OECD Reviews of Innovation Policy

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Foreword

This review of New Zealand's Innovation Policy is part of a new series of OECD country reviews of innovation policy. It was requested by the New Zealand authorities, represented by the Ministry of Economic Development (MED) and the Ministry of Research, Science and Technology (MoRST), and was carried out by the OECD Directorate for Science, Technology and Industry (DSTI) under the auspices of the Committee for Scientific and Technological Policy (CSTP).

The review draws on information provided by MoRST and MED as well as the results of a series of interviews with major stakeholders in New Zealand's innovation system. The review was drafted by Gernot Hutschenreiter (Country Review Unit, DSTI, OECD), John Barber (consultant to the OECD, former UK representative to and Chairman of the CSTP) and John Bell (consultant to the OECD, Associate Director, The Allen Consulting Group Pty Ltd, Australia), under the supervision of and with contributions from Jean Guinet (Head, Country Review Unit, DSTI, OECD).

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OVERALL ASSESSMENT AND RECOMMENDATIONS

In the past two decades New Zealand has undergone a far-reaching process of economic reform. A solid macroeconomic framework, well-functioning markets, including a flexible and responsive labour market, and a generally favourable business environment have created the necessary conditions for strong economic growth. However, expectations concerning New Zealand's economic development have so far not been fully met. New Zealand still lags behind in terms of GDP per capita, and growth has been mainly driven by increased labour utilisation. The most important economic policy challenge is to raise income per capita sustainably by boosting productivity growth. Against this background, the New Zealand government is considering what contribution different structural policies might make to improve innovation capabilities throughout the economy.

This review assesses New Zealand's national innovation system, with an emphasis on the role of public research organisations and policies, in order to identify how and in which respects it might be improved. The review was undertaken by a team of four – two members of the OECD Secretariat and two outside experts – who engaged in face-to-face discussions with a large number of New Zealand public officials, business people and academics, examined extensive documentation, and drew on their own experience of science, technology and innovation policy making in OECD countries. On this basis, the team was able to form an overall view of the performance of New Zealand's national innovation system, its strengths and weaknesses and the challenges which it might face in the future. It was also able to formulate a number of proposals for changes in policies, programmes and institutional arrangements. However, given the time and resources at its disposal the team was not in a position to make a detailed assessment of individual elements of performance, policies and programmes although it was able to offer a fresh perspective. The recommendations for change set out below should be seen as suggestions to the New Zealand authorities as to where they might usefully undertake more detailed examinations of the need for and possibilities of change. This report should therefore be seen as a contribution to a debate within New Zealand about the importance of innovation and the role which the government can play to try to ensure that innovation makes its full and proper contribution to the country's future prosperity and social well-being.

The report makes a number of references to policies and practices in other OECD countries. These should be seen not as specific recommendations as to what New Zealand should do but as a means of casting light on possible weaknesses in existing policies and how these might be improved. The effectiveness of innovation policies is always conditioned by the national context in which they operate and no two OECD countries are exactly alike.

Main strengths and weaknesses of New Zealand's innovation system

An assessment of New Zealand's innovation system should first acknowledge some of the country's enduring features: its size, geographical position, topography and inherited economic specialisation.

- A small domestic market limits the range of economic activities that can be undertaken on a large scale and makes it difficult for firms to grow above a certain size in the absence of a large share of export sales. At the same time, New Zealand enjoys a potential advantage over larger countries in terms of managing complex social and economic processes.
- Remoteness from major markets and knowledge centres poses great challenges for maintaining the international connectivity that is essential to innovation and economic growth. This has been only partly offset by reductions in the cost of marine transport and the revolution in electronic communication. Geographical isolation is also, however, a source of comparative advantage in some innovative activities, *e.g.* in the area of bio-security and management of natural resources.
- Together, geographical isolation, many businesses "at the smaller end of the size distribution" (Mills and Timmins, 2004), and few large firms operating at international level make it difficult for New Zealand to move into the rapidly growing industries in which the scope and returns to innovation are likely to be greatest. At the same time, owing to its location, New Zealand enjoys an exclusive economic zone in the surrounding oceans and seas.
- New Zealand's topography is an economic asset, *e.g.* for tourism and film making, but it is also demanding in terms of physical infrastructure, *e.g.* transport, electricity transmission.
- Historically, the New Zealand economy has been shaped by the exploitation of natural resources through agriculture, forestry and fishing, and associated processing and service activities. More recently, agro-food-related biotechnology, tourism and film making have emerged as new industries able to exploit natural comparative advantage. The importance

of land-based activities has shaped New Zealand's innovation and R&D system.

Main strengths

- *The basic conditions for entrepreneurship and innovation are good.* New Zealand offers a unique physical environment for work and living in an open society which engenders trust. A resourceful, English-speaking and entrepreneurial population recognises cultural diversity as a source of creativity.

- *Most aspects of framework conditions are conducive to innovation.* This includes a sound macroeconomic framework and a predictable and good business environment. Product markets work well, and the labour market is flexible and responsive. New Zealand has adopted a pro-competitive stance, with policies that favour open trade and investment. Over the past two decades, the New Zealand economy has gained much in openness and adaptiveness.

- *Government is aware of the importance of science and technology in escaping the "low productivity trap"* and social acceptance of science and technology in and outside the workplace is satisfactory by international standards.

- *A predictable policy environment and a competent public administration* which aims to take a rigorous approach to the rationale for government intervention. This reduces the risk of government failures and uncertainties for firms and creates a solid basis for public-private partnerships.

- *Accumulated skills and institutional capabilities in public research organisations.* Over time, some Crown Research Institutes (CRIs) and universities have developed world-class competencies in many areas, especially but not exclusively in agricultural and health research. They have been quite responsive to the new opportunities provided by biotechnology, notably agricultural biotechnology.

- *Competitive natural resource-based sectors.* Their demand for specialised goods, services and software provides opportunities for high-technology/ value added businesses, *e.g.* green biotechnology, which could be exploited further.

- *Pockets of excellence in new industries* such as software and creative industries.

Main weaknesses

- *Shortcomings in the physical and virtual infrastructure.* Bottlenecks in internal land transport, including within the Auckland conurbation,[1] and vulnerability in the area of energy delivery are weaknesses in an otherwise relatively good overall business environment. The relatively limited availability (*e.g.* compared to Australia) of broadband Internet access at reasonable cost is a significant deterrent to the economy-wide diffusion of new technologies and knowledge, the efficient networking of geographically dispersed research and innovation activities, and the development of creative industries.

- *Lack of investment in business R&D.* The relatively small proportion of GDP accounted for by business enterprise R&D (around one-third of the OECD average) reflects in part the country's industrial structure. However, it is also due in part to a lack of external funding at some stages of business innovation processes, barriers to business growth in R&D-intensive industries, and insufficient motivation and innovation capabilities in some other sectors. A lack of management resources and appropriate personnel may also limit investment opportunities in R&D.

- *Barriers to business growth.* Given New Zealand's favourable business environment, the growth of new firms – though higher than in many European countries – seems to fall short. The cost and difficulty of accessing distant international markets is a factor as is the preference of many entrepreneurs for "lifestyle business."[2] Barriers on which government policy might act more readily are those related to capital market failures, tax disincentives to offshore expansion and the lack of sufficient public support to innovation-related investment, including fiscal incentives for R&D.

- *A lack of management, marketing and distribution skills* appears to be a major impediment to innovation.

- *Shortcomings in the process of technology diffusion and adoption* for both generic technologies, such as biotechnology and information and communication technologies (ICT), and more specialised inputs and know-how. The CRIs and tertiary education institutions are actively undertaking industry-relevant applied research, but there is some

1. The government has now completed a study on road-pricing/congestion-charging options for the Auckland region.

2. In conventional business terms, "lifestyle businesses" typically have limited potential for growth when such growth would destroy the very lifestyle for which their owner-managers set them up.

mismatch between the supply of and demand for complementary technical services, training and advice to help small and medium-sized enterprises (SMEs) to articulate and satisfy their needs.

- *Insufficient policy co-ordination regarding foreign direct investment (FDI)*. The lack of domestically owned large firms with global reach is a key impediment to the efficient commercialisation of research results and innovation in some areas. Barriers to outward FDI are important obstacles to business growth. A lack of policy co-ordination, *e.g.* between innovation and tax policy, may have at times been detrimental to both inward and outward FDI.

- *A fragmented system of government support to R&D and innovation, combined with a lack of coherence across the full range of innovation-related policies*. This reflects some defects in the policy governance of the innovation system. These defects make it difficult to allocate public resources in a strategic manner and can result in wasteful duplication of effort and sub-optimal scale of many support programmes.

- *Inadequate incentives provided to public sector research organisations* (PROs). Competitive funding of CRIs and universities has undoubtedly encouraged PROs to enhance their research quality and relevance. These are worthwhile objectives. However, such an approach, if carried too far for too long, can have drawbacks, with regard to building long-term capabilities, financing research infrastructure, transferring research results to business and offering internationally competitive wages to research leaders and staff.

- *Excessive reliance on a few policy principles* – the "automatic steering syndrome". New Zealand's government and public administration show motivation and skills in learning from international best practices and determination in submitting public policy design to strict discipline, based on solid economic foundations, such as principal-agent theory or market failure analysis. However, this appears to have been done to the detriment of some pragmatism in ensuring efficacious implementation and to have weakened the role of evaluation in monitoring and formulating policy and of co-operation in implementing it. One example is the strict application of the customer-contractor principle to public funding of R&D, which might have overlooked in some cases the fact that the contractor (CRIs, business) may be better placed than the customer (government agencies) to say what societal, business or even government needs might be, and the further fact that the capabilities needed to satisfy the customer can only be built up over a period of time and in expectation of a regular flow of future work. Time-consuming vertical relationships imposed by the "purchaser-provider model" work at the expense of horizontal co-ordination.

Challenges and opportunities

Without change, and given current and prospective global trends, the weaknesses of New Zealand's innovation system might produce the following undesirable medium- to long-term consequences:

- New Zealand might fail to return its GDP per capita income to the top half of the OECD. Lagging GDP per capita and relatively low levels and growth of productivity would persist.
- New Zealand might be marginalised as a location for internationally mobile investment in innovation.
- Relative returns on investment in innovation might decrease, making the domestic and foreign business sector's investment shift even more towards non-tradable goods and low value-added services.
- The outflow of highly qualified staff and entrepreneurs might accelerate.
- The accumulated intellectual capital and other skills of public research organisations might deteriorate, with decreasing prospects of revitalisation through inflows of new talent.

Such risks seem to be well acknowledged by many stakeholders in the New Zealand innovation system, and the government has recently taken measures to address some of the weaknesses described above, especially regarding the funding of CRIs. But there is still debate on what should be a more comprehensive policy response. The debate centres on how best to build on strengths and overcome weaknesses in order to exploit new opportunities. It should recognise that the latter include:

- Greater exploitation of value-adding innovation in the primary and associated sectors.
- Continued and more extensive exploitation of the opportunities for innovation to raise productivity and growth in emerging industries.
- More efficient exploitation of New Zealand's environmental advantage.
- Improvement of international connectivity and access to global innovation networks.

Strategic tasks and guiding principles

The overriding objective of New Zealand's innovation policy should be to strengthen the basis for sustainable long-term growth by fostering market-pulled innovation throughout the economy, focusing basic and mission-oriented research in areas in which both critical mass and excellence can be achieved, and creating solid platforms so that all types of research may interact to address creatively well-defined priority socioeconomic needs. This involves three main interrelated strategic tasks:

- Make the business environment more supportive of R&D and innovation, through improved key framework conditions and appropriate specific incentives.
- Reinforce the public research system's capacity to contribute to innovation and to human resource development, notably via improved steering and financing mechanisms. One should recognise that the CRIs and tertiary education institutions need to play a more important role in applied research and in ensuring the international connectivity of the innovation system than they do in many other advanced countries, since New Zealand lacks large firms in R&D–intensive sectors and must find other ways of sustaining an adequate stock of knowledge.
- Strengthen the domestic and international networks and other institutional frameworks that ensure that the flows of knowledge among key actors of the innovation system contribute effectively to increasing value added in resource-based sectors, and to developing new industries and services.

In accomplishing these tasks policy should be subjected to some key guiding principles:

- *A broad approach to innovation*. Innovation policy should avoid an "R&D and high-tech myopia". This means in particular that policy should recognise the importance of "soft" innovation, *e.g.* as the Growth and Innovation Framework (GIF) rightly did for design, and should not neglect natural-resource-based sectors which offer considerable scope for economic growth through the application of advanced science and technology.
- *A systemic approach to promoting innovation*. Innovation processes are not linear; they are both science-pushed and market-pulled, with complex feedback loops. Therefore, a broad range of policies influence their dynamics and efficiency. These different policies need to be made coherent according to a clear overarching strategy.

- *An appropriate policy mix designed to cope with market as well as systemic failures*. Market failures will generally justify some form of financial support, grants or tax incentives. Coping with systemic failures, which impair optimal transactions between public and private research, for example, will often require institutional building, such as technology licensing offices at tertiary education institutions or public-private partnerships.
- *Market-friendly "clever" targeting*. Neither "picking winners" nor a pure bottom-up definition of policy objectives is a feasible option, especially in small countries that must make the best use of limited resources. Some degree of top-down prioritisation, in consultation with research performers and research end users, is needed to ensure some concentration of resources in areas in which national capabilities can match innovation opportunities that help achieve important socio-economic goals.
- *Advanced governance principles*. While maintaining a clear distinction between policy formulation and policy implementation, the latter should be accomplished by using an effective mix of a range of proven instruments: co-ordination, competition (*e.g.* competitive funding), co-operation (*e.g.* joint research projects); performance-based steering mechanisms (*e.g.* performance contracts, funding criteria).

Recommendations

Improving framework conditions for innovation

New Zealand's business environment and framework conditions for innovation need to be excellent. Currently they are only quite good. Merely matching average OECD country conditions and incentives will not be sufficient to overcome the combined disadvantages of small size and remoteness from big international markets. New Zealand needs a business environment that encourages firms to innovate, grow and become international through trade, investment and links to international sources of knowledge at an early stage.

As an overriding priority, improving this environment involves adopting a comprehensive strategy for removing obstacles to increased entrepreneurship and growth of small high-technology/high value-added businesses, taking into account their need to move into international markets at a very early stage in their development. Such a strategy would address, among other things, issues related to capital markets, taxation, access to global markets and outward investment.

More specifically, building more favourable framework conditions for young and also for other innovative firms, which are the central actors for exploiting New Zealand's existing comparative advantages and creating new ones, would require:

- Continuing to improve the supply of seed and venture capital in New Zealand. The Venture Capital Investment Fund (VIF) and Seed Co-investment Fund are commendable initiatives whose operations have recently been improved. However, some further fine tuning may be warranted.
- Correcting mismatches in the demand and supply of skills. Encourage students to take up science and technology studies. Consider matching government support for the teaching of individual students in tertiary education institutions more closely with the costs of providing certain courses, in particular with a view to preventing shortages in engineering skills. Address the paucity of managerial skills and of complementary skills in marketing and distribution. Foster a closer integration of education, immigration and labour market policies with innovation policy.
- Improving the availability of broadband Internet access at appropriate cost and variety. This would provide opportunities for productivity gains in businesses across the board but particularly in sectors such as the digital creative arts.[3] The impact of the recent Telecommunications Amendment Act should be carefully monitored.
- Eliminating any remaining disincentives to inward and outward foreign investment.

Improving the governance of the innovation system

Overall governance and priority setting

Overall, the GIF has helped to improve policy governance by prompting, structuring and even in some cases institutionalising dialogue on innovation policy across government, in consultation with key stakeholders. In that sense it has been a useful step in a policy learning process which should continue. While it has represented a commendable attempt to focus New Zealand's efforts to grow firms whose competitive niche is based on innovation, its achievements in this regard have not really met stakeholders' expectations. At the same time it may have engendered frustration in non-targeted sectors, suggesting the need for future policies to balance more

3. A new high-speed digital network connecting academic institutions is being introduced.

carefully support to R&D-based industries, support to knowledge diffusion in other industries, and support to the general infrastructure for knowledge generation and diffusion. It is therefore hoped that within the context of its new Economic Transformation Agenda (ETA) the New Zealand government will find an opportunity to:

- *Produce a clear statement of national policy towards innovation, science and technology*, which recognises the wide range of government policies that affect innovation and serves to foster coherence and co-operation among the various departments and agencies involved. The government might consider entrusting this task to a newly created Advisory Council on Innovation Policy representing all stakeholders of the innovation system, perhaps backed by an information-gathering unit.

- *Examine the allocation of support* between firms in areas of current strengths and in emerging industries. Innovation surveys show that many high-technology firms can be found in so-called low-technology sectors, and these sectors may offer considerable scope for improving productivity through the application of advanced science and technology.[4] The goal should include better exploitation of potential strengths in niche markets, commercial exploitation of hotspots of scientific research in which New Zealand has world-class capability and innovations in areas in which New Zealand businesses have a substantial customer base. The review team would expect such an examination to result in a higher proportion of support directed to sectors outside those conventionally defined as high-technology.

- *Support the resulting changes by modest increases in government support* for basic and applied research and in support for commercial innovation activities. Avoid sudden large increases in funds for science, technology and innovation on grounds of fiscal prudence and limited capabilities to use these resources efficiently in the short term.

- *Consider increasing funding for strategic research*, particularly multi-disciplinary research with a practical objective and research which contributes simultaneously to scientific and useful technological knowledge (basic technology). This would require encouraging the funding bodies to take a more strategic approach than an academic peer review to the selection of the relevant projects.

4. For a discussion of innovation in so-called low-technology sectors, see von Tunzelmann and Acha (2005). Sector boundaries are often arbitrary and are changing owing to technological innovation often more quickly than the official statistical classifications which try to define them.

Steering and funding of public research organisations[5]

In recent years funding of public research organisations has strongly relied on the contestability principle, and the share of truly stable funding has been indeed exceptionally low.[6] While this approach has substantial merit, over-reliance on competitive bidding processes for relatively short periods of funding can entail high transaction costs and have undesirable consequences, as the experience of some CRIs demonstrates. By creating uncertainty about future funding, such an approach can negatively affect the career development and retention of human resources for science and technology, prevent the build-up of a core knowledge base and distort the PROs' portfolios of activities, to the detriment of engineering, for example. Uncertainty about funding can encourage directors to bid widely and cause the institute concerned to be gradually pulled away from its core mission and area of expertise. It is necessary to provide stable conditions in order to maintain the long-term research capabilities which are vital for New Zealand's future economic and social needs. At the same time, too large a share of guaranteed funding can induce complacency and indifference to the needs of the public and private sectors which the institute is designed to serve. In New Zealand, a better balance needs to be struck between the two types of funding to encourage the long-term efforts which its funders wish to support.[7]

5. For a detailed discussion of international experience in steering and funding of PROs, see *The Governance of Public Research – Towards Better Practice* (OECD, 2003). It provides generic lessons based on an analysis of archetypal science systems and concrete national policy practices and shows that, beyond some generic "golden rules", policies in OECD countries differ owing to institutional, cultural and historical factors that structure national science systems. Thus, there is no optimal governance pattern for countries to adopt. However there is ample scope for OECD countries to learn from one another.

6. For example, not only did CRIs have to rely mostly on competitive funds, other sources of funding cannot be described as real base or core funding either. First, in initial years non-specific output funding (NSOF) was tied to the amount of funds won in competitive bidding in the Foundation for Research, Science and Technology (FRST) programmes, so that it declined as a proportion of CRIs' total funding as their revenues from commercial contracts increased, Second, in the new formula, when the Capability Fund replaced NSOF, the reference base for the allocation of funds was broadened (total government research income – TGRI) but is still linked to competitive funding.

7. The history of UK funding of research and technology organisations (RTOs) illustrates the effects of different funding regimes. Many of these organisations started life as non-profit-making co-operative research associations serving more traditional sectors and received significant amounts of government institutional support to help them carry out this role. Over the years this bred complacency and non-responsiveness to the needs of their constituencies. As a result funding was cut back and confined to support for specific government-sponsored programmes. This was followed by mergers, closures and the emergence of a subset of highly effective and commercially orientated research contractors. However, the latter became reluctant to invest in the kinds of capabilities needed to

- *Crown Research Institutes (CRIs) should be provided with more core funding* of, say one-third or one-half of their total budget. An increased allocation of core funding, based on five-to-seven year agreements with the government, would support the worthwhile activities undertaken by CRIs which have no immediate and direct external "customer". These include longer-term research with a wide range of potential beneficiaries and for which the CRI itself can best judge the likely benefits, research designed to enhance the CRIs' own knowledge capabilities, training of staff, etc. An initiative that would be a step in the right direction was recently announced by the New Zealand government.[8]

- Along with the introduction of more core and/or long-term funding, *provide the CRIs with a proper system of mission statements, objectives and performance indicators* agreed between the institutes and the government.[9] These performance indicators should be primarily based on the impact of their research, commercialisation successes and technology transfer activities. The recent release by the Crown Company Monitoring Advisory Unit (CCMAU) of a set of research application indicators that focus on the impact of their research is a welcome initiative.

- *Use them as the basis for regular evaluations of the CRIs' performance*, say every five years. These would be separate but draw on evaluations of individual research programmes in which the CRI concerned was involved. The Ministry of Research, Science and Technology (MoRST) and the CCMAU would have a major role in all these evaluation but at least some of the individual CRI evaluations should be put out to tender.

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undertake programmes with government support aimed at firms in need of assistance most of whom were not promising commercial customers. The best UK RTOs are now internationally competitive research businesses that find their most lucrative and demanding customers abroad. Reaching an appropriate balance in funding regimes is partly a matter of trial and error, and because of lags in how the behaviour of institutes responds, a period of rebalancing may be necessary.

8. Initially this will apply to three of FRST's programmes: NERF, RfI and environmental research. Up to 30% of future investments in these programmes will be provided in this way. A subsequent review will consider whether to apply this more widely. In addition the review should consider minimising review and compliance costs and ways of ensuring greater certainty regarding duration of funding.

9. The review team is aware that a system is already in place for setting strategic directions and priorities for CRIs, but our conversations with representatives of CRIs left us with the impression that the system did not provide the CRIs with sufficient guidance or that the CRIs themselves did not have the necessary degree of buy-in. Any reappraisal of the role of the CRIs or the funding regime needs to be accompanied by a fresh look at their governance arrangements.

- Establish a process for revising or updating the CRIs' mission statements, objectives and performance indicators in the light of changing circumstances and/or the results of evaluation.
- *Encourage CRIs to provide appropriate training for their staff* in order to increase their ability to deal with commercial end users.
- *Use licensing to business firms as the preferred route to the exploitation of CRIs' research results*. CRIs should not try to create new businesses when New Zealand-based firms, capable of exploiting the technology, already exist.
- *Maintain the Performance-Based Research Fund (PBRF*) as a good tool to raise the quality of university research. However, although it is too early to assess its full impact, it already seems that the PBRF should take better account of and, where appropriate, adequately reward research impact, commercialisation of research, and interaction with industry and users of research.
- *Improve the mode of financing of research infrastructure in PROs* (CRIs and tertiary education institutions), notably regarding the treatment of depreciation on large equipment.[10]
- *Keep the level of university and CRI scientist salaries under close review*. There is a risk that the relatively low academic salaries, which do not reflect market conditions affecting different disciplines, may erode New Zealand's attractiveness for the "best brains" and undermine New Zealand's capabilities in both science and applied research.
- *Consider, as a medium- or long-term target, consolidating the public research sector*. There may currently be too many PROs (tertiary education institutions and CRIs) on too many different sites. As a first step, an evaluation of the costs and benefits of current location patterns could be undertaken. In the short term, use all opportunities provided by modern communication technology to realise greater economies of scale and scope through virtual networks.

10. The statement issued by the Minister for Science, Research and Technology on 4 May 2006 proposed to improve certainty of funding for "backbone" infrastructure.

- *Adopt a more systematic approach to* ex ante *appraisal and monitoring and* ex post *evaluation* of researchers, research institutions and public policy programmes.[11] While some aspects of evaluation are well developed and continuously improved, *e.g.* the PBRF, others are not. In particular, the evaluation of institutions and programmes – currently some are close to a self-assessment – might be improved, including through a stronger involvement of international experts. The Advisory Council on Innovation Policy, the creation of which is suggested above, could play a major role as a clearing house for evaluation work.

Improving the effectiveness of competitive research funding

Given the weight of competitive funding in public funding of research, the relevant funding agencies and their programmes play a key role in the innovation system. There is a reasonable variety of such agencies and a well-developed portfolio of instruments covering a wide spectrum of needs: non-targeted support to quality research, research in specific fields (*e.g.* health), research consortia, centres of excellence, etc. However, at the programme level, the division of labour among agencies appears less clear. There seems to be a tendency for each agency to try to provide its own solution to the same problem. This leads to a multiplication of partly overlapping, sometimes underfunded programmes. In addition there is room for fine tuning the operations of some programmes.

- *The Foundation for Research, Science and Technology (FRST)* reporting to the Minister of Research, Science and Technology, a well-managed organisation with a good track record, plays a dominant role in funding strategic research with identifiable end users. However, FRST could benefit from additional funding and some streamlining of its portfolio of programmes, a number of which may be underfunded. Application processes need to be simplified and decision-making times shortened.

- *Research for Industry (RfI)*, managed by FRST, is a valuable tool to steer CRIs through competitive funding. However, it could benefit from making its overall architecture clearer as a programme (rather than an "output category"). Increasing the involvement of firms (beyond participation in consortia) could increase the impact on business innovation, and that of universities could help exploit better their potential to carry out high-quality and economically relevant research.

11. The recent Stable Funding initiative contains a provision for "technical review" which establishes a process for *ex ante* evaluation.

- *Research Consortia*, part of RfI, is a commendable initiative to promote public/private partnerships (P/PPs) in research. However, it has so far failed to reveal potential for P/PPs outside agriculture-related research. This may be partly due to its design. Some adjustment should be considered regarding governance arrangements and eligibility criteria. Concerning the latter, one option might be to accept smaller consortia for an initial period of three years; if successful, these consortia could be offered an extension of funding.

- *The New Economy Research Fund (NERF)*, also managed by FRST, is basically a sound programme that might be expanded. In particular it is a tool that can be used to give additional support to multidisciplinary research with a practical objective and strategic research which contributes simultaneously to scientific and useful knowledge. However, in doing so, some issues need to be addressed: *i)* the admittedly generic issue of depreciation; and *ii)* obstacles to the entrepreneurial commercialisation of successful NERF-funded research.

- *The Marsden Fund*, administered by the Royal Society of New Zealand, plays a key role in supporting excellent blue sky research which is important for ensuring that New Zealand does not miss unexpected opportunities. The Marsden Fund should be larger since this would increase the probability of successful, high-impact research yielding a big pay-off for society. An increase in budget should be accompanied by greater efforts to improve community understanding of the importance of fundamental research.

- *The Centres of Research Excellence (CoREs)*, which are managed by the Tertiary Education Commission (TEC) are helpful in rewarding the best research groups. However, given their financing structure, it is not clear how effectively they can achieve their stated goal, which is to create stronger links with potential end users beyond what can be done by the participating PROs.

- *Partnerships for Excellence (PfX)* is another recent TEC initiative which aims to increase private-sector investment in tertiary education and foster better links between higher education and business. A broad range of expenditures are eligible for PfX support, from investment in buildings to scholarships and chairs. To avoid overlap with other programmes, notably Research Consortia, it is important for PfX support to remain concentrated on facilitating private investment in the improvement of universities' research environment and infrastructure rather than research co-operation.

Promoting innovation in the business sector

While improving framework conditions for innovation (see above) is necessary, more specific government support is also warranted. Part of this support is channelled through public research organisations (see recommendations above on how PROs could improve their services for business innovation). Like other OECD countries, New Zealand has a variety of programmes aimed at correcting market failures which affect small, innovative firms especially. These programmes are mostly managed by the Ministry for Economic Development (MED) but some other ministries, especially MoRST, are also active in this area. A challenge is to meet the needs of a heterogeneous population of firms through a reasonably differentiated, but not too costly and cumbersome, set of policies. Another challenge is to reach firms which are not yet very innovative and have difficulty articulating their needs. Like all other OECD countries, New Zealand has only partly succeeded in meeting these challenges.

- *Improve the portfolio of funding instruments*. There are currently too many small innovation support programmes with too great a variety of objectives and rules. Fewer, better funded programmes should improve the average quality of supported projects as would a more even spread of support funding over time. This would also lead to savings in administration and compliance costs.

- *Consider the introduction of an R&D tax incentive, drawing on international good practice.* The current system of public financial support for R&D and innovation is entirely based on grants. International experience suggests that tax incentives for R&D, if well designed, can induce additional privately financed R&D effort and can also send a powerful signal deep into the system from SMEs to R&D intensive multinational companies.

- *Adapt the policy mix accordingly.* The introduction of a tax incentive for R&D would offer an opportunity to rationalise the system of public support for R&D and contribute to achieving a more balanced policy mix with each instrument. It would allow the phasing out of the present multiplicity of small R&D grants and make way for the introduction of a more focused system of larger grants concentrated on a more limited number of very deserving cases. This should serve to improve the cost-effectiveness of grant support for R&D.

- *Improve co-ordination among policy agencies*. The rationalisation of grant-based support to innovation should both help and result from better co-ordination of ministries, especially between MoRST and MED. Both ministries should be closely involved, with MED playing the leading role in supporting near-market innovation activities and MoRST in more pre-competitive research but also in promoting feedback from commercial innovation to basic research. Regarding the promotion of technology diffusion and adoption, there is a need to enhance synergies between New Zealand Trade and Enterprise programmes and relevant FRST programmes, notably Technology New Zealand lines of action.

- *Reinforce the outward-looking component of Technology New Zealand*. Technology New Zealand programmes play a useful role in promoting networking among national players but additional resources should be preferentially devoted to forging international linkages.

- *Reinforce New Zealand Trade and Enterprise (NZTE) programmes* as they provide much needed support for business innovation, including design, by helping SMEs in particular access technical services, training, advice and export markets. Again, grants are often too small to have a significant impact.

- *New Zealand should develop a clearer strategy regarding support for developing key infrastructure for innovation.* Some institutions magnify the efficiency of public support for innovation. For example, incubators help to translate entrepreneurship into commercial enterprise, and clusters help firms to overcome the disadvantages of small size through co-operation and to establish working links to knowledge institutions. New Zealand seems to have had some hesitant policies regarding cluster development and there seems to be a debate about the real outcomes of incubators in terms of innovation.[12]

12. For example, the NZTE's Cluster Development Programme was disbanded.

Summary table: New Zealand's strengths, weaknesses, opportunities and threats

Strengths	Opportunities
• Resourceful and entrepreneurial population • Unique physical environment for work, living, sports and tourism • Well-functioning product and labour markets • Strong presence in primary sectors such as agriculture, forestry and fishing and some strength in related industries and services • A sound education system and a reasonably high level of innovation • Relatively strong university and public-sector research institutions • Awareness of the importance of science and technology in meeting socioeconomic goals, including ecological objectives • Strength in agricultural biotechnology and health research • Pockets of excellence in fast-growing industries such as software and creative industries as well as in the underlying sciences • An open society which engenders trust, and a frank and open policy environment • A society that recognises cultural diversity as a source of innovation	• Greater exploitation of value-added innovation in the primary and associated sectors • Continued exploitation of the opportunities for innovation raising productivity and growth in emerging industries • Use of New Zealand's strengths in science and technology in resource-based industries and related value-added services, *e.g.* application of ICT in a range of sectors • More efficient exploitation of New Zealand's environmental advantages • Improvement of international connectivity and access to knowledge of international markets, *e.g.* by improved use of ICT, leveraging the New Zealand diaspora and using the knowledge of immigrants about their home countries
Weaknesses	**Threats**
• Lagging GDP per capita and relatively low levels and growth of productivity by OECD standards • Small national market with a preponderance of small enterprises • Relative isolation from world markets and the processes of globalisation • Shortcomings in the physical and virtual infrastructure (broadband, energy, transport) • Lack of investment in business R&D associated with a lack of external funding for business R&D and innovation • Fragmented system of government support for R&D and innovation combined with a lack of coherence across the full range of innovation-related policies • Inappropriate incentives for public-sector research institutions in respect of building long-term capabilities, financing research infrastructure and transferring research results to business • Shortcomings in the process of technology diffusion • Barriers to growth of firms, including a preference of many entrepreneurs for "lifestyle" businesses	• Relatively weak productivity performance holds back living standards • Marginalisation of New Zealand as a location for internationally mobile investment and innovation • Deterioration in the long-term capabilities of public research institutions, including through failure to pay internationally competitive salaries for professors and scientists • Accelerated outflow of highly qualified staff and entrepreneurs

ÉVALUATION GÉNÉRALE ET RECOMMANDATIONS

Depuis deux décennies, la Nouvelle-Zélande traverse un processus de réforme économique de grande ampleur. Avec un cadre macroéconomique solide, des marchés efficaces, dont un marché du travail souple et réactif, et des conditions globalement favorables aux entreprises, le pays a créé les conditions nécessaires d'une croissance économique robuste. Toutefois, son développement économique ne répond pas entièrement aux attentes. La Nouvelle-Zélande reste à la traîne en termes de PIB par habitant, et sa croissance s'explique essentiellement par l'utilisation accrue des forces de travail. Le principal défi de politique économique, pour le pays, consistera à accroître durablement son revenu par habitant en stimulant la croissance de la productivité. Dans ce contexte, le gouvernement néo-zélandais examine actuellement les contributions potentielles de différentes politiques structurelles à l'amélioration des capacités d'innovation dans l'ensemble de l'économie.

Cet examen évalue le système d'innovation national de la Nouvelle-Zélande en mettant l'accent sur le rôle des organismes et politiques de recherche publics, afin d'identifier dans quelle mesure et de quelle manière celui-ci pourrait être amélioré. L'étude a été menée par une équipe de quatre personnes – deux membres du Secrétariat de l'OCDE et deux experts externes – qui se sont entretenues avec un large éventail de responsables gouvernementaux, chefs d'entreprise et universitaires néo-zélandais, en s'appuyant sur leur propre expérience de l'élaboration des politiques scientifiques, technologiques et d'innovation dans la zone OCDE. En procédant de la sorte, l'équipe a pu se faire une idée d'ensemble des performances du système d'innovation de la Nouvelle-Zélande, de ses forces et faiblesses et des défis qui l'attendent. Sur cette base, elle a formulé un ensemble de propositions visant à modifier certains dispositifs institutionnels, programmes et politiques. Cependant, le temps et les ressources dont elle disposait ne lui ont pas permis d'effectuer sa propre évaluation des différents éléments des performances, des politiques et des programmes, même si sa contribution a l'avantage d'apporter un regard extérieur neuf. Les recommandations de changement formulées ci-dessous ont pour but d'attirer l'attention des autorités néo-zélandaises sur les domaines dans lesquels elles gagneraient à évaluer les besoins et possibilités de changement plus en détail. Ce rapport doit donc être perçu comme une contribution au débat national sur l'importance de l'innovation et sur ce que les pouvoirs publics peuvent mettre en œuvre pour s'assurer que l'innovation participe pleinement et positivement à la prospérité et au bien-être social futurs du pays.

Ce rapport contient un certain nombre de références aux politiques et pratiques des autres pays de l'OCDE. Celles-ci ne doivent pas être interprétées comme des recommandations spécifiques aux autorités néo-zélandaises, mais comme des indications générales des types de problèmes soulevés par les politiques existantes et de la manière dont certaines politiques peuvent être améliorées ou renforcées. L'efficacité d'un système d'innovation est subordonnée au contexte national, et aucun pays de l'OCDE n'est tout à fait semblable à un autre.

Principaux points forts et points faibles du système d'innovation de la Nouvelle-Zélande

Pour évaluer le système d'innovation de la Nouvelle-Zélande, il faut avoir conscience de certaines caractéristiques spécifiques plus ou moins permanentes du pays, notamment sa taille, sa situation géographique, sa topographie et ses domaines de spécialisation économique traditionnels.

- La petite taille du marché intérieur limite la gamme des activités qui peuvent être mises en œuvre à une échelle suffisante pour être économiquement viables et ne permet guère aux entreprises de croître au-delà d'un certain seuil si elles n'exportent pas une proportion élevée de leur production. Cela étant, la Nouvelle-Zélande bénéficie d'un avantage potentiel par rapport aux pays plus grands en termes de gestion des processus sociaux et économiques complexes.

- Le maintien de la connectivité internationale, condition essentielle de l'innovation et de la croissance économique, est rendu difficile par l'éloignement des principaux marchés et centres de connaissances. La réduction du coût des transports maritimes et la révolution des communications électroniques n'ont que partiellement atténué ce handicap. Cependant, l'isolement géographique est également source d'avantages comparatifs dans certains domaines d'activité innovants, tels que la biosécurité et la gestion des ressources naturelles.

- Conjugué à l'isolement géographique, le fait qu'un grand nombre d'entreprises néo-zélandaises se concentrent « dans le bas de l'échelle de répartition des tailles » (Mills et Timmins, 2004) et que très peu aient une stature internationale empêche la Nouvelle-Zélande de prendre pied dans les secteurs à croissance rapide, qui sont précisément ceux où la portée et le rendement potentiels de l'innovation sont les plus élevés. D'un autre côté, grâce à sa situation géographique, la Nouvelle-Zélande bénéficie d'une zone économique exclusive dans l'espace maritime environnant.

- La topographie de la Nouvelle-Zélande constitue un atout économique, notamment pour le tourisme et l'industrie du tournage cinématographique. Néanmoins, elle impose de fortes contraintes en termes d'infrastructures physiques, notamment pour les transports (y compris le transport de l'électricité).

- L'économie néo-zélandaise a toujours été dominée par l'exploitation des ressources naturelles (agriculture, sylviculture et pêche) et par les activités de transformation et de services associées. D'autres activités économiques fondées sur l'exploitation des avantages comparatifs naturels commencent à émerger depuis peu – biotechnologies liées au secteur agroalimentaire, tourisme et tournage de films. L'importance des activités « basées sur la terre » a largement influencé le système d'innovation et de R-D de la Nouvelle-Zélande.

Principaux points forts

- *Le contexte national est favorable à l'entrepreneuriat et à l'innovation.* Forte d'un environnement physique unique et d'une société ouverte qui encourage la confiance, la Nouvelle-Zélande est un pays où il fait bon vivre et travailler. Anglophones, imaginatifs et entreprenants, les Néo-Zélandais perçoivent la diversité culturelle comme une source de créativité.

- *La plupart des aspects des conditions-cadres sont propices à l'innovation.* La Nouvelle-Zélande jouit notamment d'un cadre macro-économique sain et d'un environnement commercial prévisible et favorable. Les marchés de produits fonctionnent correctement et le marché du travail est souple et réactif. Les autorités nationales ont adopté une politique générale favorable à la concurrence qui encourage l'ouverture des échanges et des investissements. Au cours des deux dernières décennies, l'économie néo-zélandaise a beaucoup gagné en ouverture et en capacité d'adaptation.

- *Les pouvoirs publics sont conscients de l'importance de la science et de la technologie en tant que moyens d'échapper au « piège de la faible productivité »*, et le niveau d'acceptation sociale de la science et de la technologie, sur le lieu de travail et en dehors, est satisfaisant à l'aune des normes internationales.

- *Le pays peut compter sur un cadre d'action prévisible et une administration publique compétente*, qui s'efforce d'adopter une approche rigoureuse en matière de justification des interventions de l'État. Cette approche réduit le risque de défaillances de l'État et d'incertitudes pour les entreprises, tout en jetant des bases solides pour les partenariats public-privé.

- *L'accumulation de compétences et de capacités institutionnelles dans les organismes de recherche publics.* Au fil du temps, certains Instituts de recherche de la Couronne (Crown Research Institutes – CRI) et universités ont acquis des compétences de classe mondiale dans de nombreux domaines, en particulier (mais sans s'y limiter) la recherche agricole et sanitaire. Ils ont été relativement prompts à saisir les nouvelles possibilités offertes par la biotechnologie, notamment la biotechnologie agricole.

- *Les secteurs concurrentiels basés sur l'exploitation des ressources naturelles* ont besoin de produits, de services et de logiciels spécialisés – un créneau prometteur pour les entreprises de haute technologie ou à forte valeur ajoutée (opérant dans le secteur des biotechnologies vertes notamment), qui mériterait d'être mieux exploité.

- *Des poches d'excellence se sont formées dans de nouveaux secteurs*, tels que les logiciels et les industries créatives.

Principaux points faibles

- *Les infrastructures physiques et virtuelles.* La congestion des transports terrestres intérieurs, y compris dans la conurbation d'Auckland[13], et la vulnérabilité des infrastructures énergétiques constituent des handicaps même si, par ailleurs, l'environnement économique est relativement satisfaisant. La disponibilité relativement limitée (en comparaison de l'Australie par exemple) des services Internet à large bande d'un prix raisonnable est un obstacle majeur à la diffusion des nouvelles technologies et des connaissances dans le pays, à l'établissement de réseaux efficaces reliant les activités de recherche et d'innovation géographiquement dispersées et au développement des industries créatives.

13. Le gouvernement a achevé une étude sur les options de péage et de tarification de la congestion routière dans la région d'Auckland.

- *Le manque d'investissements dans la R-D des entreprises*. La part relativement faible de la R-D des entreprises dans le PIB (environ un tiers de la moyenne de l'OCDE) reflète en partie la structure industrielle du pays. Cependant, elle s'explique également par le manque de financements externes à certaines étapes des processus d'innovation des entreprises, par les obstacles qui freinent la croissance des entreprises dans les secteurs à forte intensité de R-D et par le manque de motivation et de capacités d'innovation dans certains autres secteurs. Les possibilités d'investissement en R-D pourraient également être limitées par le manque de ressources de gestion et de personnel qualifié.

- *Les obstacles à la croissance des entreprises.* Bien qu'elle soit plus élevée que dans de nombreux pays européens, la croissance des nouvelles entreprises déçoit quelque peu au regard de l'environnement économique favorable du pays. Parmi les facteurs à incriminer figurent les coûts et la difficulté, pour les entreprises, d'accéder aux marchés internationaux éloignés à un stade précoce de leur développement, ainsi que la préférence de nombreux créateurs d'entreprise pour les lifestyle businesses[14], plus axées sur l'épanouissement personnel que sur la croissance. On peut néanmoins citer d'autres obstacles sur lesquels la politique gouvernementale a plus de prise, par exemple les imperfections des marchés financiers, les désincitations fiscales à l'expansion extra-territoriale et le manque de soutien public aux investissements dans l'innovation, y compris (jusqu'à présent) sous la forme d'incitations budgétaires à la R-D.

- *Le manque de capacités en matière de gestion, de commercialisation et de distribution* apparaît comme un obstacle majeur à l'innovation.

- *Les déficiences des processus de diffusion et d'adoption des technologies*, qu'il s'agisse des technologies génériques telles que les biotechnologies et les technologies de l'information et des communications (TIC) ou de facteurs de production et savoir-faire plus spécialisés. Les CRI et les établissements d'enseignement supérieur s'investissent activement dans la recherche appliquée axée sur l'industrie, mais il existe un certain décalage entre l'offre et la demande de services techniques complémentaires, de formations et de conseils, autant d'outils qui aident les PME à mieux cerner et à satisfaire leurs besoins.

14. Les *lifestyle businesses* ont typiquement un potentiel de croissance limité, dans la mesure où cette croissance détruirait le mode de vie recherché par leurs propriétaires-directeurs lorsqu'ils les ont créées.

- *Le manque de coordination des politiques liées à l'investissement direct étranger (IDE)*. Le manque de grandes entreprises à capitaux néo-zélandais bénéficiant d'une stature internationale est un frein majeur à la commercialisation efficiente des résultats de la recherche et à l'innovation dans certains domaines. Les obstacles aux investissements directs à l'étranger entravent considérablement la croissance des entreprises. Enfin, il est possible que l'absence de coordination entre les politiques, par exemple entre la politique de l'innovation et la politique fiscale, ait gêné, en certaines occasions, les investissements directs tant de l'étranger qu'à l'étranger.

- *La fragmentation du système de soutien public à la R-D et à l'innovation et le manque de cohérence entre les politiques liées à l'innovation.* Cette situation reflète certains défauts du mode de gouvernance du système d'innovation, qui empêchent l'État d'allouer ses ressources de manière stratégique. Il en résulte une duplication inutile des efforts et des programmes de soutien souvent sous-dimensionnés.

- *Des incitations inadéquates aux organismes de recherche publics (ORP).* Il ne fait aucun doute que le financement sur concours des CRI et des universités a incité les ORP à améliorer la qualité et la pertinence de leurs recherches. Il s'agit là d'un objectif louable. Cependant, si elle est poussée trop loin pendant trop longtemps, cette approche peut produire des effets négatifs sur le plan du développement des capacités à long terme, du financement des infrastructures de recherche, du transfert des résultats de la recherche aux entreprises et de la possibilité de maintenir les salaires des responsables et personnels de recherche à des niveaux compétitifs selon les critères internationaux.

- *Le recours excessif à un nombre limité de principes d'action* – le « syndrome du mode de pilotage automatique ». Le gouvernement et l'administration publique de la Nouvelle-Zélande possèdent la motivation et les compétences requises pour tirer les enseignements des pratiques internationales exemplaires et sont déterminés à soumettre le processus de conception des politiques à une discipline stricte fondée sur des bases économiques solides, par exemple la théorie des relations mandant-mandataire et l'analyse des défaillances du marché. Il semble néanmoins que cette démarche n'ait pas su être conciliée avec un minimum de pragmatisme au regard de l'efficacité de la mise en œuvre, et qu'elle ait affaibli le rôle de l'évaluation dans le suivi et la formulation des politiques et celui de la coopération dans leur mise en œuvre. Par exemple, les autorités ont appliqué le principe de la relation client-fournisseur de façon stricte au financement public de la R-D, négligeant parfois le fait que le fournisseur (CRI, entreprises) est mieux placé que le client (agences gouvernementales) pour identifier les besoins potentiels de la société, des entreprises et même de l'État, et que le fournisseur a besoin de temps et doit pouvoir compter sur un flux de travaux futur régulier pour se doter des capacités nécessaires à la satisfaction des besoins de son client. À l'évidence, les relations verticales imposées par le « modèle acheteur-fournisseur », très coûteuses en termes de temps, laissent peu de place à la coordination horizontale.

Défis et possibilités

Compte tenu des tendances mondiales actuelles et prévisibles, en l'absence de mesures correctives, les faiblesses du système d'innovation de la Nouvelle-Zélande risquent d'entraîner les effets indésirables suivants à moyen ou à long terme :

- La Nouvelle-Zélande ne retrouvera pas sa place parmi les pays de l'OCDE qui occupent la moitié supérieure du classement en termes de PIB par habitant. Elle continuera de pâtir d'un PIB par habitant à la traîne, et d'un niveau et d'une croissance de la productivité relativement faibles.
- La Nouvelle-Zélande sera marginalisée en tant que destination potentielle pour les investissements internationalement mobiles dans l'innovation.
- Le rendement relatif des investissements dans l'innovation diminuera, avec, à la clé, une concentration encore plus marquée des investissements des entreprises nationales et étrangères dans les secteurs des biens non échangeables et des services à faible valeur ajoutée.
- Le pays risque de se vider de sa main-d'œuvre hautement qualifiée et de ses entrepreneurs à un rythme accéléré.
- Le capital intellectuel et autres compétences accumulés par les organismes de recherche publics diminueront, tout comme la probabilité qu'ils soient revitalisés par l'arrivée de nouveaux talents.

