 2007 is a useful programme, as is the Tertiary Education Commission's Gateway initiative, but it will take much more. The key shortfall is in engineering. The nature of our geography and economy suggests we should have similar requirements to the OECD norm, yet we need to more than double the number of graduates at almost every level from trades to PhD level to approach this level of participation.

The 2005 revision of the student component of equivalent full-time students (EFTS) funding for universities and polytechnics gave engineering one of the lowest rates of increase. This is hardly likely to help. Additionally, government must show willingness to pay the true costs of attracting engineering and technology graduates into higher degrees through setting scholarship stipends in line with the market. The benefit will be those people moving into industry and providing leadership in our businesses.

Action 5: Building the capability of our workforce to use physical capital

5

Government must provide support for programmes that build participation in education within economically-critical disciplines to internationally acceptable standards.

- Long-term assertive actions are required to address the key shortfall in engineering and technology at all levels from trades to PhD.
- Scholarships and bursaries provided for postgraduate study must reflect the market cost of engineering and technology graduates so that they can be attracted to higher degrees.

6

Action 6: Building the capability of our workforce to create and use ICV

Government must undertake the following actions:

- analyse the nature of tertiary education in the key sectors of engineering, technology and design, and their relationship with business education, to develop qualifications that better meet ICV-based industry needs
- use CRIs as capability transfer agencies to move R&D-capable people into the private sector
- create technical/business capability development programmes for SMEs

9.6 Building the capability of our workforce to create and use ICV

In the manufacturing sector, basic and applied engineering and design-based R&D is most likely to lead to ICV of sufficient quality to be internationally competitive. We have only to look at our successes in building ICV-based businesses to see the evidence. The development teams at Fisher & Paykel are full of mechanical and electronic engineers, Fonterra is the largest New Zealand employer by far of chemical/process engineering graduates, and Tait Electronics is rich in electronic and software engineers. All of these businesses adhere to the principle of seeking excellence in the use of financial capital by using highly educated teams whose collective skills allow technical and business matters to be properly considered together.

The IPENZ public policy document *Growing Smartly*[1] argued that CRIs can build research absorptivity in industry through performance-based bulk funding under the economic goal. It is vital that the performance measures incentivise personnel transfer from CRIs to industry. Schemes such as Technology in Industry Fellowships are useful, but are relatively ad hoc approaches compared with direct financial incentives for CRIs to have a personnel transfer plan.

Formative education as an engineer or technologist commences when young people start to study technology at school. Technology education is a compulsory curriculum subject in Years 1 to 10 of compulsory education. It is a curriculum subject option in Years 11 and 12. The technology curriculum is ill-understood and poorly valued by the tertiary sector, and inadequately developed. The transition from school to tertiary study needs to be addressed.

Engineering and technology are part of the business community, not part of science, even though they rely on scientific knowledge. However, with advances in technical knowledge over recent decades tertiary engineering programmes at all levels have been under pressure from "technical over-crowding" and as a result graduates may not have a broad enough business background to meet the business needs to drive growth and innovation whilst also improving sustainability.

At present New Zealand tertiary providers offer a mix of four-year Bachelor of Engineering degrees, three-year Bachelor of Engineering Technology degrees, two-year Diplomas of Engineering and various trade certificates. The Master of Engineering is a separate one-year programme following a Bachelor of Engineering. Ireland is considering moving to a five-year Master of Engineering degree from the current four-year Bachelor of Engineering degree, arguing that in a knowledge economy engineers need to be better educated than at present.

In recent times government has been emphasising that its investment in tertiary education must go to programmes of good quality and strategic relevance. Without interfering with student choice, government can use a variety of instruments such as charters and profiles, levels of funding for the student component and capping of EFTS funding in certain regions and discipline areas to ensure that our tertiary education system meets the needs of our people and the nation as a whole.

Engineering education is too vital to get wrong. The Tertiary Education Commission should urgently analyse the nature of tertiary education in the key sectors of engineering, technology and design, and their relationship with business education, to develop qualifications that better meet ICV-based industry needs. IPENZ has offered to co-ordinate the input of all the key national engineering stakeholders to such a review.