De nombreuses parties prenantes du système d'innovation néo-zélandais sont parfaitement conscientes de ces risques et le gouvernement a récemment pris des mesures pour corriger certaines faiblesses décrites ci-dessus, notamment en ce qui concerne le financement des CRI. Cependant, le débat se poursuit pour tenter de définir une réponse plus globale à ces problèmes. Il s'agit en l'occurrence de déterminer quels sont les meilleurs moyens d'exploiter les atouts et de surmonter les faiblesses actuels pour tirer parti des possibilités nouvelles, qui incluent, en particulier :

- Une exploitation accrue de l'innovation à valeur ajoutée dans le secteur primaire et les secteurs associés.
- Une exploitation continue et toujours plus étendue des possibilités d'augmentation de la productivité et de la croissance par l'innovation dans les secteurs émergents.
- Une exploitation plus efficiente de l'avantage environnemental de la Nouvelle-Zélande.
- L'amélioration de la connectivité internationale et de l'accès aux réseaux d'innovation mondiaux.

Actions stratégiques et principes directeurs

L'objectif prioritaire de la politique d'innovation de la Nouvelle-Zélande doit être de consolider les bases d'une croissance soutenue à long terme en encourageant le développement de l'innovation tirée par le marché dans tous les secteurs de l'économie, en focalisant la recherche fondamentale et la recherche utilitaire sur les secteurs où il est possible d'atteindre une masse critique et l'excellence et en créant des plates-formes solides qui permettent aux différentes catégories de recherche d'interagir entre elles pour répondre, de manière créative, à des besoins socio-économiques prioritaires clairement définis. La réalisation de ces objectifs passe par trois grandes actions stratégiques liées entre elles :

- Faire en sorte que l'environnement économique soit plus favorable à la R-D et à l'innovation, à la fois en améliorant les principales conditions-cadres et en créant des incitations spécifiques appropriées.
- Renforcer la capacité du système de recherche public à participer à l'innovation et au développement des ressources humaines, notamment en améliorant les mécanismes de pilotage et de financement. Il faut savoir que les CRI et établissements d'enseignement supérieur devront continuer à jouer un rôle plus important dans la recherche appliquée et dans le maintien de la connectivité internationale du système d'innovation que ne le font leurs homologues de nombreux pays plus avancés, car la Nouvelle-Zélande compte peu de grandes entreprises spécialisées dans les activités à forte intensité de R-D et doit trouver d'autres moyens pour constituer un stock de connaissances adéquat.
- Renforcer les réseaux nationaux et internationaux et autres cadres institutionnels qui garantissent que les flux de connaissances entre les principaux acteurs du système d'innovation contribuent efficacement à l'accroissement de la valeur ajoutée dans les secteurs basés sur

l'exploitation des ressources et au développement de nouvelles industries et de nouveaux services.

Pour mener à bien ces missions, les pouvoirs publics devront se conformer à un certain nombre de principes directeurs :

- *Adopter une approche large vis-à-vis de l'innovation.* La politique de l'innovation ne doit pas avoir la vue courte en matière de R-D et de haute technologie. Cela signifie en particulier qu'elle doit reconnaître l'importance des innovations « molles » (comme le Cadre pour la croissance et l'innovation l'a fait pour la conception) et qu'elle ne doit pas négliger les secteurs basés sur les ressources naturelles, qui offrent un potentiel de croissance économique considérable à travers l'application des sciences et technologies de pointe.

- *Adopter une approche systémique de la promotion de l'innovation.* Les processus d'innovation ne sont pas linéaires car ils sont à la fois poussés par la technologie et tirés par le marché, avec des boucles de rétroaction complexes entre les deux processus. Par conséquent, de très nombreuses mesures peuvent avoir un impact sur la dynamique et l'efficience de l'innovation. C'est pourquoi ces mesures doivent être cohérentes et s'inscrire dans une stratégie globale bien claire.

- *Mettre en place un bouquet de mesures approprié pour pallier les déficiences systémiques et du marché.* Les défaillances du marché justifient généralement l'octroi d'un soutien financier, de subventions ou d'incitations fiscales quelconques. La correction des déficiences systémiques, qui empêchent par exemple la réalisation de transactions optimales entre la recherche publique et la recherche privée, passe souvent par un renforcement des capacités institutionnelles (création de bureaux de transfert de technologie au sein des établissements d'enseignement supérieur) ou par des partenariats public-privé.

- *Pratiquer un ciblage « intelligent » respectueux des lois du marché.* Si la pratique consistant à « désigner les gagnants » doit être bannie, une définition purement ascendante des objectifs des politiques est également à exclure, en particulier dans les petits pays qui doivent faire le meilleur usage de leurs ressources limitées. Il est nécessaire d'instiller un certain degré de hiérarchisation descendante, en consultation avec les auteurs et les utilisateurs finals de la recherche, pour assurer une concentration suffisante des ressources dans les domaines où il y a concordance entre les capacités nationales et les possibilités d'innovation et où celles-ci peuvent contribuer à la réalisation des objectifs socioéconomiques prioritaires.

- *Mettre en œuvre des principes de gouvernance avancés.* Tout en maintenant une distinction claire entre les processus de formulation et de mise en œuvre des politiques, il y a lieu d'appuyer la mise en œuvre sur un ensemble d'instruments éprouvés : coordination, concurrence (financement sur concours notamment), coopération (projets de recherche conjoints par exemple), et mécanismes de pilotage basés sur les performances (contrats de performance, critères de financement, etc.).

Recommandations

Améliorer les conditions-cadres de l'innovation

L'environnement économique et les conditions-cadres de l'innovation en Nouvelle-Zélande doivent être rien moins qu'excellents. À l'heure actuelle, ils sont tout juste corrects. Si elle se contente d'égaler les conditions et incitations qui prévalent dans la moyenne des pays de l'OCDE, la Nouvelle-Zélande ne parviendra pas à surmonter le double handicap de sa petite taille et de son éloignement des grands marchés internationaux. Le pays a besoin d'un environnement économique qui encourage les entreprises à innover, à se développer et à s'internationaliser au travers des échanges et des investissements et en établissant des liens avec les sources internationales de connaissances à un stade précoce de leur développement.

Pour améliorer cet environnement, la priorité absolue sera de mettre en œuvre une stratégie exhaustive visant à éliminer les obstacles à l'essor de l'entrepreneuriat et à la croissance des entreprises de haute technologie et à forte valeur ajoutée, en tenant compte du fait qu'elles doivent s'implanter sur les marchés internationaux à un stade très précoce de leur développement. Cette stratégie devra prendre en considération, entre autres, les questions liées aux marchés financiers, à la fiscalité, à l'accès aux marchés mondiaux et aux investissements à l'étranger.

Plus spécifiquement, pour rendre les conditions-cadres plus favorables aux jeunes entreprises ainsi qu'aux autres entreprises innovantes, qui ont un rôle clé à jouer dans l'exploitation des avantages comparatifs existants de la Nouvelle-Zélande et dans la création de nouveaux avantages, il est nécessaire de :

- Continuer à accroître l'offre de capital d'amorçage et de capital-risque en Nouvelle-Zélande. Le Venture Capital Investment Fund (VIF) et le Seed Co-investment Fund sont des initiatives louables, d'autant que leur fonctionnement a été récemment amélioré. Néanmoins, quelques perfectionnements supplémentaires seraient justifiés.

- Corriger les déséquilibres entre la demande et l'offre de compétences. Encourager les étudiants à s'orienter dans les filières scientifiques et technologiques. Mieux proportionner le soutien de l'État aux élèves de l'enseignement supérieur en fonction du coût relatif des différents types d'enseignement, notamment pour prévenir d'éventuelles pénuries de compétences techniques. Combler le déficit de compétences en gestion et dans les domaines complémentaires comme la commercialisation et la distribution. Encourager une intégration plus poussée entre les politiques liées à l'éducation, à l'immigration et au marché du travail et la politique de l'innovation.

- Améliorer la disponibilité des services Internet à large bande, en veillant à ce qu'ils soient suffisamment diversifiés et à ce que leur coût soit correct. Cela contribuerait à améliorer la productivité de l'ensemble des entreprises, mais plus particulièrement de celles qui opèrent dans le secteur des arts numériques créatifs.[15] Il y aura lieu de suivre attentivement l'impact de la nouvelle Loi modifiant la loi sur les télécommunications.

- Éliminer les derniers obstacles aux investissements directs de l'étranger et à l'étranger.

Améliorer la gouvernance du système d'innovation

Gouvernance globale et définition des priorités

Dans l'ensemble, le Cadre pour la croissance et l'innovation (GIF) a contribué à une légère amélioration de la gouvernance des politiques, en encourageant, en structurant, voire même en institutionnalisant le dialogue sur la politique de l'innovation dans les différents secteurs de l'administration, en consultation avec les principales parties prenantes. En ce sens, il a marqué une étape importante du processus d'apprentissage politique, qui doit maintenant se poursuivre. Bien que le GIF représente une tentative estimable de focaliser les efforts nationaux sur le développement des entreprises dont la niche concurrentielle repose sur l'innovation, ses résultats dans ce domaine n'ont pas réellement répondu aux attentes des parties prenantes. Par ailleurs, il est possible qu'il ait engendré une certaine frustration dans les secteurs non ciblés, d'où la nécessité, à l'avenir, de parvenir à un meilleur équilibre entre le soutien aux secteurs basés sur la R-D, le soutien à la diffusion des connaissances dans les autres secteurs et le soutien aux infrastructures générales de production et de diffusion des

15. Un nouveau réseau numérique à grande vitesse est en train d'être installé entre les établissements d'enseignement supérieur.

connaissances. Il faut souhaiter qu'à la faveur de son nouveau Programme de transformation économique (Economic Transformation Agenda – ETA), le gouvernement néo-zélandais trouvera l'occasion de :

- *Formuler une déclaration de politique scientifique, technologique et d'innovation claire*, qui reconnaisse la grande diversité des mesures gouvernementales susceptibles d'affecter l'innovation et qui encourage la cohérence et la coopération entre les différents ministères et agences concernés. Le gouvernement devrait confier cette tâche à un Comité consultatif sur la politique de l'innovation spécialement créé, qui serait représentatif de l'ensemble des acteurs du système d'innovation et bénéficierait de l'appui d'un service de collecte d'informations.

- *Examiner la répartition du soutien aux entreprises entre les secteurs actuellement en pointe et les secteurs émergents.* Les enquêtes sur l'innovation montrent qu'il existe un grand nombre d'entreprises de haute technologie dans les secteurs dits de faible niveau technologique. Plus généralement, ces secteurs pourraient améliorer considérablement leur productivité à travers l'application des sciences et technologies avancées[16]. Entre autres objectifs, il faudrait améliorer l'exploitation des avantages potentiels sur les marchés de créneau, promouvoir l'exploitation commerciale des domaines de recherche scientifique où la Nouvelle-Zélande a su développer des capacités de classe mondiale, et encourager l'innovation dans les secteurs où les entreprises néo-zélandaises disposent d'une clientèle substantielle. Les auteurs de l'examen s'attendent à ce que cet exercice débouche sur l'octroi d'un soutien accru aux secteurs n'appartenant pas aux industries traditionnellement définies comme « de haute technologie ».

- *Soutenir les changements obtenus à travers une augmentation modeste du soutien de l'État à la recherche fondamentale*, à la recherche appliquée et aux activités d'innovation commerciale. Éviter toute augmentation brutale des financements accordés aux activités scientifiques, technologiques et d'innovation, tant pour des raisons de prudence budgétaire que parce que les possibilités d'utiliser ces ressources de manière efficiente à court terme sont limitées.

- *Envisager d'accroître le financement des recherches stratégiques*, en particulier des recherches pluridisciplinaires qui poursuivent un objectif pratique et des recherches qui contribuent à améliorer aussi bien les

16. Pour en savoir plus sur l'innovation dans les secteurs dits de faible niveau technologique, voir von Tunzelmann et Acha (2005). La démarcation entre les secteurs est souvent arbitraire et, du fait de l'innovation technologique, se modifie souvent plus rapidement que les classifications statistiques officielles qui essaient de les définir.

connaissances scientifiques que les connaissances techniques utilitaires (technologies de base). Par conséquent, il faudrait encourager les organismes de financement à adopter une approche plus stratégique que celle fondée sur l'examen académique par les pairs pour sélectionner les projets pertinents.

Pilotage et financement des organismes de recherche publics[17]

Depuis quelques années, le financement des organismes de recherche publics repose largement sur le principe de contestabilité et la part des financements véritablement stables est exceptionnellement faible.[18] En dépit des nombreux mérites de cette approche, le recours excessif aux appels à la concurrence, pour des périodes de financement relativement courtes, peut entraîner des coûts de transaction élevés et produire des effets indésirables, comme l'atteste l'expérience de certains CRI. En réduisant la prévisibilité des financements futurs, cette approche peut porter préjudice au déroulement des carrières et au maintien d'effectifs suffisants dans les domaines scientifiques et technologiques, faire obstacle à l'accumulation de connaissances fondamentales et fausser la composition du portefeuille d'activités des ORP, notamment au détriment de l'ingénierie. Le caractère incertain du financement peut inciter les directeurs de recherche à multiplier leurs candidatures aux appels d'offres, au risque d'éloigner progressivement les instituts concernés de leur mission fondamentale et de leur domaine de compétences. Il est nécessaire de garantir des conditions stables à la recherche afin de préserver ses capacités à long terme, qui sont vitales au regard des besoins socioéconomiques futurs de la Nouvelle-Zélande. Cela

17. Pour un examen détaillé des expériences internationales de pilotage et de financement des ORP, voir *The Governance of Public Research – Towards Better Practice* (OCDE, 2003). Cet ouvrage présente un ensemble d'enseignements généraux basés sur l'analyse de systèmes scientifiques archétypaux et de politiques nationales concrètes, pour montrer qu'au-delà de quelques « règles d'or » générales, les politiques de l'OCDE diffèrent en raison des facteurs institutionnels, culturels et historiques qui structurent les systèmes scientifiques nationaux. Il n'existe donc pas de mode de gouvernance optimal auquel chaque pays serait tenu de s'adapter. Il n'en demeure pas moins que les pays de l'OCDE peuvent beaucoup apprendre les uns des autres.

18. Par exemple, non seulement les CRI sont lourdement tributaires des fonds attribués sur concours, mais leurs autres sources de financement ne peuvent pas réellement être assimilées à des financements de base. Ainsi, durant les premières années, le Non-Specific Output Funding (NSOF, Financement de produits non spécifiques) était lié au montant des fonds obtenus à l'issue des appels à la concurrence de la FRST, ce qui signifie que le montant du NSOF en proportion du financement total des CRI diminuait lorsque les recettes commerciales des instituts augmentaient. Depuis l'introduction de la nouvelle formule, qui a vu le NSOF remplacé par un Capability Fund, l'assiette de référence pour l'octroi des fonds a été élargie (ensemble des revenus de recherche publics) mais reste liée au fonds alloués sur concours.

étant, une proportion de financements garantis trop élevée peut conduire à un certain relâchement des comportements et rendre les instituts indifférents aux besoins des secteurs public et privé qu'ils sont censés satisfaire. La Nouvelle-Zélande doit trouver un meilleur équilibre entre les deux types de financement, qui irait dans le sens des objectifs à long terme que les bailleurs de fonds entendent soutenir[19].

- *Le financement de base des Crown Research Institutes (CRI) doit être augmenté*, pour atteindre de l'ordre d'un tiers à la moitié de leur budget global. Une augmentation des financements de base, régie par des accords de cinq à sept ans avec l'État, permettrait de soutenir les activités des CRI qui ne s'adressent pas immédiatement à des clients extérieurs directs mais qui n'en sont pas moins utiles. Ces activités incluent la recherche à long terme, qui peut profiter à un large éventail de secteurs et dont les CRI sont les mieux à même d'évaluer les avantages potentiels, la recherche axée sur les capacités d'accumulation de connaissances au sein du CRI lui-même, la formation du personnel, etc. Récemment, le gouvernement néo-zélandais a annoncé une initiative qui devrait marquer un progrès dans ce sens[20].

19. L'histoire du financement des organismes de recherche et de technologie (ORT) au Royaume-Uni illustre les effets de différents régimes de financement. Un grand nombre de ces organismes ont démarré leurs activités en tant qu'associations coopératives de recherche à but non lucratif. Celles-ci s'adressaient aux secteurs plutôt traditionnels et recevaient un soutien institutionnel significatif de l'État pour mener à bien leur mission. Cependant, au fil des années, elles ont relâché leurs efforts et sont devenues moins attentives aux besoins de leur public-cible, en conséquence de quoi leur financement a été considérablement réduit pour se limiter à un soutien à quelques programmes spécifiques parrainés par l'État. Ce tournant a été suivi d'une série de fusions, de cessations d'activité et de l'émergence d'un petit nombre d'organismes de recherche à vocation commerciale extrêmement performants. Cependant, avec le temps, ces derniers sont devenus de moins en moins enclins à investir dans les capacités requises pour mettre en œuvre les programmes de soutien public axés sur les entreprises ayant le plus besoin d'aide, dont la plupart ne constituaient pas des clients commerciaux prometteurs. Les ORT britanniques les plus performants sont devenus des entreprises de recherche concurrentielles au plan international, qui recrutent leurs clients les plus lucratifs et les plus exigeants à l'étranger. Trouver le bon équilibre entre les différents régimes de financement demande quelques tâtonnements. De plus, comme il faut un peu de temps aux instituts de recherche pour adapter leur comportement, une période de fluctuations est parfois inévitable.

20. Dans un premier temps, cette initiative concernera trois programmes de la FRST – le NERF, RfI et la recherche environnementale. Jusqu'à 30 % des investissements futurs dans ces programmes seront effectués selon ces modalités. Un examen sera réalisé ultérieurement pour déterminer s'il y a lieu d'étendre l'initiative. Par ailleurs, cet examen sera l'occasion d'examiner les moyens de réduire au minimum les coûts d'évaluation et de mise en conformité et de rendre la durée de financement plus prévisible.

- En marge de l'augmentation des financements de base et des financements à long terme, *chaque CRI devrait être pourvu d'un système d'énoncés de mandats, d'objectifs et d'indicateurs de performances adéquat*, convenu entre l'institut et le gouvernement[21].Ces indicateurs de performances devraient mesurer principalement l'impact des recherches, les performances en termes de commercialisation et les activités de transfert de technologie. La publication récente, par la Crown Company Monitoring Advisory Unit (CCMAU), d'une série d'indicateurs d'application de la recherche mesurant l'impact des travaux de recherche des instituts, est une initiative opportune de ce point de vue.

- *Utiliser ces indicateurs pour évaluer les performances des CRI régulièrement*, par exemple tous les cinq ans. Ces examens seraient distincts des évaluations des programmes de recherche individuels des CRI, mais ils s'en inspireraient. Le ministère de la Recherche, de la Science et de la Technologie et la CCMAU seront amenés à jouer un rôle majeur dans toutes ces évaluations, mais une partie au moins des évaluations individuelles des CRI devraient être adjugées à des organismes extérieurs.

- Établir une procédure de révision ou d'actualisation des énoncés de mandats, des objectifs et des indicateurs de performances à la lumière de l'évolution des circonstances ou des résultats des évaluations.

- *Encourager les CRI à offrir des formations appropriées à leurs employés*, pour que ceux-ci soient plus aptes à traiter avec des utilisateurs finals commerciaux.

- *Faire de l'octroi de licence aux entreprises commerciales le mode privilégié d'exploitation des résultats des recherches des CRI*. Il est inutile que les CRI établissent de nouvelles entreprises dès lors qu'il existe déjà dans le pays des entreprises capables d'exploiter les technologies concernées.

- *Maintenir le* Performance-Based Research Fund *(PBRF, Fonds pour la recherche axé sur les performances)*, qui contribue à améliorer la qualité des recherches universitaires. Toutefois, même s'il est encore trop tôt pour évaluer pleinement l'impact de cet outil, il apparaît d'ores et déjà

21. Les auteurs de cet examen sont conscients que la Nouvelle-Zélande a déjà mis en place un système pour fixer les orientations stratégiques et les priorités des CRI. Cependant, nos conversations avec les représentants des CRI nous ont donné l'impression que ce système ne remplissait pas entièrement sa fonction de guidage, ou qu'il nécessitait un minimum d'adhésion de la part des CRI eux-mêmes. Toute réévaluation du rôle des CRI ou du régime de financement devra s'accompagner d'un regard neuf sur leur mode de gouvernance.

que le PBRF devrait mieux prendre en considération l'impact des recherches, leur commercialisation et les interactions avec l'industrie et les utilisateurs de la recherche, et, le cas échéant, rétribuer les performances correspondantes de manière adéquate.

- *Améliorer le mode de financement des infrastructures de recherche des ORP (CRI et établissements d'enseignement supérieur)*, notamment en ce qui concerne les règles d'amortissement des installations de grande dimension[22].

- *Surveiller étroitement le niveau des salaires des scientifiques qui travaillent à l'université et dans les CRI.* Le niveau relativement bas des salaires des universitaires, qui ne reflète pas les conditions du marché affectant les différentes disciplines, risque de réduire l'attrait de la Nouvelle-Zélande pour l'élite intellectuelle et scientifique et d'entraîner, à terme, une érosion des capacités nationales en matière de recherche scientifique et appliquée.

- *Se fixer comme objectif à moyen ou à long terme de consolider le secteur public de la recherche.* Actuellement, les ORP (établissements d'enseignement supérieur et CRI) sont peut-être trop nombreux et éparpillés sur un trop grand nombre de sites. Une première étape utile consisterait à évaluer les coûts et avantages du mode de localisation et de répartition actuel. À court terme, la Nouvelle-Zélande devra utiliser toutes les possibilités offertes par les technologies de communication modernes pour accroître les économies d'échelle et de gamme au moyen des réseaux virtuels.

- *Adopter une approche plus systématique en matière d'évaluation* ex ante*, de suivi et d'évaluation* ex post *des chercheurs*, des institutions de recherche et des programmes d'action[23]. Si certaines procédures d'évaluation sont de bon niveau, et même continuellement améliorées (comme le PBRF par exemple), ce n'est pas le cas pour d'autres. Il y a lieu en particulier d'améliorer l'évaluation des institutions et des programmes – qui, en l'état actuel, relève parfois presque de l'auto-évaluation – notamment en faisant davantage appel aux experts internationaux. Le Comité consultatif sur la politique de l'innovation dont nous avons recommandé la création plus haut pourrait jouer un rôle

22. Dans sa déclaration du 4 mai 2006, le ministre de la Science, de la Recherche et de la Technologie a proposé d'améliorer le degré de certitude des financements destinés aux infrastructures « de base ».

23. L'initiative récente sur la stabilisation du financement (Stable Funding) prévoit un « examen technique » marquant l'instauration d'une procédure d'évaluation *ex ante*.

majeur dans ce domaine, en faisant fonction de centre d'échange d'informations sur l'évaluation.

Améliorer l'efficacité du financement sur concours de la recherche

Compte tenu du poids des financements sur concours dans le financement public de la recherche, les agences de financement concernées et leurs programmes jouent un rôle clé dans le système d'innovation. Ces agences sont raisonnablement diversifiées et utilisent une large palette d'instruments de financement, à même de satisfaire les besoins les plus variés : soutien non spécifique à la recherche de qualité, recherche dans des domaines précis (par exemple la santé), consortiums de recherche, centres d'excellence, etc. Cependant, au niveau des programmes, la division du travail entre les agences est moins claire. Face à un problème unique, elles ont tendance à vouloir toutes fournir leur propre solution. Il en résulte une multiplication des programmes, des recoupements partiels et un manque de financement pour certaines initiatives. Par ailleurs, le fonctionnement de certaines agences pourrait être amélioré moyennant quelques ajustements.

- *La Foundation for Research, Science and Technology (FRST, Fondation pour la recherche, la science et la technologie)*, qui rend compte au ministère de la Recherche, de la Science et de la Technologie, est une organisation bien gérée aux antécédents solides. Elle joue un rôle dominant dans le financement de la recherche stratégique destinée à des utilisateurs finals identifiés. Néanmoins, la FRST gagnerait à être mieux dotée financièrement et à rationaliser quelque peu son portefeuille de programmes, dont certains sont potentiellement sous-financés. Les procédures de dépôt de candidature doivent être simplifiées et les délais de prise de décision raccourcis.

- Géré par la FRST, *Research for Industry (RfI, Recherche pour l'industrie)* est un outil précieux qui guide les CRI dans le processus de financement sur concours. Cependant, il serait souhaitable de clarifier son architecture globale en lui conférant le statut de programme (et non plus de « classe de produits », « output class »). Par ailleurs, le renforcement de la participation des entreprises (au-delà de leur participation dans les consortiums de recherche) amplifierait l'impact produit sur l'innovation dans la communauté économique. De même, il serait utile de faire participer davantage les universités, pour pouvoir exploiter davantage leur capacité à effectuer des recherches de grande qualité et économiquement pertinentes.

- *Research Consortia (Consortiums de recherche)*, qui fait partie de Research for Industry, est une initiative méritoire qui a pour but de promouvoir les partenariats de recherche public-privé. Cependant, les possibilités de partenariat qu'elle a identifiées jusqu'à présent ne sortent pas du domaine de la recherche agricole. Cela pourrait être dû en partie à sa conception. Le mode de gouvernance et les critères d'admissibilité gagneraient, le cas échéant, à être révisés. S'agissant de ces derniers, une solution pourrait consister à accepter des consortiums plus restreints pour une durée initiale de trois ans, avec possibilité de prorogation du soutien financier en cas de réussite.

- *Le New Economy Research Fund (NERF, Fonds pour la recherche sur la nouvelle économie)*, également géré par la FRST, est fondamentalement un bon programme qui pourrait être étendu. Son emploi est tout indiqué, en particulier, pour renforcer le soutien aux recherches pluridisciplinaires poursuivant un objectif pratique et aux recherches stratégiques qui contribuent à améliorer aussi bien les connaissances scientifiques qu'utilitaires. Pour ce faire, certains problèmes doivent néanmoins être résolus : *i)* le problème de l'amortissement (qui revêt certes un caractère générique) ; et *ii)* les obstacles à la commercialisation par les entreprises du produit des recherches financées par le NERF.

- Administré par la Royal Society of New Zealand, *le Marsden Fund* joue un rôle essentiel dans le soutien à la recherche d'excellence *blue sky* (c'est-à-dire la recherche fondamentale à très long terme), ce qui est important pour garantir que la Nouvelle-Zélande ne passera pas à côté d'occasions inattendues. Si l'on veut augmenter les probabilités de succès et d'impact élevé de la recherche et faire en sorte qu'elle produise d'importantes retombées positives sur la société, il faudrait doter le Marsden Fund de fonds supplémentaires. Par ailleurs, cette augmentation budgétaire devrait être accompagnée d'efforts accrus visant à sensibiliser le public à l'importance de la recherche fondamentale.

- *Les Centres of Research Excellence (CoRE, Centres d'excellence en recherche)*, qui sont gérés par la Tertiary Education Commission (TEC, Commission de l'enseignement supérieur), ont le mérite de récompenser les meilleurs groupes de recherche. Néanmoins, compte tenu de leur structure de financement, il n'est pas certain qu'ils puissent atteindre leur objectif déclaré d'établir des liens plus solides avec les utilisateurs finals potentiels, au-delà de ce que peuvent faire les ORP participants.

- *Partnerships for Excellence (PfX, Partenariats pour l'excellence)* est une autre initiative récente de la TEC qui a pour objectif d'accroître les investissements du secteur privé dans l'enseignement supérieur et d'améliorer les liens entre l'enseignement supérieur et les entreprises. La gamme des dépenses admissibles à un soutien du PfX est large, allant des investissements dans les bâtiments aux dépenses liées aux bourses et aux chaires d'enseignement. Pour éviter d'éventuels chevauchements avec d'autres programmes, notamment Research Consortia, il est important que le soutien du PfX reste focalisé sur la promotion des investissements privés dans l'amélioration de l'environnement et des infrastructures de recherche des universités, plutôt que sur l'encouragement à la coopération dans la recherche.

Promouvoir l'innovation dans le secteur des entreprises

S'il est nécessaire d'améliorer les conditions-cadres de l'innovation (voir ci-dessus), un soutien public plus spécifique est également justifié. Une partie de ce soutien est acheminée par le biais des organismes de recherche publics (voir les recommandations ci-dessus sur la manière dont les ORP pourraient améliorer leurs services en faveur de l'innovation des entreprises). Comme d'autres pays de l'OCDE, la Nouvelle-Zélande a mis sur pied différents programmes qui ont pour but de corriger les défaillances du marché affectant en particulier les petites entreprises innovantes. La plupart de ces programmes sont gérés par le ministère du Développement économique, mais d'autres ministères, en particulier celui de la Recherche, de la Science et de la Technologie, sont actifs dans ce domaine. L'un des défis, en l'occurrence, consiste à satisfaire les besoins d'une population d'entreprises hétérogène en mettant en œuvre un ensemble de mesures suffisamment différenciées mais qui ne soient pas trop coûteuses ni trop lourdes pour autant. Un autre défi est d'atteindre les entreprises qui ne sont pas encore très innovantes et qui ont du mal à identifier leurs besoins. Comme tous les autres pays de l'OCDE, la Nouvelle-Zélande n'a pas entièrement réussi à relever ces défis.

- *Améliorer le portefeuille d'instruments de financement.* À l'heure actuelle, il y a trop de petits programmes de soutien à l'innovation en Nouvelle-Zélande, et leurs règles et objectifs sont trop diversifiés. Des programmes moins nombreux et mieux dotés financièrement permettraient d'améliorer la qualité moyenne des projets soutenus et de répartir le soutien financier à l'innovation plus uniformément dans le temps. Par ailleurs, cette rationalisation entraînerait des économies sur les coûts d'administration et de mise en conformité.

- *Envisager l'introduction d'un dispositif d'incitation fiscale à la R-D, en s'inspirant des meilleures pratiques internationales.* Le système actuel de soutien financier public à la R-D et à l'innovation repose exclusivement sur les subventions. D'après l'expérience internationale, les incitations fiscales à la R-D, lorsqu'elles sont bien conçues, sont de nature à encourager les efforts de R-D financés par des fonds privés. Elles peuvent également envoyer un signal puissant capable de se transmettre à tous les niveaux du système, y compris les PME et les entreprises multinationales à forte intensité de R-D.

- *Adapter le panachage des mesures en conséquence.* L'introduction d'une incitation fiscale à la R-D permettrait de rationaliser le système de soutien public à la R-D et de parvenir, à travers chaque instrument, à un dosage des mesures plus équilibré. Les autorités pourraient éliminer la multitude de petites subventions à la R-D qui existent actuellement et les remplacer par un système plus ciblé de subventions plus élevées, réservées à un nombre plus restreint d'initiatives hautement méritoires. Cela contribuerait à améliorer le rapport coût-efficacité des subventions à la R-D.

- *Améliorer la coordination entre agences.* La rationalisation du système de subventions à l'innovation devrait à la fois contribuer à améliorer la coordination entre les différents ministères concernés, en particulier le ministère de la Recherche, de la Science et de la Technologie et le ministère du Développement économique, et être elle-même facilitée par cette coordination renforcée. Les deux ministères doivent rester étroitement impliqués. Il appartient au ministère du Développement économique de jouer le rôle de chef de file dans le soutien aux activités d'innovation proches du stade de la commercialisation, et au ministère de la Recherche, de la Science et de la Technologie de se focaliser davantage sur la recherche pré-compétitive mais aussi de promouvoir le retour d'informations de l'innovation commerciale vers la recherche fondamentale. S'agissant de l'encouragement à la diffusion et à l'adoption des technologies, il est nécessaire de renforcer les synergies entre les programmes de New Zealand Trade and Enterprise et les programmes pertinents de la FRST, notamment les activités de Technology New Zealand.

- *Renforcer l'ouverture à l'extérieur de Technology New Zealand.* Les programmes de Technology New Zealand jouent un rôle utile d'encouragement à la création de réseaux entre les acteurs nationaux. Cependant, il serait souhaitable que les ressources supplémentaires mises à leur disposition soient consacrées, de préférence, à l'établissement de liens internationaux.

- *Consolider les programmes de New Zealand Trade and Enterprise (NZTE)*, qui apportent un soutien très précieux aux activités d'innovation des entreprises, y compris la conception, en aidant les PME en particulier à accéder aux services techniques, de formation et de conseil et aux marchés d'exportation. Encore une fois, les subventions sont souvent trop restreintes pour produire un impact significatif en l'état actuel.

- *La Nouvelle-Zélande devrait adopter une stratégie plus claire en ce qui concerne le soutien au développement des infrastructures clés pour l'innovation.* Certaines institutions contribuent à amplifier l'efficience du soutien public à l'innovation. Par exemple, les pépinières d'entreprises aident les entrepreneurs à traduire leurs projets en entreprises commerciales, tandis que les grappes aident les entreprises à surmonter le handicap de leur petite taille en coopérant entre elles et à établir des relations de travail avec les institutions du savoir. La Nouvelle-Zélande semble avoir nourri quelques hésitations vis-à-vis de la politique à suivre en matière de développement des grappes d'entreprises, et les résultats réels des pépinières en termes d'innovation font visiblement débat[24].

24. Par exemple, le Cluster Development Programme de NZTE a été supprimé.

Tableau synthétique : Forces, faiblesses, possibilités et menaces dans le système d'innovation de la Nouvelle-Zélande

Forces	Possibilités
• Une population imaginative et entreprenante • Un environnement physique unique, propice au travail, au tourisme, à la pratique sportive, et où il fait bon vivre • Des marchés de produits et du travail performants • Une forte présence dans les secteurs primaires tels que l'agriculture, la sylviculture et la pêche, et quelques atouts dans les secteurs et services associés • Un système éducatif de qualité et un niveau d'innovation raisonnablement élevé • Des établissements d'enseignement supérieur et des organismes de recherche publics relativement performants • La conviction que la science et la technologie sont importantes pour satisfaire les objectifs socioéconomiques, y compris les objectifs écologiques • Des atouts dans le domaine de la biotechnologie agricole et de la recherche sanitaire • Des poches d'excellence dans les secteurs à croissance rapide tels que les logiciels et les industries créatives, ainsi que les sciences qui les sous-tendent • Une société ouverte qui encourage la confiance et un cadre d'action clair et ouvert • Une société qui voit dans la diversité culturelle une source d'innovation	• Exploiter davantage les possibilités d'innovation à valeur ajoutée dans le secteur primaire et les secteurs associés • Continuer à exploiter le potentiel d'augmentation de la productivité et de la croissance par l'innovation dans les secteurs émergents • Exploiter les atouts scientifiques et technologiques du pays dans les secteurs basés sur les ressources et les services à valeur ajoutée associés (application des TIC dans divers secteurs par exemple) • Exploiter les avantages environnementaux du pays de manière plus efficiente • Renforcer la connectivité internationale et l'accès aux connaissances sur les marchés internationaux, par exemple en améliorant l'utilisation des TIC, en mettant à contribution la diaspora néo-zélandaise et en utilisant les connaissances des immigrants sur leur pays d'origine
Faiblesses	**Menaces**
• Un PIB par habitant à la traîne et un niveau et un taux de croissance de la productivité relativement bas en comparaison de la moyenne de l'OCDE • Un marché national restreint, où les petites entreprises sont prépondérantes • Un isolement relatif vis-à-vis des marchés mondiaux et des processus de mondialisation • Des infrastructures physiques et virtuelles insuffisantes (Internet à large bande, énergie, transport) • Des investissements insuffisants dans la R-D des entreprises, conjugués à un manque de financements externes pour la R-D et l'innovation des entreprises • Un système de soutien public à la R-D et à l'innovation fragmenté, combiné au manque de cohérence des diverses politiques liées à l'innovation • L'inadéquation des incitations adressées aux organismes de recherche publics, qui freine le développement des capacités à long terme, le financement des infrastructures de recherche et le transfert des résultats de la recherche aux entreprises • Des processus de diffusion des technologies imparfaits • Des obstacles à la croissance des entreprises, y compris la préférence de nombreux entrepreneurs pour les activités axées sur l'épanouissement personnel (*lifestyle businesses*)	• Risque de stagnation des niveaux de vie, dû à une productivité relativement faible • Marginalisation de la Nouvelle-Zélande en tant que destination potentielle pour les investissements internationalement mobiles dans l'innovation • Détérioration des capacités à long terme des organismes de recherche publics du fait, en particulier, des salaires non compétitifs (selon les critères internationaux) des professeurs et des scientifiques • Fuite accélérée de la main-d'œuvre hautement qualifiée et des entrepreneurs

Chapter 1

INNOVATION AND ECONOMIC PERFORMANCE

1.1. Macroeconomic performance

In the past two decades New Zealand has undergone a profound process of economic reform. Macroeconomic and structural policy reforms and a policy stance that fosters openness have contributed to creating well-functioning markets, including a flexible and responsive labour market, and a generally favourable business environment. These efforts have prepared the ground for New Zealand's favourable overall economic performance, low inflation and sound public finances.

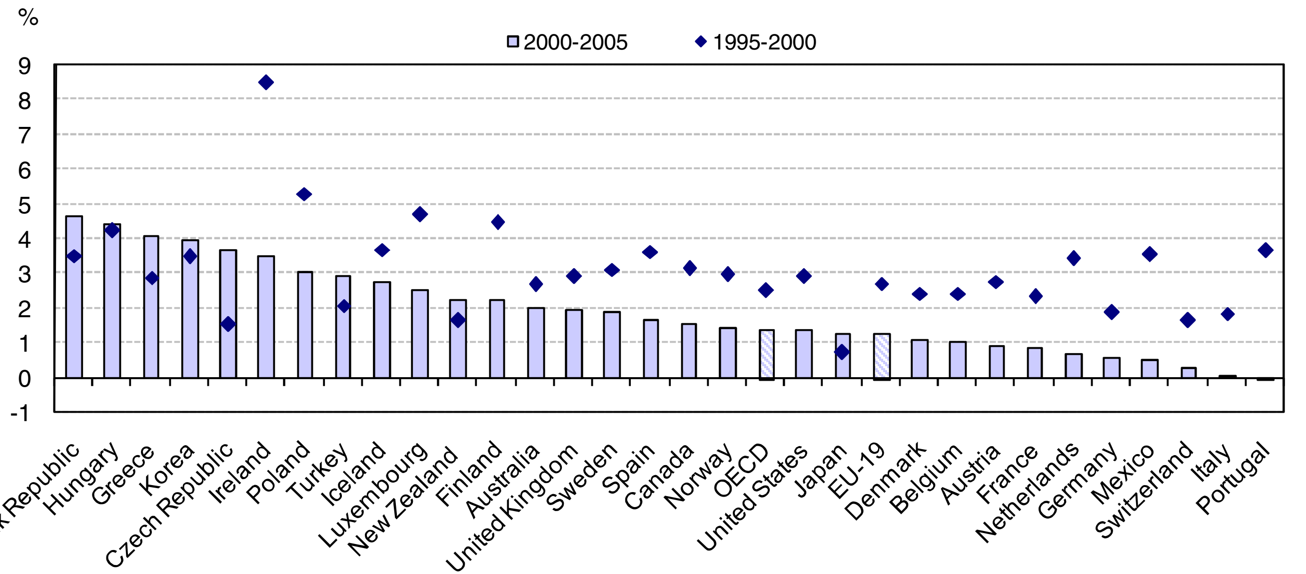
In the medium term, New Zealand's growth performance has indeed been relatively strong by international standards. Between 1994 and 2004 real GDP grew faster than the average in the OECD area. Following the dip that occurred in 1998 in the wake of the Asian crisis, economic growth picked up sharply in the first years of the new millennium with GDP expanding at about 4% a year. Growth slowed to 2% in 2005 and is estimated to have been between 1.5 and 2% in 2006 (OECD, 2007). The increase in the potential growth rate in the 1990s was driven by a rapid increase in population owing to positive net migration inflows, an ongoing increase in trend participation rates, decreases in the estimated structural unemployment rate and accelerated growth of the business capital stock (OECD, 2005a, p. 18 ff.).[25]

Growth of GDP per capita also picked up in the 1990s, especially in the years from 1998 to 2004, but has not come close to that of the top-performing OECD countries over an extended period (Figure 1.1).

25. For a detailed analysis of New Zealand's growth performance, see also New Zealand Treasury (2004).

Figure 1.1. Growth in GDP per capita

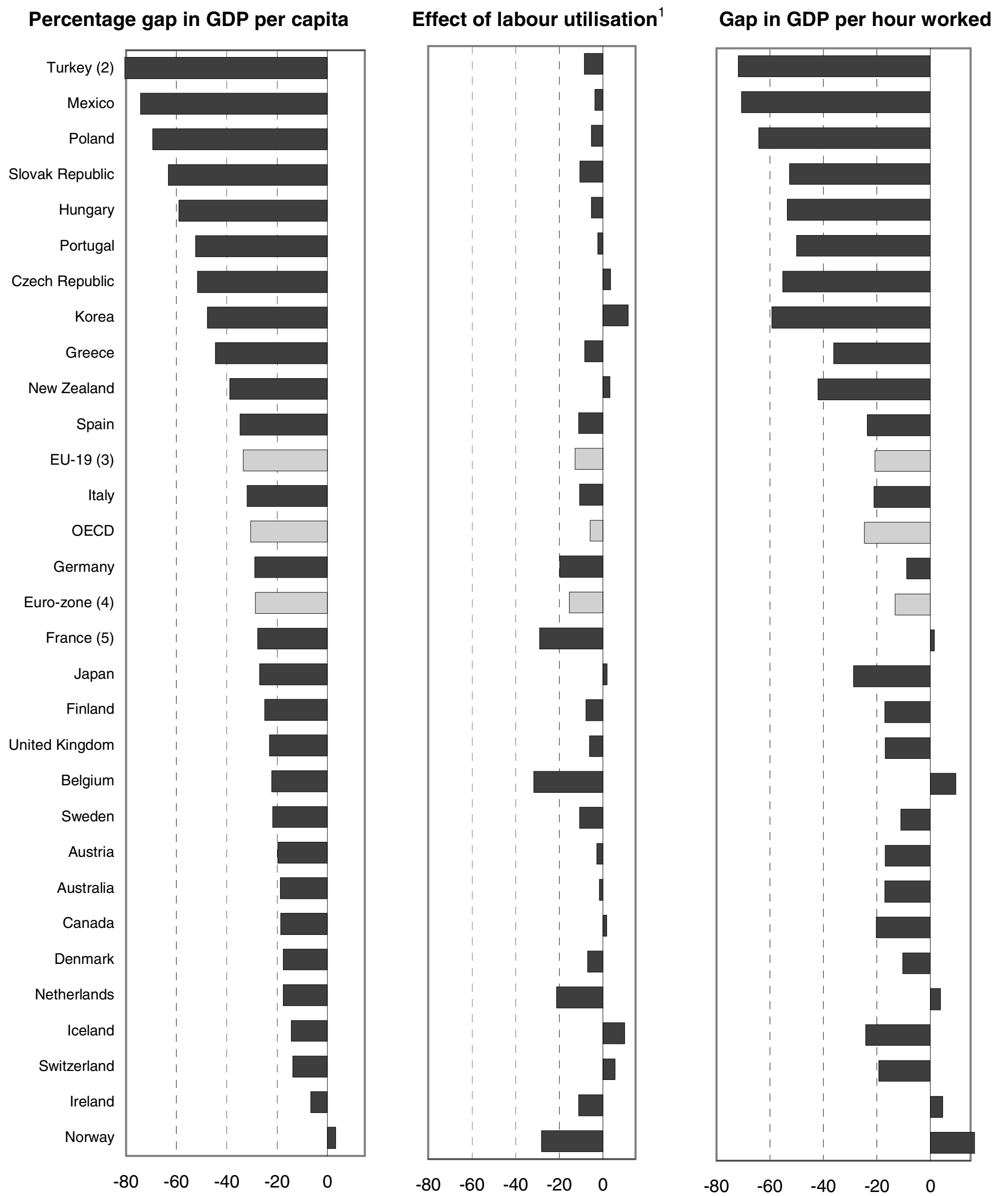
Total economy, percentage change at annual rate



Note: EU19 includes all EU members that are also OECD member countries.
Source: OECD (2006b).

Figure 1.2. Income and productivity levels, 2005

Percentage point differences with respect to the United States



1. Based on total hours worked per capita. 2. GDP for Turkey is based on the 1968 System of National Accounts. 3. EU member countries that are also member countries of the OECD. 4. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain. 5. Includes overseas departments.

Source: OECD (2006b).

Figure 1.3. Catch-up and convergence in OECD income levels, 1950-2005, *United States = 100*

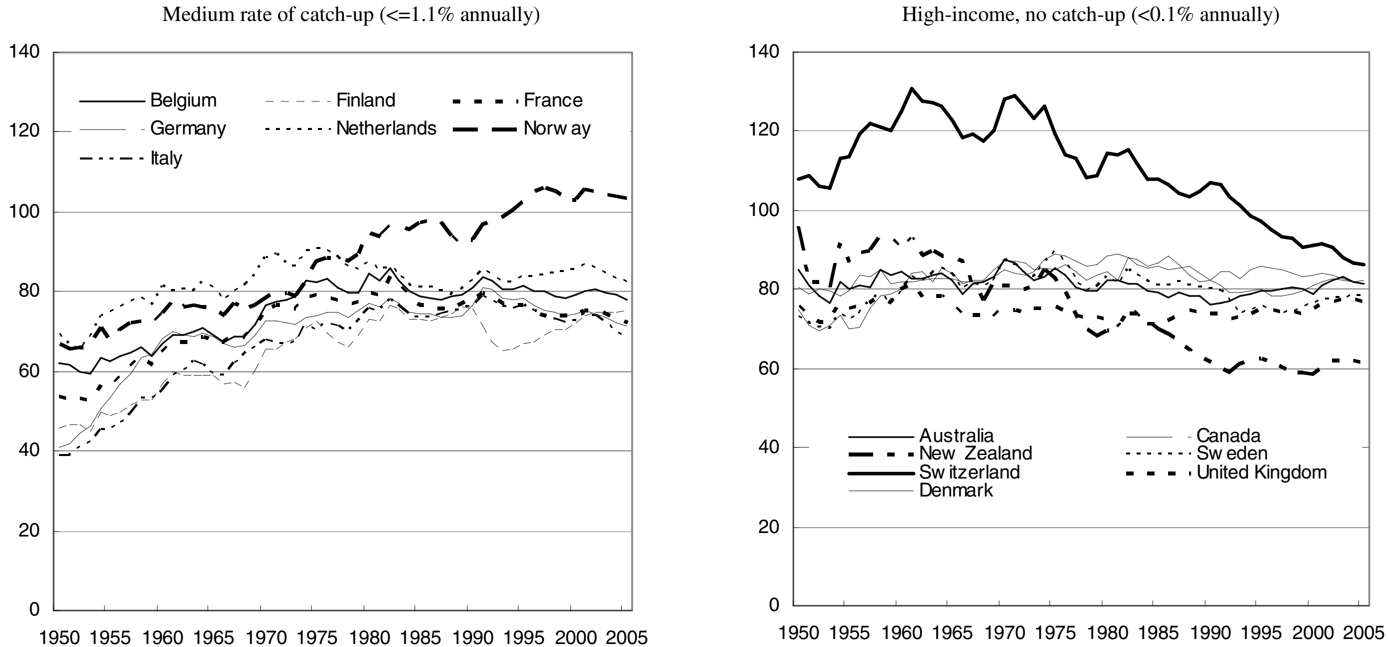
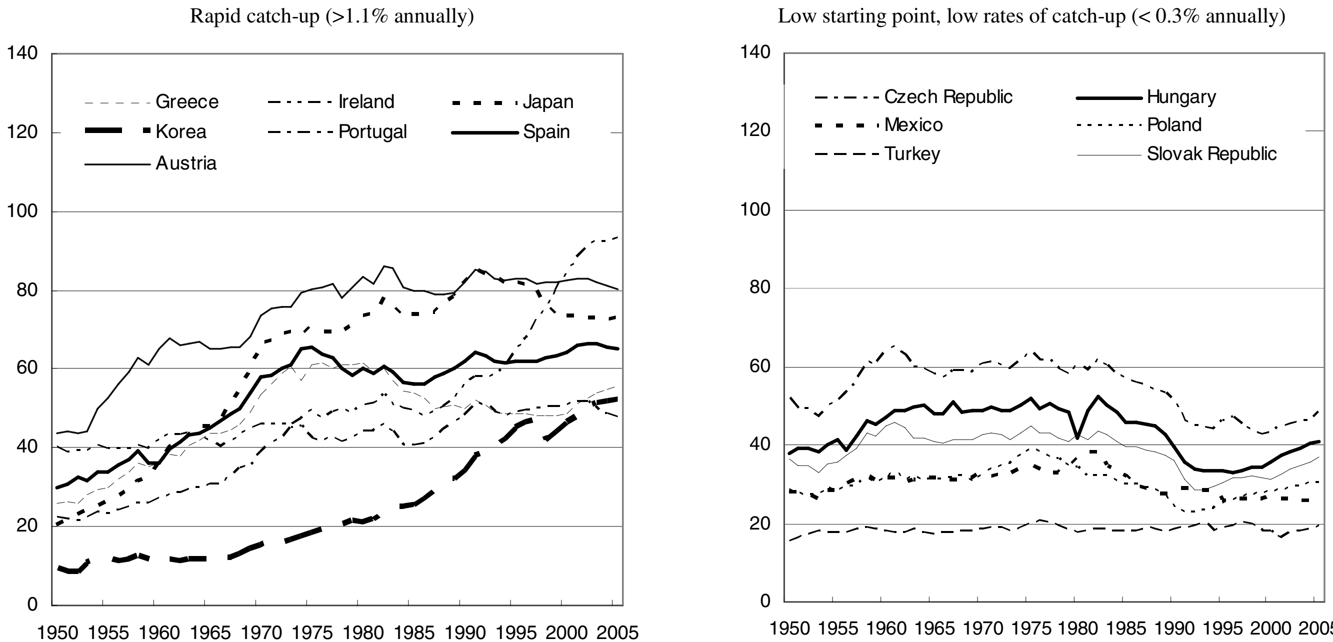


Figure 1.3. Catch-up and convergence in OECD income levels, 1950-2005 (continued), ***United States = 100***



Note: 2005 income levels from Figure 1.1; previous years based on OECD productivity database and Angus Maddison (2001), *The World Economy: A Millennial Perspective*, Development Centre Studies, OECD, Paris. *Source:* OECD (2006b).

Overall, economic performance has improved as compared to the pre-reform period or any likely no-reform scenario. At the same time expectations concerning New Zealand's economic development have not yet been fully met:

- New Zealand still lags behind the OECD average in terms of GDP per capita[26] (Figure 1.2). This is the result of a long-lasting trend: New Zealand has had a long-run decline of GDP per capita relative to the United States (Figure 1.3). The relative decline in income was brought to a halt in the 1990s, but despite New Zealand's sustained efforts at economic reform the trend has not been solidly reversed. Growth of GDP per capita has not been strong enough to allow New Zealand to catch up to the top half of OECD countries.

- New Zealand's economic performance has not kept pace with that of its closest neighbour and most important partner for trade and many other types of interaction, Australia, which is frequently used as a benchmark for the performance of the New Zealand economy.

- Growth of GDP per capita has been driven mainly by increased labour utilisation, not by labour productivity growth. Given New Zealand's already high level of labour utilisation this road to economic growth has obvious limitations in the long run.

- It is sometimes argued that some basic structural features of New Zealand's economy may limit New Zealand's future economic and innovative performance and thus pose a risk for its position in an increasingly globalised world.

The main proximate cause of New Zealand's lagging GDP per capita is its comparatively low level of productivity (see Figure 1.2, based on purchasing power parities – PPP). Hourly labour productivity, for example, is significantly below the OECD average. While productivity estimates differ, depending, for example, on the specific methodology applied and the period of observation, evidence that productivity growth picked up in the second half of the 1990s seems sufficiently robust (OECD, 2005a, p. 26). However, growth of labour productivity has remained one of the lowest among OECD countries (Figures 1.4 and 1.5). New Zealand is among the very few OECD countries in which GDP per hour worked in 2005 was lower than in 1973, relative to the United States. This lacklustre productivity growth has induced debate about the causes (see Box 1.1). A specific aspect of the debate concerns the contribution of R&D to output and productivity growth (see Box 1.2).

26. Its conceptual limitations notwithstanding, GDP per capita still represents a useful indicator of overall well-being. For a discussion of alternative measures of well-being see OECD (2006a).

Box 1.1. The productivity debate

The issue of innovation and economic growth has been taken up in studies of New Zealand's productivity performance. The Treasury, the Reserve Bank and the Ministry of Economic Development (MED) sponsored two productivity workshops in 2002 and 2004, with international speakers invited to give their perspective on New Zealand's situation. The workshops sought to identify reasons for New Zealand's lacklustre productivity growth relative to Australia and other OECD countries. Various papers focused on investment in R&D, physical and human capital and ICT uptake and suggested that weaknesses in these areas may have contributed to New Zealand's relatively low productivity growth.[27]

Earlier studies using growth accounting breakdowns to identify the proximate sources of growth in New Zealand include Black *et al.* (2003). Diewert and Lawrence (1999) estimated multifactor productivity for various sectors of the New Zealand economy for the period 1978-98. One key finding is strong annual growth rates for *i)* communications (6.8%) and *ii)* electricity, gas, and water (3.5%). The authors note that technological improvements in communications appear to have made an important contribution to that sector's productivity growth.

A small number of studies have attempted to look at the effect of information and communication technologies (ICTs) on productivity growth in New Zealand, but the robustness of both data and methodologies has been questioned. Engelbrecht and Xayavong (2006) distinguish between industries with high and low rates of ICT investment, and find mixed evidence of a causal relationship between adoption of ICT and productivity growth. Barker *et al.* (2006) consider the extent to which inter-country productivity gaps are explained by different levels of ICT investment and penetration. Their results suggest that spillovers from the networking and externality effects of ICT are more important drivers of productivity growth than capital deepening, and that differences in ICT uptake explain almost a third of the productivity gap between the United States and New Zealand. Using a more descriptive approach, Parham and Roberts (2004) suggest that a lack of investment, particularly in ICTs, may contribute to New Zealand's low productivity growth relative to Australia.

Possible explanations of the weak productivity growth are discussed in OECD (2005a, pp. 26 ff.).

Source: The papers from the 2004 conference are available at *www.treasury.govt.nz/productivity/.*

27. On the question of ICT uptake in New Zealand, it has to be noted that recent revisions to the estimation procedure for software investment have led to an increase in the measured investment levels. These revised figures, available from Statistics New Zealand, show software investment approximately three times higher than previously estimated.

Box 1.2. The economic impact of R&D

A number of recent quantitative studies examine the relationship between R&D and productivity in New Zealand. In general, these models use times series techniques in order to establish correlation rather than causation between aggregate economic growth and R&D activity (in various sectors).

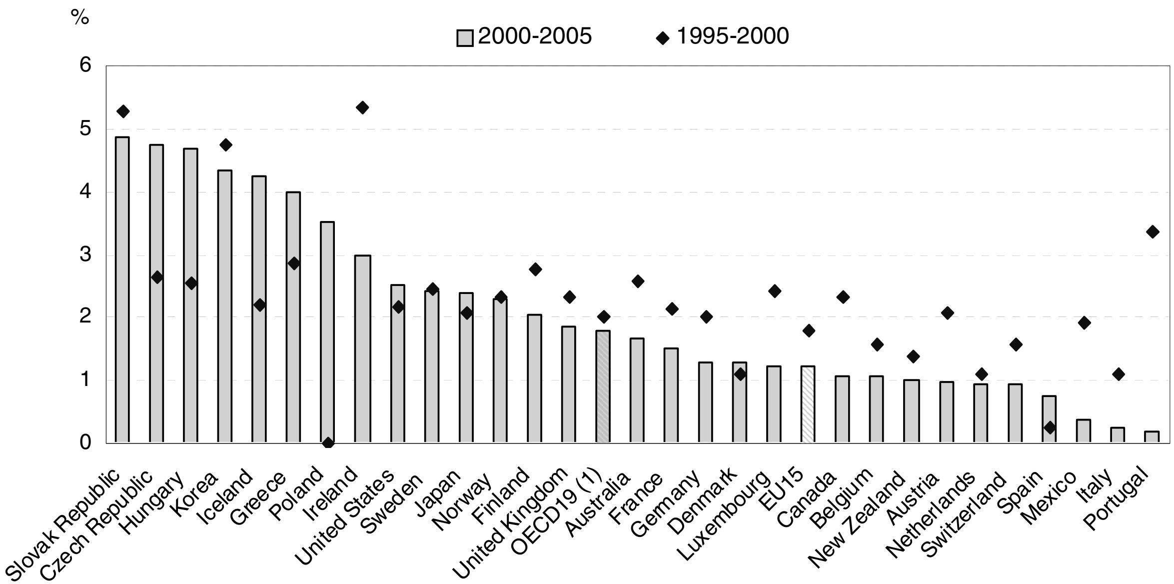
Johnson *et al.* (2006) examine the relationship between privately and publicly performed R&D, and both own-industry and aggregate output across nine industry sectors. The results suggest "reasonably significant" evidence of R&D spillovers from industry to the rest of the New Zealand economy over the period 1963-2000. They find no evidence for spillovers from foreign knowledge, proxied by Australian R&D stocks, and no measurable returns from public R&D. The authors acknowledge that their results should be interpreted carefully and note that their estimates are likely to provide a lower bound, owing to measurement error. See also Johnson (2000a, 2000b) for earlier work on this question.

Scobie and Hall (2006) investigate the contribution of agricultural R&D to productivity growth from 1927 to 2001. The model specification concerns only the agricultural sector, which has a direct and well-understood impact on economic growth for New Zealand. The study found that foreign knowledge stocks (proxied by US patent numbers) are consistently important in explaining productivity growth, and estimated the rate of return to domestic R&D to be around 17% in their preferred model. While the qualitative results appear to be robust, there is a wide margin of error around specific results.

Other studies illustrate the economic impact of specific long-term R&D programmes. Williams (2004) discusses the role of such programmes for enhancing international competitiveness, for producing generic technologies that become important platforms for researchers, for developing new products and processes or improving existing production. Leung-Wai and Nana (2004) show that seismic isolation research over many years has led to hazard mitigation benefits as well as an estimated annual economic impact of 80 full-time equivalent jobs and gross output of about NZD 12 million. A similar study (Jameson *et al.*, 2004) shows that wood drying R&D makes a crucial contribution of NZD 855 million to the competitiveness of annual sawn timber exports. Both studies find that these generic technologies provide a platform for firm formation in high-value niche areas of expertise and foster the development of science-industry linkages, as seen in the work of Scion's Wood Drying Group.

Figure 1.4. Growth in GDP per hour worked, 1995-2000 compared with 2000-05

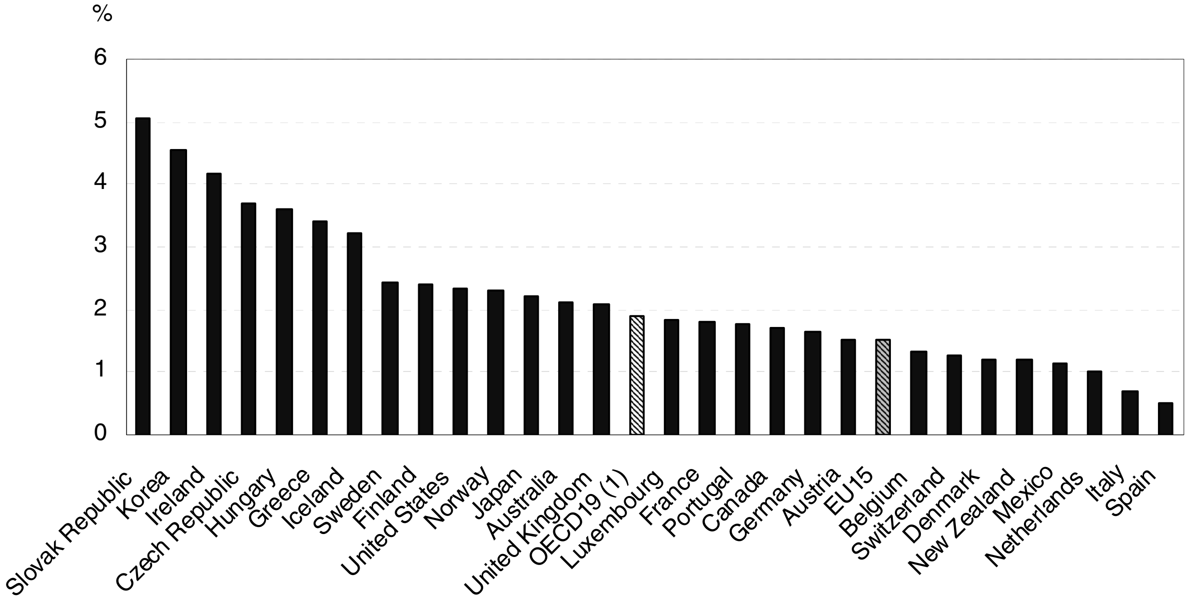
Total economy, percentage change at annual rate



Source: OECD (2006b).

Figure 1.5. Growth in GDP per hour worked, 1995-2005

Total economy, percentage change at annual rate

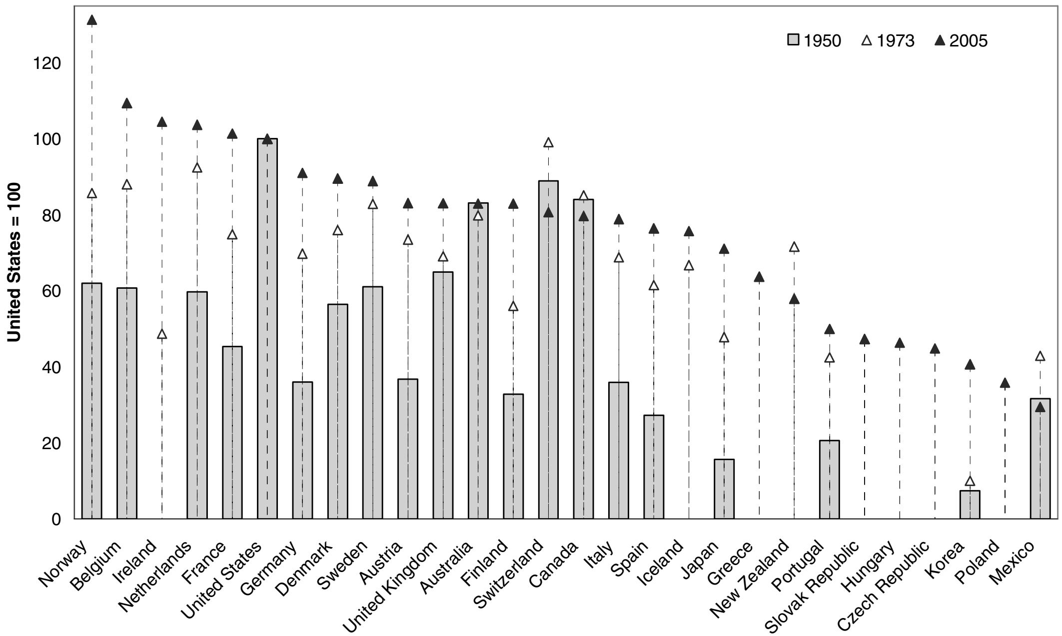


1. OECD19 includes Japan, EU15 and NAFTA.

Source: OECD (2006b).

Figure 1.6. GDP per hour worked in the OECD area, 1950, 1973 and 2005

United States = 100



Source: OECD (2006b).

The New Zealand government seeks to achieve higher income per capita through sustainable growth. Specifically, one of its longer-term objectives has been to lift New Zealand's GDP per capita into the top half of OECD countries. Given these objectives, increasing productivity growth can be seen as the primary policy challenge ahead. In addition to boosting productivity growth, the *OECD Economic Survey of New Zealand 2005* (OECD, 2005a) identified two related policy challenges. The first is further improvement of labour utilisation, especially among under-represented groups. The second is improvement in the area of public finances, in particular "to manage public finances to focus spending on policies and programmes that yield the highest possible social return and contribute most to raising living standards over time" (OECD, 2005a, p. 17). While there is some scope for increasing labour utilisation, the potential is limited and cannot act as a driver of sustainable growth in per capita income. In fact, New Zealand already has one of the highest levels of labour utilisation – defined as the total number of paid hours worked per head – among OECD countries.

For these reasons there appears to be a consensus that boosting productivity growth has the greatest potential as a basis for sustainable real income gains and higher living standards in New Zealand. New Zealand's economic policy actively seeks to increase long-run productivity, which can be addressed in various ways, *e.g.* by raising multifactor productivity growth or increasing capital per worker (capital deepening).

Fostering innovation is a major, sustainable route to boosting productivity growth.[28] Indeed, the New Zealand government's Growth and Innovation Framework (GIF) highlighted the role of innovation in increasing labour productivity, and the new Economic Transformation Agenda, which replaced the former in March 2006, continues the New Zealand government's long-term commitment to improving income per capita through innovation and raising productivity in an environmentally sustainable way.

28 . The role of innovation in economic growth is well recognised in New Zealand. See for example, MED (2005a).

1.2. Structural features and international linkages of the New Zealand economy

New Zealand is a small, resource-based, commodity-exporting economy distant from major international markets. The combination of the absence of a sizeable home market and geographical distance from major markets abroad impinges on the structure and functioning of the economy. The co-occurrence of these factors tends to limit competition and the potential for realising economies of scale and scope and thus for gains from specialisation, and to raise costs for exporters (as well as importers) through higher transport and transaction costs associated with accessing remote markets. The same factors may also pose obstacles to knowledge and information flows. While these impediments can to some extent be mitigated by modern means of transport and communication they remain present. On the other hand, remoteness is the source of some very specific advantages, such as New Zealand's special ecological characteristics which make it a location valued by consumers of a variety of agricultural products, many tourists or, more recently, film makers around the world. In addition it has qualities such as flexibility and a generalist approach in people and institutions, including business firms.

1.2.1. Industry structure

New Zealand's economic structure differs markedly from that of other OECD countries. In particular, the Agriculture, hunting, forestry and fishery sector maintains a high share in total gross value added (9.2% as compared to 2.0% in the OECD on average in 2001/02). The sector's total contribution, including related manufacturing and services activities, is much higher. The agricultural sector's direct contribution to GDP is higher than in most OECD countries (approximately 5% of GDP), and agricultural exports in a broader sense account for close to 60% of New Zealand's merchandise exports.

In line with international trends, the relative share of services has been increasing while that of manufacturing, which was quite limited to begin with, is declining. In contrast to other OECD countries, the share of Community, social and personal services did not increase between 1980 and 2000. The share of the business services sector is similar to the OECD average. Despite the continuing weight of "land-based" industries it should not be overlooked that the New Zealand economy has diversified significantly in the past decades. Structural change also takes the form of shifts in the structure of activities *within* sectors and industries. Indeed significant changes of this kind seem to have taken place.

Invoking the so-called "resource curse", some argue that New Zealand's rich resource base inhibits innovation because firms are able to export large amounts of basic commodities for high profits. This is not necessarily the case (Smith, 2006), but the discussion around this issue indicates that New Zealand requires a "customised" innovation strategy which takes proper account of the specificities of its economy.

1.2.2. Firm size structure

A significant feature of the New Zealand economy is the lack of very large indigenous firms.[29] New Zealand has not succeeded in nurturing very large firms as some other countries have done, including some small countries in rather peripheral (but still comparatively privileged) geographical locations. This appears to be related to basic features of New Zealand, notably the combined effect of the size of its economy and its remoteness from major international markets. Chapter 2 will show in greater detail that by international standards relatively small firms account for a comparatively large share of New Zealand´s business sector R&D investment. Moreover, New Zealand's few larger firms tend to differ from typical large firms in other countries. The largest business R&D investor by far is a primary-sector collective exporter, Fonterra. Fisher and Paykel which performs most of its production abroad is to some degree an exception.

The lack of very large firms, both in the manufacturing and the services sector, has significant implications, including for the innovative performance and development opportunities of other firms but also for the innovation system as a whole. In many countries, networks linking large firms and small and medium-sized enterprises (SMEs) act as powerful drivers of innovation. The lack of firms operating at international scale has a number of other consequences. It implies, for example, that there may be fewer opportunities to develop managerial skills that could have a wider impact on the economy. New Zealand firms mention, among others, the scarcity of management resources as a major obstacle to innovation. Chapter 2 provides more information on issues related to innovation skills.

29. New Zealand does not look different from other countries when "large firms" are conventionally defined (*e.g.* as firms with 250 or more employees) but it looks quite different at the very top end of the firm size distribution.

1.2.3. International linkages

Given its geographical location, size and structure, international connectedness in a variety of dimensions, *e.g.* global market access, inward and outward foreign direct investment, international flows of people and knowledge, is crucial to the future development of New Zealand's economy. As for other countries, the recent acceleration in globalisation holds great opportunities, but also the risk of falling behind if these opportunities are not seized. Indeed there are indications that the integration of New Zealand's economy into the world economy has not kept pace with current trends in globalisation (Skilling and Boven, 2006a, 2006b).

International trade

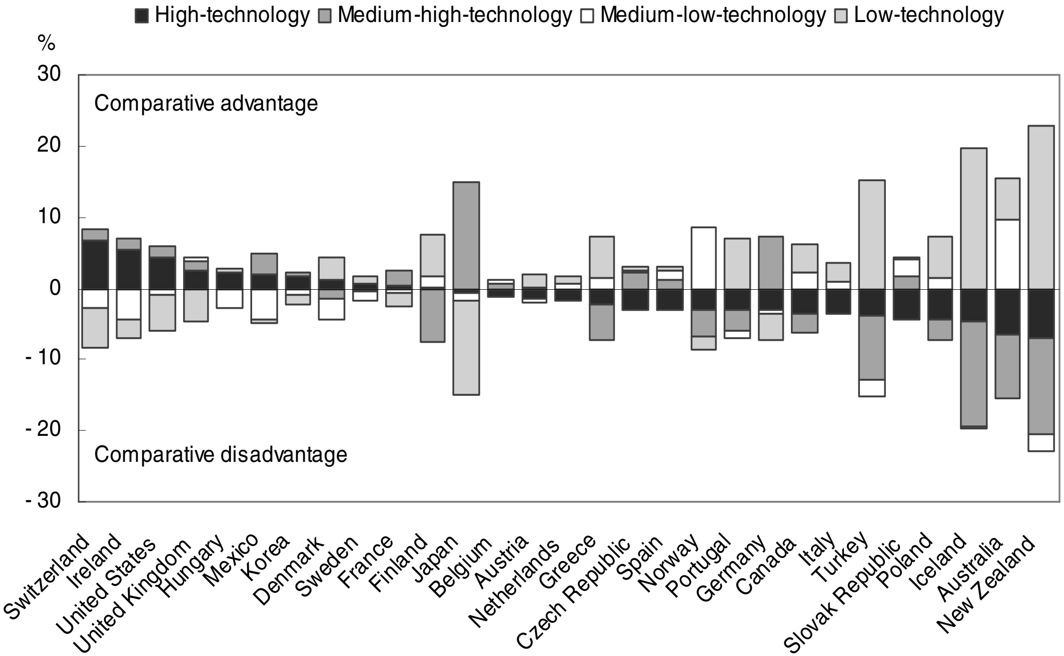
In the recent past, New Zealand's exports of goods and services have not kept up with those of other OECD countries and worldwide. Its exports are still relatively limited, especially for a country of its size, and seem to have changed little. Notably, there is no indication of a sustained upward trend in the ratio of exports to GDP since the early 1990s.

New Zealand's exports – in line with its comparative advantage – continue to rely predominantly on "land-based" merchandise. Its top export items are meat, wool, butter, milk and cream, etc. The share of manufactured products in total exports is quite low. Among manufacturing exports, the share of high-technology and medium-high-technology goods is low despite some growth in the past decade. Only the low-technology segment makes a positive contribution to the manufacturing trade balance; medium-low, medium-high, and especially high technology all show a negative balance (Figure 1.7). The trade balance in ICT goods is strongly negative, equivalent to about 8% of total goods trade in 2003. Services exports are mainly related to tourism and the share of business-related services is quite low.

Just as there are few large firms, there are also very few New Zealand firms involved in significant export activities. In 2005, 50 firms accounted for 58% of total exports (see Chapter 2 for more detail). This also has implications in terms of international flows of knowledge since exporting firms acquire large quantities of economically useful information.

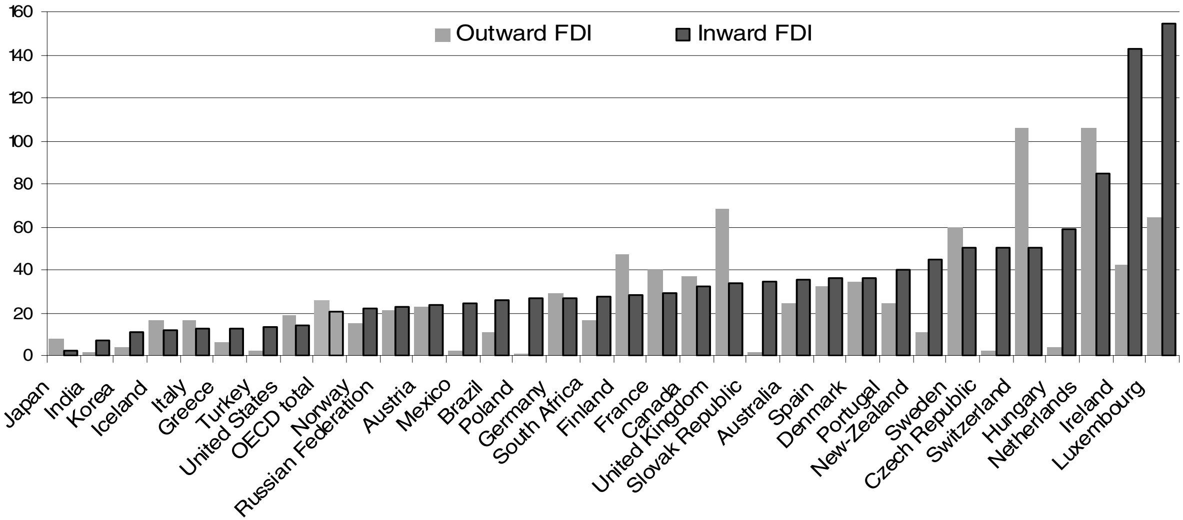
Figure 1.7. Contribution to the manufacturing trade balance, 2003

As a percentage of manufacturing trade



Source: OECD (2005b).

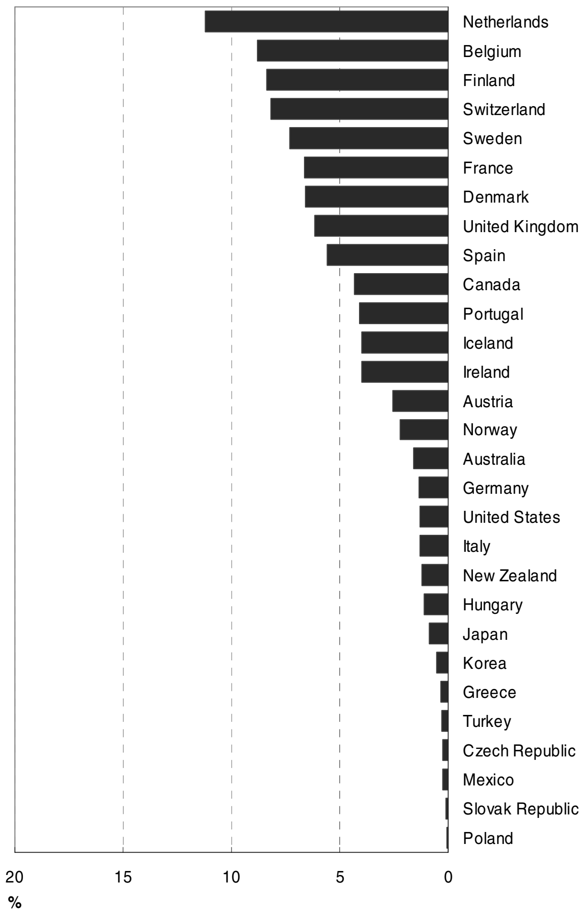
Figure 1.8. FDI stocks, as a percentage of GDP, 2003



Source: OECD Factbook (OECD, 2006c).

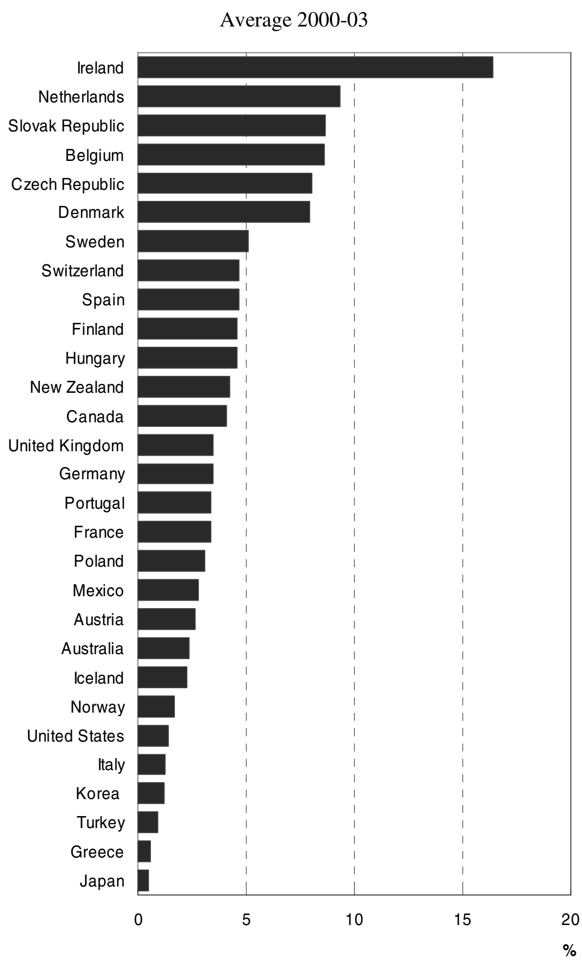
Figure 1.9.
FDI outflows from OECD countries
As a percentage of GDP

Average 2000-03



Source: OECD, International Investment database.

Figure 1.10.
FDI inflows to OECD countries
As a percentage of GDP



Source: OECD, International Investment database.

Foreign direct investment

Outward stocks and flows of foreign direct investment (FDI) are low, significantly lower than corresponding inward FDI figures. New Zealand's stock of outward FDI was just 11.3% of GDP (2003) while the inward FDI stock, at 44.3%, was about four times higher and thus also relatively high when compared to other OECD countries (Figure 1.8). Over the period 2000-03, New Zealand was in the lower third of OECD countries in terms of average FDI outflows while FDI inflows were again higher (Figures 1.9 and 1.10), reinforcing the more robust pattern observed in FDI stocks. Overall, New Zealand did not take part in the surge of outward FDI that took place in the developed world as a whole. Subsidiaries of New Zealand firms operating abroad – many of them in Australia – are relatively small by international business standards. Subsidiaries of foreign-owned enterprises operating in New Zealand, including in the banking and insurance sectors, tend to be larger. The issue of FDI is also discussed in Chapter 2.

Flows of knowledge

The adoption of technology and ideas from abroad and international linkages are considered to play an important role in countries' innovation and growth performance. International knowledge flows are at least potentially of great importance for small open economies and for countries that are not at the forefront of technological development. While international linkages are believed to be an essential source of new knowledge for New Zealand firms, quantitative studies focusing on the effects of international linkages on innovation and economic performance in New Zealand are scarce.[30]

The Innovation Survey 2003 provides empirical evidence on the extent of New Zealand firms' international engagement. It showed that over half of the innovating firms rated overseas businesses as being important sources of information. At the same time, about 44% of larger businesses (with over 50 employees) as against less than 30% of smaller businesses made use of knowledge obtained from overseas R&D. This result complements the finding of a "consistently low incidence of acquisition of R&D and other external knowledge" (Statistics New Zealand, 2004a, p. 34). As one might expect, overseas R&D was rated as more important among larger businesses and those producing new-to-market innovations. The lack of large firms may limit opportunities to reap more benefits from overseas R&D.

30. An exception is the work on agricultural R&D by Scobie and Hall (2006).

New Zealand's technology flows – both payments and receipts – are the lowest among OECD countries as a percentage of GDP (OECD, 2005b, p. 155). This may be seen as a further indication of weak international linkages in New Zealand's business sector in terms of knowledge and, in particular, technology flows, which in turn tend to limit international knowledge spillovers in the New Zealand economy.

International mobility of personnel

New Zealand has seen substantial inward and outward migration of skilled personnel. This issue is dealt with in Chapter 2.

1.3. Framework conditions for innovation

1.3.1. Macroeconomic framework and business environment

New Zealand's macroeconomic framework is sound and sustainable, and together with the legal framework, predictable policies and a high level of trust and transparency in the society, it provides favourable overall conditions for innovative activity. The business environment is good and by and large conducive to innovation. After two decades of macroeconomic and structural reforms, product markets generally work well. This is a significant achievement given the country's small population and geographical location. As part of its economic reform programme, New Zealand has adopted a pro-competitive stance, including through policies that favour open trade and investment.[31] Over the past two decades, the New Zealand economy has gained much in flexibility, making the country better equipped to respond to shifts in demand and to exogenous shocks in general.[32]

31. Screening procedures are the reason why New Zealand does not perform as well in international comparisons of FDI Regulation Restrictiveness as in other regulation indicators such as those referred to below (see Koyama and Golub, 2006). On FDI restrictions see also OECD (2005a, p. 53) as well as MED and The Treasury (2005).

32. External developments play an important role for a small open economy such as New Zealand. There is some evidence that long-term associations between innovation and New Zealand's economic growth are likely to have been driven by external demand shocks, rather than favourable supply conditions owing to domestic innovation (Jackson, 2002).

1.3.2. Competition policy

Overall, New Zealand's competition enforcement regime comes out rather well in international comparisons. In general, the country seems well exposed to competition, despite some difficult areas for competition and regulatory policy. At the same time, it has to be acknowledged that the specific formation that prevails in a small, geographically isolated economy (low firm density, high transport costs and transaction costs with the rest of the world) "aggravates the existing tensions between concentration and scale" (OECD, 2005a, p. 53).

Following a general trend among OECD countries, New Zealand has since the late 1990s taken to implementing sector-specific regulation, *e.g.* concerning the dairy, telecommunications and electricity sectors. In the case of electricity generation and transmission, it would appear necessary to reduce uncertainties by providing a more stable and predictable regulatory framework. Competition has not been working satisfactorily in the electricity sector. Regulatory policies at the sectoral level and related recommendations are presented in more detail in OECD (2005a, pp. 57ff.).

1.3.3. Product and labour market regulation

Product-market regulation is very important for economic performance. Available evidence relates product market regulation to various dimensions of economic performance. Empirical work deals, for example, with the impact on business dynamics, by relating regulation indicators to firm entry and hazard rates (Brandt, 2004). There are indications that some features of the regulatory system may impede firm entry. Product market competition is a driver of productivity growth, either directly or indirectly through a positive impact on innovation, at least until a certain intensity of competition is reached. Such an inverse U-shaped relationship was established by Aghion *et al*. (2005).

The OECD system of indicators on product market regulation comprises the following dimensions (Conway *et al.,* 2005).

Inward-oriented policies

- State control of economic activities, including indicators on public ownership and involvement in business operations.
- Barriers to entrepreneurship, encompassing indicators on regulatory and administrative opacity, administrative burden on start-ups and barriers to competition.

Outward-oriented policies

- Barriers to trade and investment, including indicators on explicit barriers to trade and investment and other barriers (regulatory barriers).

Overall, as Figure 1.11 illustrates, New Zealand has a favourable position in terms of product market regulation (PMR).

Another dimension of the regulatory environment is employment protection legislation (EPL). New Zealand is known to have a flexible and responsive labour market. The unemployment rate is at the very low end among OECD member countries and participation rates are high overall and across different groups. Labour market institutions and regulations can be expected to have a major impact on labour utilisation and eventually on labour productivity.

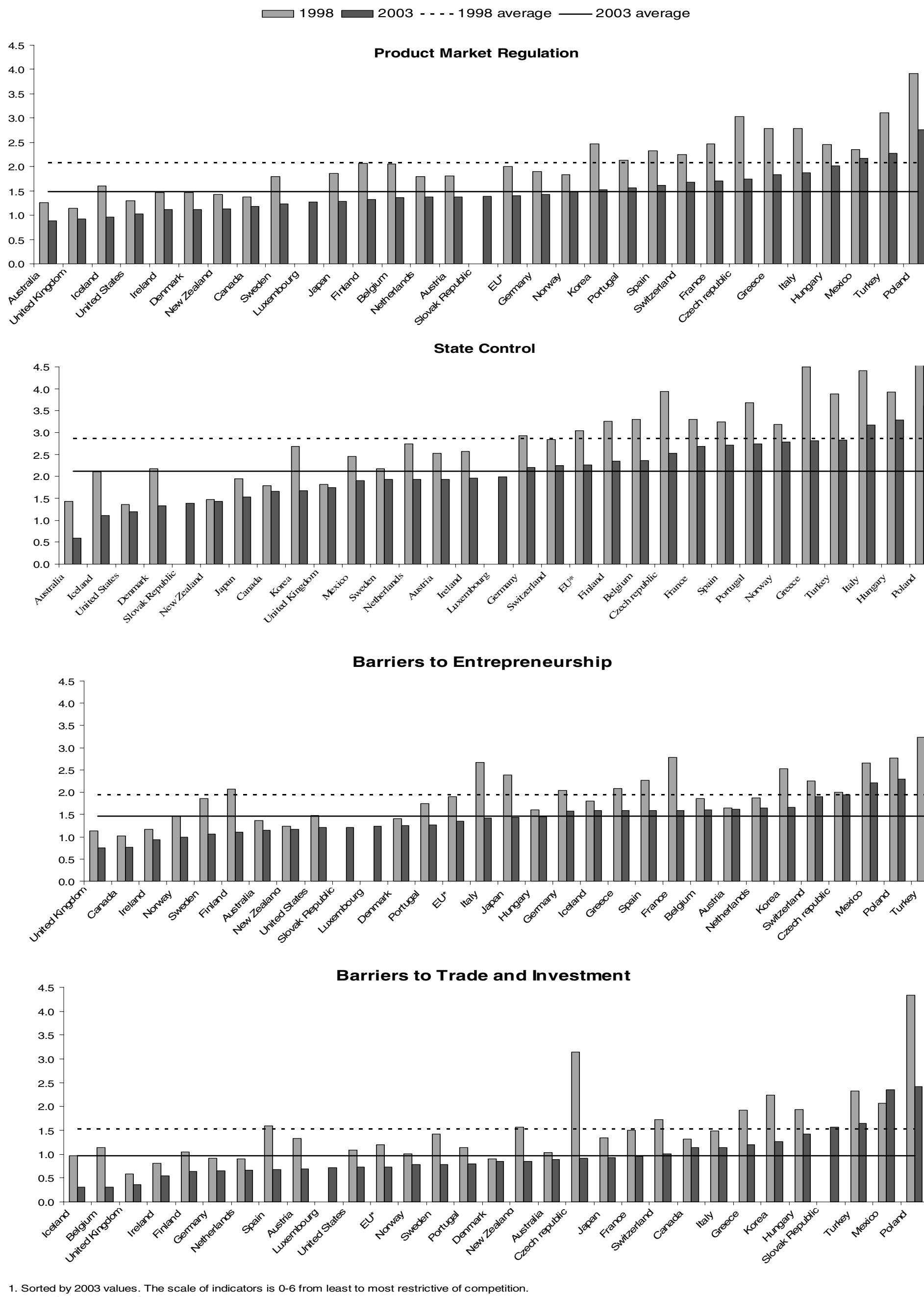
When combining PMR and EPL indicators, New Zealand again compares favourably. In 1998 just two and in 2003 – partly owing to increased labour protection – five countries performed better in both dimensions then New Zealand, some of them only slightly (Conway *et al.*, 2005).

Productivity growth is ultimately achieved by changes at the level of firms. The entry and exit of firms accounts for a large part of productivity growth either directly or via increased competition. Evidence concerning the flexibility of New Zealand's economy – in particular on the issue of whether regulation presents barriers to entrepreneurship and innovation – supports the notion that the New Zealand product, capital and labour markets function well and that there are few institutional barriers to entrepreneurship and business growth (or downsizing) (McMillan, 2004a).

As mentioned, firm dynamics are likely to be spurred by a favourable business environment and a regulatory framework that supports entrepreneurship. Indeed, New Zealand's firm entry rates lead among OECD countries (Mills and Timmins, 2004). While entrants' productivity is initially below average, surviving firms eventually make a positive contribution to productivity growth. Firm exits also contribute to productivity growth. Overall, the evidence, including high firm turnover (entry plus exit) rates, indicates a high degree of market dynamics.[33]

33. Work examining firm dynamics in New Zealand includes Law and McLellan (2005), Mills and Timmins (2004), Carroll *et al.* (2002) and McMillan (2004b).

Figure 1.11. Regulation, 1998 and 2003[1]



1. Sorted by 2003 values. The scale of indicators is 0-6 from least to most restrictive of competition.
* EU 15 (simple average)

Source: Conway *et al*., 2005.

1.4. Performance in science, technology and innovation in an international comparison

Fostering innovation is a major route to boosting long-run productivity growth. This section provides an overview from an international perspective of some key information concerning recent innovative performance by the New Zealand innovation system.[34]

The *Economic Development Indicators Report* (MED and The Treasury, 2005) provides an up-to-date summary of New Zealand's performance in a wide range of areas, drawing on numerous surveys and studies. The report includes macroeconomic indicators, such as income and productivity, and international comparisons of innovative activity, such as investment in R&D, patenting and publishing outcomes, and investment in skills and talent. The Ministry of Research, Science and Technology (MoRST) recently released the detailed *Decade in Review* (MoRST, 2006a) report, covering changes in both public R&D (mainly university and Crown Research Institutes) and business sector R&D for the ten years to 2004. As is other countries, certain particularities of the methodology of R&D surveys need to be recalled when interpreting the data (see Box 1.3).

1.4.1. Investment in R&D

New Zealand's total R&D intensity – the share of gross expenditure on research and development (GERD) in GDP – is 1.14%, about half the OECD average of 2.25% (2003). This puts New Zealand in the lower third of OECD countries. While growth of R&D expenditure picked up in at the beginning of the 2000s, R&D intensity has changed only slightly over the past decade (Figure 1.12).

New Zealand's level of business expenditure on R&D (BERD) – at 0.49% of GDP – is even lower relative to the OECD average (1.53%). Business R&D and its structural features are discussed in detail in Chapter 2. Compared to this relatively low business sector R&D, New Zealand's public R&D expenditure is relatively high.

34. Engelbrecht and Darroch (1999) provided an account of New Zealand's national innovation system in the late 1990s. Comparing macroeconomic indicators of innovation potential with those of other OECD countries, they found that New Zealand's national innovation system was relatively weak, with low investments in R&D and little evidence of technology diffusion. Positive factors included a high degree of international engagement implying a strong potential for taking on knowledge from abroad, and a relatively high rate of tertiary education, though with low participation in science and engineering.

Box 1.3. Data limitations

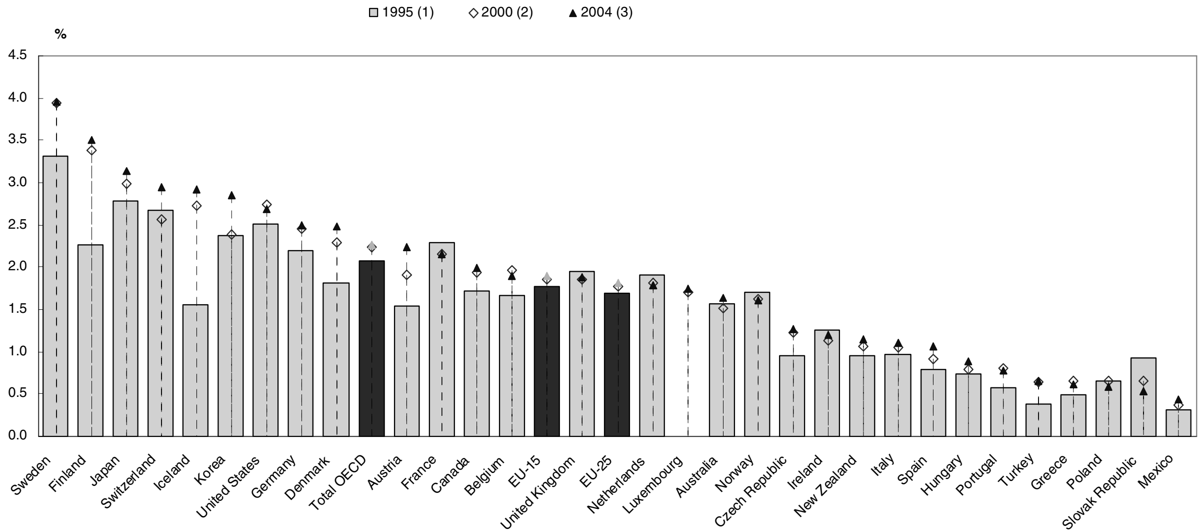
R&D survey results of different years are not directly comparable owing to methodological and population changes. In 2004, a sampling methodology replaced the list-based census methodology previously used. Investigation of the 552 business-sector enterprises that were common to both the 2002 and 2004 R&D surveys revealed there was a 9% increase in BERD, compared to a 29% increase when looking at all firms involved in the surveys. Changes to the survey population for the R&D survey of 2002 mean that the 2002 results are not directly comparable to results from 2000 and earlier. This effect is most apparent in the business sector. MoRST's *Decade in Review* (MoRST, 2006a) attempts to adjust for these differences. As a consequence the *Decade in Review* data for the business sector has been compiled so that it generally excludes businesses with fewer than 10 employees. It also adjusts the 2004 data as if the 2004 survey used a list-based approach (as in previous years), rather than the sampling approach actually used. Other changes were also made in the period 1994–2000, as outlined in the detailed methodology of the *Decade in Review*.

In New Zealand, 42.5% of GERD is performed by industry, 28.5% by the higher education sector and 28.9% by government. This distribution is quite different from that of most OECD countries. The corresponding shares for total OECD are 67.9% (R&D performed by industry, *i.e.* BERD), 17.1% (performed by higher education) and 12.5% (performed by government) (see Figure 1.14). In New Zealand the government plays a strong role in funding R&D. Only 38.5% of New Zealand's GERD is financed by industry while 45.1% is government-financed. In the OECD as a whole, 61.9% of GERD is financed by industry and just 30.9% by government (see Figure 1.15).

An interesting question which has been discussed in this context is the following: To what extent can the New Zealand "BERD gap" – relatively low R&D expenditure in the business enterprise sector compared to other OECD countries – be attributed to New Zealand's specific industry structure, or what other factors, such as different industry-specific R&D intensities, might play a role in explaining this difference (see Box 1.4). The underlying data on R&D intensity by industry are presented in Chapter 2.