The development of technical/business skills in SMEs requires a different approach. The incremental cost of taking on a full-time graduate is too great, so SMEs tend to take on neither business nor technical graduates in significant numbers. Perhaps the most practical thing that could be done for SMEs would be to establish a pool of suitably qualified mentors who are available to work on shorter-term assignments to advise SMEs on initiatives to achieve individual business growth and innovation. These mentors would need to be multi-skilled in business, technology and engineering.

"These businesses adhere to the principle of seeking excellence in the use of financial capital by using highly educated teams whose collective skills allow technical and business matters to be properly considered together."

Action 7: Maintaining suitable national infrastructure

7

Government must undertake the following actions:

- continue increased public sector capital investment programmes in key infrastructure
- adopt policies that encourage further private sector investment in key public infrastructure projects
- review resource management legislation to lower the risks for attracting private capital to infrastructure projects
- develop high quality resource allocation systems, particularly for water

8

Action 8: Maintaining economic efficiency

Government must undertake the following actions:

- review resource management legislation to lower the risks for attracting private capital to innovation-based projects
- ensure that if employment law is further changed workers do not receive new entitlements unless it can be demonstrated that there are compensatory gains in labour productivity
- ensure that regulatory costs imposed on New Zealand businesses do not create undue penalties in comparison with international competitors

9.7 Infrastructure bottlenecks

It is becoming increasingly apparent that lack of investment in the underpinning infrastructure of transport, utilities, energy and telecommunications is impacting on business efficiency and raising business cost. A lack of investment in transport infrastructure over many decades is limiting the efficient flow of goods and services, particularly in the Auckland region. Energy and water shortages are emerging as major potential limitations on growth over the next decade. We need smart allocation models for water in particular. Access to broadband and new telecommunications improves business efficiency. There have been some concerns that we have lagged behind in deploying very high speed systems, partly because of our low population density.

Significant capital investment in these sectors will be required to ensure they do not dampen business and national economic growth. Smart engineering solutions and innovative ways of financing investment will be vital to lifting productivity. Historically, capital for infrastructure was provided though taxation or borrowing by central or local government. Private sector investment or public:private partnerships will arguably be a necessary component, given the quantum of funding required to overcome lack of expenditure in past decades, and fund new investment to increase capacity and meet future demand.

The Resource Management Act looms as a dampener on the speed with which improvements can be made. Whilst in principle it is excellent legislation, the debate is whether we can afford the costs and delays that arise while a matter is debated. Undue delay and costly disputes will limit private capital availability, and slow the rate at which public capital can be deployed.

9.8 Economic efficiency

Employment, environmental and other social legislation impacts on business productivity and regulatory compliance costs. Risk-averse policies can contribute to a compliance mindset and loss of entrepreneurial culture.

The Resource Management Act is a major concern (see 9.7). In addition to its effect on infrastructure projects, it may be affecting the willingness of investors to commit capital to innovation-based projects in New Zealand.

The risk we face is that we may be creating a business environment where no one loses, but it is hard to be a winner. Increasingly, risk-averse decisions against expansion of production capacity will be taken if, for example, labour units taken on cannot be easily retrenched, or exposure to carbon taxes is increased.

It is critical that new legislation or regulations do not increase costs by unduly restricting production and processing practices. Whilst important to the goal of sustainability, implementation of the Kyoto Protocol may have a major impact on industry costs and therefore competitiveness compared to countries not implementing Kyoto. The continued supply and cost of water, and compliance costs associated with testing requirements may impact on production costs and new investment decisions.

The issue is compounded if the business environment for new investment is perceived to be more friendly in other countries such as Australia. Changes to employment legislation in New Zealand that increase labour costs and reduce business flexibility, coupled with changes to employment law in Australia that improve business competitiveness, may drive business investment across the Tasman. Australia also has an advantage in terms of their larger market, R&D strategies and incentives offered by state governments.

In its 2005 review on New Zealand, the OECD indicated that there were some sectors, particularly the electricity industry, where competitive pressures could be increased. The OECD was positive about the recent changes in depreciation regimes, and advocated retaining labour market flexibility. It issued a warning that there was an ongoing challenge to manage public finances prudently and channel resources into the highest priority areas. It stated that education services need a sharper focus on results.