Figure 1.12. R&D intensity in OECD countries, 1995, 2000 and 2004

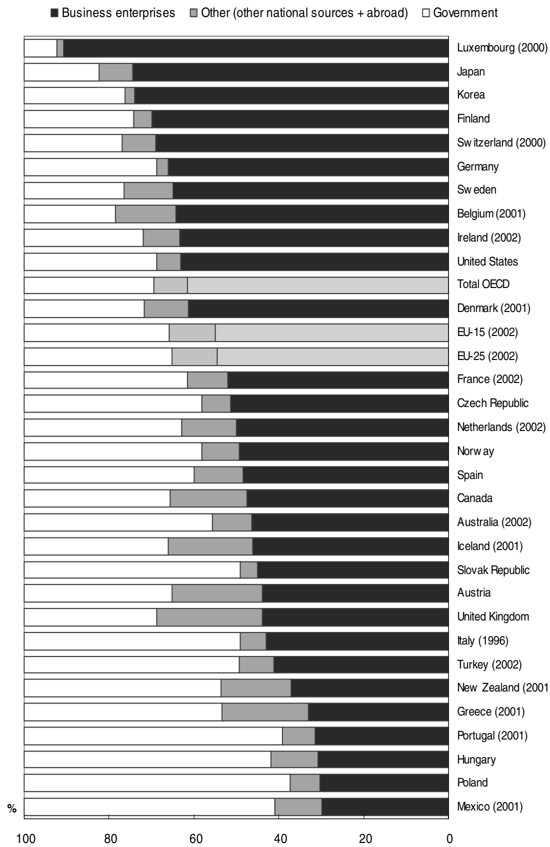
Gross expenditure on R&D as a percentage of GDP



1. 1996 instead of 1995 for Japan and Switzerland.
2. 1998 instead of 2000 for Austria; 1999 for Denmark, Norway, New Zealand and Sweden.
3. 2002 for Austria and Turkey; 2003 for Australia, Greece, Iceland, Mexico, New Zealand, Portugal and Sweden.
Source: OECD Main Science and Technology Indicators Database, June 2006.

Figure 1.13. GERD by source of funding, 2003

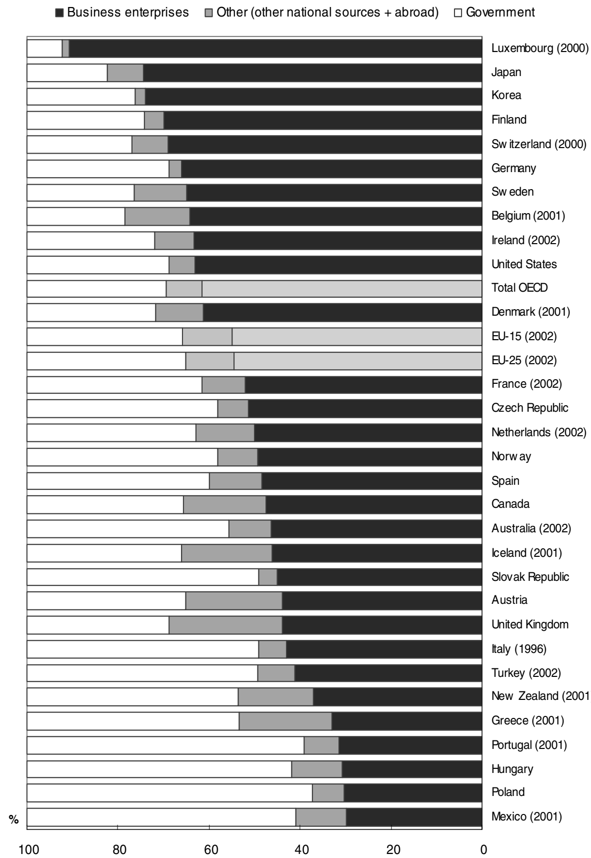
As a percentage of the national total



Source: OECD (2005*b*).

Figure 1.14. GERD by performing sector, 2003

As a percentage of the national total



Source: OECD (2005*b*).

Box 1.4. The BERD gap

Di Maio and Blakeley (2004) examine the relationship between industry structure and aggregate R&D intensity by decomposing aggregate R&D intensity into an industry intensity component and a structural component. According to this study the major difference in overall R&D intensity between New Zealand and the OECD average is in the within-industry R&D intensities. The industrial structure, in particular a low share of industries which are commonly recognised as high-technology or highly R&D-intensive, also contributes to the gap, but to a lesser degree. Where New Zealand is substantially under-represented in a specific sector (in terms of share of value added), the respective sector is also substantially less R&D-intensive than in other OECD countries. The interpretation of these findings is not simple, given the interrelations between the nature of a given industry, R&D intensity, and share of GDP. Industry composition may have indirect effects on R&D intensity.

A cross-country econometric analysis (Crawford *et al.*, 2004) suggests that country-specific characteristics (*i.e.* New Zealand's distance from major markets, heavy reliance on agriculture, high rates of self-employment and a small number of very large businesses) go some way towards explaining the low level of business R&D. The authors find that after controlling for these factors, New Zealand is not an outlier in terms of investment in R&D, but is a mild positive outlier in terms of patenting. However, there has been some debate in New Zealand concerning the robustness of the results.

A number of other hypotheses have been advanced to explain New Zealand's low level of business R&D (*e.g.* the neutral tax treatment of R&D, low labour mobility in the research sector), but these have not been explored exhaustively and further empirical work is required.

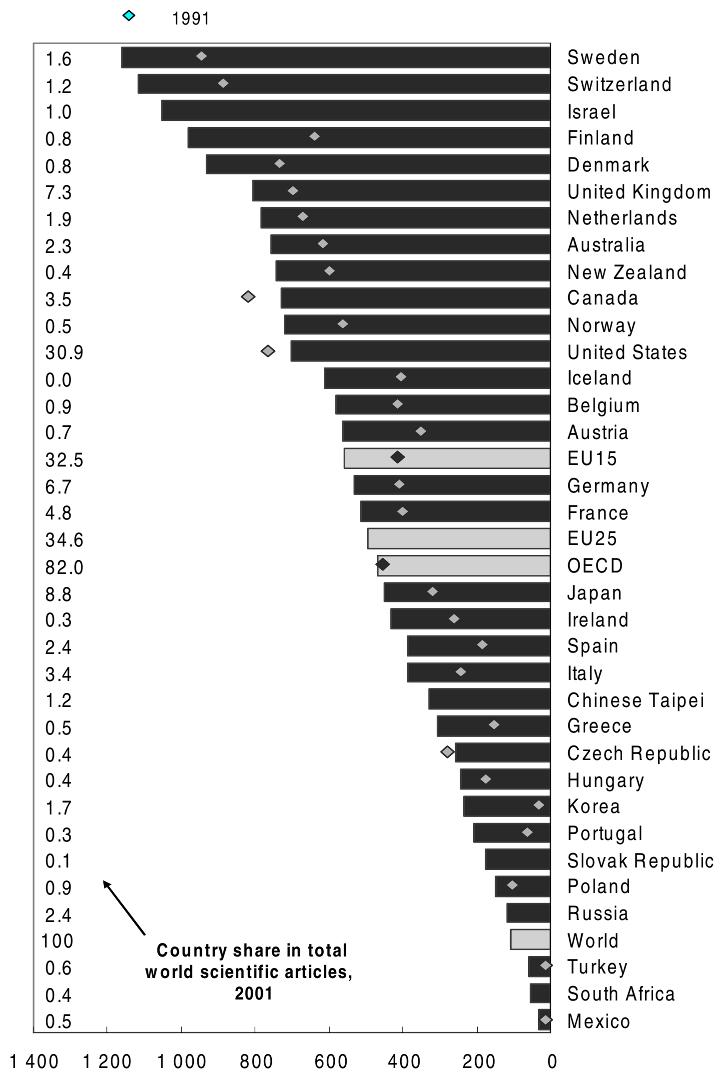
The ratio of industry-financed aggregate R&D expenditure (GERD) amounts to 0.44% in New Zealand as compared to 1.40% for the OECD on average (2003). In contrast, the gap in the ratio of government-financed GERD (0.52% in New Zealand against 0.68% for the total OECD) is far less pronounced.

Nearly half of New Zealand's BERD is in the manufacturing sector, a further 39% in the services sector and 12% in the primary sector (a relatively high share by the standards of most OECD countries). Owing to the classification of some research directed towards the primary sector in the services sector, the primary sector plays an even larger role in New Zealand's total business R&D than its direct R&D expenditure indicates.

1.4.2. Scientific output

Various indicators show strong scientific performance for New Zealand, *e.g.* in terms of scientific articles per million population New Zealand is in the top third of OECD countries, far above the OECD average and part of a group of countries just behind the best performers (Figure 1.15).

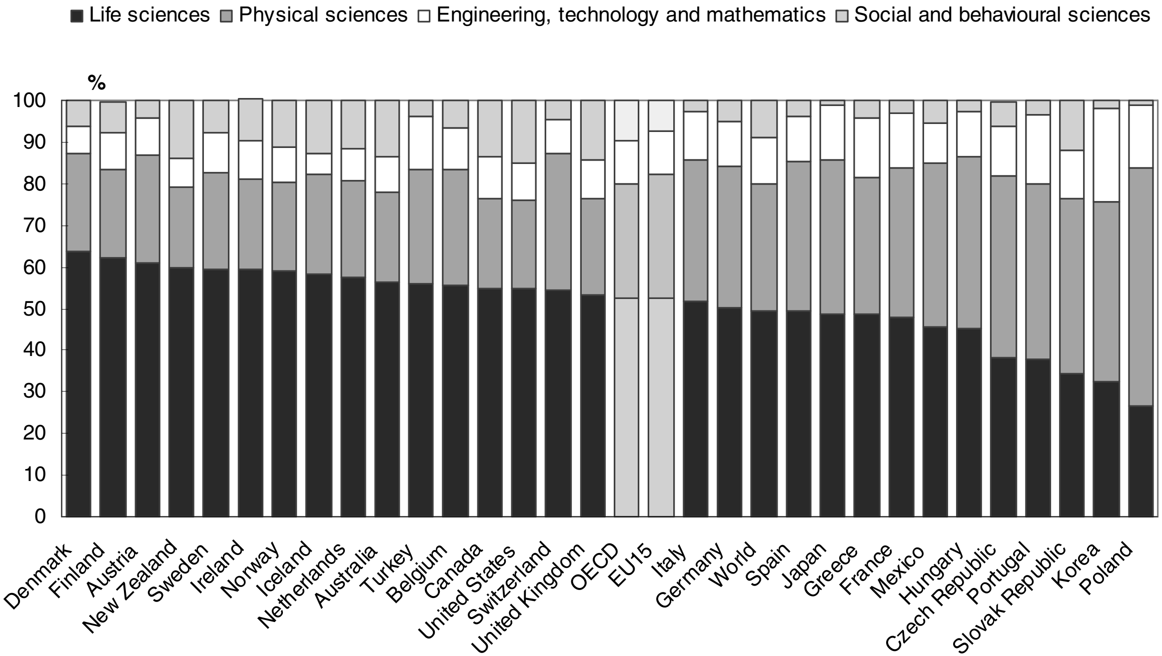
Figure 1.15. Scientific articles per million population, 2001



Source: OECD (2005b).

Figure 1.16 Distribution of scientific articles by field, 2001

As a percentage of total scientific articles



Source: OECD (2005b).

New Zealand has a comparatively high share of scientific articles in the life sciences as well as in the social and behavioural sciences, whereas engineering, technology and mathematics and – to a lesser degree the physical sciences – are underrepresented by international standards (Figure 1.16).

1.4.3. Human resources for innovation

While the number of researchers per 1 000 employees has been above the OECD average for over 20 years (Williams, 2004), the number of researchers per 1 000 business employees is significantly and consistently below the OECD average. In 2003, the number of researchers per 1 000 business employees was 3.7 compared with the 2002 OECD average of 6.3 (OECD, MSTI, June 2006).

The estimated human resources (full-time equivalents – FTEs) devoted to R&D increased by 60% over the decade to 2004 (MoRST, 2006a). Researchers represented approximately 65% of the human resource input into R&D in 2004, technicians 20% and support staff 15%. The contribution of the "researchers" category has increased more rapidly (8% a year) than support staff (5% a year) or technicians (1% a year) over the decade. The percentage of employment devoted to R&D is almost 80% for the scientific research industry, 20% for the other services sector and less than 10% for the manufacturing and primary industry sectors (MoRST, 2006a, p. 48).

Highly skilled and educated people are indispensable for an innovative, knowledge-based economy. In a global view, New Zealand shows some strengths as well as areas in which there is scope for improvement.[35] At 30% (2002) New Zealand has a high proportion of tertiary education which compares favourably not only with the OECD average (25%) but also with the figures for a number of high-income OECD countries.[36] However it should be noted that most of the growth in tertiary participation in recent years has been in courses which are at a low level on the qualifications framework and in many instances have no appreciable value for vocational training (*e.g.* community education courses). The proportion of adults with

35. There have been some attempts to measure the stock of human capital in New Zealand (*e.g.* Le *et al.*, 2005, and related papers by the same authors). David and Lopez (2001) provide a framework for thinking about human capital and economic growth more generally, before discussing the specific situation of human capital in New Zealand and drawing some implications for public policy. MoRST (1998) provides an overview of the stock of human resources in research and science in the late 1990s. A shorter, up-to-date account is included in MoRST (2006b), and a more broadly based set of indicators on talent and skills in MED and The Treasury (2005).

36. On tertiary education in New Zealand see OECD (2006d).

secondary and post-secondary non-tertiary education is at the OECD median and above the corresponding figure for a number of advanced countries. New Zealand also performs very well in international comparisons with respect to continuing education and training.

At the same time there is a rather "long tail of under-achievement" in education. New Zealand lags behind the OECD median for adult literacy although the situation seems to be improving, as current secondary school students perform better in international comparisons than the current adult population. The proportion of students who leave school with no qualification is relatively constant at 15%. There are still marked differences between ethnic groups (MED and The Treasury, 2005, p. 81ff.).

In the environment of strong economic performance which has prevailed until recently, labour shortages and skills have been a major constraint for business firms. In the Innovation Survey 2003 the availability of skilled labour was also cited as a major obstacle for innovation (see Chapter 2). Labour shortages have eased in the recent slowdown (OECD, 2006a) but can be expected to recur when growth picks up again.

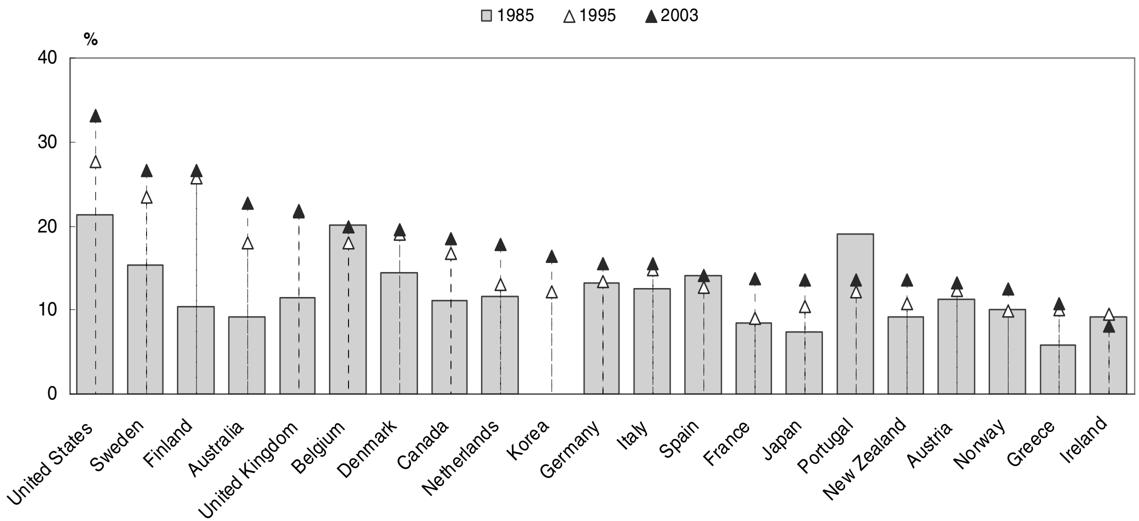
1.4.4. ICT uptake

There has been some debate regarding the uptake of ICT and the impact of ICT on economic performance in New Zealand. Investment in ICT, *e.g.* as a percentage of fixed capital formation, has been rather low by OECD standards (Figure 1.17). However, it should be borne in mind that ICT investment data may be affected by the method of calculating the components of ICT investment (in particular, investment in software).

However, there is evidence in addition to investment data, such as widely used indicators that measure the uptake of specific technologies. Recent data on broadband uptake confirm that New Zealand continues to be lag behind by OECD standards (Figure 1.18). Possible explanations for the slow uptake of ICT are discussed in OECD (2005a, p. 65). A recent study by IDC (2006) looks at the economic impact of the ICT sector and of broadband uptake in New Zealand. A project commissioned by the Ministry of Economic Development used case studies to look at innovation via ICT which reinforced the notion that the effect of ICT depends more on how it is applied than on uptake *per se* (Howell *et al.*, 2004).

Figure 1.17. Investment in ICT,[1] 1985-2003[2]

As a percentage of fixed capital formation



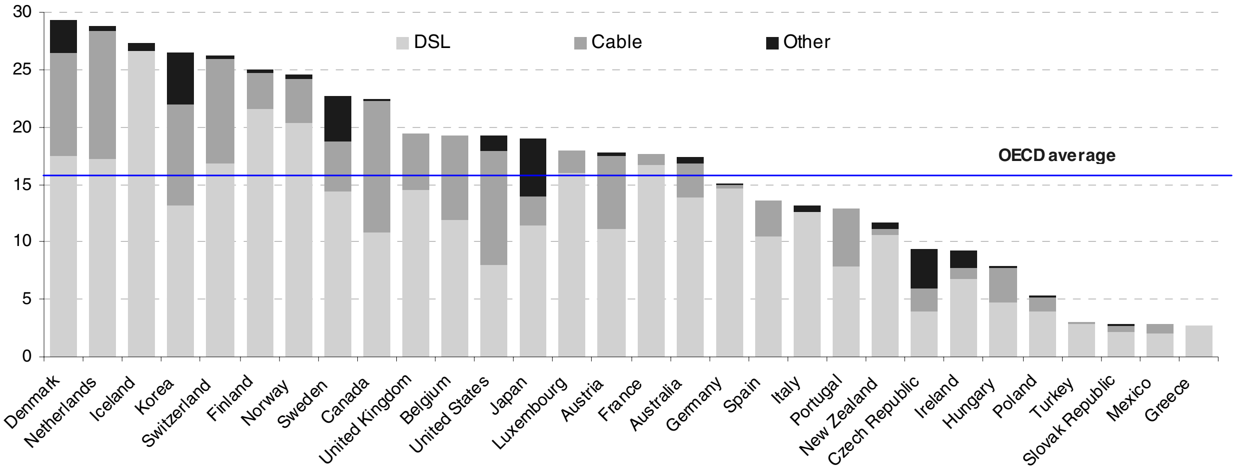
1. ICT equipment is defined as computer and office equipment and communication equipment; software includes both purchased and own account software. In Japan, investment in software is likely to be underestimated, owing to methodological differences.

2. 2002 for Australia, France, Japan, New Zealand, Norway and Spain, and 2001 for Italy.

Source: OECD (2005b).

Figure 1.18. Broadband subscribers per 100 inhabitants, June 2006[2]

By technology



Locke (2004) uses firm level data to examine the relationship between adoption of ICT and growth in sales, profits and market share among New Zealand's SMEs. The study suggests a positive relationship between increasing profits and the use of ICTs. However, this seems to occur via a reduction in costs rather than an increase in sales or market share.

In May 2006, a government review concluded that limited competition was hampering broadband development. Since then, there have been major changes to the regulation of New Zealand's telecommunications sector. These changes were mainly contained in the Telecommunications Amendment Act (No. 2) 2006, which came into force on 22 December 2006. The objective of the Amendment Act is to promote competition in telecommunications markets for the long-term benefit of end users of telecommunications services in New Zealand. In particular, it seeks to improve New Zealand's broadband uptake and performance while maintaining an environment conducive to investment. The Act's provisions are therefore relevant to the recommendation in the OECD's draft report that the New Zealand government should take steps to improve the "availability of broadband Internet access at appropriate cost and variety". The major features of the Amendment Act are:

- The implementation of local loop unbundling (LLU).
- The removal of existing restrictions on the unbundled bitstream service and the clarification that wholesale bitstream can be purchased without the purchase of a telephone line ("naked DSL").
- The requirement for the operational separation of Telecom New Zealand.
- The streamlining of regulatory processes under the Telecommunications Act 2001.

LLU is implemented in the Act by requiring Telecom New Zealand to allow alternative service providers access to its copper lines, roadside cabinets and exchanges. Operational separation of Telecom New Zealand is mandated by the Act's requirement that it be separated into three business units: retail; wholesale and fixed network access; the last of which will provide access services for all companies, including Telecom's wholesale and retail divisions. These three units must operate independently and have separate financial reporting.

Operational separation has not yet occurred, as the precise form of the separation is still to be determined. Under the Act, the separation plan must be drafted by Telecom, with the Minister of Communications having a significant role, including the eventual ability to make any changes to the proposed plan before accepting it. The final form of the separation is expected to be settled by mid-2007.

Chapter 2

INNOVATION IN NEW ZEALAND: THE ACTORS

This chapter describes the key players and processes in New Zealand's innovation (*i.e.* the key "providers" in Figure 2.1). It focuses on those that perform R&D and innovation activities, mainly the business sector, the Crown Research Institutes (CRIs), and the universities. Interaction between these groups, particularly between the public and private sectors, is examined. Commercialisation of public sector research and technology transfer are discussed, together with the financing of innovation and the human resources aspect of the national innovation system. The role of government in providing basic incentives, institutional frameworks and support measures for R&D and innovation are examined in Chapter 3.

Some characteristics of the New Zealand economy have shaped the innovation system, notably:

- *The country's small size and geographical isolation.* New Zealand's population of a little over 4 million limits the possibilities for achieving critical mass in some research fields. Peer review systems used to allocate some research funding are more difficult to manage because of limited competition and difficulties in ensuring independent review. Remoteness from other major R&D-performing countries has encouraged a spirit of self-reliance among researchers. This may help to explain the innovative nature of much New Zealand research. However it also makes investment in international co-operation and networking in science and innovation more important. While it might be thought that the proximity of the Australian market could provide New Zealand technology-based firms with an easy and accessible target, in fact many New Zealand firms find Australia challenging as a market while many of New Zealand's individual talents find it attractive as a place to work.

Figure 2.1. Institutional profile of the New Zealand Innovation System

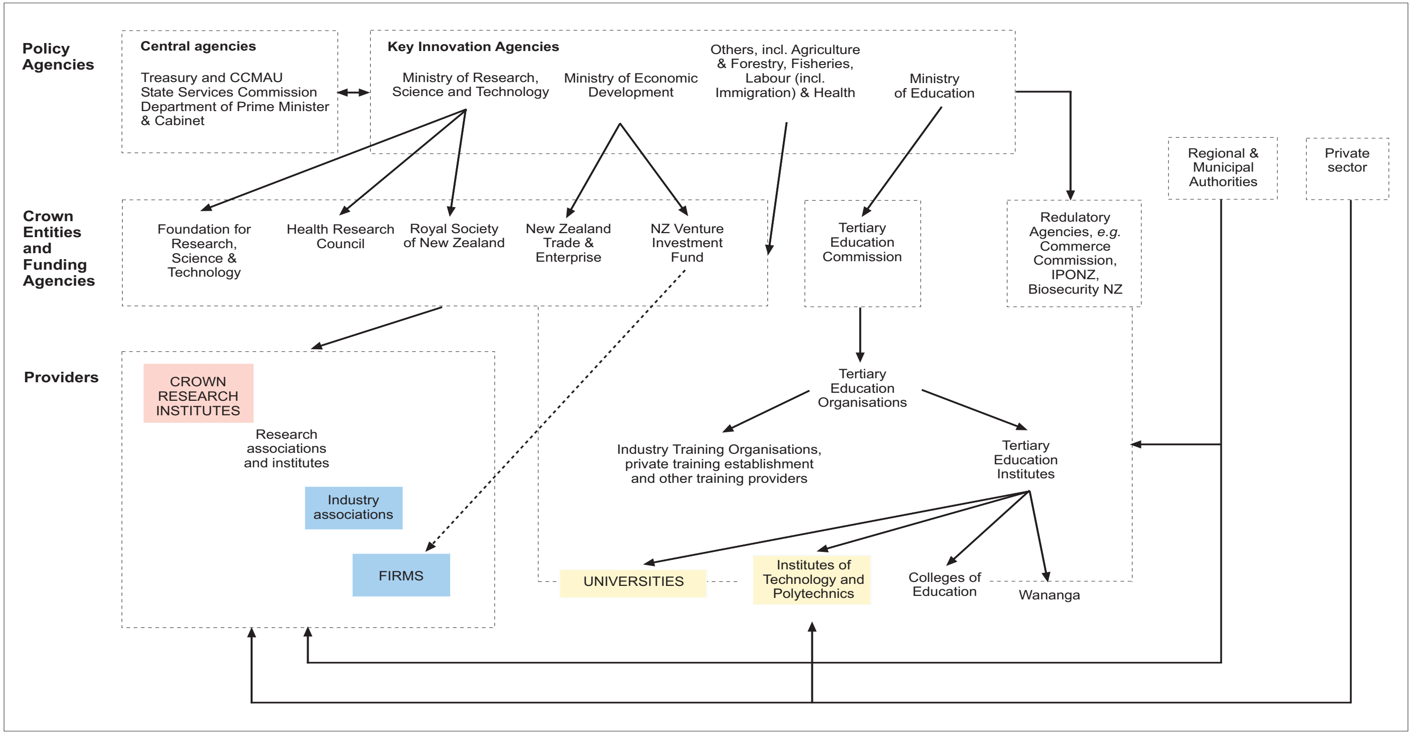
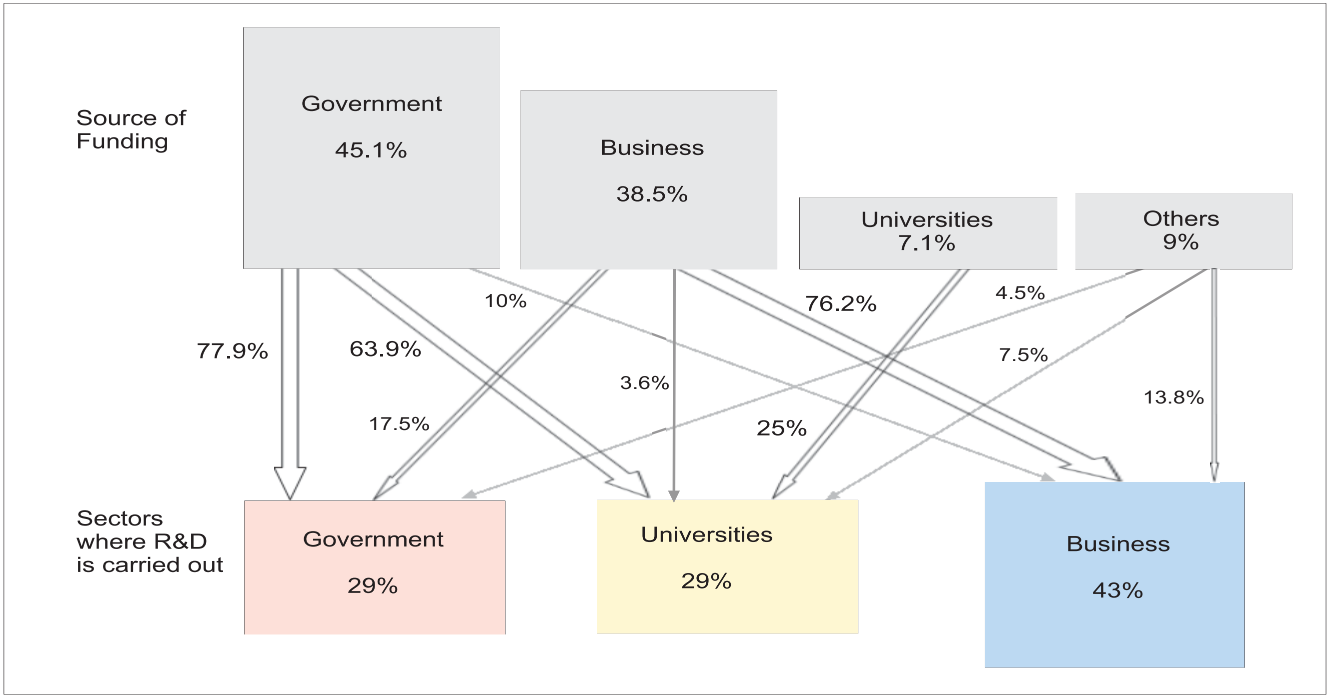
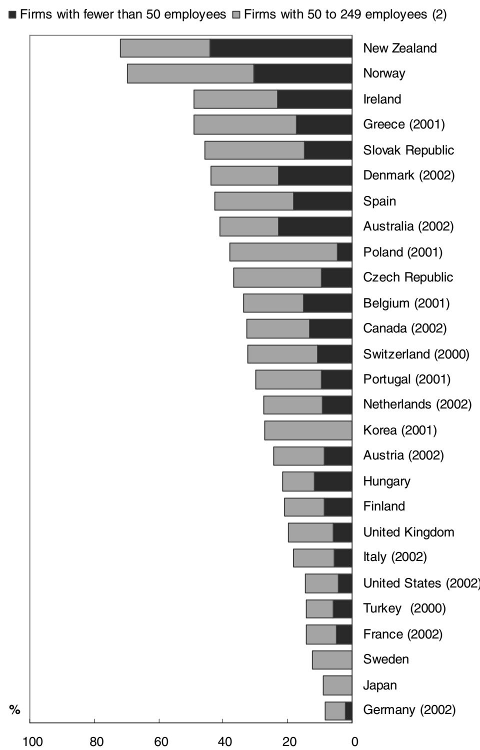


Figure 2.2. R&D funding and performance in New Zealand, 2004



- *The limited number of large firms operating on an international scale.* New Zealand's business sector largely consists of very small companies and over a third of businesses are located in the Auckland region. Very few large firms undertake significant amounts of R&D. However, the share of SMEs in business R&D is larger in New Zealand than in most other OECD countries (Figure 2.3). This underscores the significance of the CRIs and universities as sources and diffusers of knowledge and innovation. Together, they carry out a larger share of R&D than similar institutions in the majority of OECD countries (Figure 2.2).

Figure 2.3. Share of business R&D by size class of firms,[1] 2003



- Because of the historic importance of agriculture, the sector is an important focus of R&D activity in both the public and private sector, even though its direct contribution to GDP is now only about 6%. In the composition of exports, primary products dominate, and they also still strongly influence the type of R&D demanded in New Zealand, including in new areas such as biotechnology (Table 2.1). In 2004, 12% of BERD was in the primary sector, which is relatively high by the standards of most OECD countries.[37]

Table 2.1. BERD by socioeconomic objectives, 2004

	NZD millions	Percent
Animal production	16.2	2.4
Dairy production	74.2	11.0
Horticultural, arable production	29.8	4.4
Forestry	12.1	1.8
Fishing	7.0	1.0
Agriculture, forestry and fishing	**139.3**	**20.6**
Meat and fish processing	15.6	2.3
Dairy processing	38.5	5.7
Fruit, crop and beverage processing	29.0	4.3
Fibre and skin	8.8	1.3
Wood and paper products	7.9	1.2
Materials, construction, electronics and engineering	112.9	16.7
Industrial development	**212.7**	**31.4**
Commercial and trade services	28.8	4.2
Urban and rural planning	6.3	0.9
Transport	9.2	1.4
Information, communication and technology software	126.6	18.7
Development of infrastructure	**170.8**	**25.2**
Energy	15.8	2.3
Environment	18.2	2.7
Health	87.6	12.9
Social development	9.1	1.3
Earth and atmosphere	0.5	0.1
Defence	2.7	0.4
Other	20.5	3.0
Other purposes	**154.3**	**22.8**

Source: Statistics New Zealand, Research and Development in New Zealand 2004.

37. Owing to the likely classification of some primary sector research in the services sector, the level of primary sector BERD is probably understated in the R&D and Innovation surveys (Davis *et al.*, 2006). For instance, in the 2004 R&D Survey, business R&D directed towards socioeconomic outcomes related to Agriculture, forestry and fishing was NZD 139.2 million but business R&D performed by the primary sector was only NZD 79.1 million (see Table 2.1).

2.1. The business sector

2.1.1. Business environment and entrepreneurial culture

Successful innovation requires a strong science and engineering base, an entrepreneurial culture, capital investment, skilled people and a good business environment. While New Zealand has a strong science base and some strength in engineering and, as pointed out in Chapter 1, many elements of a sound business environment, some of the framework conditions for innovation are less favourable. This partly explains the relatively low proportion of firms involved in technological innovation (Table 2.2). If one considers New Zealand's need to promote export-oriented innovation activities, as well as outward investment in knowledge-based industries, in order to sustain more dynamic long-term growth,[38] some barriers to technology-based entrepreneurship and growth of innovative firms deserve special attention.

The NZ Global Entrepreneurship Monitor (GEM) survey for 2003-04 (Unitec, 2004) shows that New Zealanders have a satisfactory propensity to set up companies and rate well in terms of indicators of entrepreneurial activity. But it also shows that many entrepreneurs tend to create what have been described as "lifestyle" firms. New Zealanders talk about the "three Bs syndrome" – batch (house at the beach), BMW and boat. New Zealand businessmen who achieve the "three Bs" lack the motivation to grow their company further by expanding offshore, listing their company or seeking foreign investment. The significance and importance of this syndrome is hard to judge. Many countries have a large number of so-called "lifestyle" businesses but the syndrome was mentioned to the review team on a number of occasions. The fact that cultural attitudes may be among the factors responsible, the "lifestyle business" syndrome does not mean that government cannot improve the situation. New Zealand may have to reinforce its entrepreneurship policy. At least it could do more by working with interested parties such as the Enterprise New Zealand Trust.

38. As already noted New Zealand's exports remain dominated by primary products, a sector in which growth is modest and scope for future growth limited. Further, some 95% of New Zealand's exports are generated by less than 1% of New Zealand firms.

Table 2.2. Percentage of all businesses reporting R&D and innovation

	Businesses with R&D activity (last 12 months)	Technological innovation (last 24 months)		Total innovation rate[1] (last 24 months)
Business size		Goods or services	Operational processes	
6-19 employees	7	29	27	50
20-49 employees	7	33	33	57
50-99 employees	12	40	40	65
100 or more employees	15	42	46	68
Industry				
Agriculture, forestry and fishing	9	16	28	42
Mining and quarrying	6	17	31	44
Manufacturing	17	49	40	65
Electricity, gas and water supply	13	40	33	52
Construction	4	12	22	41
Wholesale trade	8	40	34	61
Retail trade	3	28	25	46
Accommodation, cafes and restaurants	6	30	23	50
Transport and storage	3	26	37	53
Communication services	2	45	38	62
Finance and insurance	7	40	47	68
Property and business services	7	25	27	50
Education	9	39	30	58
Health and community services	3	34	28	59
Cultural and recreational services	6	32	24	57
Overall	**8**	**30**	**29**	**52**

1. Including organisational and managerial innovation.

Source: Statistics New Zealand (2005), Business Operations Survey 2005.

The government should also seriously consider the impact of the current tax system on SMEs' incentives to move beyond the "three B syndrome" and, more generally, on both inward and outward knowledge-intensive investment.

As noted in Chapter 1, New Zealand is not yet sufficiently integrated into the global economy, especially when compared to other small developed countries (Skilling and Boven, 2006b). Levels of outward foreign investment are low. Yet with a small domestic market, many SMEs that have achieved a modest turnover will never realise their potential and will eventually stagnate or be sold to foreign investors, who appear to be willing to pay more than New Zealand investors for such businesses (Table 2.3). New Zealand businesses are not adequately rewarded for efforts to grow business offshore. This suggests that the government needs to ensure that the after-tax rewards justify the risks. There may also be a need for other or stronger incentives and assistance measures.

There is an ongoing debate in New Zealand about changes to its tax system. New Zealand's current tax system encourages domestic firms to stay small and local or to relocate their headquarters outside of New Zealand if they plan to expand their activities abroad. Changes proposed by the government which could encourage inward investment and benefit New Zealand firms investing abroad are welcome steps. However, the proposed system may be too complicated for small investors (for more detail see OECD, 2007, Chapter 4).

New Zealand's superannuation arrangements are very different from those in nearby Australia. In Australia, compulsory contributions to superannuation have resulted in a strong capital market and flow of investment funds into the share market. This has given companies launched on the Australian stock exchange an advantage over their New Zealand counterparts and attracted some New Zealand technology-based companies to list in Australia.

Compared to outward FDI, New Zealand has a relatively high level of inward investment (stock of FDI as a percentage of GDP). New Zealand's current stock of FDI focuses more on non-tradable sectors than on export-oriented sectors. Its business environment is currently insufficiently attractive to foreign investors, given the small domestic market and remoteness from world markets. Yet there is evidence that foreign investors tend to expand New Zealand-based production faster that the New Zealand industry average and generally improve firm performance (Infometrics, 1999). While some foreign investors maintain a presence in New Zealand, others shift the businesses overseas. For New Zealand this results in a loss of high-skill jobs, exports, tax revenue and other benefits.

Table 2.3. A selection of sales of New Zealand companies by the founder/entrepreneur

Company	Founded	By	Known for	Size at sale (revenue, staff)	Sold	MNE (home country)
ADIS International	Late 1960s	Graeme Avery	Pharmacovaluation, medical research publishing	$45m Staff: 225 in NZ, 400 world	1996	Wolters-Kluwer (Netherlands)
Switchtec	1985	Dennis Chapman	Power supplies for telecoms	$40m	1997	DTR Power Systems/ Invensys (UK)
Binary Research	~1990	Murray Haszard	'Ghost' disk cloning software	16 in team	1998	Symantec (US)
MAS Technology	1976	Neville Jordan	Microwave telecom/electronics	$100m. Staff: 240	1999	DMC (US)
Holliday Group	1990	Phil Holliday	WAP applications	$2-3m. Staff: 30	2000	Itouch (UK)
Deltec	1977	Peter Graham	'Teletilt' remote antennae technology	$34m. Staff: 80	2001	Andrew Corp (US)
Interlock	1961	Stuart Young	Innovative window and door hardware	$60m. Staff: 420	2001	Assa Abloy (Sweden)
Marshall Software	1994	Spin-off of Design.Tech	Content security software	$12m. Staff: 57	2002	NetIQ (US)
Navman	1988	Peter Maire	Satellite navigation systems	~$130m. Staff: 350 world	2003	Brunswick (US)
Jade	1978	Gil Simpson	Software environ. (LINC, JADE)	$36.8m. Staff: 330	2004	ICap Partners (US)

Source: Davenport, S. (2006), "Technology Transfer by Takeover: Reframing a Nation's 'Loss' of High-Tech Companies Through Off-shore Acquisition", Victoria University of Wellington.

Table 2.4. R&D intensity[1] by industry, an international comparison, 2002

	NZ	Australia	Canada	Denmark	Finland	Ireland	Netherlands	Norway
Year	2002	2000	2000	1999	2001	1999	2000	1998
Agriculture, hunting, forestry	0.4	-	-	-	-	-	-	-
Mining	0.2	-	-	-	-	-	-	-
Food, beverages, and tobacco	1.0	1.0	0.4	1.5	2.3	1.0	2.4	1.5
Textiles, leather, and footwear	1.7	0.8	1.1	0.8	2.6	1.0	1.0	1.8
Wood, paper, printing, publishing	0.0	0.8	0.4	0.3	1.3	0.2	0.3	0.9
Chemical, rubbers, plastics & fuel products	3.9	-	2.1	8.1	7.0	0.4	7.2	-
Pharmaceuticals	1.5	-	23.9	33.6	63.7	4.5	25.4	19.6
Non-metallic mineral products	0.3	0.8	0.2	1.2	1.7	1.1	1.0	1.6
Basic and fabricated metals	0.4	2.2	1.1	1.0	3.6	1.4	1.5	3.0
Machinery and equipment n.e.c.	2.7	5.1	2.1	7.1	7.3	3.6	9.1	6.1
Electrical machinery	2.5	-	5.6	8.1	14.6	6.4	7.8	4.5
Electrical equipment	3.0	13.6	30.5	12.4	25.9	6.3	25.4	16.4
Motor vehicles	8.7	8.1	1.4	-	3.7	5.9	5.9	9.2
Aircraft	0.0	-	14.0	-	8.1	-	0.6	13.5
Transport equipment n.e.c.	0.7	-	-	0.6	16.9	0.0	1.7	0.8
Other manufacturing	6.9	-	-	-	-	-	-	-
Total manufacturing	**1.4**	**3.3**	**4.1**	**6.0**	**9.4**	**2.2**	**5.7**	**4.1**
Services	**0.4**	**0.4**	**0.4**	**0.9**	**0.5**	**0.4**	**0.3**	**0.7**

1. As a percentage of value-added.

Source: New Zealand calculated by Di Maio and Blakeley (2004). Other data from OECD.

The 2006 Business Tax Review raises the prospect of lowering the company tax rate from 33% to 30% (Australia's current corporate tax rate). The cut in the corporate tax can be expected to have positive short-term effects on the competitiveness of enterprises based in New Zealand and help retain profits. However, this may not be enough to spur long-run growth. It is recommended to "adopt a more comprehensive growth-enhancing tax package beyond the measures announced in the Business Tax Review" (on these issues, see OECD, 2007). In addition, personal tax policies need to ensure that New Zealand can attract expatriates back to help build innovative businesses.[39]

2.1.2. Business sector R&D

Solid business sector R&D performance is critical to New Zealand's future. Investment by business in R&D today determines the nature and quality of the jobs that will be available to New Zealanders tomorrow. Business R&D generates spillover benefits which are not captured by the firms involved, but generate community benefits. Firms that are actively engaged in R&D and technology-intensive sectors provide valuable partners for publicly funded researcher organisations, helping them raise quality and social relevance. Government has a responsibility to encourage and assist such investment to correct market failures and other structural disincentives such as those that exist in New Zealand. Is New Zealand business spending enough on R&D? Is there an appropriate amount of government support for business R&D (BERD)? These questions are explored in this section.

As noted in Chapter 1, New Zealand has a low level (0.49% of GDP) of reported BERD relative to other OECD countries. In 2003, BERD as a proportion of value added of industry was 0.65%, compared to the OECD average of 2.17% (OECD MSTI, June 2006). This figure has been consistently low compared to the OECD average (see Williams, 2004, for the period 1981–2001). While the level of BERD is relatively low, growth rates have been quite high at 7% a year since 1994 versus 5.9% for the OECD as a whole. New Zealand's growth rate accelerated over the period 2000–04 to 11% a year in current prices (MoRST, 2006a). This momentum needs to be maintained.

For almost all sectors (19 out of 22), R&D intensities in New Zealand are below the corresponding OECD averages (Table 2.4). New Zealand is considerably less R&D-intensive in industries in which OECD countries report high R&D intensity (electrical and communication equipment,

39. From April 2006 new migrants and returning New Zealanders who have not been tax-resident for at least ten years are exempted from tax for four years on foreign income (OECD, 2007).

pharmaceuticals, aircraft, and rail equipment and transport equipment). New Zealand's industry shares in R&D-intensive industries are lower (sometimes much lower) than for the OECD as a whole (Di Maio and Blakeley, 2004).[40]

It is estimated that, in 2004, New Zealand had about 584 businesses that employed ten or more people and also conducted R&D. These businesses employed 6 440 FTE personnel in R&D activities: 4 022 researchers and 1 409 support staff.

The industry composition of business R&D appears to have changed only slightly over time, at least as regards the share of manufacturing, services and primary sectors (MoRST, 2006a, p. 32). The most significant change has been the growth of the scientific research[41] sub-category of the services sector, which trebled its R&D expenditure between 1994 and 2004 and increased its share of BERD from 25% to 34%. This represents annual growth of 11% over the decade (compared with 7% for BERD as a whole). The scientific research industry accounted for 43% of total growth in BERD, significantly more than manufacturing (32%) and other services (23%). The high growth can be partly explained by the large amount of firm restructuring, which in many cases involved outsourcing to the scientific research industry, and by strong growth in biotechnology research, which is mostly performed within the scientific research industry (MoRST, 2006a, p. 34).

Business R&D in New Zealand is concentrated in a small number of firms. Concentration of R&D expenditures is more pronounced in the primary sector, in which the top five performers account for 71% of BERD. As noted in Chapter 1, by OECD standards, relatively small firms account for a high share of R&D expenditures. Approximately 1% of businesses with 10-20 employees perform R&D, compared with 8% for businesses with more than 100 employees. The propensity of firms to collaborate with other firms on innovation activities is also positively related to firm size (Statistics New Zealand, 2004b).

40. These data were used to perform the breakdown of R&D intensity to shed light on New Zealand's BERD gap (see Box 1.4).

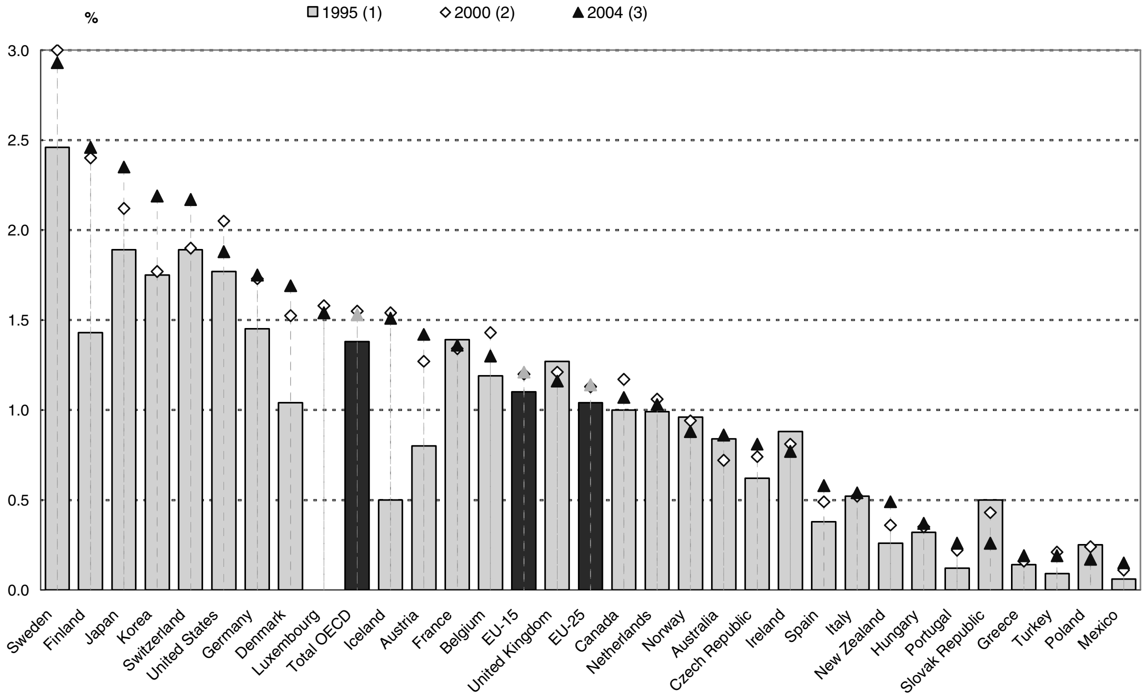
41. Scientific research includes those firms whose main activity relates to the conduct of R&D in any of the sciences – agricultural, biological, physical or social – irrespective of the objective of the R&D. It will therefore include a number of firms established with the aim of conducting R&D for specific industry sectors or specific firm groups operating in New Zealand (MoRST, 2006a).