Action 9: Being a role model in government's own activities

9

Government should demonstrate its own commitment through activities such as:

- assertive actions to demonstrate that it uses public capital wisely using the best possible mix of engineering, technology, design and business skills
- demonstrating that SOEs and other Crown entities conform to best practice governance and senior management standards and skills mixes
- ensuring directors on state sector boards are chosen for their knowledge and expertise of the particular business
- including a wider range of disciplines in public sector senior management development programmes
- moving high performing managers between the public and private sectors
- assertive action on sustainability

9.9 Government as role model

It is vital that both central and local governments demonstrate their commitment and show the private sector the benefits of taking these recommended approaches. For example, government should be able to demonstrate that it uses public capital wisely using the best possible mix of engineering, technology, design and business skills. It should be able to demonstrate that SOEs and other Crown entities conform to best practice governance and senior management standards. The profiles of government-appointed boards could be published to show that the skills mix selected meets the needs of the organisation.

The public sector is a large employer whose activities cover a range of disciplines. A wide range of disciplines should be included in public sector senior management development programmes so that Ministries and Departments such as Transport, Environment, Research, Science and Technology, and Building and Housing have senior staff with diverse backgrounds that are equal to those in the private sector. Government can also show that it values key technical/business skills by positive actions such as moving high performing managers between the public and private sectors. Government can also demonstrate the value of assertive action on sustainability.

"Our investment in human capital has not adequately addressed the key issue of developing private sector capability to perform and use R&D (that is, convert financial capital to ICV and physical capital)."

THE CONTRIBUTION OF THE ENGINEERING PROFESSSION

10.

Engineering education has historically been focused on technical matters and has not attempted to develop wider management or leadership skills. Whilst the analytical skills of the engineer add value when an engineer moves into management and governance, considerable education and skill development beyond an engineering qualification is needed.

IPENZ is instituting a professional development framework that supports engineers as they develop their career through four stages.

- Stage 1: Initial engineering qualification at tertiary level. This qualification develops underpinning theoretical knowledge and skills through study towards an engineering degree accredited by IPENZ to internationally-benchmarked standards.
- Stage 2: Development of professional competence. After graduation, engineers, through experiential (on-the-job) learning and additional professional development activities, progressively develop the competencies (knowledge, skills and attitudes) expected of competent engineering practitioners capable of independent practice. This is benchmarked to the competence standard in the Chartered Professional Engineers Act 2002, and the International Professional Engineers Register. Having developed initial competence, engineers must then maintain that competence through ongoing professional development.
- Stage 3: Managerial or technical leadership. Engineers are encouraged to further develop their career beyond the capability for independent practice. They will usually choose between a business management route and becoming a nationally-renowned technical expert in their area of engineering practice. IPENZ is providing support services for engineers to further develop their own competence on either pathway.
- Stage 4: Governance and expertise. Engineers who have selected the business management route are assisted to move into executive management or governance roles through the development of higher level competence in these areas. Alternatively, those who choose the technical route are encouraged to develop their expertise towards recognition for their technical expertise at an international level.

By participating in our programmes, engineers are expected to develop worthwhile careers for themselves, but also to ensure that the contribution of the engineering profession to the nation as a whole is realised. By creating a pool of engineers with the skills to compete for jobs in technical business management, as a profession we can be confident that we have contributed to national needs.

CONCLUSIONS

11.

The relatively piecemeal and unconnected actions in the present GIF will not bring about the substantial increase in growth rate required to return New Zealand to the top half of the OECD. A concerted, bipartisan approach led by government is needed instead.

Our low rate of growth in the key indicator labour productivity (GDP/hour) is a result of poor performance in a number of areas:

(a) the benefit:risk ratio has favoured financial capital investment being directed towards property investment rather than towards production of products and services we can sell

(b) our private sector financial capital conversion into ICV is very low meaning that we do not generate enough potential value in our business sector

(c) our ICV creation through public sector funding of R&D has been too low, meaning that capital has not been attracted to pick up and use the research results

(d) our investment in human capital (in both tertiary education and ongoing professional development) has inadequately and inappropriately skilled our workforce as a whole to deploy and derive benefits from physical capital investment

(e) our investment in human capital has not adequately addressed the key issue of developing private sector capability to perform and use R&D (that is, convert financial capital to ICV and physical capital)

(f) the movement of people, resources, goods and services through both our high technology and traditional infrastructure is too slow and limits the ability of our businesses to be internationally competitive in distant markets

(g) the compliance costs of doing business and the risks associated with planning and getting approval for major projects are impeding development, and may have a negative impact on our economic efficiency

The proposed national plan of action will address these seven issues if adopted in its entirety. In addition, government must demonstrate leadership, articulate the plan and be a role model in its own activities. It must also commit to consistency of approach in its quest for both prosperity and sustainability.

ABBREVIATIONS

12.

GDP:	GROSS DOMESTIC PRODUCT
GIF:	GROWTH AND INNOVATION FRAMEWORK
GPI:	GENUINE PROGRESS INDICATOR
ICV:	INTELLECTUAL CAPITAL VALUE
IP:	INTELLECTUAL PROPERTY
IPENZ:	THE INSTITUTION OF PROFESSIONAL ENGINEERS NEW ZEALAND INCORPORATED
MFP:	MULTI-FACTOR PRODUCTIVITY
PPP:	PURCHASING POWER PARITY
R&D:	RESEARCH AND DEVELOPMENT
SME:	SMALL- TO MEDIUM-SIZED ENTERPRISE

REFERENCES

13.

[1] The Institution of Professional Engineers of New Zealand Incorporated 2004, *Growing Smartly: A Review of National Policies for Fostering Research, Development, Innovation and Entrepreneurship in New Zealand*, IPENZ, Wellington. Available at: http://www.ipenz.org.nz/ipenz/forms/pdfs/Growing_Smartly-Policy_Review_2004.pdf

[2] New Zealand Government 2002, *Growing an Innovative New Zealand*, New Zealand Government, Wellington. Available at: http://www.beehive.govt.nz/innovate/innovative.pdf

[3] Cullen, Hon Dr Michael 2004, *December Economic & Fiscal Update 2004*, New Zealand Government. Wellington. Available at: http://www.treasury.govt.nz/forecasts/defu/2004/defu04-1.pdf

[4] Ministry of Economic Development & The Treasury 2004, E*conomic Development Indicators 2005: Growth Through Innovation*, New Zealand Government, Wellington. Available at: http://gif.med.govt.nz/aboutgif/indicators-2005/report/report.pdf

[5] Cullen, Hon Dr Michael 2005, *Pre-Election Economic and Fiscal Update 2005*, The Treasury, New Zealand Government, Wellington. Available at: http://www.treasury.govt.nz/forecasts/prefu/2005/pdfs/prefu05.pdf

[6] Deutsche Bank Research 2005, *Global Growth Centres, Current Issues*, 23/03/05, Deutsche Bank Research, Germany. Available at: http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000185704.pdff

[7] Organisation for Economic Co-operation and Development 2005, *National Accounts of OECD countries, Main aggregates*, Volume 1 (updated July 2005, OECD Publishing, Paris.

[8] The Treasury 2005, *Budget Economic & Fiscal Update 2005*, New Zealand Government, Wellington. Available at: http://www.treasury.govt.nz/forecasts/befu/2005/

[9] Statistics New Zealand 2000, *Key Statistics – December 2000 – Measuring Capital Stock in the New Zealand Economy*, New Zealand Government, Wellington. Available at: http://statsnz.resultspage.com/search?p=Q&ts=custom&w=capital+stock+1992+1997&ucHeader%3AsearchButton.x=14&ucHeader%3AsearchButton.y=7

[10] Ministry of Education 2002, *Tertiary Statistics, Graduates and Qualification Completions 2002*, New Zealand Government, Wellington. Available at: http://www.minedu.govt.nz/index.cfm?layout=document&documentid=7116&indexid=6141&indexparentid=1051

[11] Hill, Susan & Johnson Jean 2004, *Science and Engineering Degrees: 1966-2001*, National Science Foundation: Division of Science Resources Statistics, USA.

[12] The New Zealand Institute of Economic Research 2005, *R&D spending trending upwards*, National Business Review 10/06/05, Wellington. Available at: http://www.nzier.org.nz/SITE_Default/SITE_News/x-files/11940.pdf

[13] Deutsche Bank Research 2005, *Global Growth Centres, Current Issues*, 01/08/05, Deutsche Bank Research, Germany. Available at: http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000190080.PDF

[14] Organisation for Economic Co-operation and Development 2002, *Table A4.1 tertiary graduates, by field of study (2000), Education at a Glance 2002*, OECD Publishing. Available at: http://www.oecd.org/dataoecd/52/37/33669055.xls