Table 2.5. R&D by firm size by industry, 2004

	RME (rolling mean employment) less than 50				RME 50 or greater			
	NZD millions	Firms	Average (NZD '000s)	%	NZD millions	Firms	Average (NZD '000s)	%
Primary	**44.8**	**84**	**533**	**6.6**	**34.3**	**35**	**980**	**5.1**
Food, beverages and tobacco	4.2	55	76	0.6	76.8	80	960	11.3
Petroleum, coal, chemical & associated product manufacturing	34.6	109	317	5.1	30.5	55	555	4.5
Fabricated metal products except machinery and equipment	4.3	69	62	0.6	9.3	24	388	1.4
Radio, television and communication equipment and apparatus	10.3	23	448	1.5	48.1	8	6013	7.1
Other manufacturing	35.8	248	144	5.3	81.9	187	438	12.1
Manufacturing	**89.1**	**504**	**177**	**13.2**	**246.6**	**354**	**697**	**36.4**
Wholesale trade	27.9	130	215	4.1	24.7	115	215	3.7
Computer and related activities	53	141	376	7.8	36.9	10	3690	5.5
Other services (including other business activities)	94	463	203	13.9	25.8	140	184	3.8
Services	**174.8**	**734**	**238**	**25.8**	**87.5**	**265**	**330**	**12.9**
Total	308.8	1322	234	45.6	368.4	654	563	54.4

Source: Statistics New Zealand, Research and Development in New Zealand 2004.

Figure 2.4. BERD as % of GDP



Source: OECD, Main Science and Technology Indicators, June 2006.

Around three-quarters of BERD in New Zealand is funded from within the business sector. The other main sources include overseas (12%) and government (10%). Funding sourced from overseas grew from NZD 8 million in 1994 to NZD 83 million in 2004. Funding patterns vary significantly across industries. The manufacturing and primary sectors receive most of their funds internally, whereas firms in the scientific research and other services sectors receive approximately half their funding from outside sources owing their role as research intermediaries.

Compared with other OECD countries, New Zealand has a somewhat higher percentage of business R&D financed by government and overseas sources and a lower share funded by industry. While BERD as a percentage of GDP has grown (Figure 2.4), New Zealand needs to take further measures to encourage business to invest in R&D. In a country with few large technology-based businesses, government policy should aim to encourage the creation, growth and expansion of R&D-intensive innovative SMEs.

Considering some of the issues discussed above, a case can be made for bringing government support for business R&D closer to the OECD average. This would require a significant increase over current levels of investment. The Business Tax Review Discussion Document raises the possibility of a 7 to 15% tax credit for R&D. Experience in other OECD countries, including Australia, suggests that a well-designed tax measure could help to increase business R&D. The empirical evidence on the effectiveness of fiscal incentives for R&D is surveyed by Hall and van Reenen (2000) (see also the section on tax treatment of R&D in Chapter 3).

Stable support arrangements are important for ensuring effective support for business R&D. Frequent changes in programmes, underfunding which results in fully allocating programme funds early in the financial year, uncertainty as to whether government support will be maintained for the duration of a project and low success rates for some programmes all have a negative impact on the effectiveness of government support. Excessive reporting and review of supported projects results in high compliance costs and can make support measures unattractive. Examples of these problems in New Zealand are discussed in Chapter 3.

2.1.3. Business innovation

Looking broadly at innovation, how well do New Zealand firms perform? A recent national innovation survey provides some answers (Statistics New Zealand, 2004b). Some 44% of New Zealand businesses reported innovation activity during the period 2001-03. The propensity to innovate was greater in larger businesses. Innovation success rates were comparable across business sizes. Innovation survey data suggest that businesses spend as much again on innovation-related expenditures as on business R&D, highlighting the importance of other innovation activities such as the acquisition of new machinery and equipment, design and marketing activities (Table 2.6).

Table 2.6. Intensity of investment in innovation, 2002-2003

	Number of businesses with innovation activities	Ratio of R&D investment in total innovation investment	Ratio of innovation investment to total operating expenditure	Ratio of innovation investment to expenditure on fixed assets
		NZD 1:NZD 100		
Business size				
10-29 employees	3 267	52.2	1.4	32.7
30-49 employees	789	42.6	3.1	64.1
50 or more employees	1 053	47.4	1.5	27.7
Industry				
Industry sector				
Agriculture, forestry and fishing	474	51.6	1.1	16.5
Mining and quarrying	21	16.1	1.1	4.5
Manufacturing	2 004	44.9	1.6	31.6
Construction	297	35.3	0.4	9.7
Services sector				
Wholesale trade	819	45.3	0.5	36.2
Transport and storage	336	29.9	0.8	8.2
Finance and insurance	189	41.2	3.9	26.1
Business services	975	57.7	4.6	96.4

Source: Statistics New Zealand, Innovation in New Zealand 2003.

Table 2.7. Main outcomes from innovation activities, % of all reporting innovators

	Increased profitability	Increased range of goods and services	Opened new or expanded markets in NZ	Opened new markets overseas	Improved efficiency	Reduced energy consumption	Reduced environmental impact
10-29 employees	78	80	65	26	73	18	21
30-49 employees	77	79	61	32	83	18	18
50 or more employees	80	82	64	41	75	19	23
Agriculture, forestry & fishing	83	65	52	39	70	16	45
Mining and quarrying	80	60	80	20	100	0	80
Manufacturing	79	83	68	41	75	23	19
Electricity, gas and water	100	0	50	50	0	0	0
Construction	84	93	61	3	73	31	45
Industry total	80	81	65	36	74	23	26
Wholesale trade	78	82	73	21	71	17	23
Transport and storage	71	71	50	23	82	15	16
Communication services	91	100	82	18	91	27	36
Finance and insurance	79	77	56	13	83	4	6
Business services	77	77	61	27	74	9	9
Media industries	67	67	40	13	73	13	0
Services total	77	78	63	23	75	13	15
Overall	**79**	**80**	**64**	**30**	**75**	**18**	**21**

Source: Statistics New Zealand (2004b), *Innovation in New Zealand 2003*.

According to the broad definition of innovation used in the 2005 Business Operations Survey,[42] around half of businesses were innovative, with innovation evenly spread among goods and services, operational processes, organisational/management practices and marketing methods, although there was significant variation by industry. Employee training and acquisition of computer hardware or software were the most common activities performed to support innovation. One in four businesses conducted in-house R&D while around one in ten acquired external R&D.

New Zealand's performance on innovation measures varies from sector to sector. In general, New Zealand manufacturing firms appear to perform relatively poorly while services firms are on a par with the European averages (Statistics New Zealand, 2004b).

According to the 2003 Innovation Survey the main benefits from innovation were increased range of goods and services, increased profitability, improved efficiency, and new or expanded markets within New Zealand (Table 2.7). Less than one-third of businesses reported outcomes resulting in new overseas markets (30%), reduced environmental impact (21%) or reduced energy consumption (18%). This provides further evidence of New Zealand businesses' insufficient focus on developing products and services for world markets. The development of a wider range of technology-based manufacturing and service exports would diversify New Zealand's export base and encourage economic growth.

According to the business operations survey (2006), a lack of management resources was the biggest impediment to innovation (62% of all businesses), followed by a lack of appropriate personnel and development costs. Lack of co-operation with other businesses (30%) and access to intellectual property rights (17%) were the least important impediments to innovation. This ranking of impediments was consistent with the results from the Innovation Survey 2003.

2.1.4 Innovation in selected knowledge-intensive industries

This section briefly examines New Zealand's innovation performance in the four sectors targeted in 2002 by the Growth and Innovation Framework (GIF) (see Box 2.1).

42. Consistent with the OECD *Oslo Manual 2005*.

Box 2.1. Government support to selected knowledge-intensive industries under the Growth and Innovation Framework[43]

The New Zealand's Growth and Innovation Framework (GIF) was announced in February 2002 and set out the government's strategic approach to economic development. The GIF has targeted four knowledge-based sectors which are seen as having significant potential to affect other sectors of the economy positively: biotechnology, information and communications technology (ICT), and creative industries (design and screen production). Each of the four areas has been the subject of thorough examination by taskforces with strong stakeholder representation.

The GIF ***Biotechnology*** Taskforce released its plan in 2003. MoRST has subsequently co-ordinated the different government agencies involved in implementation of this strategy. Outcomes to date include the establishment of a new biotechnology industry body – NZBio – and the inclusion of New Zealand in what is now the Australia-New Zealand Biotechnology Alliance (ANZBA), a partnership whose members are the Australian state and territory governments and the government of New Zealand. ANZBA works directly with industry and the research sector to promote leading R&D and business opportunities in the region. Other biotechnology taskforce outcomes have included an intellectual property manual for New Zealand life sciences, and the removal of tax barriers to international venture capital investment. There has been good progress in implementing the GIF Taskforce recommendations. For example, ANZBA is already providing a number of benefits for the New Zealand biotechnology sector, including helping to increase research co-operation with Australia and attracting Australian venture capital. However, this has not solved the broader problem of access to early-stage capital. Easing such access is one of the improvements of the business environment which is required to allow more biotechnology companies enjoy faster and sustained growth.

The GIF ***ICT*** Taskforce reported in June 2003 a ten-year vision, together with a set of recommendations concerning mentoring, education and support for ICT company executives. The taskforce target to grow a further 100 ICT companies with annual sales of NZD 100 million by 2012 appears overambitious. The failed attempt to attract fundable ICT Research Consortium proposals suggests that other means of support may have to be considered.

The ***Design*** Taskforce proposed an integrated package of initiatives focusing on educating and enabling New Zealand business to understand and utilise design as a competitive business strategy. The effort to promote good design in New Zealand has been slow getting started and has involved only a modest investment to date.

…/…

43. For a more detailed description of the GIF see Chapter 3. In March 2006, the GIF was replaced by the Economic Transformation Agenda.

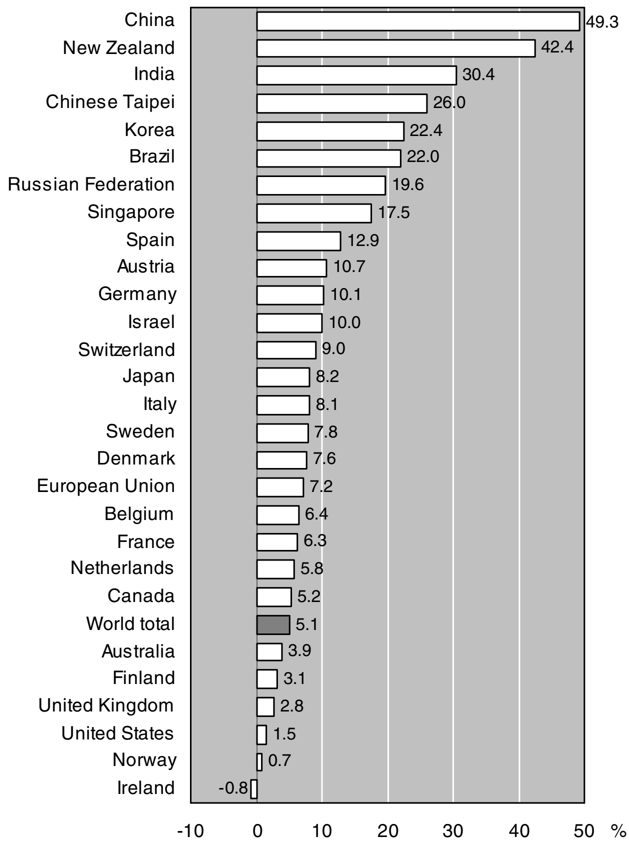
Box 2.1. Government support to selected knowledge-intensive industries under the Growth and Innovation Framework *(continued)*

The ***Screen Production Industry*** Taskforce set a target of NZD 400 million in annual foreign exchange earnings for the sector, with recommendations on how the government could work with the screen production industry to achieve this, including the creation of a representative industry body, and measures to improve the business environment, as well as marketing and training. The government established the New Zealand Screen Council with initial funding of NZD 450 000 for two years. It has also created a Large Budget Screen Production Grant administered by the New Zealand Film Commission to facilitate the production of large internationally financed films in New Zealand. Screen (television and film) productions that meet the eligibility criteria are entitled to a 12.5% rebate on their production spend (minimum NZD 15 million) in New Zealand. A MED evaluation of this programme estimated the net economic impact of the scheme at between a "best case" NZD 33 million net gain and a "worst case" NZD 38 million net loss. However, the government considered that the overall benefits outweighed the costs. The evaluation found that large-scale productions had injected NZD 363 million into the economy and generated direct economic growth of NZD 173 million as well as indirect growth of NZD 22 million from the impact of films on New Zealand's tourism sector.

Biotechnology

As an essential enabling technology, the biotechnology sector has become an important part of OECD countries' innovation system. New Zealand appears to have had some success in developing an internationally competitive biotechnology sector, based on the rapid accumulation of patentable knowledge in several important market niches (Figures 2.5 and 2.6). The country hosts some biotechnology companies that are world leaders in their field (Box 2.2). New Zealand's strength in biotechnology is particularly evident in some areas of agricultural and medical research.

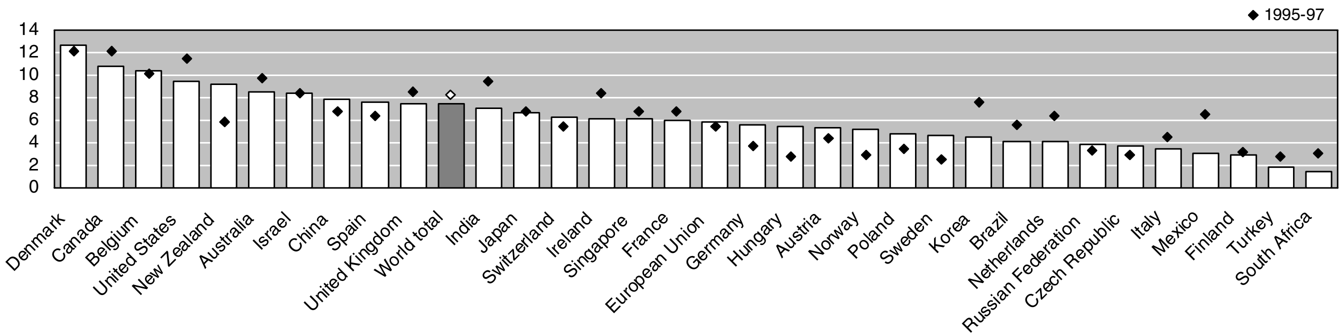
Figure 2.5. Growth in biotechnology patent applications to the EPO,[1] 1995-2003



1. The graph only covers countries/economies with more than 150 patent applications to the EPO in 2003.

Source: OECD, Patent database, September 2006.

Figure 2.6. Biotechnology patents[1] as a percentage of national total, 2001-2003



1. This graph only covers countries/economies with more than 150 patent applications to the EPO in 2003.

Source: OECD, Patent database, September 2006.

Box 2.2. Two leading New Zealand's biotechnology companies

The ***Livestock Improvement Corporation*** is a world leader in pastoral livestock genetics. It achieves dairy herd improvement through a unique national database which offers unparalleled traceability, world class genetic improvement systems and laboratory automation solutions. As a result, New Zealand dairy farmers enjoy the lowest-cost milk production in the world, a result of the high technology transfer rate (research to farm practice), national farm management and breeding strategies and the highest rate of genetic gain (for the New Zealand environment) of any dairy industry in the world.

Proacta is developing a new generation of cancer drugs that target physiological attributes of solid tumours. Proacta's first lead programme, a hypoxia-targeted small-molecule prodrug, is designed to improve the outcomes of current treatment regimens, including chemotherapy and radiotherapy. Proacta was founded by leading cancer researchers at Stanford University and the University of Auckland and has built up a strong intellectual property (IP) portfolio in hypoxia and other important areas of cancer drug research. The founding scientists, Professors Bill Denny and Bill Wilson at the Auckland Cancer Society Research Centre, at the University of Auckland (ACSRC), and Professors Martin Brown and Amato Giacca at the Division of Radiation and Cancer Biology and the Department of Radiation Oncology at Stanford University, are leading authorities in the field of tumour hypoxia. The research programme involves more than 35 scientists working with acknowledged world leaders in this scientific area at the University of Auckland and Stanford University.

Proacta now holds exclusive worldwide rights to 25 patent families, across more than nine chemical families. Ongoing development of the portfolio is supported by significant grant funding and led by acknowledged international experts in the field at University of Auckland and Stanford University. Proacta's strong IP and ongoing research activities in physiologically targeted cancer therapies give it a leadership position in meeting a substantial unmet need for the large and growing oncology market.

New Zealand's long history of sheep, dairy, beef and, more recently, deer farming has given rise to world-class associated science and technologies. Plant-based biotechnologies, based on knowledge of the biology of industrially significant plants, pasture grasses and clover, trees and crops are also important. One of the most often quoted bioscience success stories of New Zealand is the development of a new kiwifruit variety (Box 2.3).

Box 2.3. ZESPRI™GOLD kiwifruit

ZESPRI™GOLD kiwifruit is considered New Zealand's most outstanding horticultural research success. ZESPRI™ GOLD Kiwifruit, developed by HortResearch New Zealand and licensed exclusively to ZESPRI, is an innovative breakthrough. Unlike what happened for the well-known green-fleshed Kiwifruit, New Zealand has protected the intellectual property associated with ZESPRI™. This includes plant variety rights and trademarks. As a result, new Zealand should be able to capture the benefits from this new variety – benefits that were lost to others with the previous variety.

Continuous improvement and innovation have been the keys to the success of this new product, accompanied by quality assurance processes, improved orchard management and environmental growing methods. Apart from the ZESPRI™ System's programme, which applies to all export-grade kiwifruit, ZESPRI™ ORGANIC Kiwifruit are grown to strict international BIO-GRO standards and have carved a valuable niche in markets with a demand for this special product.

In addition, ZESPRI's research and development arm, ZESPRI Innovation Company Ltd, has responsibility for constant improvement of the existing product lines and the introduction of viable new cultivars.

Bioprocessing and biomanufacturing, biocontrol, biosecurity and bioremediation are also areas in which New Zealand has strengths. Food and beverage exports make up nearly half New Zealand's exports. Therefore, New Zealand has the resource base to extract beneficial compounds, and develop nutraceutical, bioactives and functional health foods.

New Zealand's biotechnology has already made useful contributions to productivity in the primary sector. Kaye-Blake *et al.* (2005) estimated the direct economic contribution of four innovations in biotechnology important in New Zealand R&D: clonal propagation/cell manipulation, biocontrol agents, enzyme manipulations and marker-assisted selection. The total estimated net benefit of these innovations to the primary sector is currently NZD 266 million a year, assuming constant prices. The advancement of research in some areas was delayed by a voluntary moratorium on release and field testing of genetically modified organisms, which were in place during the deliberations of the Royal Commission on Genetic Modification. This commission reported to the government in 2001, recommending a precautionary approach which the government endorsed. With a clear regulatory framework in place, these areas are now progressing.

New Zealand medical schools have established a tradition of internationally competitive biomedical science and drug discovery medical research. Currently, it is estimated that New Zealand researchers have between nine and eleven drug candidates in clinical trials. But capturing the value from pharmaceuticals is a particular challenge for New Zealand as long as no large pharmaceutical company is ready to invest in health-related biotechnology in New Zealand. When the sale or licensing of technology to major pharmaceutical companies is the only available route to market, it is important to maximise the value of the technology before this occurs. In addition, links into international markets are lacking in some areas. Many medical researchers are concerned that the policies of New Zealand's Pharmaceutical Management Agency (Pharmac) are not only discouraging multinational pharmaceutical companies from investing in New Zealand's medical research but also resulting in suboptimal health outcomes.

Investigating the determinants of innovative output using data from a comprehensive survey of biotechnology enterprises, Marsh and Oxley (2005) found that smaller enterprises tended to have a higher rate of innovation. The lack of early-stage investors remains a key bottleneck. The scale and mandate of the Pre-Seed Fund have not been sufficient to allow New Zealand's biotechnology sector to achieve its full potential. New Zealand has only a few biotechnology companies listed on the national stock exchange and a few more listed on the Australian exchange.

Whereas companies like Proacta and the Livestock Improvement Corporation show what New Zealand can achieve in applications of biotechnology, an improved research and business environment is necessary to ensure that more such companies can enjoy faster and sustainable growth. Publicly funded research plays a key role in developing the knowledge base of the biotechnology industry but the commercialisation of its results could be improved.

Information and communications technology

It is estimated that 15% of all researchers involved in business R&D in New Zealand are in the field of computers and related services. The high-technology industry cluster in Canterbury accounts for around half of New Zealand's ICT production, and is estimated – when indirect contributions are taken into account – to contribute NZD 1.6 billion to the New Zealand economy (Saunders and Dalziel, 2003). ICT is also recognised as an important enabling technology throughout the economy but evidence on the level of ICT adoption is somewhat mixed. In general it is considered to be fairly low. For example, the Economic Development Indicators report shows both ICT investment and broadband uptake in New Zealand to be low relative to other OECD countries (MED and The Treasury, 2005).

The GIF Taskforce found that, despite good growth performance:[44] *i)* the New Zealand ICT industry has not achieved its full potential; and *ii)* the economy does not appear to have enjoyed the productivity gains to be expected with the adoption of ICT in other sectors.

New Zealand's ICT sector is primarily composed of small companies, some in very narrow market niches. Large domestic firms are few in number but several have achieved outstanding performance. Some have emerged in the last 20 years, such as Navman (Box 2.4) and Synergy International Ltd, a software and applications integration company, established in 1992, which has a strong track record in the area of mobile solutions, particularly in the banking sector. Some others have been in existence for a longer time, such as Tait Communications and Rakon (Box 2.5).

Box 2.4. Navman: a New Zealand success story

Navman began in AN Auckland garage and has grown to be a global navigation technology company. Founded in 1986 by Peter Maire as Talon Technology, the business originally specialised in developing electronic products for the Marine market, such as chart plotters, fish-finders and wind and depth gauges. The company changed its name and moved into global positioning system (GPS) technology in the 1990s. It launched its first portable in-car navigation devices in 1997 and has created sports performance measurement tools from 2004.

Navman entered business-to-business (B2B) markets in 2000 with the launch of its Wireless Business Solutions group (now Vehicle Tracking Solutions). It acquired the Rockwell/Conexant GPS module business in 2001 to become a commercial GPS solutions arm, providing off-the-shelf GPS as well as custom solutions. Navman created the first personal digital assistant (PDA)-based in-car navigation device in 1997, its first wireless B2B products in 2001 and the first mass market portable in-car navigation device, the iCN 630 in 2003. The company developed the world's first integrated GPRS and GPS receiver, which enables businesses to manage their fleet more efficiently. Its GPS modules are used in applications ranging from mobile phones to construction.

As Navman expanded its product range, it expanded its global presence. Navman now operates in South-east Asia, Europe and the Americas. It was purchased by the US-based Brunswick Corporation in 2004.

44. For example, over 9%in 2003 to provide a NZD 5.56 billion net contribution to GDP.

Box 2.5. Tait Communications and Rakon: two long-standing leading New Zealand ICT companies

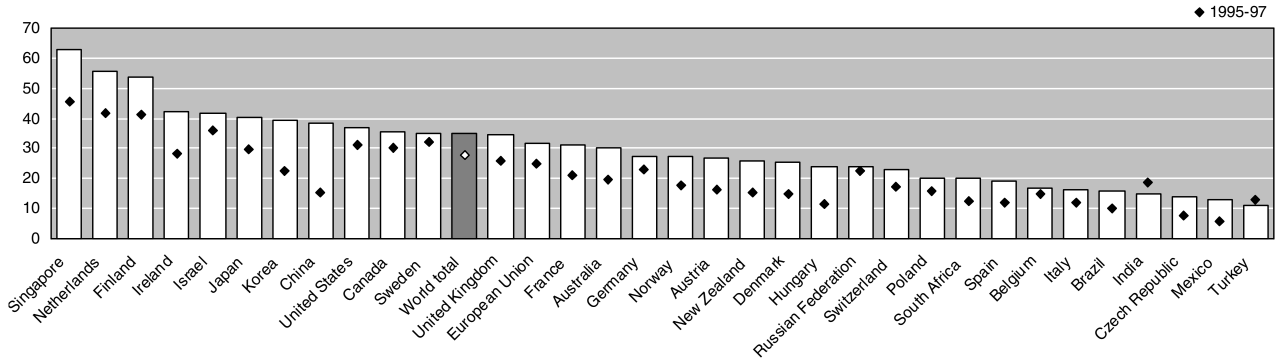
Tait Communications is New Zealand's largest electronics company and a leading international supplier of mobile communications equipment. It exports nearly 95% of its production with sales of around NZD 150 million a year. The company began in 1969 with a staff of 12 and now has 850 employees in New Zealand, mainly in Christchurch, and another 150 offshore.

Established in 1967, Rakon Ltd. is a world-leading producer of high performance crystals and oscillators. Over the last 12 years it has achieved an average annual growth rate of 66%. Rakon's high-performance frequency control products and technology (based on quartz crystals) can be found in 50% of global positioning systems (GPS) receivers produced worldwide. Rakon has about 450 employees and is located in Auckland, with overseas offices in Taipei and Chicago.

The growing share of ICT-related patents in the national patent portfolio (Figure 2.7) and the fact that several multinational enterprises are undertaking innovative projects in New Zealand are other signs that the country has something to offer in development of ICT applications. Companies actively researching, designing and manufacturing in New Zealand include Digital Microwave Systems (United States), Ericsson (Sweden), Invensys (United Kingdom) and Allied Telesys (Japan). Multinational companies also form alliances with New Zealand companies, generating a range of public and private benefits, notably in terms of staff training. One interesting example of collaboration between a multinational company and the government is Microsoft's participation in an innovative project to improve patient care through online patient records management (Box 2.6).

New Zealand's ICT sector is of significant scale and shows promise, but some limiting factors should be addressed. The GIF Taskforce emphasised one: companies tend to hit a barrier and plateau when they reach annual sales of NZD 10-15 million (or double that for electronics companies). This may be due in part to a lack of professional, management and leadership skills, but there exists also financial barriers to the creation and growth of new, export-oriented, technology-based firms.

Figure 2.7. ICT-related patents[1] as a percentage of national total, 2001-2003



1. This graph only covers countries with more than 150 patent applications to the EPO in 2003.

Source: OECD, Patent database, September 2006.

The limited availability and cost of broadband in New Zealand has held back innovations that could use this technology. Internet use by New Zealand business is reported to be 68% of all firms in 2003 (stronger than in Australia), which indicates the potential for business use of broadband. However, without the wider availability of affordable broadband, New Zealand cannot expect to see the establishment and growth of new businesses that use this technology, nor can it realise the productivity gains to be achieved when businesses outside the ICT sector use broadband to provide value-enhanced services. The lack of broadband access in rural areas also limits the development of applications of ICT to agriculture.

Box 2.6. Microsoft's Healthcare Collaboration Initiative

Jointly funded by Microsoft New Zealand and the Foundation for Science, Research and Technology (FRST), this proof-of-concept project is based on the journey of a typical diabetic patient through a variety of care settings with the support of collaborative workforce management technologies.

In the longer term, the project will demonstrate how technology can be deployed to enhance management of patient records and improve clinical and administrative processes through online collaboration. It will allow physicians, clinicians, researchers and administrators to work together in integrated, collaborative teams.

Microsoft New Zealand and FRST have each contributed NZD 416 000 to phase one of the initiative, with Microsoft contributing an additional NZD 99 000 in technical assistance and consulting support. New Zealand Trade and Enterprise, FRST and Microsoft New Zealand provided initial seed funding, and the project will be implemented by the New Zealand HealthIT Cluster, comprising leading New Zealand health IT vendors.

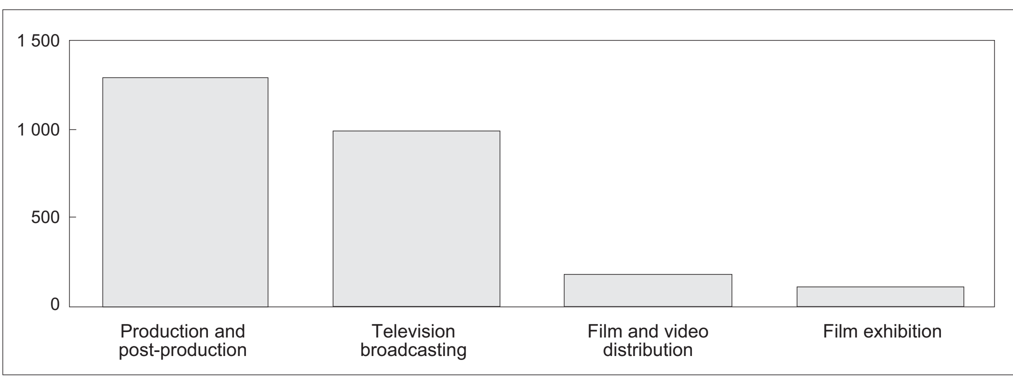
While biotechnology has received strong support from government, public investment in ICT has been much smaller, despite the fact that there is a greater likelihood of earlier returns from investments in ICT. This reflects the smaller role of pre-competitive research in the innovation process.[45] The challenge for government is to continue to invest in leading-edge ICT infrastructure, while at the same time stimulating business research and helping companies to make creative use of ICT to provide new goods and services. The failed attempt to attract fundable ICT Research Consortium proposals suggests that other means of support may have to be considered.

45. In biotechnology, product development generally takes much longer, with present commercial applications typically being the result of long-term research (10-15 years).

Creative industries

Across the OECD, design is seen as playing a vital role in innovation and in international competitiveness. However “design” ranges from a blueprint for complex engineering systems involving many technologies to improving the aesthetic appearance of consumer goods to ensuring that goods and services are fit for purpose. In part because of the advent of computer-aided design (CAD) and manufacture (CAM), design is increasingly outsourced to specialised design consultancies. New Zealand’s success in designing America’s Cup yachts is well known but good design can play an important role in many other sectors. The Better by Design programme has been the main government response, including a conference in 2005, a Design Resource Directory and an audit programme. The potential for good design to add value to New Zealand goods warrants greater effort. There is also scope to encourage good design in Māori crafts, an area in which New Zealand has unique opportunities.

Figure 2.8. Gross revenue in the screen industry by business type (NZD millions), 2005



Source: Statistics New Zealand.

New Zealand has enjoyed some notable successes in the film production industry in recent years, most notably with “Lord of the Rings”, which highlighted the talent and innovation of New Zealand companies such as Wellington-based Weta Workshop. Weta is a comprehensive film and television effects facility, a five-time Academy Award winning company that offers services to all aspects of the industry including design, special make-up effects and prosthetics, creatures, armour, weapons, miniatures, prop building, large scale sculpture, display work and costuming. Thus there is some cross-over from the film production sector to the ICT sector. In addition to Weta, other New Zealand companies that have found a niche in the film industry include Chain Mail and Animation Research. New Zealand

and Film New Zealand have co-operated on marketing New Zealand as a film production location. Both Wellington and Auckland have invested in soundstages where productions can be undertaken in any weather. A Film Business School has been established.

Total turnover for the sector in the 2005 financial year was NZD 2.6 billion, *i.e.* as much as the horticulture and forestry and logging sectors. NZD 592 million (or 62%) of gross revenue for production companies was received from other countries. There were 2 058 businesses engaged in the screen industry.

There is strong international competition for major screen productions. New Zealand has some natural and created comparative advantages with attractive and diverse landscapes, relatively low labour costs, as well as innovative screen industry support.

While there can be no denying that the spin-off benefits from support for large screen productions have been significant (*e.g.* an increase in the number of tourists to New Zealand), public support presently mainly takes the form of a direct subsidy, of which funding flowing to technological innovation is only a small component. This support has helped to put New Zealand "on the map" as a location for leading-edge activities in the screen industry. Now there is scope to look at ways of modifying the support to generate more sustainable longer-term returns. For example, increased broadband capacity would benefit the most innovative segments of this sector.

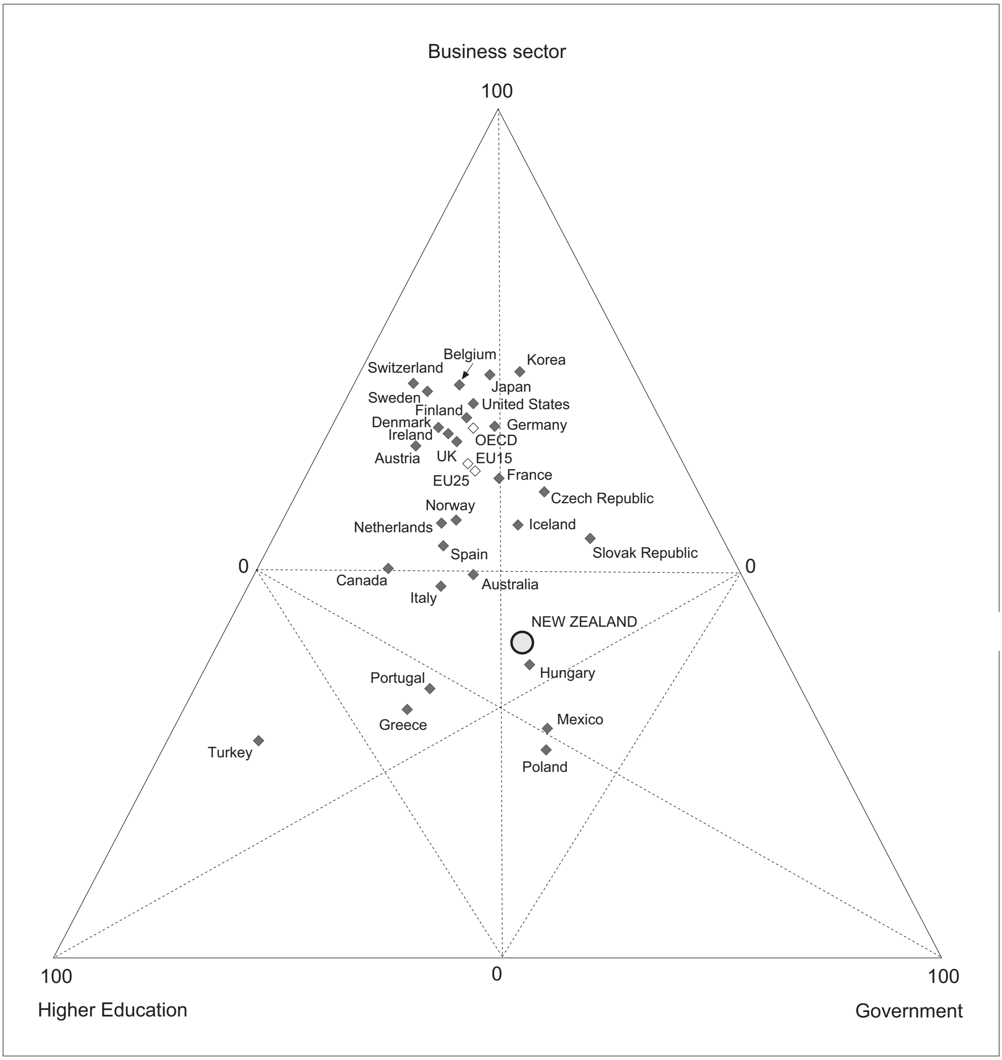
2.2. Public sector R&D

Public sector R&D makes an important contribution to innovation. It provides training for the skilled workforce necessary for innovation in the business sector. When undertaken in co-operation with the business sector, public research can enhance national competitiveness, and public research institutions are vital sources of knowledge to feed innovation in the business sector. To what extent is public sector R&D delivering these outcomes in New Zealand?

Compared to most OECD countries, the New Zealand innovation system is characterised by both a larger share of publicly funded organisations in total R&D and the dominance of public labs in publicly funded research (Figure 2.9). The major research performers are the Crown Research Institutes (CRIs) and the universities. New Zealand has nine CRIs and eight universities. In addition, there is a small number of research associations and non-commercial private research institutions.

Figure 2.9. R&D by three main types of R&D performers

% of GERD total, 2004



Source: OECD, MSTI database, January 2006.

2.2.1. The Crown Research Institutes

CRIs are a very important element of the New Zealand knowledge infrastructure. In 2002, an appraisal of CRIs (not an independent analysis of performance) found that they had achieved good economic returns, particularly those in the agriculture sector. In addition, they have generated valuable environmental, social and knowledge outcomes. They have also contributed to exports and have been involved in the creation of new firms (MoRST, 2002).

The CRIs were created as part of reforms within the New Zealand government in the 1980s. In a 1988 report, the Science and Technology Advisory Committee recommended separating advisory, funding and operations in the New Zealand science and technology system. A 1990 ministerial task group recommended that this be achieved by restructuring existing government research institutes into government-owned limited liability companies. Ten CRIs were founded on 1 July 1992 (one has subsequently been wound up). Between them, the nine CRIs listed in Table 2.8 are spread over 50 sites around New Zealand. The number of sites would appear to be excessive and lead to inefficiencies.

AgResearch is the largest CRI, but it is not the only CRI involved in agriculture-related research. Five (or six, when considering the Institute of Geological and Nuclear Science's role in oil and gas) of the nine CRIs have a primary industry focus, three in agriculture. About 39% of CRI research is categorised with the socioeconomic objective of agriculture, forestry and fishing. AgResearch is broadening its focus and is now a bioscience research organisation. The ability to adjust skills and research portfolios to evolving needs is essential for the future of all CRIs. The ability of a sufficient number of firms to pay for CRI research may be an obstacle in some cases.

CRI governance

The CRI Act sets out the purpose and principles of operation for the CRIs. The government, as owner, appoints their boards. The CRI Act requires CRIs to be viable companies and compete for public- and private-sector research contracts. They are also required to exhibit a sense of social responsibility and to undertake research for the benefit of New Zealand. There are tensions between the commercial and public good aspects of these requirements.

Table 2.8. The Crown Research Institutes

CRI	Mission
AgResearch Ltd	AgResearch support the sustainability and profitability of New Zealand pastoral sector. It undertakes biotechnology R&D.
Horticulture & Food Research Institute of New Zealand Ltd (HortResearch)	Hortresearch undertakes fruit science research using New Zealand's resources and production systems to produce innovative fruit and food products.
New Zealand Institute for Crop & Food Research Ltd. (Crop & Food Research)	Crop & Food Research focuses on sustainable land and water use, high-performance plants, food, high-value marine products, biomaterials and biomolecules.
Industrial Research Ltd. (IRL)	IRL undertakes innovation for industry. It creates value by commercialising technologies by working with key business partners to take innovations to the market.
New Zealand Forest Research Institute Ltd (Scion)	Scion develops sustainable biomaterials. It develops new biomaterials from renewable plant resources and undertakes R&D for the forestry sector through Ensis, a joint venture between Scion and Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO).
Institute of Geological and Nuclear Science Ltd. (GNS)	GNS undertakes research on Earth systems and isotope science research, energy and mineral resources, and on geological hazards and risk, and includes a centre for isotope and non-invasive scanning technologies.
Landcare Research New Zealand Ltd. (Landcare Research)	Landcare Research specialises in sustainable management of land resources optimising primary production, enhancing biodiversity and conserving and restoring New Zealand's natural assets.
National Institute of Water & Atmospheric Research Ltd. (NIWA)	NIWA research includes marine, freshwater and atmospheric science; sustainable management and development of natural resources and ensuring optimal value is obtained from marine species.
Institute for Environmental Science & Research (ESR)	ESR provides specialist science solutions relating to public health, environmental health and forensic science.

The appraisal noted concerns about finding suitable directors for the CRIs and about turnover of directors. While some steps have been taken to address these problems, CRI boards continue to have a relatively high level of turnover and a relatively high proportion of inexperienced directors. Some would benefit from having directors with skills in the commercialisation of research. Also, the relationship between government ownership and research purchaser (*i.e.* funder) roles has proved challenging. The appraisal reported that CRIs generally considered that there "was not a good balance between ownership and purchase interests". In this regard, ensuring that the minister with ownership responsibilities is not also the minister responsible for CRI funding would help. However it is difficult to completely separate CRIs' purchasers and providers.

Once a year, ministers, as owners of the CRIs, provide a document that sets out their expectations for the CRIs. The Crown Company Monitoring Advisory Unit (CCMAU) and MoRST monitor their performance. The CRIs have an association (ACRI) which works to provide an environment in which CRIs can grow their businesses. This is important as the CRIs have much to gain from collaboration.

CCMAU sets out an operating framework for the CRIs, most recently revised in 2005 (CCMAU, 2005a). It has produced papers on issues such as internationalisation and the need to balance the need to overcome the revenue constraints of a small domestic market against the need to provide demonstrable benefits to New Zealand (CCMAU, 2005b).

CRIs need directors with both business and research knowledge. Like any business, they need to operate on the basis of longer-term plans agreed with their owner. Where CRIs undertake public good activities, these should be paid for, with appropriate overheads, by the relevant government agency.

CRl resources and funding[46]

CRI resources are set out in Table 2.9, which lists CRI full-time-equivalent staff and CRI 2004 R&D expenditure. In addition to their full time staff, more than 500 students are involved, mainly through CRI supervisors. CRI human resource input has declined slightly over the past ten years.

Table 2.9. CRI resources, 2004

CRI	**FTE staff**	**2004 R&D expenditure** (NZD millions)
AgResearch Ltd	934	89.2
HortResearch	514	56.4
Crop & Food Research	356	37.7
IRL	436	42.9
Scion	348	28.6
GNS	275	43.6
Landcare Research	401	50.3
NIWA	611	40.6
ESR	355	4.5
Total	**4230**	**393.8**

Source: CCMAU(2005b) and MoRST)2006a).

46. This issue is further discussed in Section 4.4.

Average CRI expenditure on research over the last decade has grown by about 1% a year in real terms. AgResearch has shown the strongest growth, mainly as a result of a major acquisition in 1999, while IRL and Scion have shown a small decline. Nearly all of the growth in CRI revenues has been from sources other than FRST. Between 1992 and 2003-04 the CRIs paid NZD 92 millions in tax and NZD 57.4 million in dividends. However operating surpluses have declined in recent years.

The CRIs now receive about 6.5% of their support in the form of direct support through the Capability Fund. However, apart from these funds, the CRIs compete for every dollar they receive in addition to the contract research they undertake. When the CRIs were first established it was expected that as much as 90% of their revenue would come from FRST. However they currently receive about 50% of their revenue from FRST, nearly all of it contestable. In addition, most FRST contracts are for three years. As a consequence, CRIs' cash flows are unstable. CRIs want to provide a stable employment environment in order to attract quality staff, but in a highly contestable system, new projects may not be available to provide continuing employment, so that CRIs are left either to carry unfunded staff between projects or to resort to recruiting project staff on short-term contracts. The resulting uncertainty affects staff morale and longer-term research projects. CRI management is concerned that the purchasing (funding) agencies do not always understand the management challenges which the high levels of contestability brings.

Providing a more stable funding environment for CRIs has been a concern for policy makers. The development of the CRI Capability Fund, announced as part of the Vote Research, Science and Technology in the 2005 budget package, has started to address this issue. This fund is designed to provide CRIs with greater ability to undertake long-term planning, in addition to capability maintenance and development in research areas important to New Zealand. Some NZD 46 million has been provided but is not enough to provide the necessary increased stability.

As one CRI has noted, contestable funding may be more appropriate for projects that aim to generate new scientific knowledge; for projects where economic outcomes are the objective, contestability should be at organisational rather than project level. Contestability involves high transaction costs and does not support the capability underpinning a technology/knowledge acquisition partnership with business. Lumpiness in project funding can lead to the loss of key personnel. CRI funding mechanisms need to balance the maintenance of ongoing capability with an appropriate level of contestability. CRIs need more discretionary funds to make strategic investments.

Recently this issue was again raised in work carried out by MoRST and reported in *New Zealand's Future – Picking up the Pace* (MoRST, 2005a). The document suggests reducing reliance on contestable allocation processes and shifting towards a longer-term investment philosophy. This might involve providing additional funding for the CRI Capability Fund, revising CRI operating frameworks and developing non-financial performance indicators. Since the review team's visit, this appears to be moving ahead. Concerns remain that the Capability Fund may lack the resources to fund strategically challenging science research for lengthy periods of time.

CRI performance

Non-financial measures of CRI performance in 2004-05 included publications, research papers, conference papers and books (4 649), industry seminars and workshops (935), as well as patents and plant variety rights (23). Key performance indicators for the CRIs are currently under discussion. While it is understandable that the CRIs would want to point to numbers of publications in refereed journals as an indicator of the quality of their research, other indicators of commercial impact should be more important if their role is to be distinguished from that of the universities.

One of the most often quoted success stories of the CRIs is the development of a new kiwifruit variety Zespri™. However, there is evidence that some CRIs lack experience in commercialising their research and in developing commercial relationships with firms and other research organisations. During its visit, the review team received examples from firms and universities which indicated that some CRIs need to put more effort into their relationships with both commercial and research partners. For example, when developing joint research proposals with universities, arrangements need to be agreed on how funds will be shared in the event that the amount received is less than that sought. Further, arrangements regarding intellectual property need to be clearly understood by both the CRI and their commercial partners from the start of projects.

Changes in expectations have encouraged CRIs to set up spin-off companies. The number of these remains modest so far although it is starting to increase. These spin-off companies need investment if they are to be successful. It is not clear where the required capital will come from. Will private and business investors be willing to invest, and are the governance arrangements sufficiently at arm's length from the government to give them confidence in making such investments?

There are several possible explanations for the modest level of CRI licensing revenues. The predominantly agricultural focus of the CRIs limits their scope for achieving more licensing revenues. CRI researchers often seek to maximise returns to New Zealand rather than to their CRI. CRI clients have not been paying commercial rates for research in the past and some consider that they have already contributed to CRI costs through taxes. Getting CRI clients to recognise and accept a more commercial approach will take time.

Some members of the New Zealand business community find CRIs difficult to work with, and question the adequacy of the training of CRI staff to work with the private sector. There is concern about the length of time it takes to get a project with a CRI agreed and started, and there is questioning about how well the CRIs understand the markets their research aims to address. Firms interested in working with or developing CRI intellectual property (IP) report that valuing the IP is often the subject of disagreements, with the result that the IP remains "on the shelf". One CRI wanted to own the IP resulting from a project even when most of the funding had come from business and government programmes. Business is not willing to accept the idea that CRIs can capitalise the benefits of government grants even when these are awarded jointly to a business-CRI partnership. To ensure that businesses exploit IP developed with CRI assistance, a time-limited "use or lose" provision may be appropriate. In any event a clarification is needed since under the present situation a CRI may well find itself in the middle, between the wishes of its commercial customers and the requirements of its Funding Act which can be interpreted as implying that the CRI should retain ownership of IP when it thinks that the private partner(s) will not exploit it effectively "to the benefit of New Zealand".

Some commentators claim that the CRIs have high overheads, possibly owing to the public good element of their charter. Others express concern that the public good role of the CRIs could be threatened by a greater emphasis on commercial outcomes. Increasingly, the CRIs have to compete with the universities as providers of research services.

Summary diagnostic

The CRIs are delivering useful outcomes. However, a number of issues need to be addressed with a view to increasing their contribution to New Zealand innovation.

Governance can be improved. CRI managers are currently accountable to their own boards, to their owner (the minister), to CCMAU, FRST and Treasury. These arrangements are complex and onerous. While New Zealand's science system seeks to separate policy, purchaser and provider roles, it fails to fully achieve this in relation to the CRIs. The government should consider giving CRIs greater independence. CRI boards and management should agree on goals and how these will be financed over a fixed period (five to seven years) and be held accountable for their performance. The ministerial owner of a CRI should preferably be different from the minister responsible for providing funds to CRIs.

CRIs need more stable cash flows. An increased allocation of core funding, based on a five-to-seven year agreement with the government, would help to address this issue and would also recognise CRIs' public good activities. Since the review team visited New Zealand, the government has announced changes that will improve the stability of CRI funding (MoRST, 2006c). These are a step in the right direction, but there are concerns that they involve significant review and compliance costs and that the duration of the funding is not assured. Further, the percentage contribution to each CRI budget varies considerably.

CRI performance indicators should primarily be based on the impact of their research, commercialisation successes and technology transfer activities. There is a need to develop a greater commercial focus within the CRIs, and this requires appropriate training of CRI staff.

2.2.2. New Zealand's universities

New Zealand has eight universities and about 30 other major tertiary education institutions, together with several hundred similar private tertiary education organisations. The following focuses on universities, which account for nearly all research in New Zealand's higher education sector.[47] By OECD standards, with the exception of Auckland University, New Zealand universities are relatively small in terms of student numbers and research budgets. The New Zealand Vice Chancellors' Committee, established under the Universities Act, represents the collective interests of the universities.

47. New Zealand's Institutes of Technology and Polytechnics (ITPs) are primarily providers of vocational, professional, continuing and practical education and training. They also undertake applied and technical research that aids development and supports innovation in industries and communities. The content of their teaching programmes is informed by and responsive to commerce, industry and the professions they serve. ITPs also provide "staircasing" opportunities, enabling some students to transfer to universities. ITPs have a regional focus and contribute to local and regional economic development.

The funding of research in universities has changed significantly over the last ten years (Figure 2.10). Broadly speaking, universities have two types of research income: income through Vote Education to support core research activities of tertiary education organisations (TEOs); and income from other sources (Vote Research, Science and Technology and the private sector), which in general, is intended to finance particular research projects, and is known as "external research income".

In 2003, the universities' total research income was around NZD 400 million. This represented around 21% of all university revenue that year. External research income was NZD 274 million (66% of research income and 14% of all income). Between 2000 and 2003, university research income increased in nominal terms by NZD 96.1 million. Of that increase, 16% was from increased research "top-ups",[48] 13% from Vote Research, Science and Technology, and 71% from other research income. The R&D expenditures of New Zealand's universities in 2004 are shown in Table 2.10.

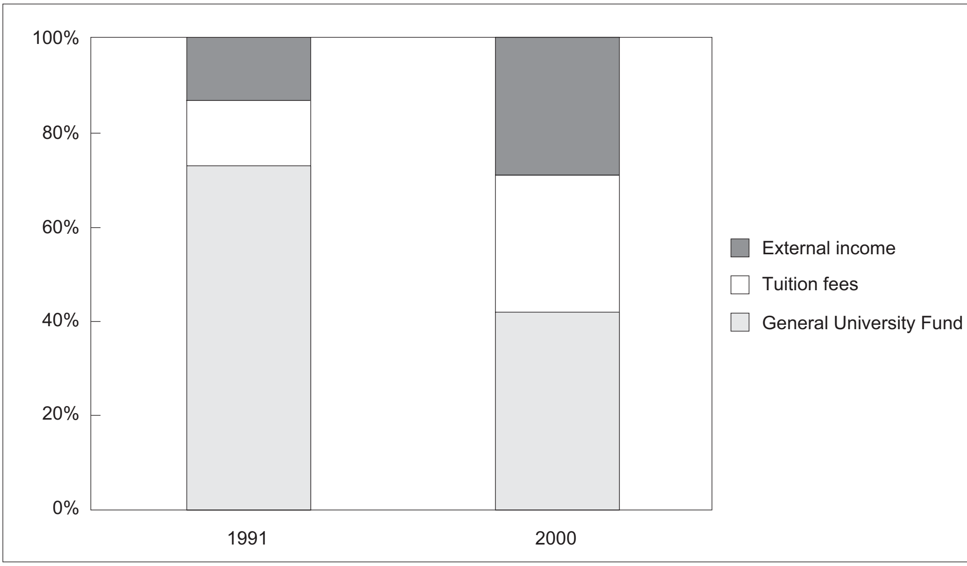
Table 2.10. R&D spending by New Zealand universities

University	**R&D expenditure 2004** (NZD millions)
Auckland	124.4
Otago	106.3
Massey	73.1
Victoria (Wellington)	41.9
Waikato (Hamilton)	38.4
Canterbury (Christchurch)	29.5
Auckland University of Technology	21.8
Lincoln	19.2
Total	**454.8**

Source: MoRST, 2006a.

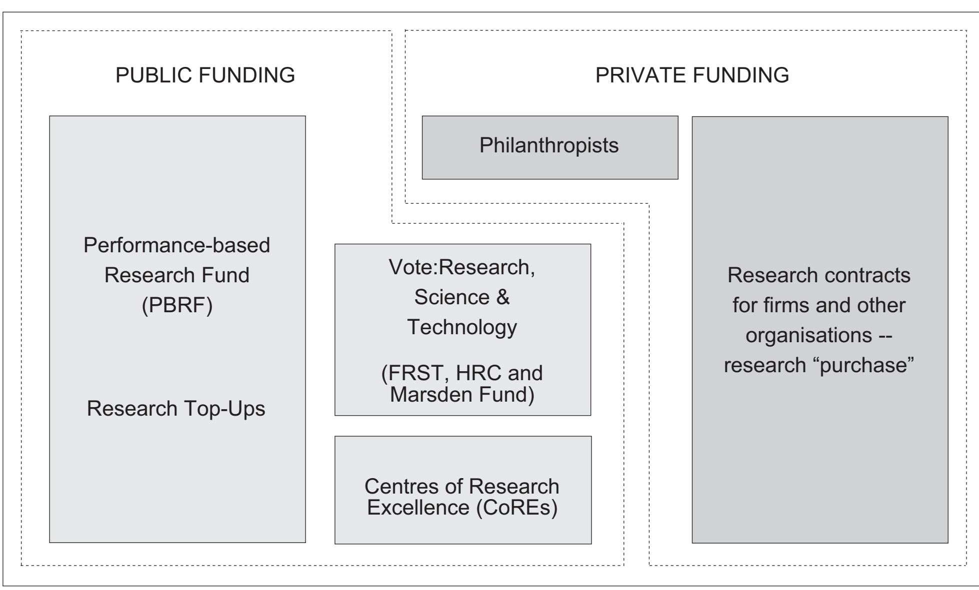
48. Research top-ups are supplements to the tuition subsidy rates for domestic degree-level and postgraduate enrolments. The rationale for allocating research funding through this means was that degrees are required under the Education Act to be taught predominantly by staff active in research. The enrolments-based funding recognised that the research effort of the TEOs teaching at that level would need resources. The level of top-up income depends on the number of enrolments at degree level and higher, with the rate of top-up funding dependent on: *i)* the course classification and hence the funding category for enrolments in the field of study; and *ii)* the level of study, with lower top-up rates being paid for undergraduate degree enrolments and higher rates for enrolments in taught postgraduate courses and for research degree enrolments.

Figure 2.10. Composition of New Zealand universities' income, 1991-2000



Source: Guy Scott and Helen Scott, "A longitudinal study of New Zealand university income and student numbers", *New Zealand Journal of Tertiary Education*, Vol. 1, No. 2, 2005.

Figure 2.11. Sources of university research funding



In terms of overall research intensity, the University of Otago leads Auckland. Otago has a concentration in medical research (41%). Auckland also has a strong medical research effort (28%). The universities of Auckland and Canterbury have strong engineering schools. Massey University, Waikato University, AUT and Victoria University also offer engineering degree courses.

In 2005 the *Times Higher Education Supplement* ratings of the world's top 200 universities listed the University of Auckland at 52nd place, with Otago at equal 186th and Massy at equal 188th. The 2005 academic ranking of world universities by the Institute of Higher Education, Shanghai Jiao Tong University, lists the University of Auckland in the 203-300 range, Otago in the 301-400 range and Massey, Canterbury and Victoria University of Wellington in the 401-500 range.

Research training, research intensity and a link between research and teaching at all levels are essential features of a New Zealand university. Seven universities generally have a significant proportion of their students undertaking postgraduate research (Table 2.11).

Table 2.11. Student enrolment and postgraduate research students as a percentage of total student numbers

University	Students enrolled (2004)	Postgraduate EFTs/total EFTs (%)
The University of Auckland	29 253	17.08
Auckland University of Technology	16 325	3.65
University of Waikato	11 592	15.95
Massey University	32 480	17.23
Victoria University of Wellington	15 376	15.39
University of Canterbury	12 366	15.2
Lincoln University	3 626	17.87
The University of Otago	17 565	14.76

Source: TEC, 2004 and New Zealand Vice Chancellors' Committee, 2004.

The lack of a high-speed/bandwidth network for researchers has only recently started to receive attention. Some fields of research, such as bioinformatics, have been significantly disadvantaged by the lack of such a network. Researchers manipulating large data sets (*e.g.* in geology) are likely to be early users.

Box 2.7. Auckland and Otago, New Zealand's leading research universities

Auckland University

Auckland University achieved the highest quality score, and the highest funding allocation, in the Performance-Based Research Fund review, released in 2004 by the Tertiary Education Commission (TEC), which concluded that: "On virtually any measure, the University of Auckland is the country's leading research university. Not only did it achieve the highest quality score of any tertiary education organisation, but it also has by far the largest share of A-rated researchers in the country."

Auckland University conducts research is a wide range of fields including gene therapy, neuronal rescue, Pacific health, structural biology, marine conservation, fish navigation, invasive species, atmospheric physics, quantum and atomic optics, microlensing in astrophysics, surface science, materials chemistry, crystal fluids, group theory, inductive power transfer, computational electro-mechanics, sail aerodynamics and organisational change.

The university hosts four of the seven centres of research excellence (CoREs):

- The Centre for Molecular Bio-discovery.
- The New Zealand Institute of Mathematics and its Applications.
- The National Institute of Research Excellence for Māori Development and Advancement (Nga Pae o te Maramatanga).
- The National Research Centre for Growth and Development.

In addition to the four CoREs, the University of Auckland supports the work of 12 research units, 36 research centres and six research institutes. The university's research revenue reached NZD 141 million in 2005. Auckland University researchers accounted for just under half of the Health Research Council funding awarded in 2005, and over a quarter of the Marsden Fund grants to universities. The university was also successful in winning two new Partnerships for Excellence projects.

The University of Auckland is also a partner in the Allan Wilson Centre for Molecular Ecology and Evolution, hosted by Massey University and the Centre for Advanced Bioprotection Technologies, hosted by Lincoln University.

The university has collaborative research relationships with the CRIs. One example is the hosting of a Landcare Research laboratory on the university's Tamaki Campus, together with the establishment of joint research centres in biosecurity and sustainability and co-location of staff and research facilities. Under a 2001 memorandum of understanding, AgResearch established a Structural Biology Laboratory in the University's School of Biological Sciences. AgResearch is also a partner institution in the National Research Centre for Growth and Development.

The university also has numerous collaborative links with industrial research partners, managed through its commercial arm, UniServices (see below).

The University of Otago

The University of Otago is New Zealand's oldest university, founded with a land grant in 1869. It now has about 18 000 students. With both a medical and dental school, Otago's student population in 2004 included 4 246 students in health sciences and 4 344 students in science. The university received 15 grants worth NZD 11 million in the 2005 Marsden Funding round and NZD 19 million from the HRC. The university has a small commercialisation company, Otago Innovation Ltd.

Some aspects of the allocation of funds within the higher education sector raise questions about the adequacy of funding arrangements. For example, funding allocations appear not to give sufficient recognition to the differential costs of training students in different fields of study, and in different parts of the tertiary education system. Commercialisation of university research (see also section 2.3) would be enhanced if universities' commercial arms could access government support.

Summary diagnostic

While New Zealand's universities, institutes of technology and polytechnics serve the country well, some issues deserve particular attention. The relatively large number of higher education institutions suggests that the government should be careful to ensure critical mass and high-quality research infrastructure; also, university commercial arms would seem to need to have easier access to government support.

2.3. Interaction within the national innovation system

2.3.1. Co-operation in research and innovation

The importance of co-operation and collaboration by researchers is well understood in New Zealand. Sharing ideas can result in more rapid achievement of outcomes and sharing research equipment contributes to efficiency. In a well-functioning national innovation system, collaboration across sectors and between different institutions ensures vitality and best use of skilled resources. In a small country like New Zealand, it helps to overcome a lack of critical mass and ensures optimal use of scarce resources. Co-operation between the public and private sectors can enable public-sector research skills to assist the development of firms, particularly when these have limited capacity to undertake their own research.

There is co-operation between the agricultural CRIs. Co-operation between CRIs and between CRIs and universities takes place at both a formal and informal level. The CRIs increasingly work together on joint proposals (*e.g.* to FRST), some of which involve formal legal entities (*e.g.* Biopolymer Network Ltd). Government programmes such as CoREs encourage joint projects. There are also good examples of co-operation between CRIs and the universities. Contestable funding should, in principle, be more conducive to co-operation among beneficiaries than pure institutional funding, but whether the existing degree of contestability leads to the desired level of co-operation is a matter of judgement. There is evidence that the current high level of contestability of funding somewhat inhibits co-operation among public research organisations (PROs). In certain cases research organisations have deliberately chosen to sacrifice relations with their partners in order to avoid having to make their staff redundant due to loss of funding. Naturally, the funding agencies will often not fund all parts of a joint bid.

There is some evidence of good co-operation between small and medium-sized enterprises, particularly when their primary competition is with firms in other countries rather than in New Zealand. The Auckland marine industry cluster provides an example of SMEs working together for their mutual benefit. Unfortunately, significant shifts in government policy drove some key players in this industry offshore in the 1980s, and this sector has not realised its potential in spite of New Zealand having won the America's Cup (CANZ, 2004). This is a sector in which design is an important element of competitiveness. Another example is the ICT/software cluster in Canterbury.

The regional dimension of the promotion of inter-firm co-operation is important. For example, the Canterbury region, centred around Christchurch in the South Island, is active in this field. The CDC (Box 2.8) shows what a strong well-supported regional organisation can achieve. However government support for such bodies appears to be very small which may explain their variability in performance.

Box 2.8. The Canterbury Development Corporation (CDC)

The Canterbury Development Corporation (CDC) is Christchurch's economic development and employment agency. It promotes economic growth within the region through the provision of a broad range of business development services. The CDC is a non-profit company that facilitates economic growth in the region by working with businesses to improve their management capabilities, helping communities to help themselves, and working alongside key agencies to promote Christchurch and Canterbury as an investment and business location. The CDC's technology initiatives aim to promote Christchurch as a modern knowledge-based city, develop high-technology industry clusters, facilitate innovative cross-sector R&D partnerships and accelerate the speed of technology transfer.

The CDC has been the key force behind the establishment of the Canterbury Innovation Incubator and the Human Interface Technology Laboratory New Zealand (HIT Lab NZ). HIT Lab is a human-computer interface research centre hosted at the University of Canterbury. Technologies currently being developed at the HIT Lab include 3D panoramic displays, virtual and augmented reality, voice and behaviour recognition and intuitive aural and tactile feedback. The lab is a partner of the world-leading HIT Lab US based at the University of Washington in Seattle.

2.3.2. Industry-science relationships and commercialisation of public research

New Zealand's strong public sector research is well placed to assist industry and there are examples of PROs' very effective contribution to industrial innovation (Box 2.9). However, finding suitable research and business partners is a significant problem for universities and CRIs. Several agencies provide incentives for university-industry interaction (see Chapter 3); these include the Research Consortia and the Technology for Business Growth scheme which has led to numerous collaborative arrangements. Government funding for co-operation between the public and private sectors has grown in recent years. Universities' commercial arms actively seek to build relationships between universities and the business sector. Business funding of R&D in the higher education and government sectors is relatively high, compared to the OECD average, owing in part to the central position of the CRIs as research performers.

Box 2.9. Auckland University's Light Metals Research Centre

The university's Light Metals Research Centre provides a full suite of research and development capabilities for the global light metals sector and currently works with over 20 aluminium smelters, alumina producers and metal processors around the world. When New Zealand Aluminium Smelters came to upgrade their smelter in 1994, their scientists and engineers worked collaboratively with the Chemical and Materials Engineering and Chemistry Departments of the university to develop a new dry scrubber for cleaning gases. This saved the company between NZD 12 million and 15 million. New efficiencies underpinned by research at the university saved enough electric power to more than justify all capital costs on the NZD 465 NZD millions upgrade. Ongoing production increases and savings run to hundreds of millions of NZD. The gains have ensured a longer plant life and a 6% reduction in greenhouse gas emissions.

All New Zealand universities have an office or company charged with managing intellectual property and contract research. Exchange of experience between the commercialisation managers of the universities appears to be good. Most university commercialisation arms are small and under-resourced. Unlike the situation in the United States, there is some government encouragement (*e.g.* in the form of FRST contracts) but no government requirement for universities to make follow-on investments in research outcomes that have commercial potential. The impact of most commercial arms is limited. However, Auckland UniServices Ltd. is an outstanding performer (Box 2.10).

Box 2.10. Auckland UniServices Ltd.

Auckland UniServices Limited (UniServices) is a wholly owned company of the University of Auckland that manages the university's commercial research and consultancy partnerships, forms new business ventures based on university research and owns and develops the university's intellectual property. UniServices operations include:

- Managing research partnerships – UniServices develops partnerships ranging from small research and consultancy contracts to projects worth NZD 30 million.
- Developing new knowledge and technology.
- Protecting and commercialising intellectual property – UniServices protects all intellectual property developed at the university and has an extensive portfolio of new technologies that are available for commercial licensing.
- Creating new businesses – UniServices starts new companies based on new knowledge developed at the university and, along with several unincorporated new business ventures, has a strong track record of successful start-ups in New Zealand, the United States and the United Kingdom.

UniServices has helped start 17 companies operating in New Zealand, the United States and the United Kingdom. Companies in which UniServices holds an interest based on intellectual property are listed below.

In 2005 UniServices achieved revenues of NZD 71.2 million. In addition to its portfolio of 180 patents and 115 licences, UniServices investee businesses market capitalisation reached NZD 266 million. Its financial contribution to the University of Auckland was NZD 23.7 million. These results make UniServices the best performer of its type in New Zealand and Australia.

Some Auckland UniServices companies

BrainZ Instruments Ltd. is developing brain monitoring technology. The company uses leading-edge signal processing techniques which are coupled to develop instrumentation to aid in the management of brain injuries.

Clinical Trials Research Unit (CTRU) co-ordinates clinical trials in Australasia, Asia and Europe, employing more than 60 health research workers including epidemiologists, statisticians, study managers, data managers and computer programmers.

The Centre for Software Innovation (CSI) is a separate consulting and research organisation based at the university to help clients resolve fundamental computer science challenges. The Centre draws on over 100 PhD-level researchers.

DNA Diagnostics Ltd, a joint venture between UniServices and Diagnostic Medlab. DNA Diagnostics Ltd. was the first company formed by UniServices and has been operating since 1989 when it began the first New Zealand DNA-based paternity testing service.

English Language Academy (ELA) opened in 2000 as a separate business entity with the assistance of UniServices. The ELA provides Academic English and IELTS training to hundreds of international students.

Freezecon Ltd. was established to commercialise a freezing process for removing water from biological fluids, particularly milk on farms.

…/…

Box 2.10. Auckland UniServices Ltd. ***(continued)***

LactoPharma Ltd., formed in 2002 to discover and commercialise biomedical components in milk. This research aims to identify new food ingredients, nutraceuticals and drug leads.

Neuren Pharmaceuticals Ltd. is developing novel therapeutics in the fields of neuroprotection and metabolic disorders. It was listed on the Australian Stock Exchange in 2005.

Protemix Corporation Ltd. is a biotechnology company focused on discovery, development and commercialisation of novel treatments for diabetes and cardiovascular disease.

Proacta Therapeutics Ltd. is developing cancer therapeutics for the treatment of solid tumours. Proacta draws on a broad portfolio of intellectual property supported by significant grant funding and led by acknowledged international experts in the field at Auckland and Stanford Universities.

Commercialisation of research can occur through licensing or sale of intellectual property. In recent years there has been strong interest in formation of spin-out companies. Counting spin-outs and normalising this indicator in terms of the number per USD 1 billion has become an international measure of commercialisation, even though the capital raised and survival rates may vary widely.

A study of spin-out companies from FRST-funded projects found a significant increase in both university and CRI spin-offs after 2000 and reported that more spin-offs are formed from New Zealand universities on a per-dollar basis than in the United States but fewer than in Australia and Canada. The number of spin-offs from New Zealand universities and research institutes combined was slightly smaller than for Australia (NZIER, 2005). This is an encouraging result. FRST funding supported the research on which just over half of the spin-outs were based. Difficulties in raising capital were identified as the biggest problem for spin-offs.

2.3.2. Infrastructure and financing for innovation and technology-based entrepreneurship

Technology diffusion

There have been effective models of technology transfer in the past, such as the farm advisory (extension) service that helped New Zealand's dairy industry to achieve world leadership. The government-funded agricultural extension service largely disappeared at the time the CRIs were established. The Livestock Improvement Corporation and Meat & Wool New Zealand maintain limited extension services. Some CRIs now contract other organisations to provide a network of individuals with expertise to help introduce new technologies and procedures and Agriculture New Zealand offers training courses. The Agriculture and Forestry Vote continues to provide some limited support for extension activities.

There are also a number of categories of manufacturing in which the productivity of firms depends more on technology developed elsewhere than on their own innovation. However, New Zealand does not currently have an effective technology diffusion model or a means of assisting companies with accelerated product development and prototyping. The Danish Technology Institute and Australia's Queensland Manufacturing Institute could be useful models. Such an organisation could play a useful role in transferring technology, particularly systems technologies that are applicable across a number of firms. There could also be a role for such an organisation to assist manufacturers to achieve international best practice.

Technology/innovation parks and business incubators

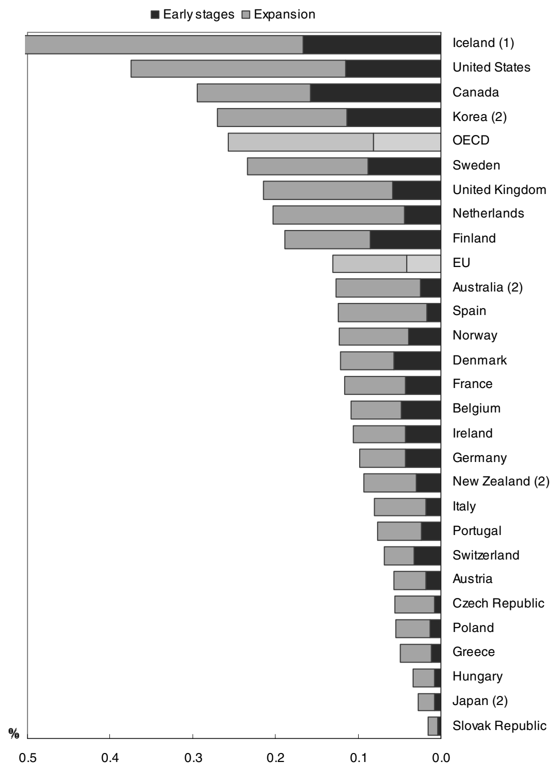
New Zealand has two small technology/innovation parks and about 14 business incubators (Incubators New Zealand, 2006). Such facilities provide valuable assistance to technology-based start-up companies. Waikato Innovation Park is a relatively new initiative.[49] Staff from the University of Waikato's Management School offer an eight-week programme to help nurture technology-based businesses. The Canterbury Innovation Incubator, located in Christchurch, enjoys strong support from local education institutions and corporate sponsors. It has the capacity to host between 16 and 24 companies.

Technology parks in Asia have been shown to play a valuable role in national innovation systems (Allen Consulting Group, 2005). Such parks and incubators can promote stronger linkages between key players. However, they need significant investment to succeed. New Zealand Trade and Enterprise has provided NZD 10.4 million over five funding rounds to assist incubators. On a per-incubator annual basis, this is a sub-optimal level of support. When divided by the number of companies being helped in each incubator, the effective rate of assistance to incubated companies is very small. Yet, according to results of international benchmarking projects, New Zealand's technology parks and incubators appear to rank well in terms of economic impact for dollars invested. Providing more government support should therefore be cost-effective.

49. Waikato is a region centred around Hamilton in the North Island.

Figure 2.12. Venture capital in OECD countries

Investments in venture, capital % of GDP, 2000-2003



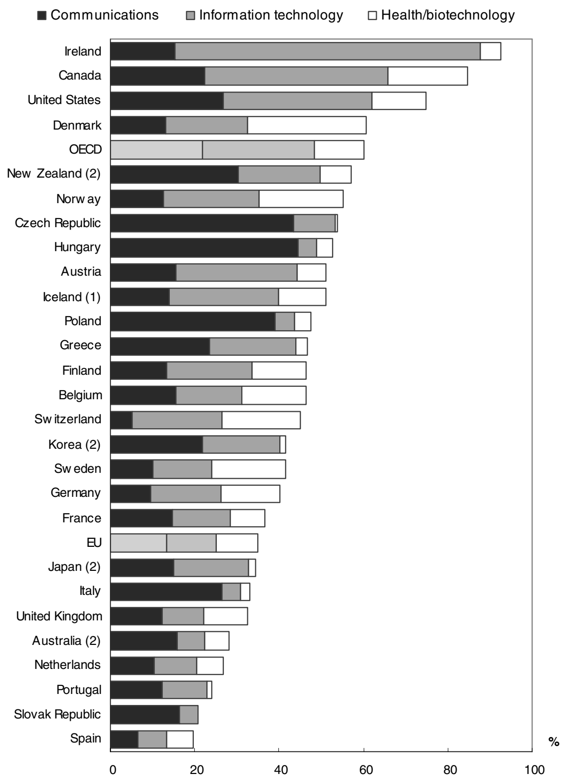
1. 2000-2002.

2. 1998-2001.

Source: OECD (2005d).

Figure 2.12. Venture capital in OECD countries

Share of high-technology sectors in total venture capital,
% of total venture capital investment, 2000-2003



1. 2000-2002.

2. 1998-2001.

Source: OECD (2005d).

Financing innovation

Although New Zealand's capital markets do not seem to suffer from major or pervasive failures, there are localised market failures in early-stage financing of small, young knowledge-based firms. As noted in the Innovation Survey 2003 (Statistics New Zealand, 2004b), businesses access a variety of funding options to support innovative activity. Over 95% of leading and "new to market" innovators sourced funds from within their own businesses. This may be a significant constraint on innovation activities especially in young firms. Among the different groups of innovators, "active adopters" sourced their funds from banks, family and friends, while leaders in the "new to market" category accessed shareholder funds and government assistance. More than one in five businesses ranked development costs as the highest barrier to innovative activity.

There is some evidence that business lending by New Zealand banks has increased relative to home mortgage lending. This has been suggested as the reason for 54% of new start-up companies having a written business plan compared to 20% of older firms (Hamilton and Fox, 1999). If so, this is a useful development. However, equity finance appears to be the major challenge in a country with relatively few business angel investors, and, as in other countries, company founders are unwilling to relinquish control in return for equity investment that could be used to expand their business. The New Zealand venture capital market is still embryonic (see Figure 2.12 and Chapter 3). In spite of government assistance, financing the development of technology-based products needs further attention from policy makers.

Private-sector investment in innovation generally appears to be modest, with a very small business angel investment community. Business angels usually prefer to take a low public profile and are not easy to identify or organise into networks.

In 2004 the New Zealand Parliament passed legislation that removed a barrier limiting the ability of unlisted New Zealand companies to access offshore venture capital. It may be some time before this has an impact. The New Zealand Venture Capital Association (NZVCA) reports that seed and expansion investments represented 67% of all deals made in 2005, probably reflecting the influence of the Venture Investment Fund (VIF) programme. Some NZD 64 million was invested by venture capitalists in 2005. At the end of 2005, some NZD 174 million was available for venture capital deals (Ernst and Young, 2005).

2.3.3. International linkages

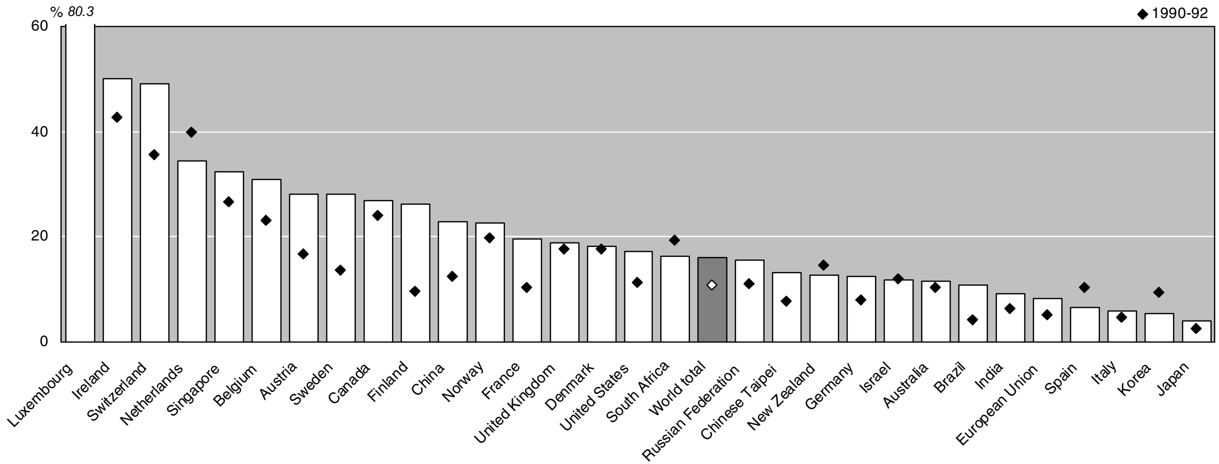
Given New Zealand's size and geographical isolation one would expect it to have built a dense web of international linkages. However, many indicators converge to tell a different story. For example, a small proportion of New Zealand innovative firms have a presence abroad (Table 2.12). This translates in particular into a low share of inventions made abroad in total patents owned by New Zealand residents (Figure 2.13), although the percentage of patents with foreign co-inventors looks better in an international comparison (Figure 2.14).

Table 2.12. Percentage of all businesses reporting international presence

Business size	**Businesses with part-foreign ownership** (last 12 months)	**Businesses with shares in overseas business** (last 12 months)
6-19 employees	4	2
20-49 employees	7	4
50-99 employees	17	7
100 or more employees	32	11
Industry		
Agriculture, forestry and fishing	4	2
Mining and quarrying	25	5
Manufacturing	9	5
Electricity, gas and water supply	38	19
Construction	2	1
Wholesale trade	19	6
Retail trade	1	2
Accommodation, cafes and restaurants	6	0
Transport and storage	7	2
Communication services	18	0
Finance and insurance	19	6
Property and business services	8	4
Education	3	2
Health and community services	1	0
Cultural and recreational services	9	2
Overall	**7**	**3**

Source: Statistics New Zealand, Business Operations Survey 2005.

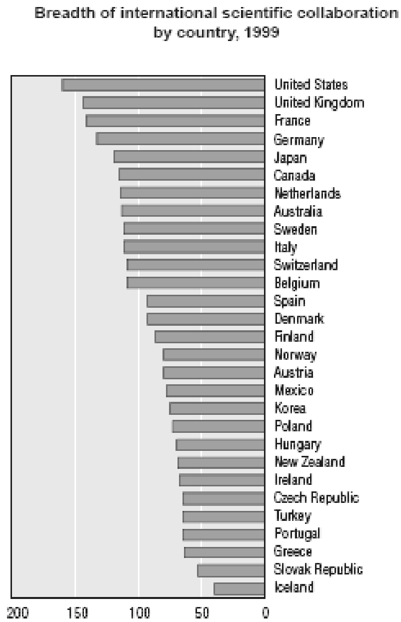
Figure 2.13. Domestic ownership of inventions made abroad,[1] 2000-02



1. Share of patent applications to the EPO invented abroad in total patents owned by country residents.

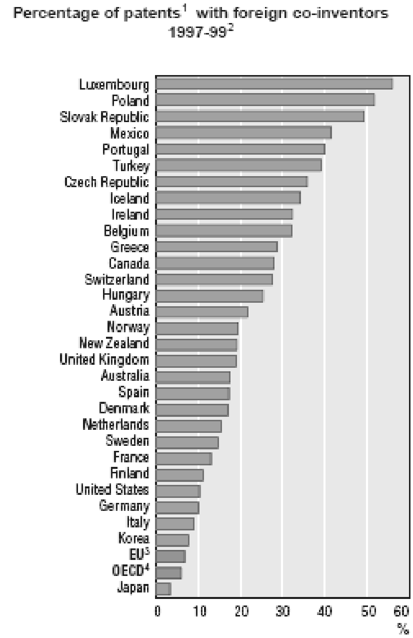
Source: OECD, Patent Database, September 2006.

Figure 2.14. International collaboration in science and innovation



Note: The figure shows the number of countries that shared at least 1% of their internationally co-authored papers with the country.

Source: OECD, based on data from the National Science Foundation, *Science and Engineering Indicators 2002*.



1. Patents applications to the European Patent Office.
2. Priority years.
3. The EU is treated as one country; intra-EU co-operation has been netted out.
4. Patents of OECD residents that involve international co-operation.

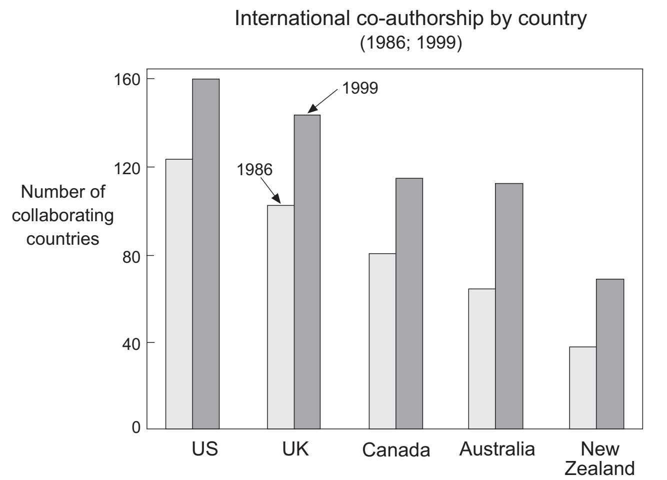
Source: OECD, Patent database, May 2003.

International co-operation is also vital for New Zealand's researchers. It can provide access to large and expensive facilities not available in New Zealand and expose researchers to new research ideas and techniques. International co-operation by individual researchers is quite strong, as seen in high rates of publication with overseas co-authors (Figure 2.15). However the geographical breadth of such collaboration could probably be expanded (Figure 2.14).

Figure 2.15. International co-authorship comparison

International co-authorship of research publications

	Year	Number of publications	Internationally co-authored share of publications
United States	1986	182 792	9.2%
	1999	183 906	21.6%
Australia	1986	11 028	15.3%
	1999	15 287	31.7%
New Zealand	1986	2 211	18.3%
	1999	2 981	35.7%



Source: LEK Consulting, 2003.

New Zealand has bilateral science agreements with a number of countries and science counsellors in Washington and Brussels. International collaboration in science and technology was the subject of a recent study (LEK Consulting, 2003) which concluded that there has not been a clear policy focus on nurturing strategic collaborations and greater levels of co-investment with foreign research funders. Instead, New Zealand policy settings and institutional arrangements have resulted in a relatively closed research, science and technology market. Since this report, links between New Zealand and Australia in biotechnology have improved, and, more recently, New Zealand has decided to participate in the Australian Synchrotron Project.

Current sources of funds available to researchers and companies for engaging in international co-operation are limited. The International Science and Technology Linkages Fund and the International Investment Opportunities Fund are the major sources of support. The CRIs and universities have their own dedicated funds to support their international linkages programmes. Involvement in major overseas activities such as the European Union's Framework Programme is still limited. Where Australian groups have succeeded in becoming involved in EU Framework projects, there may be opportunities for New Zealand researchers also to become involved, subject to the availability of funding. Facilitating New Zealand firms' access to foreign sources of knowledge, including through their participation in global innovation networks, should be a high policy priority.

2.4. Innovation skills

2.4.1. Broad patterns in supply and demand

Innovation is very dependent on the availability of appropriate technical, managerial, entrepreneurial, financial, etc., skills. Is New Zealand training enough graduates with skills that can contribute to innovation? How do the numbers of scientists and engineers per thousand population compare with other OECD countries? Are these graduates finding employment where they can use their skills? What is the impact of migration on the numbers of people with science and engineering training? If New Zealand succeeds in raising its level of innovation will it be able to increase its supply of skilled people in step? This section provides some elements of answers to these questions which, however, have ramifications which go far beyond the scope of this report.

Table 2.13 shows that the lack of management resources and appropriate personnel are perceived by New Zealand enterprises as the most important hindrances to innovation. But this seems to rather due to qualitative than to quantitative supply mismatches.

Table 2.13. Factors hampering innovation activity, last two financial years at August 2005

	Degree of hampering			Did not hamper
	High	Medium	Low	
	Percentage of all businesses			
Lack of management resources (including time)	19	25	18	38
Lack of appropriate personnel	12	23	21	44
Costs to develop or introduce	17	23	15	44
Government regulation	15	12	18	55
Lack of marketing expertise	5	17	22	56
Lack of information	2	11	27	59
Lack of co-operation with other businesses	2	8	20	70
Access to intellectual property rights	1	3	13	83

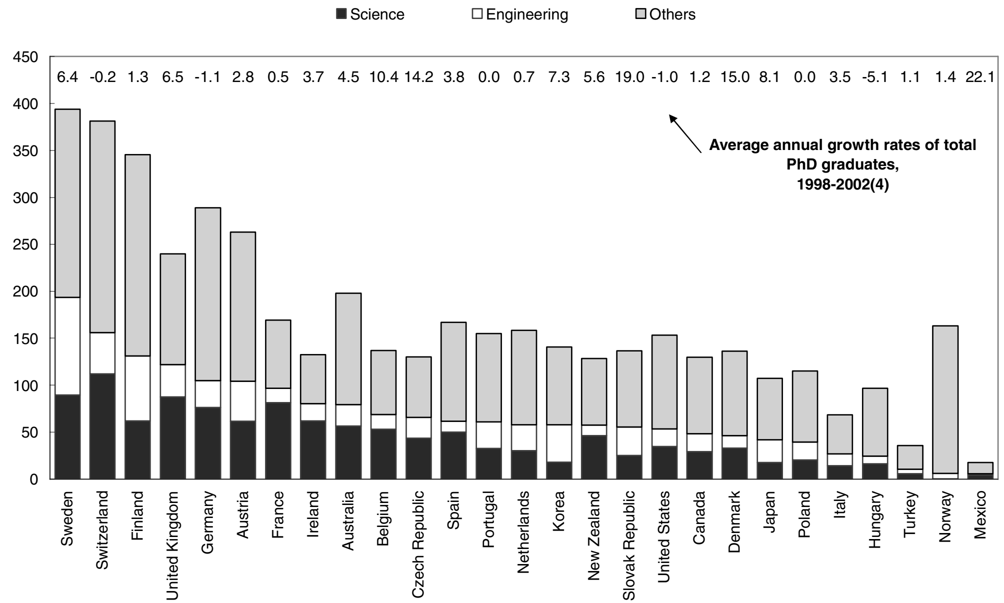
Source: Statistics New Zealand, Business Operations Survey 2005.

Using the OECD definition of human resources in science and technology (HRST), Zealand's stock of people with an HRST qualification is 292 000, with approximately equal number of males and females. The number of science and technology jobs is estimated at 436 000 (MoRST, 2006a). A number of these jobs are therefore filled by people without a university qualification. Some 154 000 graduates in science and technology are actually employed in relevant occupations (some are employed in other fields, are retired or unemployed). When the definition is limited to science and engineering, there are 103 000 jobs of which 43 000 personnel have university-level qualifications.

New Zealand is very dependent on skilled migrants. In 2001, of those working in science and technology jobs, 72 000 were born overseas compared with 163 000 born in New Zealand. Some 30% of university-qualified personnel were born overseas. By comparison, only 20% of New Zealand's population was born overseas.

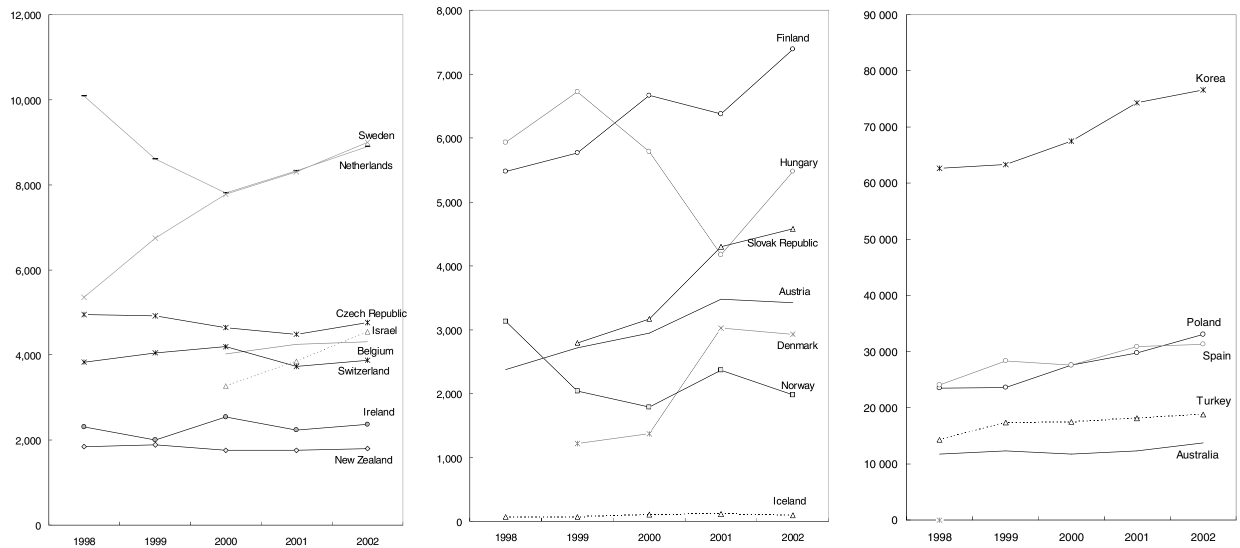
New graduates are important contributors to innovation. The supply of graduates with science and engineering skills in New Zealand is determined by the number of students graduating from the nation's universities and polytechnics, together with the number of skilled immigrants. In 2004 138 583 students were enrolled in New Zealand's universities (approximately 57% female and 43% male). There were 21 103 international students paying full fees. Government funding by bulk grant was more than

Figure 2.16. PhD graduates in science and engineering and other fields, 2002, per million population



Source: OECD, Education database, June 2006.

Figure 2.17. Supply of engineering graduates in selected non-G7 economies, 1998-2002



Note: Engineering, manufacturing and construction according to the International Standard Classification of Education 1997 (ISCED 97).

Source: OECD, Education database, June 2006.

NZD 890 million and funding per equivalent full-time student (EFTS) was about NZD 8 745.[50]

In terms of broad specialisation, New Zealand differs from some leading OECD countries in that the number of science degrees awarded exceeds the number of engineering degrees. While New Zealand's graduation rate at doctoral level is well below that of Sweden and Finland but ahead of that of Canada (Figure 2.16). New Zealand universities may not produce enough engineers (see Figure 2.17 for the number of engineering graduates) and ICT specialists. Indeed there is evidence that the number of engineers, at least in some disciplines, and IT professionals being trained by New Zealand universities is insufficient to meet demand. Levels of training of mechanical (Department of Labour, 2006a) and civil engineers (Department of Labour, 2005a) have been low.[51] In contrast, demand for these occupations has risen rapidly owing to buoyant growth in the non-residential building, transport infrastructure and machinery and equipment manufacturing sectors. The mismatch between growth in demand and supply is reflected in the small proportion of advertised vacancies filled in these occupations. In 2005 only 18% of structural engineering vacancies and 28% of mechanical engineering vacancies were filled within 10 weeks of advertising (Department of Labour, 2005b).

A shortage of IT professionals has emerged in New Zealand since the lull in the IT sector at the beginning of this decade. Demand for IT professionals has been growing rapidly over the past six years, with annual growth in employment exceeding 25% a year, for a total of almost 4 000 positions created annually. In contrast to the rapid growth in demand, the growth in supply from training has slowed. The number of degrees and postgraduate diplomas with an IT major awarded declined from a high of about 1 650 in 2003 to about 1 300 in 2005. The number of students enrolled for IT degrees and postgraduate diplomas declined by 44% between 2001

50. The government has recently introduced changes to interest on university student loans. These changes will involve a significant cost to revenue. From 1 April 2006 student loans are interest-free for borrowers living in New Zealand. Interest will continue to be charged to borrowers' loans but if the borrower is eligible, this interest will be written off after 31 March each year. This should encourage more students to undertake university studies and also provide an incentive for them to remain in New Zealand after graduation.

51. A training rate of 2.8% for civil engineers was measured in 2003 and an average training rate of 2.0% between 2000 and 2005 was measured for mechanical engineers. An occupational training rate expresses the proportion of new graduates as a proportion of total employment in the occupation. It measures the potential growth in supply from the tertiary education system. The training rate for civil and mechanical engineers compares poorly with the average training rate of 7.3% (between 2000 and 2005) for all professionals.

and 2005. This indicates that the number of IT graduates is likely to continue to decline in the next few years (Department of Labour, 2006b).

As indicated above, the mechanisms of fund allocation within the higher education sector do not appear to give sufficient recognition to the differential costs of training students, to the detriment of engineering schools. In addition, perceptions of low starting salaries may be why engineering schools and ICT-related courses have difficulty in attracting the best students in sufficient numbers.

As noted elsewhere in this report a lack of management skills is a major impediment to innovation. Developing marketing and distribution capabilities is also important if New Zealand wants to seize the opportunities of globalisation more consistently and effectively.

The number of researchers in New Zealand grew at an average annual rate of nearly 9% between 1999 and 2003, more than double the OECD average. Growth in the number of researchers in business was particularly strong. These are encouraging trends but New Zealand's manufacturing sector is probably still well below the OECD average in terms of the proportion of scientists and engineers in the workforce (Davenport and Campbell-Hunt, 2001). In addition, some complementary skills are in shortage, notably regarding the management of innovation and of new technology-based companies.

2.4.2. Migration issues

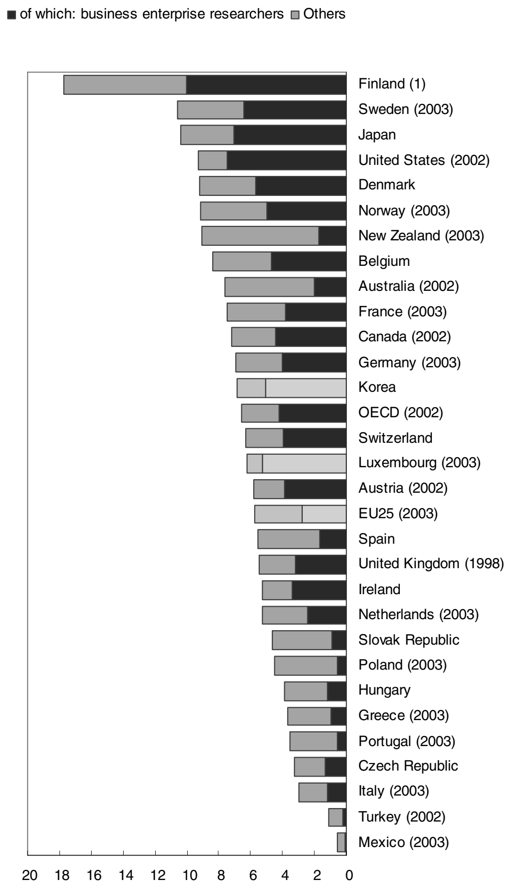
In purely quantitative terms New Zealand had a net gain of about 24 000 skilled workers[52] between 1992 and 2005 through migratory flows. In contrast, over the same period .there was a net loss of about 17 000 semi-skilled and unskilled workers. Within the skilled category there has been a strong positive net inflow of nearly 6 000 science professionals.[53] However, these figures do not carry any information about the relative quality of emigrants and immigrants and do not provide information as regards the extent to which overseas qualifications are recognised by New Zealand employers and how appropriate they are to the New Zealand workplace. See also Department of Labour (2006c).