[15] The World Bank 2005, *World Development Report: A Better Investment Climate for Everyone*, World Bank & Oxford University Press, Washington. Overview available at: http://siteresources.worldbank.org/INTWDR2005/Resources/FNL_WDR_SA_Overview6.pdf

[16] Organisation for Economic Co-operation and Development 2003, *The Sources of Economic Growth in OECD Countries*, OECD Publishing. Available for purchase at: http://www.oecdbookshop.org/oecd/display.asp?lang=EN&sf1=identifiers&st1=112003011e1

[17] Gwartney, James & Lawson, Robert 2003. *Economic Freedom of the World: 2003 Annual Report*, The Fraser Institute & The Economic Freedom Network, Canada. Available at: http://www.fraserinstitute.ca/shared/readmore.asp?sNav=pb&id=551

[18] International Monetary Fund 2005, *IMF Country Report No. 05/152: New Zealand: 2005 Article IV Consultation – Staff Report; and Public Information Notice on the Executive Board Consultation*, International Monetary Fund (Publication Services), Washington. Available at: http://www.imf.org/external/pubs/ft/scr/2005/cr05152.pdf

[19] Statistics New Zealand, National Accounts (*Revised): Year ended March 2004, Net Capital Stock by Industry*, New Zealand Government, Wellington. Available at: http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/web/Hot+Off+The+Press+National+Accounts+(Revised)+Year+ended+March+2004?open

[20] Ministry of Economic Development, *What Other Countries Are Doing* [web page accessed 06/10/05], Growth and Innovation Policy Team, Wellington. www.gif.med.govt.nz/aboutgif/countries.asp

[21] Ministry of Economic Development, *Growth and Innovation Framework Homepage* [website accessed 06/10/2005], Growth and Innovation Policy Team, New Zealand Government, Wellington. Available at: http://gif.med.govt.nz/

[22] Australia, Finland, Ireland, New Zealand and UK data sourced from: Organisation for Economic Co-operation and Development 2005, OECD Publishing, Paris.

[23] Singapore data sourced from: Statistics Singapore 2005, *Key Stats: Economic Survey of Singapore Second Quarter 2005 Labour Productivity by Industry* [web page accessed 29/06/05], Singapore Department of Statistics, Singapore. Available at: http://www.singstat.gov.sg/keystats/mqstats/ess/essa22.pdf

[24] Eurostat, Luxembourg. Available at: http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,30070682,1090_33076576&_dad=portal&_schema=PORTAL

[25] New Zealand data sourced from: *Statistics New Zealand, Analytical Reports, Research and Development in New Zealand 2002, Gross Expenditure on R&D (GERD)* [web page accessed 20/06/05], New Zealand Government, Wellington. Available at: http://www.stats.govt.nz/analytical-reports/research-development-2002/part-1.htm?print=Y

[26] Australia data sourced from: Australia from Australian Bureau of Statistics 2004, *8112.0 2002-03 Research and Experimental Development, All Sector Summary* [web page cited 29/06/05], The Australian Government, Australia. Available at: http://www.abs.gov.au/Ausstats/abs@.nsf/e8ae5488b598839cca25682000131612/07e66f957a46864bca25695400028c64!OpenDocument

[27] The Engineering Council (UK) & the Engineering and Technology Board (etb) 2004, *Digest of Engineering Statistics 2003/4 (Report 2004)*, Engineering and Technology Board, London. Available at: http://www.etechb.co.uk/pdf/Engineering_Digest_2003.pdf

[28] Tullet, Amanda, Amir Pirich & Ken Carlaw 2003, *Enterprising Intellectual Property; Enabling Exit of Intellectual Property from the Publicly Funded Science and Technology System*. Ministry of Economic Development, Wellington, & the University of Canterbury.

[29] Ahlbäck, Johan 2005, *The Finnish National Innovation System*, European Regions Research and Innovation Network, Helsinki University Press, Helsinki.

[30] Ministry of Research, Science and Technology (MoRST) 2005, New Zealand Government, Wellington. See http://www.morst.govt.nz/default.asp?CHANNEL=Channels&PAGE=Home

[31] Organisation for Economic Co-operation and Development 2005, *OECD Policy Brief: Economic Survey of New Zealand*, 2005, OECD Publishing, Paris. Available at: http://www.oecd.org/dataoecd/45/47/35064055.pdf