52. According to External Migration data provided by Statistics New Zealand; "skilled" workers include managers, professionals, associate professionals, technicians and trade workers while "semi-skilled and unskilled" include all other major occupational categories.

53. "Science professionals" include Physicists, Chemists and related professionals; Mathematicians, Statisticians & Related Professionals; Computing Professionals; Architects, Engineers & Related Professionals; and Life Science Professionals.

Figure 2.18. Number of researchers

Per thousand employment, 2004



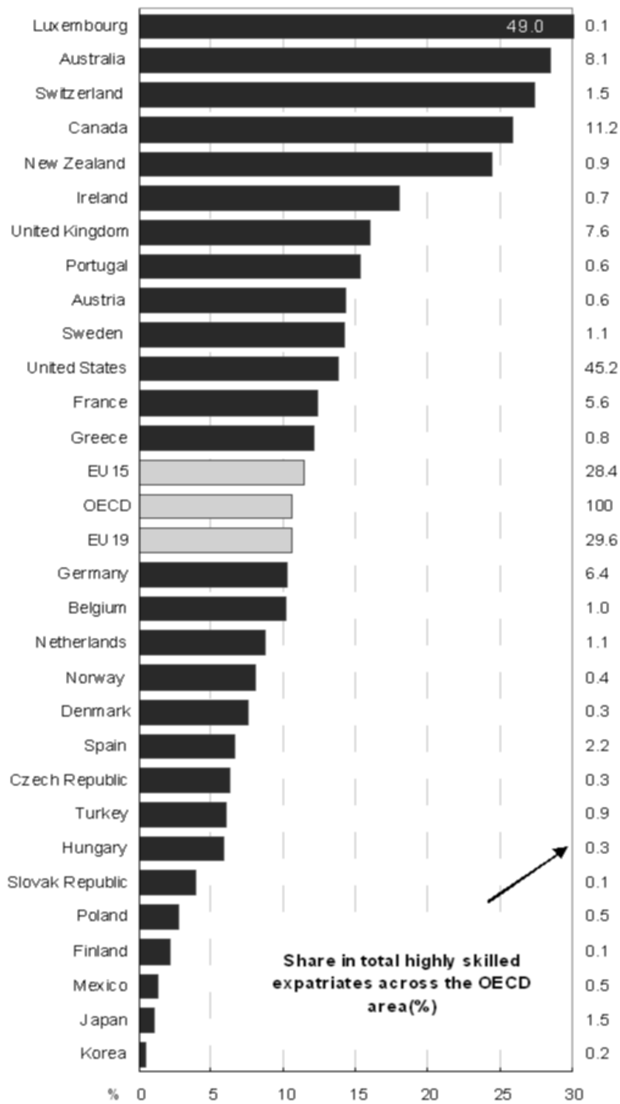
1. Overestimated. Also includes holders of engineering degrees and graduates of vocational polytechnics.

Source: OECD, MSTI database, June 2006.

Figure 2.19. Foreign students in doctoral programmes, *as%* of total doctoral enrolment in host country, 2002

Source: OECD, Education database, February 2006.

Figure 2.20. Highly skilled immigrants, as% of total highly skilled residents in host country, 2001



Source: OECD, database on immigrants and expatriates, February 2006.

Against the background of increased global mobility of skilled workers and given the tendency to lose skilled workers to Australia, there are recurring debates about the risk of suffering from brain drain (Davenport, 2004). The government should remain attentive to the need to maintain conditions[54] for taking even more advantage of "brain circulation" (Glass and Choy, 2001), including the contribution from expatriates, since an increasing flow of science and engineering graduates into and out of the country could enrich the national innovation system.

Some important government initiatives have addressed this issue. An example was the World Class New Zealand programme. Managed by NZTE, this programme aims to provide New Zealand entrepreneurs with the opportunity to learn from internationally recognised experts in relevant areas for business growth, whether they are expatriate New Zealanders or "New Zealand friendly" foreign nationals. The programme includes awards that recognise New Zealanders who make an outstanding contribution to New Zealand's economic development.

54. For example, it should be attentive to the fact that academic salaries in New Zealand lag well behind those in Australia and elsewhere (Kubler and Roberts, 2005).

Chapter 3

THE ROLE OF GOVERNMENT

This chapter describes and assesses how New Zealand's government and government agencies support innovation. This support has many similarities with what is observed in other OECD countries, in terms of broad rationale and objectives. As in other countries, it includes core funding and competitive grant schemes to support investigator-initiated research in universities, support for business-sector innovation activities and a policy framework to define overall strategies, steer publicly funded research organisations, ensure inter-departmental co-ordination and consultation of stakeholders in policy formulation, and evaluate policies and programmes.

The involvement of government in the governance of the innovation system exhibits a number of distinctive features in New Zealand, however, notably:

- The research system is highly reliant on government support with 45% of R&D funds provided by government, compared with the OECD average of 30%. Yet the degree of contestability of research funding is higher than in most OECD countries.
- The government clearly separates policy, purchasing and service delivery activities based on agency theory, public choice theory and new public management concepts.
- Contrary to many other countries in which individual ministries take responsibility for funding research in their area of responsibility, the Ministry for Research, Science and Technology (MoRST) plays a pivotal role in research policy. The Ministry for Economic Development (MED) and the Ministry of Education are the two other government departments with a significant influence on research directions and funding. The MED has responsibility for most other forms of support to business innovation.
- Public servants and policy makers have a strong economic culture. When designing programmes and support instruments, they generally take quite a rigorous approach to the rationale of government involvement.

3.1. Overall policy governance

3.1.2. Policy agencies

The government sets innovation policy priorities in three key ministerial policy portfolios:

- Vote Research, Science and Technology (the Ministry of Research, Science and Technology is the administering department): NZD 646 million in 2006/07 with four science goals:
  - An economic goal which seeks to increase the contribution knowledge makes to the creation and value of new and improved products, processes, systems and services, in order to enhance the global competitiveness of New Zealand enterprises.
  - An environmental goal which seeks to increase understanding of the environment, including the biological, physical, social, economic and cultural factors that affect it.
  - A social goal which seeks to increase understanding of the social, biological, environmental, cultural, economic and physical determinants of well-being in order to build a society in which all New Zealanders enjoy health and independence and have a sense of belonging, identity and partnership.
  - A knowledge goal which seeks to accelerate knowledge creation and develop people, learning systems and networks in order to enhance New Zealand's capacity to innovate.
- Vote Economic, Industry and Regional Development (E,I&RD) (the Ministry of Economic Development[55] is the administering department): NZD 286 million in 2006/07.
- Vote Education (the Ministry of Education is the administering department): NZD 8 969 million in 2006/07 of which NZD 1 740 million to tertiary education and training.[56]

55. In 2000, the Ministry of Commerce was renamed the Ministry of Economic Development with a new branch responsible for industry and regional development. In 2002, the Office of Tourism and Sport was restructured into the Ministry of Tourism which became a Ministry within MED. The Ministry of Consumer Affairs is also a part of MED.

56. In addition, the Performance-based Research Fund receives NZD 190 million and the Centres of Research Excellence NZD 23 million in 2006/07.

A range of other government policy agencies have important roles in the innovation system. These include the primary sector-focused departments of the Ministry of Agriculture and Forestry (MAF) and the Ministry of Fisheries.[57] The Department of Labour has an interest in ensuring well-functioning labour markets and its ambit includes the Immigration Service. The Ministry of Health is involved in setting health research priorities.

The Tertiary Education Commission (TEC) now has an enhanced role in the development of tertiary education policy. This includes the lead role for policy advice on tertiary issues as set out in the tertiary reforms. The Ministry of Education has a lead role in relation to system-wide issues.

3.1.3. Crown entities and funding agencies

Policy agencies are concerned mostly with strategic policy development. Many policy agencies also purchase specific outputs from Crown entities or delivery or purchase agencies. These agencies allocate funding to policy priorities for each policy area for which they have been contracted to deliver certain outputs by the policy ministry. Each purchase agent operates with reasonable discretion under the auspices of the relevant ministry. In recent years, initiatives have sought to better co-ordinate the activities of purchase agents both within each ministry and across government generally.

For research, science and technology, the purchase agencies are the Royal Society of New Zealand (RSNZ); the Foundation for Research, Science and Technology (FRST); and the Health Research Council (HRC).[58] All three invest funds in R&D. The agencies are guided by a set of operating principles that:

- Align investment with policy priorities.
- Seek collaboration with appropriate agencies for effective investment.
- Invest to support innovation capabilities.
- Involve end users and providers in investment strategy planning.
- Increase international connections.
- Develop effective evaluation processes.

57. MAF finances around NZD 20 million of Frascati R&D and NZD 23 million of non-Frascati research; the Ministry of Fisheries finances around NZD 26 million of non-Frascati research (MoRST, 2006a, pp. 81-82).

58. FRST and the HRC are Crown entities. The RSNZ is an independent, national academy of science comprising a federation of some 60 scientific and technological societies, as well as individual members.

For economic, industry and regional development, the main delivery agency is New Zealand Trade and Enterprise (NZTE). NZTE was formed in July 2003 through the merger of two Crown entities, Trade New Zealand and Industry New Zealand (INZ). INZ was established in 2000 to be the primary delivery agency for the new industry and regional development initiatives. NZTE focuses on providing services for firms, regions and industry sectors and also for administering certain funds. It seeks to support the development of internationally competitive businesses by building business capability, improving the environment for enterprise and growth, and helping build international connections for business. NZVIF also receives its public money through Vote Economic, Industry and Regional Development. The Large Budget Screen Production Grant and several small funds are administered by MED itself.

The Tertiary Education Commission was established in 2003. Its functions and responsibilities cover all forms of tertiary education and training. It is the means through which the government works with the tertiary education sector to ensure the strategic use of resources, capability building and the implementation of its tertiary education strategies. It can only fund tertiary education organisations. In distributing funds, TEC considers current and future skill requirements at regional and national levels.

Regulatory agencies are funded through a number of policy agencies. The Ministry of Economic Development funds the key regulators: the Commerce Commission, the Telecommunications Commissioner, the Electricity Commission, the Intellectual Property Office of NZ (IPONZ) and the Securities Commission. Biosecurity New Zealand receives its funding through the Ministry of Agriculture and Forestry (Vote Biosecurity[59]). The Ministry of Fisheries sets fisheries regulations and enforces them. The Department of Labour enforces labour and health and safety regulations.

3.2. Evolving high-level strategies

Prior to 2000, the New Zealand government did not have a strong focus on innovation as part of its economic policy approach, although specific policy instruments in the Research, Science and Technology portfolio funded R&D to improve international competitiveness and lift firms' technological capabilities. During the 1990s, the prevailing view was that getting foundational policies right was generally sufficient for achieving competitive markets, dynamic efficiency and good innovation and growth outcomes.

59. Total appropriations for Vote Biosecurity in 2006/07 are NZD 151 million.

In 2000, the government's strategy for growth through innovation (later known as the Growth and Innovation Framework – GIF) put innovation much more at the centre of economic policy. The government explicitly recognised the importance of innovation to economic growth and development. The GIF provided a framework for viewing New Zealand's innovation system and explicitly recognised the links between different policy areas.

In March 2006, the government's Economic Transformation Agenda (ETA) replaced the GIF. It continues to place innovation at the core of the economic development strategy by recognising innovation's significant contribution to productivity growth. Economic transformation, led and co-ordinated by the MED, is one of three stated high-level government priorities (the other two are national identity and families – young and old). A number of strategies feed into the GIF/ETA, including the Tertiary Education Strategy and strategies relating to the science system. Under the GIF/ETA, a number of cross-agency steering groups and working groups have been established to improve innovation policy coherence and co-ordination across government.

In 2000, the government embarked on a comprehensive programme of tertiary education reforms.[60] Following recommendations of the Tertiary Education Advisory Commission, the Tertiary Education Strategy (TES) was established to articulate the strategic direction and priorities for the tertiary system and to demonstrate how this derives from and is aligned with the government's broader goals. The TEC was established to negotiate their strategic direction and activities with education providers in order to give effect to the TES. The TES is designed to be a framework for thinking about improving tertiary outcomes and a set of signals to be interpreted differently in different parts of the system. A Statement of Tertiary Education Priorities (STEP) was established in 2003 and was updated in 2005.

In March 2006, further changes to the tertiary education system were agreed by the Cabinet. A key objective of these changes was to ensure tertiary education's focus on government, regional and development priorities. These reforms are designed to create a system that will align planning, funding and quality assurance and monitoring to ensure the system delivers for stakeholders, especially students, employers, communities and regions, and meets government priorities, as set out in the STEP. The new system is designed to enable the government to invest in priority areas. Each tertiary education organisation is required to develop a plan outlining the education and training they will provide over a three-year period, and to show how that education or training meets the needs of stakeholders and

60. *www.tec.govt.nz/downloads/a2z_publications/tertiaryeducationstrategy-2002-2007.pdf.*

reflects government priorities. These plans, to be agreed with the TEC, will also contain performance measures and capability development activities.

The Growth and Innovation Framework

New Zealand's Growth and Innovation Framework has had a strong influence on innovation policy making in recent years and is therefore important to this review, even though many of the initiatives taken under the GIF are too recent to demonstrate significant outcomes while their future, if any, under the new overall strategic plan (ETA) it is still uncertain.

The GIF was announced in February 2002 by Prime Minister Clark, and set out the government's approach to economic development (New Zealand Government, 2002). The GIF built upon reports and consultations in the period 2000-02 including the recommendations from the Knowledge Wave Conference in 2002 and various studies (MED, 2006a). The overriding aim of the GIF was to return New Zealand's per capita income to the top half of the OECD. The GIF focused on:

1. *Raising the capacity of firms to innovate*, particularly in the areas of R&D, technology adoption and new organisational forms and processes, and investment in plan and equipment.
2. *Building the connections of firms with international markets and customers* through targeted support for developing international markets and attracting FDI.
3. *Lifting skills and talent of the workforce* through education and training, migration policies and improving management capability.
4. *Ensuring a supportive regulatory environment and strong supporting infrastructure* for firms through high-quality, cost-effective energy, transport and telecommunications networks.

In the context of the GIF, an interdepartmental working group on innovation had been set up to identify policy areas to further strengthen New Zealand's innovative performance. The working group undertook a business practices and performance survey, an innovation survey, demand-side finance issues research, and analysis of capital investment in New Zealand. The working group had some limited success in developing a co-ordinated approach across government to policy recommendations for budgets.

The Growth and Innovation Advisory Board (GIAB) provides independent advice to the government on innovation programmes. GIAB has 15 members and meets bi-monthly. It works through action groups that focus on issues of particular interest.

The 2003 budget provided NZD 110 million over four years to implement GIF initiatives. The government has subsequently received progress reports (see MED, 2005b). This additional funding has had little leverage effect on other private and public expenditures on R&D. Government support for business R&D as a percentage of GDP remains below the OECD average and gross expenditure on R&D (GERD) is still about half of the OECD average (MoRST, 2006b).

As indicated in Chapter 2, the GIF had targeted four sectors that were seen as having significant potential to have a positive impact on other sectors of the economy: Biotechnology, information and communications technology (ICT), and design and film production. Each of the four areas that the GIF focused on is examined in more detail earlier in this report. While the GIF played a useful role in strengthening the biotechnology sector, the impact on the other three sectors appears modest.

Focusing some of New Zealand's innovation support makes sense in a small country with limited resources. The approach adopted has involved good stakeholder input. However, the four areas selected are very broad, raising questions about the effectiveness of the GIF in building clusters of strong innovative firms. Some participants in the 2001 Knowledge Wave Conference, which contributed to the design of the GIF, are disappointed that more has not been achieved.

Overall, GIF has contributed to some improvement in policy governance, prompting, structuring and even in some cases institutionalising dialogue on innovation policy across government, in consultation with key stakeholders. In that sense it has been a useful step in a policy learning process which should continue. While it has represented a commendable attempt to focus New Zealand's efforts to grow firms whose competitive niche rests on technological innovation, its achievements in this regard have been rather limited. At the same time, it has engendered frustration in non-targeted sectors, suggesting the need for future policies to balance more carefully support to knowledge-based industries, support to knowledge diffusion in other industries, and support to the general infrastructure for knowledge generation and diffusion.

Other strategies

In recent years, New Zealand has developed a number of sectoral strategies in which science and innovation are expected to contribute to policy goals. Some are listed in Table 3.1. The extent to which science and innovation stakeholders are engaged in the development of these strategies has been somewhat variable. These strategies all address issues of particular importance to New Zealand. However, it is noteworthy that they do not cover important sectors of the economy, such as manufacturing and services, in which innovation should play an important role in future competitiveness.

Table 3.1. Some sectoral innovation-related strategies

Area	Strategy
Biodiversity	Biodiversity Strategy 2000
Biosecurity	Biosecurity Strategy 2003
Biotechnology	Biotechnology strategy 2002 Biotechnology Industry Taskforce report 2002
Climate change	Climate Change Policy MOU with agricultural sector on greenhouse gas mitigation research 2004
Energy	Sustainable development Programme of Action: Sustainable Energy 2003 National Energy Efficiency and Conservation Strategy 2001
Health	Health Strategy 2000 Primary Health Care Strategy 2002
ICT	ICT Industry Taskforce Report 2003 Digital Strategy 2005 e-Government Strategy 2003
Ocean	Ocean Survey 20/20 2005 Oceans Policy
Water	Sustainable Development Programme of Action: Water 2003

Source: MoRST, 2006a.

3.3. Public programmes and instruments to support R&D and innovation

3.3.1. Overall portfolio and policy mix

Most government support for research and innovation is provided through three budget channels, or "votes": the Vote Research, Science and Technology (R, S&T), by far the largest, accounting for about two-thirds of government support for R&D; the Vote Education; and the Vote Economic, Industry and Regional Development. Each Vote has a number of "purchasing objectives", which provide a framework for delivering agencies to use in allocating funds. However many stakeholders do not understand the terminology and find the complexity of the support system and its changes difficult to follow.

Table 3.2. Vote RS&T portfolio of funding instruments, 2006/07

Vote RS&T Output Expense	Funding 2006 NZD millions	Investment agent	Portfolio from viewpoint of end user	% contestable 2006	% estimated contestable from 2007	Eligibility (all unless noted)
Advanced Network	10 360	REANNZ		n/a	n/a	
Advanced Network Capability Building	1 221	REANNZ	ANCB	100	100	(a)
Advanced Network CRI Tariffs	0 968	REANNZ		n/a	n/a	
Advice on Shaping the System	13 406	MoRST		n/a	n/a	
Australian Synchrotron	1 166	MoRST		n/a	n/a	
Convention du Metre	0 095	MoRST		n/a	n/a	
CRI Capability Fund	46 612	MoRST	Cap Fund	0	0	(b)
Development of International Linkages	2 527	MoRST	various	100	100	
Environmental Research		FRST	ECO	100	0	
Environmental Research		FRST	SRU	100	0	
Environmental Research	90 226	FRST	SCS	100	0	
Environmental Research		FRST	GLO	100	79	
Equity Investment Fund	5 000	MoRST	EIF	n/a	n/a	(c)
Health Research	58 955	HRC	(1)	100	100	
International Investment Opportunities Fund	9 600	M,F,H,R	various	100	100	
Māori Knowledge and Development Research	4 867	HRC	RHM			
Māori Knowledge and Development Research		FRST	TTW	100	100	
Marsden Fund	33 878	RSNZ	Marsden	100	100	
National Measurement Standards	5 504	IRL	NMS	n/a	n/a	
New Economy Research Fund		FRST	NZS	100	0	
New Economy Research Fund	61 586	FRST	NPT	100	12.9	
New Economy Research Fund		FRST	FHT	100	10.5	
Pre-Seed Accelerator Fund	8 267	FRST	PSAF	100	100	(c)
Promoting an Innovation Culture	4 592	M,R	various	100	100	
Research Contract Management	20 467	F,H,R, Fu		n/a	n/a	
Research for Industry		FRST	PQA	100	18.1	
Research for Industry		FRST	SPS	100	0	
Research for Industry		FRST	NBP	100	27	
Research for Industry		FRST	INF	100	0	
Research for Industry	190 663	FRST	MAN	100	0	
Research for Industry		FRST	ORI	100	0	
Research for Industry		FRST	RIC	100	0	
Research for Industry		FRST	SER	100	0	
Research for Industry		FRST	SET	100	0	
Social Research	5 860	FRST	BIS	100	100	
Supporting Promising Individuals	18 291	M,F,R, Fu	various	100	100	
Technology New Zealand	47 908	FRST	(2)	100	100	(d)
Technology Partnership Programme	1 940	FRST	TPP	100	100	(d)

1. BST + CD + DH + HIPG + HSMS + IIRD + MHND + NCD. 2. SmartStart + Tech Expert + TechNet + GPSR&D + TBG + Collectives + TIF. Abbreviations: Fu: Fulbright New Zealand; FRST: Foundation for Research, Science and Technology; HRC: Health Research Council; IRL: Industrial Research Limited; MoRST: Ministry of Research, Science and Technology; REAANZ: Research and Education Advanced Network New Zealand; RSNZ : Royal Society of New Zealand.

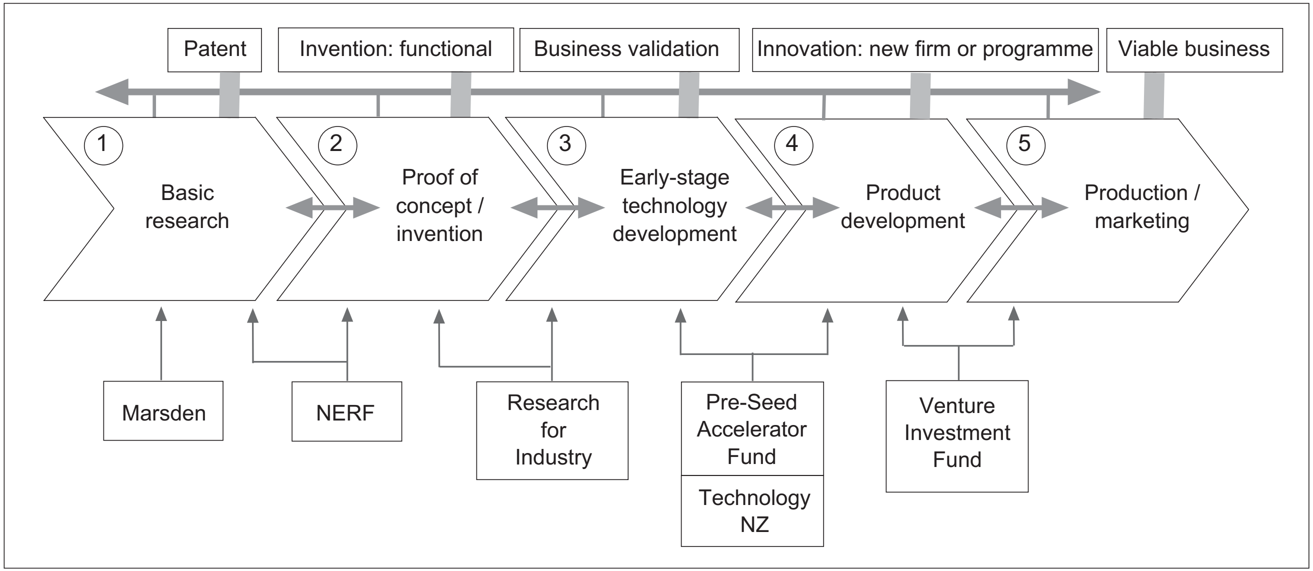
End user eligible: (a) Crown Research Institutes, Tertiary Education Institutes, and the National Library; (b) Crown Research Institutes; (c) Crown Research Institutes and Tertiary Education Institutes; (d) Firms.

Table 3.3. New Zealand government innovation-related funding schemes* (NZD millions), 2004/2005 financial year

Agency	Crown Research Institutes	Universities	Firms	Industry organisations	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
Ministry of Economic Development (MED)	0.1	0.0	40.1	4.2	0.8	0.0	1.7	46.9
NZ Trade & Enterprise (NZTE)	0.9	0.4	28.0	3.4	12.0	0.8	2.9	48.3
Ministry of Research, Science & Technology (MoRST)	9.9	0.0	18.8	0.0	0.0	0.0	1.2	29.9
Foundation for Research, Science & Technology (FRST)	286.9	52.5	109.9	0.2	0.0	0.0	32.7	482.2
Royal Society of New Zealand (RSNZ)	5.8	29.7	1.2	0.0	0.0	0.0	4.2	41.7
Health Research Council (HRC)	0.1	47.3	0.0	0.0	0.0	0.0	5.0	52.5
Tertiary Education Commission (TEC)	0.0	57.4	0.0	1.2	0.0	4.4	10.8	73.8
Ministry of Agriculture (MAF)	0.0	0.0	0.1	2.9	0.0	0.0	6.6	9.7
Total	**303.7**	**187.3**	**198.1**	**11.9**	**12.8**	**5.2**	**65.2**	**784.9**

* This does not include EFTS research top-ups to higher education institutions.

Figure 3.1. Innovation funding



Source: MoRST, 2005b.

Table 3.2 shows the portfolio of instruments funded by Vote R, S&T, with an indication of the delivering agency. Table 3.3 gives a breakdown of innovation-related funding by end user and delivering agency (more detailed information can be found in Table A.1 in Annex A). It shows for example that CRIs are the largest recipients and that the Foundation for Research, Science and Technology (FRST) is the largest delivering agency, providing almost all the government support to CRIs and over half of total funding of firms. New Zealand Trade and Enterprise (NZTE) is another significant source of government support for business sector R&D and innovation. The roles of the Ministry for Economic Development and the Ministry for Science Research and Technology are primarily policy steering although they are directly responsible for some funding. Figure 3.1 shows how some of the key government programmes support different stages in the innovation process.

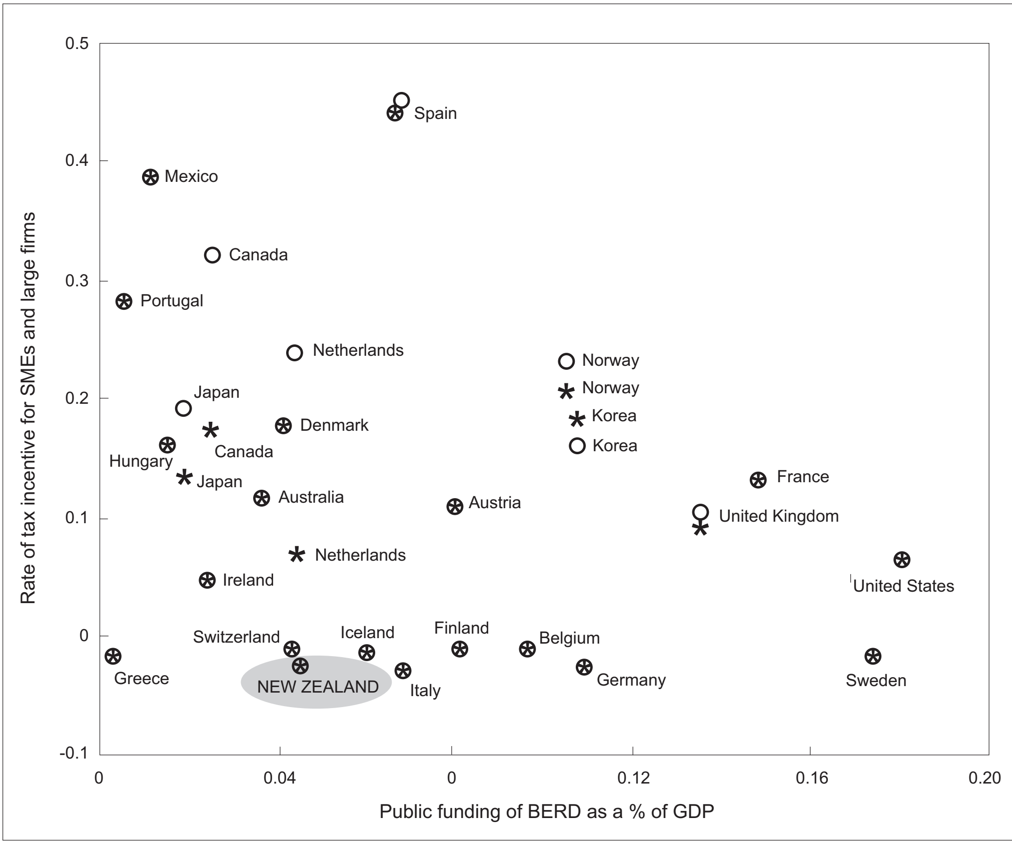
Regarding public support to R&D, New Zealand continues to rely on direct funding; it does not use tax incentives, although the introduction of a tax credit is under discussion. Among smaller OECD countries, this approach is consistent with current practices in Finland and Iceland, but differs from that used in Australia, Ireland, the Netherlands and Norway, each of which uses a mix of tax incentives and direct funding (Figure 3.2). In Australia, Canada and the Netherlands, greater financial support is provided via tax incentives than via direct funding. Figures 3.2 and 3.3 show in addition that public support to business R&D is less intensive in New Zealand than in most other OECD countries.

Two other dimensions of the policy mix concern the balance between basic and more applied research, on the one hand, and the alignment of the research orientations with the strategic needs of New Zealand, on the other. Compared to other OECD countries, at 0.4% of GDP, New Zealand does not seem to under-invest in basic research. The issue is rather to ensure high quality of non-targeted, long-term research. In this context the Marsden Fund (see below) is an important tool. As regards the second dimension, there appears to be room for improvement through better design of individual programmes, in particular with a view to achieving a clearer division of labour between them, as well as through better balance within the overall set of instruments.

3.3.2. The Ministry of Research Science and Technology

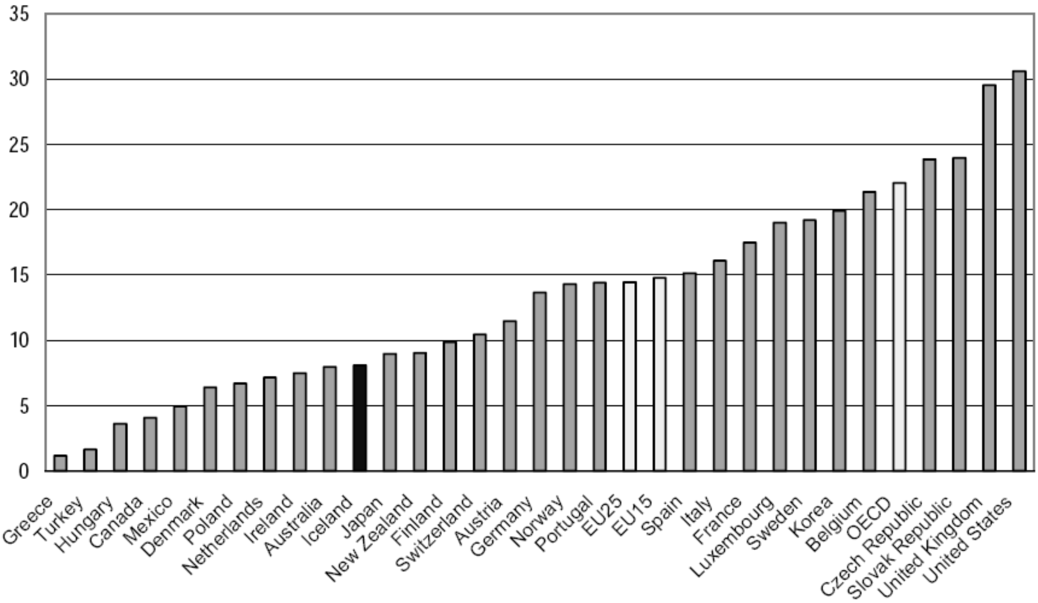
MoRST is responsible for high-level research policies and strategies and contracts the Foundation for Research, Science and Technology to manage most of the actual funding of research and innovation projects, although it provides some innovation funding itself (*e.g.* CRI Capability Fund and support for New Zealand's participation in the Australian synchrotron).

Figure 3.2. Public financial support to firms' R&D, by instrument, 2004 or latest



Source: OECD, based on MSTI database, November 2005.

Figure 3.3. Share of government R&D funding allocated to the private sector, 2004 or latest



Source: OECD, MSTI Database, November 2005.

3.3.3. The Foundation for Research, Science and Technology

FRST is a statutory authority with an independent board, reporting to the Minister of Research, Science and Technology. The Foundation's roles are to:

- Invest public funds in research and development that will benefit New Zealand users (largely strategic R&D).
- Invest in the development of human resources.
- Provide independent advice to the government on science and technology.
- Encourage technological innovation in industry.
- Administer various science-related scholarship and fellowship schemes.

In 2004-05, FRST invested more than NZD 480 million – almost one-third of New Zealand's the gross expenditure on research and development – with 67% of these funds going to CRIs, 16% to universities and 17% to the private sector. It invests in research with the objective of obtaining the greatest economic, social and environmental returns to New Zealand. FRST also provides independent policy advice to the Minister for Research, Science and Technology.

Table 3.4. FRST funding activities

Scheme	**Funding 2004-05** (NZD millions)
New Economy Research Fund (NERF)	73.3
Research for Industry (RfI)	202.5
Māori knowledge and development research	3.2
Social research	6.7
Environmental research	92.9
International investment opportunities	0.2
Supporting promising individuals: Post-doctoral fellowships	5.6
Supporting promising individuals: Tuapapa Māori fellowships	1.0
Pre-seed accelerator fund	4.4
Non-specific output funding	32.4
Technology New Zealand programmes	59.9
Total	**482.2**

FRST defines a number of investment areas, within which there is a complex structure of "investment portfolios". For the purposes of this review, FRST's major funding activities are summarized in Table 3.4. In addition to these activities, the FRST budget supports a number of innovation-related services (*e.g.* Enterprise Training and Investment New Zealand). The two main FRST programmes are the Research for Industry (RfI) programme and the New Economy Research Fund (NERF). RfI supports new and applied technology for existing industry, in contrast to NERF (see below) which provides similar support for new industry.

Research for Industry (RfI)

In 2004-05 by far the largest share (NZD 130 million) of the Research for Industry scheme was allocated to the CRIs. Firms received approximately NZD 34 million and universities NZD 17 million. The RfI scheme (which is actually an "output class" rather than a real programme) has a number of funding categories of which the research consortia described in more detail here. The overall architecture as well as the funding criteria and objectives distinguishing these categories do not seem to be very transparent from the perspective of an outside user. The RfI is obviously an important instrument in steering part of the CRIs' research activities. Increasing the involvement of firms (beyond participation in consortia) could further the impact on business innovation, and that of universities could help exploit better their potential to carry out high-quality and economically relevant research.

Research consortia

Small countries have to look for ways of achieving critical mass in their research and innovation effort. The Foundation has approached this issue with a current investment of approximately NZD 25 million a year of RfI funds in ten research consortia (see Table 3.5). These consortia are significant, longer-term research contracts between government and partnerships involving private companies, industry groups or entities that use research and research organisations.

Research consortia involve at least two users of research, such as businesses, and at least one research provider (CRI Institutes, universities). They may also include overseas entities. Research consortia participants must provide at least 50% of the cash requirements of the research. These consortia may operate for up to five to seven years and may also apply for funding from Technology New Zealand.

The Foundation uses reference groups of selected independent, knowledgeable and experienced people to consider proposals. Successful proposals are subject to due diligence to ensure that the business case and legal documentation are consistent with the Foundation's policies and with good business practice. When due diligence reports are approved by the Foundation's Board, the research consortium and the Foundation then enter into a funding contract.

Table 3.5. FRST-funded research consortia

Research consortium	Partners	Objective
Ovita Ltd (now split Into Ovita Discovery, Covita and Catapault)	Meat & Wool NZ, Wool Equities Ltd and AgResearch	Biotechnology research in sheep biology, physiology and genomics.
Pastoral Greenhouse Gas Research Consortium (PGGRC)	AgResearch, Dexcel, Livestock Improvement Corp, Via Lactia Biosciences & Australia's CSIRO and Queensland Dept. of Primary Industry & Fisheries	Mitigation solutions for non-carbon dioxide greenhouse gas emissions.
Beacon Pathway Ltd.	Scion, Building Research Association of NZ, Waitakere City Council, NZ Steel Ltd. and Fletcher Building Holdings	Development of better, healthier residential built environment.
Wood Quality Initiative Ltd	13 timber industry companies, CSIRO (Australia), Scion and Canterprise Ltd.	Wood quality improvements including characterisation, appearance, performance, structural properties and stability.
The Radiata Pine Breeding Company Ltd.	16 New Zealand and Australian timber growing interests and Scion	Tree improvement research to increasing yields and reduce production costs.
Seafood Innovations Ltd.	The NZ Seafood Industry Council Limited and New Zealand Institute for Crop & Food Research	Developing and commercialising innovative, consumer-appealing, value-added seafood and marine products.
LactoPharma	Fonterra and UniServices (Auckland University)	Biomedical technology based on active compounds found in milk.
Pastoral Genomics Ltd.	Via Lactia Biosciences, Agritech Investments, DEEResearch and AgResearch	Sustainable improvement in pasture productivity including development of a technology platform around clover genomics.
Meat Biologics Consortium	Meat and Wool NZ, Meat Industry Association, AgResearch	Research on meat proteins and enzymes for neutraceutical and health supplements, including animal growth factors.
Prevar Ltd.	Pipfruit NZ, Apple & Pear Australia Ltd., Associated International Group of Nurseries, and HortResearch	Apple and pear improvement and disease control.

Once operational, there are a series of review points for all research consortia over their life, including one after the first year. These reviews allow the Foundation to determine whether the research consortium is operating according to sound business principles and is meeting its milestones. The Foundation, in turn, provides advice to the research consortia.

Discussions aimed at the establishment of a research consortium in ICT in 2004 did not lead to the funding of a new consortium. This highlights the considerable effort and expense required to establish research consortia that meet FRST criteria, as well as the difficulties of establishing larger collaborative R&D projects in New Zealand.

Research consortia have critical mass and require a strong commitment from industry, which increases the likelihood of the research being commercialised and reducing the turnover of key research personnel. The programme has similarities with Australia's Co-operative Research Centres programme (CRCs). However, the eligibility thresholds are high and exclude sectors in which there are currently no large R&D-performing companies. If New Zealand wants to reach critical mass in new areas, the current policy settings for this programme need to be adjusted.

In summary, support for research consortia encourages the formation of larger teams with an appropriate range of disciplines. The research consortia selected for support are all in the agriculture sector (or closely related to it); formation of research consortia should be facilitated in other sectors. Some adjustments are needed to the programme. Notably, eligibility thresholds should be lowered; one approach would be to accept initial proposals for three years from smaller consortia. If successful, these consortia could be offered an extension of funding at the end of the initial period.

The New Economy Research Fund

The New Economy Research Fund (NERF) is an important FRST programmes which assists the development of "capability and knowledge in new areas of applications where industries are emerging … in order to underpin new high-technology business opportunities".[61] In 2004-05 NZD 43 million was spent in CRIs, NZD 22.4 million in universities and NZD 8 million in firms.

61. Ministerial Directive, 20 July 2006.

The NERF was evaluated in 2005 after five years of operation. At that time a total of NZD 322 million had been invested in 140 NERF research projects (some involved multiple contracts) conducted by CRIs, universities and private companies. Overall, the evaluators found NERF was on track to achieve its goals. They found it should continue to be supported and potentially expanded (Abt and Associates, 2005). The NERF was found to have been successful in:

- Supporting world-class teams with good publications records and high levels of domestic and international research collaborations.
- Training future researchers in new research fields; NERF has contributed to the training of over 400 undergraduate, 200 Master's and 350 PhD students and about 200 post-doctorates.
- Encouraging a healthy two-way international exchange of people involved with NERF projects: over 25% of NERF teams have at least one researcher or student team member who was born overseas.
- Fostering promising early signs of commercialisation such as patents and licences. As well, NERF has contributed to a total of 17 spin-out companies and 8 joint ventures.

The evaluation identified the following factors as among constraints on the potential effectiveness of NERF:

- Relatively low levels of industry participation and investment.
- A gap in funding for projects that show promise at the prototype stage to bring them to a point where they can attract significant private-sector investment. The Pre-Seed Accelerator Fund and Technology for New Zealand funding were seen as potential sources of future funding.
- The NERF research portfolio is less diversified than similar programmes overseas. About two-thirds of the total funding is targeted at biotechnology projects. The evaluators recommended more support for physical sciences and ICT.
- The development of research platforms for emerging sciences is being hindered by the difficulties faced by some teams in acquiring large (and expensive) items of capital equipment. Here there are two problems:
  - The depreciation method employed by the Foundation only works in cases where the parent research organisation is willing to invest in equipment upfront and recoup costs from the depreciation account.

– The difficulty of funding items of equipment that will be shared by scientific, medical and/or private-sector researchers which therefore crosses programme boundaries. MoRST has recently established a new process for government contributions towards the cost of large-scale research infrastructure which should help with this issue.

The evaluators reported that NERF researchers were relatively satisfied with the way the Foundation administers the fund. However they commented adversely on the depreciation arrangements used by FRST. These arrangements continue to pose major problems for the universities in relation to the purchase of major items of research equipment. There is a need to review the depreciation arrangements. They appear to place unnecessary barriers in the way of purchases of major items of new equipment. The need to draw on operating funds for depreciation seems inappropriate, particularly given uncertainties about when the item might be replaced and the fact that any replacement is likely to be paid for from a new grant.

Researchers receiving other FRST funds are concerned about the difficulty of remaining internationally competitive in their field if they lack access to major items of state-of-the-art equipment. They also pointed to the difficulty of making a business case for some items of equipment because, until the equipment is installed, it is difficult to identify the full spectrum of users or the research funding that may be attracted by projects that rely on access to such equipment.

In summary, the NERF is basically a sound programme that could be expanded. However, low industry participation rates suggest that eligibility and access requirements for industry need to be changed. The issue of depreciation, which also appears to be a problem in other programmes, needs to be addressed. The government should consider how successful NERF outcomes will be funded to reach the market. At present some NERF funding recipients do not appear to know how this gap will be bridged.

Technology New Zealand

Tech NZ is a group within the Foundation with a specific brief to help businesses develop new technology and encourage wealth creation by businesses through innovation. It achieves this by offering a range of targeted assistance programmes which complement FRST’s other investments. These programmes address important needs and include:

- Grants to assist businesses with research and development.
- A range of assessment and analysis options to see how and what technology might be most effectively applied to a business.
- Assistance in developing innovative high-value products, including arranging consultancy services from a research provider.
- Providing scholarships to students to enable them to work with companies and assist in product development and research.

Of the Tech NZ schemes, the Technology for Business Growth (TBG) is the largest component, co-funding projects that enhance firms' technological capabilities. TBG provided support for 120 new projects in 2004-05, with average funding of NZD 355 400. This represented a significant increase in grant size over the previous year. Grants for Private Sector R&D (GPSRD) are primarily for small and medium-sized enterprises (SMEs). There has been a steady decline in the number of these grants in recent years and some recipients report that the grants have very long application procedures and that the outcome can be an allocation of funding that is insufficient to achieve the proposed objectives.

There is confusion in the business community over these grants. GPRSD is targeted at new investment in R&D which extends firms' ability to undertake R&D beyond current capacity. A new investment means "an investment in an area of technological development or technological expertise that is new to the firm, that is relatively new to New Zealand, and that makes sense to be invested in locally from a global perspective". This severely restricts eligibility. For example, firms that have had a TBG grant find that they are not eligible for GPSRD.

TechLink has two components: TechNet and SmartStart. Both are aimed at firms that are either not engaged in R&D or have limited R&D capacity. However the amounts of funding provided are very small, probably too small to have a real impact.

FRST delivers some assistance through local agents and organisations. Its decision making has been streamlined in the last two years, with some decisions delegated to local staff and agents.

Examples of seven-year FRST projects that were terminated after four years, apparently because of changing priorities, may be examples of managing projects that are not achieving their objectives, but they may also be examples of a lack of long-term planning and commitment.

The introduction of technical reviews, announced since the OECD team visit to New Zealand, will need to be managed carefully. If the result is more emphasis on successful project outcomes, then the reviews will be useful. However, if the reviews increase uncertainty about ongoing project funding or result in additional compliance costs for grant recipients, there would be cause for concern.

Summary diagnostic on FRST

FRST is a well-managed organisation with a good track record. However, it has too many programmes, a number of which are significantly under-funded. The rationale for the division of labour between the various programmes, especially between RfI and NERF (support to technology-based innovation in existing industries versus support to technology development in new areas of applications in which industries are emerging or are yet to emerge) is sound in broad terms. In practice, the implementation of such a division of labour may encounter a number of problems which do not appear to have been entirely solved. There is a risk of overlap, *e.g.* when new applications of emerging knowledge are part of the innovation strategies of existing firms operating in strategic areas supported by RfI. Terminating projects before completion should be avoided except if grant recipients are under-performing. The decision to increase the average TBG grant size is a step in the right direction. Application procedures need to be streamlined and decision times shortened.

3.3.4. The Royal Society of New Zealand

The Royal Society is an independent national academy of sciences, a federation of some 60 scientific and technological bodies, as well as individual members. The Royal Society is funded through MoRST and administers six programmes, of which the Marsden Fund is by far the most important (Table 3.6).

Table 3.6. Programmes funded through the Royal Society of New Zealand

Programme	Funding in 2003-04
Marsden Fund	NZD 36.7 million
James Cook Fellowships	NZD 0.7 million
Teacher Fellows	NZD 3.5 million
Science and Technology Promotion Fund	NZD 0.3 million
International Science and Technology Linkages Fund	NZD 0.4 million
Talented Young New Zealanders	NZD 0.1 million

The Marsden Fund was created in 1994 to support excellent research and researchers. It seeks to enhance New Zealand's knowledge base and broaden and deepen its research skills. Research funded from the Marsden Fund is not subject to priorities set by the government and projects that might also have a utilitarian outcome are not precluded. The objectives of the Marsden Fund are to:

- Enhance the underpinning knowledge base, and contribute to the global advancement of knowledge.
- Broaden and deepen the research skill base.
- Enhance the quality of the research environment by creating more opportunities to undertake excellent investigator-initiated research.

The Marsden Fund operates as a fully contestable fund. Eligibility is unrestricted provided that the research proposed is either to be carried out in New Zealand or, if its nature demands that it be carried out elsewhere, by New Zealand-based researchers.

Funds support research projects or programmes, or individual researchers, including post-doctoral fellows. Funds may also be used to provide scholarships to support work towards a doctorate by post-graduate scholars, but such work should be designed as part of a larger programme which conforms to the criteria for the scheme.

The Marsden Fund undertakes peer review through eight panels. The initial application procedures of the Fund are simple, which appears to encourage researchers to "overapply". As a consequence, the Fund incurs high processing costs and success rates are low (around 7%). A 2004 review of the Fund found that it was meeting its objectives (Web Research and Technopolis, 2004).

A bibliometric analysis of publications funded partially or fully by the Marsden Fund was undertaken to assess the quantity and impact of Marsden research, and to characterise the collaborations associated with Marsden funding (Royal Society of New Zealand, 2004). The main findings of this study are:

- The number of publications attributed to the Fund rose 20-fold between 1994 and 2001, and the Marsden-funded share of New Zealand-authored publications rose from 2.6% in 1997 to 7.7% in 2001. Between 1997 and 2000, there was a 2.5-fold increase in Marsden articles published per million NZD of funding, rising from just over five articles per million in 1997, to 13 in 2000.

- Marsden-funded research articles are published in the entire spectrum of subject fields, but compared to all New Zealand-authored articles, proportionately more are published in fundamental areas such as chemistry, mathematics and physics, and fewer are published in applied fields such as agriculture/vet/environment, engineering and technology, and medical and health sciences.

- Across all fields, Marsden-funded publications accounted for 5.6% of 1997-2001 publications. In some fields, however, Marsden-funded articles accounted for a much higher percentage, *e.g.* 25-30% of publications in mathematics and physics.

- As judged by citation counts, Marsden-funded publications have a significantly greater impact than other New Zealand-authored publications.

- The great majority of Marsden-funded articles arise from tertiary institutions, reflecting the high proportion of Marsden Fund awards to this sector. Authors from CRIs, government and private-sector institutions, are however, under-represented among Marsden-funded articles as compared to the number of contracts awarded to them.

- Marsden-funded articles have a higher rate of international collaboration than New Zealand-authored articles, but a comparatively lower rate of inter-sectoral collaboration within New Zealand.

These results indicate that the Marsden Fund is achieving its objectives. However if the Marsden Fund was on a scale comparable to the US National Science Foundation it would have about twice the funding.[62] The low success rate of the Marsden Fund suggests that transaction costs are a problem – too much effort is expended on reviewing applications that prove unsuccessful. There is a significant over-bidding problem. The government's recent decision to address overbidding problems in some programmes is a welcome move.

There is a general concern on the part of researchers that the importance of supporting basic research has not yet been fully understood and that the Marsden Fund is a token effort. The Royal Society, as manager of the Fund, and the research community need to do more to explain and demonstrate the public benefits of Fund-supported research.

62. A direct comparison is complicated by the fact that New Zealand universities receive institutional funding via PBRF which they can spend on projects similar to those financed by the Marsden Fund.

In summary, The Marsden Fund needs to be larger. The Royal Society of New Zealand should seek the help of universities to actively market the successes of research supported by the Marsden Fund with a view to improving community understanding of the importance of this research. Changes should be made in the Marsden Fund rules to reduce the numbers of applications by addressing overbidding; individual researchers could be limited to a role in a maximum of two proposals. Initial Marsden Fund proposals should be required to provide more detail to better inform decisions.

3.3.5. The Health Research Council

The Health Research Council (HRC) reports to the Minister of Health, and funds and co-ordinates health research, a strong sector in New Zealand.[63] Its funding comes through the Vote Research, Science & Technology. A Memorandum of Understanding between the ministers of Health and of Research, Science and Technology sets out the arrangements. The HRC advises the Health Minister on health research policy, fosters health research skills, initiates and supports health research, consults on priorities, and promotes the uptake of research results.

The HRC's investment strategy has two elements, implemented through the annual funding round and the Partnership Programme. The HRC's nine research portfolios form the investment framework of an annual funding round. A research strategy for each portfolio defines the areas of research covered, key national issues and the research priorities. Relevance to the priorities identified in the portfolio strategies is a criterion for assessing research proposals. The portfolio strategies also prioritise research of relevance to the HRC's five priority populations.

The Partnership Programme, through which the HRC partners with other agencies to develop targeted research strategies, is designed to address specific needs for applied research. Fostering a cross-sectoral approach to health issues is a key objective of the programme, which brings a diverse range of stakeholders together to pool resources and focus on common goals.

International Collaborative Research Grants Scheme (ICRGS) is a three-way partnership between the HRC, the Australian National Health and Medical Research Council and the Wellcome Trust, a UK-based international health research funding charity. The New Zealand ICRGS investment has a primary focus on Pacific Island nations and Pacific communities living in New Zealand.

63. Investment by the Wellcome Trust in health and medical research in New Zealand is an indication of the quality and relevance of the country's research in this field.

The New Zealand government has, through the HRC, invested more than NZD 3.7 million over five years in this collaborative venture to address significant health problems in the Asia-Pacific region. A total of GBP 11.86 million (NZD 33.9 million) was allocated in 2003 to 11 projects involving Australian and/or New Zealand research teams and teams in the developing countries of the region. The emphasis of the New Zealand component of the ICRGS was on funding top-quality, multidisciplinary research with the potential to improve health outcomes for Pacific peoples.

In its 2005 budget, the government announced an additional NZD 70 million over the next four years to fund priority health research and to strengthen the health research workforce. The HRC will receive an additional NZD 61 million over the next four years for research with the potential to address the specific health needs of New Zealanders. Around a third of the funding will be dedicated to research in the highest priority areas (including cancer control, disability and diabetes). The remainder of the additional funding will be allocated through normal contestable funding. In addition, more than NZD 9 million will be used to strengthen the health research workforce.

3.3.6. The Ministry for Economic Development

The Minister for Economic Development is responsible for leading the government's Economic Transformation Agenda (and previously the GIF) as well as the industry and regional development portfolio. Currently, the business assistance programmes are aimed at:

- Improving the access to finance of New Zealand firms.
- Increasing the degree of international engagement of New Zealand firms.
- Increasing the rate of innovation of New Zealand firms.
- Improving the prospects of newly established New Zealand firms.

Each year, the government invests in business assistance programmes through Vote Economic, Industry and Regional Development. Total appropriations in 2006-07 are NZD 286.495 million.[64] NZTE delivers a range of programmes which it agrees to provide with the Minister for Economic Development through its Output Agreement with the minister.

64. GST-exclusive and excluding multi-year appropriations for the Regional Partnership Programme.

Table 3.7. Vote E, I&RD portfolio of funding instruments

Objective	Programme/service	Predominant market failure
Improving access to finance	Information on raising capital Investment ready training	Information failures
	Investment NZ Strategic Investment Fund Venture Investment Fund Seed Co-investment Fund	Externalities
	Escalator Service	Co-ordination failures
Increasing internationalisation	Generic international market development assistance Exporter education	Information failures
	Market Development Assistance Scheme Growth Services Fund* Market Development Services World Class New Zealanders 321 Go Global** Large Budget Screen Production Grants* Major Events Development	Externalities
	Beachhead programme Enterprise Networks International Biotechnology Partnership Fund** Sector Facilitation*	Co-ordination failures
Increasing innovation	Futureintech**	Information failures
	Growth Services Fund* Enterprise culture skills and activities fund Large Budget Screen Production Grants* Regional Partnership Programme (Major Regional Initiatives) Better By Design Programme**	Externalities
	Incubator support programme Sector Facilitation* GIF Industry Governed Bodies Fund	Co-ordination failures
Support for new businesses	BIZ Portal and generic assistance BIZ 0800 contact centre and regional centres Enterprise training Māori Trustee training Pacific pre-business training E-business training Mentoring	Information failures

* Programmes with multiple objectives. ** GIF taskforce initiatives.

Thirty-eight programmes are delivered through Vote E, I&RD: five by MED and the remaining either directly by NZTE (see below) or by other agents (local providers or specialist agencies). Table 3.7 shows which of the high-level objectives each of the programmes or services contributes.[65] Table 3.8 lists the programmes directly administered by MED. It should be noted that following a recent review of Large Budget Screen Production Grants, the government has decided to continue this support.

Table 3.8. Ministry of Economic Development programmes

Mechanism	Objective	Funding in 2003-04
Film New Zealand	Support for the New Zealand film industry organisation	NZD 0.7 million
Large Budget Screen Production Grants	To attract large budget film and television productions.	NZD 40.0 million
Regional Initiatives Fund	Assist regional development	NZD 1.9 million
Sector Initiatives Fund	Assist development in key sectors (GIF with some others)	NZD 4.3 million

There is a lack of clarity about the separate roles of MED and NZTE. A recent report notes that some of the programmes funded through the Vote E, I&RD are suboptimal in size and in the amount of support they provide to firms (MED, 2006b). This review agrees with those observations. The government is currently conducting a review[66] of business assistance programmes in Vote E, I&RD as part of a series of reviews aimed at improving the performance and value for money of government activities and services.

3.3.7. New Zealand Trade and Enterprise

NZTE was created in 2003 by a merger of Industry New Zealand and Trade New Zealand. NZTE contributed to the GIF by supporting the development of internationally competitive businesses. Major programmes operated by NZTE which are relevant to innovation are shown in Table 3.9.

65. Note that this breakdown is different from the breakdown provided in the budget estimates of appropriations. Some of these programmes were discontinued following Cabinet decisions in November 2006.

66. Undertaken by officials from MED, NZTE, MFAT, the Treasury and the State Services Commission. As at July 2006, 72% of the value of the programmes within Vote E, I&RD (as it exists from 2006/07) has been subject to in-depth evaluation. By the end of the 2008/09 financial year 97% of the value of the programmes will have been fully evaluated.

Table 3.9. New Zealand Trade and Enterprise programmes

Mechanism	Objective	Funding in 2003-04 (NZD millions)
Australia-New Zealand Biotechnology Partnership Fund (ANZBPF)	Facilitate trans-Tasman co-operation in biotechnology	2.5
Cluster Development Awards	Build clusters with 50% support (up to NZD 50 000) for a facilitator	0.8
Enterprise Culture, Skills and Activity Fund	Encourage enterprising skills through seed funding and pilots	1.7
Enterprise Development Fund	Help individuals to gain business skills through mentors, advice, training and market development	4.1
GIF Industry Bodies Fund	Support for industry organisations in GIF sectors	1.6
Market Development Assistance Scheme (MDAS)	Assist firms with export market development	6.7
Sector Strategies and Facilitation Fund – major events	Support for major events	1.1
GIF Sector Projects Fund	Support for GIF industry bodies (*e.g.* national biotechnology body)	1.0
Growth Services Fund	50% support for firms with high-growth potential to buy advice and services	10.5
Incubator Awards	Support for business incubators	3.1
Regional Programmes	Support for regional development	11.1
Sector Strategies and Facilitation Fund - Strategic Investment Fund	Support projects that cannot be supported though other programmes	1.9

The ANZBPF and the MDAS seem under-sized. While the MDAS was also initially short of funds, this has since been remedied. The demand for funding under these schemes results in some funds being fully committed early in the financial year. When first announced, MDAS was fully subscribed within six weeks. NZTE funding streams appear to change frequently, which companies find confusing.

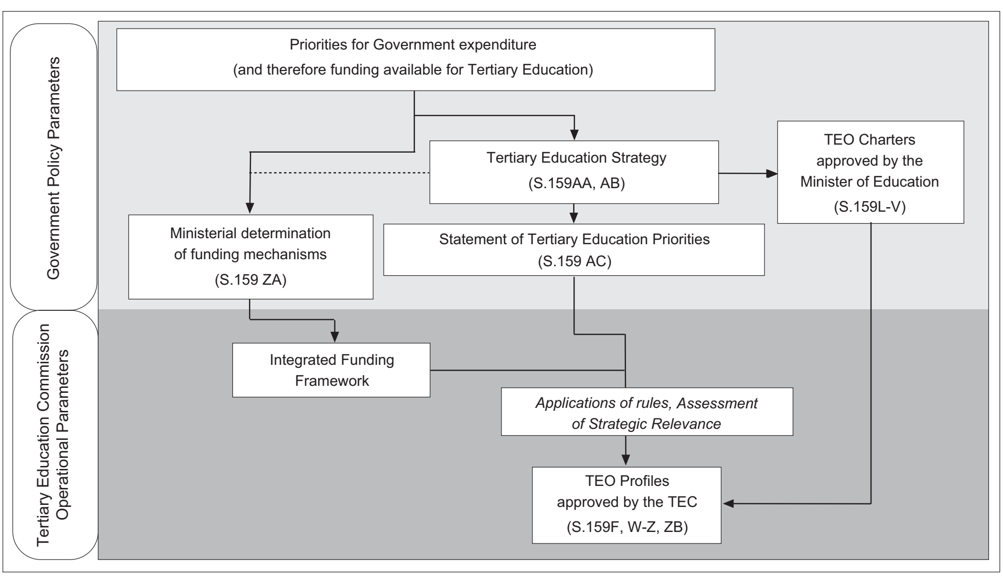
Programmes such as the Growth Services Fund meet an important need. However the numbers of grants awarded and the amounts of funding provided are too small to have a significant impact. For example, in 2003-04, only 84 grants were awarded, ranging from NZD 1 881 to NZD 75 000 (New Zealand Controller and Auditor-General, 2004). Since this report was prepared, the government has reviewed its business assistance programmes and made some minor changes.

In summary, NZTE programmes are providing much-needed support for business innovation. The Australia-New Zealand Biotechnology Partnership Fund is an excellent move to build stronger teams. However, there is some overlap between NZTE and MED programmes. There also appears to be overlap between some Vote E, I&RD and Vote R, S&T programmes. Some of the programmes funded through the Vote E, I&RD are suboptimal in size and in the amounts of support they provide to firms. There is a need for a simpler programme portfolio that can be more easily understood by the business sector and other stakeholders.

3.3.8. The Ministry of Education

The Education Act 1989 (as amended) establishes a system for setting, communicating and implementing the government's objectives for tertiary education through the Tertiary Education Strategy, the Statement of Tertiary Education Priorities, and tertiary education organisations' (TEOs) charters and profiles. This system covers both tertiary education and research. The governance framework is shown in Figure 3.4.

Figure 3.4. Governance framework for tertiary education



The Vote Education is the responsibility of the Ministry for Education. With funds from that Vote, the Tertiary Education Commission (TEC) is responsible for providing the government's contribution to tertiary education, including some support for research in the country's eight universities. Researchers in the higher education sector obtain support through the TEC, primarily the Performance-based Research Fund (PBRF), the Royal Society of New Zealand, primarily through the Marsden Fund for basic research, the Health Research Council for medical research and FRST for strategic research (see above). The CRIs (and firms) can also seek funding from the Marsden Fund, the HRC and FRST. However, most of the Marsden Fund and Health Research Council support is provided to university researchers. The universities receive a relatively small share of FRST funding.

3.3.9. The Tertiary Education Commission

The TEC was established on 1 January 2003. It is the Crown Agency charged with giving effect to the Statement of Tertiary Education Priorities through the negotiation of charters, the negotiation and approval of profiles, and the allocation of funding to TEOs.

The TEC's total budget was approximately NZD 2.6 billion in 2005-06. During 2004-05, NZD 31.3 million was paid to TEOs under the PBRF arrangements and a further NZD 23.95 million was paid to seven Centres of Research Excellence.

One of the TEC's objectives is to strengthen research, knowledge creation and uptake for New Zealand's knowledge society. The TEC encourages the development of a world-class research culture, which produces high-quality research and offers an attractive and effective learning environment for students.

The Building Research Capability in the Social Sciences (BRCSS) initiative was implemented during 2004-05. The TEC is working with the tertiary sector and key government social development agencies to identify and address important issues. A contract has been let to a consortium (led by Massey University) to advance this initiative.

The following focuses on three main TEC instruments: the PBRF, the Centres for Research Excellence and the Partnerships for Excellence.[67]

67. Other innovation-related TEC programmes include: the ITP Business Links Fund, which aims to enhance the capability of the polytechnics to transfer knowledge and expertise to industry and provide relevant education and training of high quality; and the Growth and Innovation Pilots which fund enterprise training for emerging industries, entrepreneurship and knowledge transfer.

The Performance-based Research Fund

The PBRF supports the advancement of knowledge by encouraging excellent research. It has some similarities to and was inspired by the established United Kingdom Research Assessment Exercise (UK RAE). At a time when the future of the UK RAE is in doubt, the New Zealand PBRF is only now entering a second round.

The first PBRF evaluation, completed in 2003-04, provided insights into the range and quality of research capabilities within the sector. This led to a number of refinements in the operation of the PBRF. The next evaluation is scheduled to take place this year.

Funding is allocated on the basis of performance. The PBRF has three components: assessment through periodic peer evaluations (60%), completions of research degrees (25%) and external research income (15%). The PBRF has been developed since 2000 and appears to have already had some impact in raising research performance (TEC, 2004b).

There are signs that the PBRF has heightened the university emphasis on research quality. Researchers appear to be well aware of the PBRF and its funding consequences. The peer evaluation element can be time-consuming but can be expected to generate benefits well beyond the PBRF exercise itself. It will however take time for the influence of the PBRF to flow through to citation rates for New Zealand university researchers.

Inevitably, when any assessment process is linked to future funding, there will be attempts to "game" the system. In this case, poaching key researchers from other institutions is a risk. This could result in further concentration of research talent at the expense of the smaller universities.

There are concerns that the PBRF formula may discourage some university researchers from becoming involved in commercialisation activities at the expense of producing research publications that will enhance their PBRF rating. This would be an undesirable outcome. The experience of the UK RAE supports the view that funding formulae can significantly influence researcher behaviour. While the PBRF (academic) panels were asked to take account of the impact of research, they are not well placed to do so. As a result, research which has, for example, influenced government policy but has not been published in a leading journal may be undervalued.

In summary, although it is too early to determine the full impact of the introduction of the PBRF, it is likely that it will increase the focus on quality in university research. However, there is a need to ensure that an increase in research quality does not result in a decline in researcher engagement in commercialisation of research and interaction with industry and users of research.

Centres of Research Excellence

Seven Centres of Research Excellence (CoREs) were established in 2002-03 to encourage the development of world-class research in New Zealand, by providing incentives for researchers in the tertiary education sector to conduct research that is excellent, contributes to New Zealand's future development, and incorporates knowledge transfer activities (Table 3.10).

Table 3.10. Centres of Research Excellence

CoRE	Host and partners	Objective
Allan Wilson Centre for Molecular Ecology and Evolution	Host: Massey University Partners: Canterbury, Auckland, Otago, and Victoria University (Wellington)	To unlock the secrets of New Zealand's plants, animals, and microbes by understanding their evolution, including molecular rates of evolution and biodiversity.
Centre for Molecular Biodiscovery	Host: University of Auckland.	Using genomic and proteomic data to develop new tools for biotechnology and medicine.
The MacDiarmid Institute for Advanced Materials & Nanotechnology	Host: Victoria University of Wellington. Partners: University of Canterbury, Industrial Research Ltd, & Institute of Geological and Nuclear Sciences	Research into nanoengineered materials/devices; novel electronic, electro-optic and superconducting materials; conducting polymers; soft materials; and advanced materials.
National Centre for Advanced Bio-Protection Technologies	Host: Lincoln University Partners: Massey University, New Zealand Crop and Food Research Ltd and AgResearch Ltd	Effective control of crop weeds, pests and diseases as well as the biosecurity and pest management needs of New Zealand's plant based primary industries and natural ecosystems.
National Centre for Growth and Development	Host: University of Auckland. Partners: Massey University, University of Otago, with contributions from AgResearch Ltd	Understanding causes and consequences of prematurity; gene-environment interactions in growth and disease; saving newborn babies from brain injury; and treatment of neuro-degenerative disease in adults.
New Zealand Institute of Mathematics and its Applications	Host: University of Auckland. Partner: New Zealand Mathematics Research Institute (NZMRI) Inc	Research in mathematical sciences, and use of high-level techniques in areas such as bioengineering, bioinformatics, medical statistics and operations research.
The National Institute of Research Excellence for Māori Development & Advancement (Nga Pae o te Maramatanga)	Host: University of Auckland. Partners: Te Whare Wananga O Awanuiarangi, Te Wananga O Aotearoa, Victoria University of Wellington, Universities of Otago and Waikato, & Landcare Research	Research on healthy communities in sustainable environments; social and educational transformation; and new frontiers of knowledge. Expanding and strengthening Māori research; influencing policy; building processes for communities to engage with each other; and enhancing infrastructure to support knowledge transfer.

The CoREs help the tertiary sector to meet a number of specific strategic objectives, including:

- Reward excellent research performance.
- A more focused tertiary research investment through world-class clusters and networks of specialisation.
- Greater alignment of tertiary education research with national goals.
- Improved knowledge uptake through stronger links with those that apply new knowledge or commercialise knowledge products.

The CoREs are primarily inter-institutional research networks, with researchers working together on a commonly agreed research programme. Each CoRE is hosted by a university and comprises a number of partner organisations including other universities, CRIs and wananga (Māori tertiary education institutes). The host university is responsible for the relationship with the TEC, overall management and co-ordination of the research plan, support for knowledge transfer and network activities.

In 2005 a mid-term review of the CoRE programme was undertaken to ensure that it continued to meet its objectives and to identify strategic issues. The review found that all seven CoREs are meeting performance targets and are tracking well for the future. The review also identified a number of strategic and policy issues. One outcome was a decision that any Centre of Research Excellence not approved for ongoing funding will be given a three-year phase-down.

In summary, while the rationale of the CoREs – rewarding excellent research in areas of strategic importance for New Zealand – seems sound, it is less clear how effective the CoREs are in creating stronger links with potential end users of research results beyond relying on the capabilities of individual participants.

Partnerships for Excellence

The Partnerships for Excellence (PfX) framework is another recent TEC initiative. It aims to increase private-sector investment in tertiary education and to foster better links between tertiary education institutions, industry and business. One of its objectives is to ensure that the capability of the public tertiary education sector is developed in partnership with the private sector and industry.

Table 3.11. Partnerships for Excellence awarded (2004-06 funding round)

Agriculture and Life Sciences Partnership for Excellence Partners: Massey and Lincoln Universities with key agricultural industry groups. This project will build human capacity and capability in agriculture. The partnership will operate via a new bridging trust of NZD 22.34 million from private-sector contributions of NZD 13.39 million and PfX funding of NZD 8.95 million.
Centre for Plastics Innovation and Technology Partners: Auckland University with Plastic New Zealand and key companies in the New Zealand plastics industry. The centre will perform research in industry-identified areas, facilitate the development and application of leading-edge technologies, and improve skills of industry personnel. The centre was awarded PfX funding of NZD 5 million to fit out an existing building and provide an endowment fund that will support academic positions and scholarships.
ICT Innovation Institute (Uci 3) Partners: University of Canterbury with industry partners including Jade Software and other ICT companies. The ICT Innovation Institute will step up ICT capability to meet the needs of the sector. Sir Angus Tait has donated the establishment of a chair in the Institute. The institute was awarded PfX funding of NZD 9.7 million which will be used to construct a building for the institute.
The Institute for Health Innovation – Democratising health information and technology Partners: University of Auckland with companies including Enigma Publishing, iSoft, Procare, Southern Cross, Phonak Orion and Vodafone. The institute will address the risk that future health innovations may become unaffordable given the growing proportion of GDP spent on health. The institute has been awarded PfX funding of NZD 7 million which will be invested in a purpose-built building to house the institute, co-locate collaborative partnerships and endow the position of director.
Toward a future-focused New Zealand equine industry Partners: Massey University with Bomac Laboratories Ltd., Matamata Veterinary Services Ltd. and other key participants in the equine industry. The project's goal is to increase the equine teaching and research capability of New Zealand's tertiary education sector. The partnership will be established with PfX funding of NZD 5 million.
TradeFIT – a real world trades learning and innovation centre Partners: Christchurch Polytechnic Institute of Technology (CPIT) with Orion NZ Ltd., Gough Group Ltd. and companies in the infrastructure and construction sectors. Industry partners will fund the establishment of a simulated subdivision. Trainees will gain understanding of the linkages between their own activities and those of other trades. There is a shortage of qualified, skilled people to build, maintain and upgrade New Zealand infrastructure. PfX funding of NZD 4.9 million will be used to create a student services centre, library and educational facilities next to the subdivision.

There were six successful proposals in the 2004-06 Partnerships for Excellence (PfX) funding round (Table 3.11).[68] A broad spectrum of activities was supported. While the PfX provides infrastructure and support for a director, the CoREs receive general research support.

In summary, PfX funding addresses a broader range of expenditure categories than other programmes. PfX funding appears to complement the Research Consortia programme run by FRST in achieving a common goal: broadening and deepening PRO-industry co-operation. This will remain true as long as PfX does not focus on funding research co-operation but mostly facilitates industry contributions to improving the research environment and infrastructure in universities. It will also minimise the risk of overlaps with the CoRE programme.

3.3.10. The New Zealand Venture Capital Investment Fund

Venture capital is an essential ingredient for successful innovation. Most OECD countries have taken measure to encourage this type of investment. As noted in Chapter 2, the New Zealand venture capital market is small and immature. There are shortages of start-up and early-stage capital and weak business angels' networks. The government has responded to this situation with policy measures that are starting to have an impact.

The New Zealand Venture Capital Investment Fund (VIF), established in 2002, is an equity investment programme designed to increase the supply of capital to innovative young companies and to develop the venture capital market in New Zealand. Prior to the creation of this Fund, "there was a virtual absence of dedicated venture capital funds operating in New Zealand". However, in 2005, the overall size of the New Zealand venture capital market was still considered relatively small as a percentage of GDP (LECG, 2005). The VIF is managed by New Zealand Venture Investment Fund (NZVIF) Ltd., a Crown-owned company. The goals of the VIF are:

- To accelerate the development of the New Zealand venture-capital industry by increasing the level of early-stage (seed, start-up and early expansion) investment activity in the New Zealand market.
- To develop a larger pool of people in New Zealand's venture capital market with skills and expertise in early stage investment.
- To facilitate the commercialisation of innovation from Crown Research Institutes, universities and the private sector.

68. Successful applicants from previous years include the Institute of Innovation and Biotechnology, at Auckland University, awarded in 2004.

- To get more New Zealand businesses on paths to global success by increasing their access to international experts, networks and market knowledge.

VIF Venture Capital Funds are fixed-duration, private-equity investment vehicles in which VIF is a foundation investor. The VIF Funds select, invest in and assist the growth of innovative young companies. VIF appoints venture capital fund managers through a rigorous selection process supported by independent professional due diligence. To date, VIF has committed NZD 60 million to five VIF Venture Capital Funds, which have invested in 36 companies.

From its establishment in 2002 until November 2006 the Fund invested with private-sector investors on a 1:2 ratio with a focus on seed, start-up and early expansion investment. While early stage is still the focus of funding, the investment mandate has now been extended to include expansion and late expansion stages of firm growth. The existing Crown-to-private-sector investment ratio of 1:2 will now increase to 1:1 for the seed and start-up stages.

In addition, a sliding scale has been introduced for later stages. The current ratio of 1:2 for the early expansion stage is retained. It is 1:4 for investment at the expansion stage, and 1:5 for late expansion. The sliding scale is intended to provide more incentive to invest at the very early stages of a business, while also recognising the need for greater private-sector investment at the later stages.

NZVIF also manages the recently established Seed Co-investment Fund (SCIF), which aims to provide seed funding for early-stage businesses with strong potential for high growth. This fund has NZD 40 million available for co-investment alongside selected private investor groups. Initially, there was an upper funding cap of NZD 250 000 per investment, with a requirement for at least 50:50 matching funding from private investors. Any investor group may access up to NZD 4 million from this fund.

The goals of the SCIF programme are to:

- Accelerate the development of greater professional capacity in the market for intermediating funds between investors and newer technology-based firms.
- Raise the scale of and enhance the development of networks for early stage investment.

- Increase the depth of the pool of specialist skills available to assess and manage early-stage technology-based investment.
- Catalyse investment that would not have occurred without the programme.

The funding cap per investment and the group limit may initially have been set too low. There was some recognition of this, when, in mid-2006, the government gave the NZVIF Board the discretion to approve individual transactions for follow-on SCIF co-investment of up to NZD 500 000. The government also relaxed the requirement that public share ownership be restricted to 35% for Crown Research Institutes and universities. Nevertheless, SCIF is too new to assess in detail; some further adjustments may be required in the light of experience

In summary, the VIF is a useful initiative for addressing the shortage of venture capital. It may need further funds, as this will ensure that the investor groups have sufficiently large amounts of funds under management to justify the employment of skilled managers, while keeping management expense ratios at acceptable levels by international standards. Recent changes are steps in the right direction. The SCIF cap and limits on investor groups may also need further adjustment in the light of experience. The limitation of the NZD 250 000 cap was addressed by the 2006 changes that give NZVIF discretion to allocate up to NZD 500 000. However, the costs of managing such small investments will be high as a percentage of the amount invested. If highly capable investor groups emerge, limiting them to NZD 4 million may impair the success of the programme and drive up investor costs.

3.3.11. Other sources of support for innovation

Compulsory levies have a long history in New Zealand agriculture. The Commodities Levies Act 1990 now applies, the key rationale being that industry activities may be subject to a free-rider problem. Under the Act, farmers vote every six years on the levy and its uses. Levies are used in the meat, wool, dairy and deer industries for:

- Product and market R&D.
- Generic industry promotion.
- Plant and animal health.
- Quality assurance.
- Education, information provision and training.

Unlike Australia, FRST does not match funds raised from levies in the agriculture sector. Ministries other than those discussed above commission limited amounts of contract research, usually to address specific issues and to inform policy development.

3.3.12. Tax treatment of R&D

New Zealand's tax treatment of R&D expenditure has been brought broadly into line with financial accounting practice in recent years. New Zealand does not currently provide tax incentives for business R&D, low-interest loans or loan guarantees to high-growth firms. In this regard New Zealand lags well behind most OECD economies (Sawyer, 2005), including many that enjoy far higher R&D intensity (Tables 3.12 to 3.14).

The overwhelming advantage of R&D tax incentives is their market-friendly nature. Another is that, if well-designed – keeping barriers to access and compliance costs at a low level – they are immediately available to any firm that sees an opportunity to develop an innovative new product or service. Another feature of well-designed R&D tax incentives is that administrative costs are low. There is now considerable experience among OECD countries with designing an effective tax incentive. Examples of best (and poor) practice can be readily observed. The evidence shows, for instance, that schemes that are subject to frequent changes tend to be less effective. Overly complicated and targeted schemes tend to lead to high administrative and compliance costs and lose the specific advantages that characterise such tax incentives. The in-depth discussion of the design of fiscal incentives prior to their introduction in the United Kingdom may be seen as a good practice example of how to proceed with the design of new instruments. Given New Zealand's very low levels of business R&D investment, the provision of a tax incentive in this area seems urgently needed.

As noted previously, the recently released Business Tax Discussion Document (New Zealand Inland Revenue Department, 2006) raises the possibility of a tax credit of 7 to 15% for R&D.

Table 3.12. Tax support to R&D – a decision tree

<table>
<tr><th colspan="2">Policy choice</th><th>Practices
(see Table 4.2)</th><th>Evaluation</th></tr>
<tr><td colspan="2">Whether or not to use tax incentives for promoting R&D</td><td>Over two-thirds of total OECD business R&D expenditures benefit from tax incentives. Among the largest R&D performers, only Germany does not offer such incentives.</td><td>Tax incentives are cost-effective for increasing private R&D, but their inducement power is moderate and contingent on the level of corporate income tax. Their superiority over alternative uses of government resources is clear only with regard to non-selective subsidies. At an aggregate level the effectiveness of tax incentives tends to increase (decrease) with the decrease (increase) of R&D subsidies. For an R&D fiscal measure to induce substantial and worthwhile R&D at low cost to taxpayers, there must be high spillovers from the modest amount of induced R&D to generate net benefits. This is unlikely to be the case in countries where R&D activities are more concentrated in large firms operating in sectors where appropriability problems are less severe (e.g. oligopolistic industries).</td></tr>
<tr><td rowspan="2">If yes, choose between or combine</td><td>Volume-based scheme</td><td>Ten countries.</td><td>The most generous form of tax incentives. Appropriate as part of a catching-up strategy in terms of R&D intensity. But an effective inducement is achieved at high cost. The generosity of the scheme can be reduced as countries catch up. The generosity of support can be limited for large firms and eligible expenditure may be defined in a restrictive way (Netherlands). A switch to an incremental mechanism always needs to be given careful consideration.</td></tr>
<tr><td>Incremental and mixed schemes</td><td>Ten countries.</td><td>More cost-effective than volume-based schemes for increasing R&D. However, the effective rate of support varies considerably across industries and firms and the choice of the reference base for calculating eligible incremental R&D raises difficult problems. An incentive proportionate to the intensification of R&D efforts (as a % of turnover) is more cost effective than one proportionate to the increase of R&D expenditure, unless the target is to favour fast-growing young SMEs.</td></tr>
<tr><td colspan="2">Target or grant favourable treatment to certain types of research, sector or firm</td><td>Nine countries give preferential treatment to SMEs. Only a few countries offer specific tax incentives for basic research, “priority technology areas” or co-operative research.</td><td>Preferential treatment of SMEs might be justified on the grounds that small firms are more affected than large ones by liquidity constraints stemming from capital market failures. However, it is difficult to design a scheme which will meet the various needs of all types of SMEs, as demonstrated by a relatively low participation rate in some countries. The quality of the financial and infrastructural environment of SMEs varies greatly. R&D tax incentives can be seen as a transitory remedy which may become less effective as the business environment improves. Ceilings on benefits of general schemes can make them more generous to smaller firms. Superior targeted grant-based policy tools exist to provide capital to start-ups as well as to promote specific technologies or basic research.</td></tr>
</table>

Table 3.13. R&D tax incentives in OECD countries, 2005

	Large firms		Special treatment for SMEs	
	Tax credit	Tax allowance	Tax credit	Tax allowance
Volume	Canada (20%) Japan (8-10%) Mexico (20%) Netherlands (14%) **Norway** (18%)	Belgium (113.5%) Czech Republic (200%) Denmark (150%) **Poland** (130%)* **United Kingdom** (125%)	Canada (25%) Italy (30%) Japan (15%) Netherlands (42%) **Norway (20%)**	Belgium (118%) **Poland** (150%)* **United Kingdom** (150%)
Combination (volume/incremental)	France (5-45%) Korea (7-40%) Portugal (20-50%) Spain (30-50%)*	Australia (125-175%) Austria (125-135%) Hungary (100-300%)	Korea (15-50%)	
Incremental	Ireland (20%) United States (20%)			
None	Finland Iceland Switzerland Turkey	Germany Luxembourg Slovak Republic	Greece New Zealand (under consideration) Sweden	

Bold indicates incentive introduced after 2000.
* Only for enterprises that obtain at least 50% of their income from the sale of their R&D results.
Source: OECD.

Table 3.14. R&D tax treatment B-indexes

Country	Large company 2004	Large company 2005	Change	Small company 2004	Small company 2005	Change
Australia	0.883	0.883	↔	0.883	0.883	↔
Austria	0.888	0.922	↓	0.888	0.922	↓
Belgium	1.009	1.009	↔	1.009	1.009	↔
Canada (federal)	0.827	0.827	↔	0.678	0.678	↔
Czech Republic	-	0.698		-	0.698	
Denmark						
150% allowance	0.822	0.839	↓	0.822	0.839	↓
Without allowance	1.015	1.013	↑	1.015	1.013	↑
Finland	1.010	1.008	↑	1.010	1.008	↑
France	0.866	0.866	↔	0.866	0.866	↔
Germany	1.024	1.030	↓	1.024	1.030	↓
Greece	1.015	1.015	↔	1.015	1.015	↔
Hungary						
200% allowance	0.838	0.838	↔	0.838	0.838	↔
400% allowance	0.495	0.495	↔	0.495	0.495	↔
Iceland	1.012	1.012	↔	1.012	1.012	↔
Ireland	0.951	0.951	↔	0.951	0.951	↔
Italy	1.027	1.023	↑	0.549	0.575	↓
Japan						
R&D/sales <10%	0.865	0.865	↔	0.808	0.808	↔
R&D/sales >10%	0.831	0.831	↔	0.808	0.808	↔
With universities	0.782	0.782	↔	0.808	0.808	↔
Korea	0.815	0.820	↓	0.839	0.842	↓
Mexico	0.612	0.627	↓	0.612	0.627	↓
Netherlands	0.942	0.934	↑	0.780	0.762	↑
New Zealand	1.023	1.023	↔	1.023	1.023	↔
Norway	0.794	0.794	↔	0.769	0.769	↔
Poland	-	1.011		-	1.011	
Portugal	1.014	0.717	↑↑	1.014	0.717	↑↑
Spain	0.559	0.559	↔	0.559	0.559	↔
Sweden	1.015	1.015	↔	1.015	1.015	↔
Switzerland	1.010	1.010	↔	1.010	1.010	↔
United Kingdom	0.904	0.904	↔	0.894	0.894	↔
United States (fed.)	0.934	0.934	↔	0.934	0.934	↔

Note: Portugal suspended its programme in 2004 and re-introduced it in August 2005.

* The B index measure is defined as the minimum present value of before-tax income that a firm needs to generate in order to cover the cost of R&D and to pay the applicable corporate income taxes. The lower it is the greater is the incentive to invest in R&D.

Source: Warda (2006).

3.4. Summary findings on overall governance and support instruments

Science for New Zealand (MoRST, 2006) provides a good overview of New Zealand's research, science and technology system. This document sets out the roles and responsibilities of key participants in the science sector. It provides a clear statement of the importance accorded by the New Zealand government to science and innovation. Funding arrangements and the principles underlying these arrangements are clearly articulated. The long-term nature of science and research is acknowledged.

At the highest level, New Zealand's prime minister was engaged in the GIF process. Ministers have demonstrated strong commitment to science and innovation. There is a very high level of transparency in the management and funding of science and innovation. It is probably the only OECD country where agency advice to ministers is on the public record (see for example FRST, 2005). The staff of the key ministries (MoRST, MED and Education) and their agencies impressed the review team with their knowledge of the areas for which they are responsible.

As might be expected, other ministries are less engaged in the science and innovation process. The New Zealand governance model which seeks to separate policy, funding and performance of research has its merits. However, the need for policy and funding agencies to constantly consult one another adds to the overheads of New Zealand's science and innovation system. Many funding decisions are taken by officials, rather than by independent committees and boards. The internal review processes of the funding agencies, such as FRST, appear to be fair and rigorous.

New Zealand research directions and priorities are informed by consultations with stakeholders. The GIAB provides high-level advice. However, the initial effort on the GIF has not been followed through and opportunities to expand and develop the GIF have not been taken. New Zealand's research priorities appear to have received less consideration than those of some other OECD countries.

New Zealand has no counterpart to the Australian Prime Minister's Science, Engineering and Innovation Council (PMSEIC), a high-level body comprising key ministers and leading figures in science and innovation from the public and private sectors.[69] This council normally meets twice a year, supported by working groups and a secretariat. The non-ministerial members constitute the Standing Committee of the Council, and oversee and

69. For more information see: *www.dest.gov.au/sectors/science_innovation/science_agencies_committees /prime_ministers_science_engineering_innovation_council/*

contribute to studies and research aimed at improving understanding of the major, science, engineering and innovation issues. There are similar high-level bodies in other OECD countries.

Funding agencies also undertake appropriate consultations. There are various procedures for allocating funds. Decisions to support business-sector research are largely taken by knowledgeable officials, sometimes through intermediaries. While experience with regional and other intermediaries is mixed, it is not possible for FRST, with its limited resources, to develop relations with potential clients across the country. Evaluation of government programmes is well-established. However, some evaluations have been conducted using in-house resources rather than independent reviewers and some have not been particularly critical.

There is some lack of clarity between the roles of MoRST and MED and between their funding agencies, FRST and Technology New Zealand. There is strong emphasis on providing public-sector researchers with funds to work with industry partners, which is entirely appropriate. However, there are several schemes for this. Time-consuming vertical relationships imposed by the "purchaser-provider model" obviously work at the expense of horizontal co-ordination. Another consequence is that policy officials lack the direct connections with researchers and other stakeholders that might be needed to inform some strategic decisions.

The management and steering of CRIs raise some concerns, such as the short tenures of directors and difficulties in finding suitable people for this role. However, as noted previously, the major governance issue for CRIs is the complexity of their reporting arrangements.

Perhaps the most serious problem is the fragmentation of funding. There are too many small, under-funded programmes. In some cases, the available funding is spent early in the financial year, leaving nothing to support opportunities that arise later. Stakeholders, particularly in business, have difficulty keeping track of funding schemes. Application and compliance costs can exceed the value of a small grant. There is no one-stop shop for companies to obtain information about the grant support that is available.

In terms of the mix of instruments to support innovation, a wide range of assistance programmes address different needs. There is scope for some consolidation of these programmes. A notable weakness is the absence of tax measures to support business R&D. The suggestions canvassed in the business tax discussion document are welcome in principle, although, as already noted, at the levels of benefit proposed, they may not generate the increase in business enterprise R&D (BERD) which New Zealand needs.

Finally, New Zealand needs to provide more support for science and innovation, particularly for business R&D. Increasing private-sector involvement in science and innovation is of critical importance. Ensuring the most favourable business environment for business growth (notably in terms of tax) is also important. For many businesses, this will mean exports because of New Zealand's small market size. A New Zealand business environment that is seen as supportive of the expansion of technology-based companies will help to ensure that, when these companies start to expand offshore, they retain their New Zealand base.

Chapter 4

THE EFFECTIVENESS OF THE NEW ZEALAND INNOVATION SYSTEM

Introduction

No single successful configuration of the national innovation system (NIS) is appropriate for all developed economies. Each OECD country possesses a unique inheritance from the past which conditions its ability to exploit successfully the opportunities offered by increasing globalisation, economic growth and social change, and developments in science, engineering and technology. A successful NIS is one which, given the wider economic and technological environment, enables a country to build successfully on its inherited strengths and to remedy, offset or work around its inherited weaknesses in order to exploit to the maximum extent possible its potential for future sustainable economic growth and social well-being. Innovation policy should aim to contribute to the effectiveness of the NIS in these respects.

Innovation, which includes, but is by no means only, the exploitation of developments in science and technology, is the main source of economic growth. It is also affected by a wide range of social and economic factors, whose interactions form the NIS. As a consequence, innovation is influenced by a wide range of government policies, and, in the broadest sense, innovation policy covers a wide range of both macroeconomic and microeconomic policies and some aspects of social policy. While many of these policies have objectives which do not directly have to do with innovation, it is important for the various relevant areas of policy that affect innovation to reinforce one another so that innovation performance is not weakened by conflicts among various government policies. OECD member countries see co-ordination of the different areas of government policy that affect innovation as increasingly important.

Table 4.1. The New Zealand innovation system: a SWOT analysis

Strengths	Opportunities
• Resourceful and entrepreneurial population • Unique physical environment for work, living, sports and tourism • Well-functioning product and labour markets • Strong presence in primary sectors such as agriculture, forestry and fishing and some strength in related industries and services • A sound education system and a reasonably high level of innovation • Relatively strong university and public-sector research institutions • Awareness of the importance of science and technology in meeting socioeconomic goals, including ecological objectives • Strength in agricultural biotechnology and health research • Pockets of excellence in fast-growing industries such as software and creative industries as well as in the underlying sciences • An open society which engenders trust, and a frank and open policy environment • A society that recognises cultural diversity as a source of innovation	• Greater exploitation of value-added innovation in the primary and associated sectors • Continued exploitation of the opportunities for innovation raising productivity and growth in emerging industries • Use of New Zealand's strengths in science and technology in resource-based industries and related value-added services, *e.g.* application of ICT in a range of sectors • More efficient exploitation of New Zealand's environmental advantages • Improvement of international connectivity and access to knowledge of international markets, *e.g.* by improved use of ICT, leveraging the New Zealand diaspora and using the knowledge of immigrants about their home countries

Weaknesses	Threats
• Lagging GDP per capita and relatively low levels and growth of productivity by OECD standards • Small national market with a preponderance of small enterprises • Relative isolation from world markets and the processes of globalisation • Shortcomings in the physical and virtual infrastructure (broadband, energy, transport) • Lack of investment in business R&D associated with a lack of external funding for business R&D and innovation • Fragmented system of government support for R&D and innovation combined with a lack of coherence across the full range of innovation-related policies • Inappropriate incentives for public-sector research institutions in respect of building long-term capabilities, financing research infrastructure and transferring research results to business • Shortcomings in the process of technology diffusion • Barriers to growth of firms, including a preference of many entrepreneurs for "lifestyle" businesses	• Relatively weak productivity performance holds back living standards • Marginalisation of New Zealand as a location for internationally mobile investment and innovation • Deterioration in the long-term capabilities of public research institutions, including through failure to pay internationally competitive salaries for professors and scientists • Accelerated outflow of highly qualified staff and entrepreneurs

New Zealand's research, science, technology and innovation policies should rest on an analysis of the country's strengths and weaknesses. However they must also take account of the challenges – both opportunities and threats – which the country may face in the future. Table 4.1 lists the strengths, weaknesses, opportunities and threats (SWOT) identified by the OECD review team during the course of the review and which have been described and discussed in previous chapters. They are discussed and summarised in this chapter together with some comments on science, technology and innovation policies based on the discussions in earlier chapters.

4.1. Size and geographical position

Some features of the New Zealand innovation system are given by nature and/or history and must be regarded as unique features that cannot be changed. New Zealand has a population of only 4 million and from this point of view is one of the smallest OECD member countries. This has several implications:

- A small domestic market makes it difficult for firms to grow to a large or even a medium size without a high proportion of export sales.
- Difficulty in achieving economies of scale in a number of areas, including R&D, production and business infrastructure and support.
- Limitations on the range of economic activities such as business sectors, research fields, etc., that can be undertaken on an economic scale.
- A potential advantage over larger countries in terms of networking among companies and individuals and achieving consensus on tackling economic and social issues.

The second key factor affecting innovation performance is New Zealand's geographical position. There is a telling comparison in *Growing an Innovative New Zealand* which compares Finland and New Zealand, two countries with similar populations and traditional strengths in natural resources. Within a 2 200 km radius of Helsinki live 300 million people in 39 different countries while within a 2 200 km radius of Wellington there are just 4 million New Zealanders. Such relative geographical isolation means that New Zealand faces a much greater challenge for maintaining the global connectivity essential to innovation and economic growth. New Zealand firms face greater difficulties than their Finnish counterparts for offsetting their relatively small home market by exploiting the larger markets of adjacent countries, and indeed, New Zealand exports less than is typical for a country of its size.

Globalisation has been accompanied by significant reductions in the cost of marine transport and by the revolution in electronic communication due to developments in information and communication technologies (ICTs). However, proximity to the customer (*e.g.* in supply chains organised on a "just-in time" basis) and face-to-face contacts continue to be very important.

A recent report published by the New Zealand Institute points out that New Zealand has a lower proportion of exports and foreign direct investment (FDI) than other countries of its size and that this can be largely be explained by its relative geographical isolation (Skilling and Boven, 2006b). As documented in preceding chapters, New Zealand is less well integrated into the global economy than other small OECD countries and has not participated fully in the process of globalisation over the last decade or so. The expansion of foreign trade and FDI, a major feature of globalisation, plays a key role in raising productivity and fostering economic growth, but New Zealand has not benefited as much as it might have. Geographical isolation and the small size of so many of its businesses have made it difficult for New Zealand to move into the rapidly growing areas of the global arena. These are the areas in which the scope and returns to innovation are likely to be greatest.

4.2. Economic structure

A key feature of the New Zealand economy is the major role played by exploitation of its natural resources through agriculture, forestry and fishing, and through shipbuilding, but also more recently through tourism and the making of films. Although agriculture and forestry account directly for only 5% of GDP, related industries and services make this sector far more important to the national economy. Many of New Zealand's larger firms are in natural-resource-based sectors and their demand (together with that of related government agencies) for specialised goods, services and software creates opportunities for high-technology/high-value-added businesses. Demand for leading-edge inputs enables firms (and CRIs) to develop and test in the market products which can then be sold to similar operations around the world. Software for analysing fish stocks is one example. Innovative firms serving many other sectors often face the much more difficult task of finding initial customers overseas.

It is incorrect to view natural-resource-based sectors as necessarily representing an earlier stage of economic development. They offer considerable scope for the application of advanced science and technology, such as the development of new types of plants and trees (*e.g.* the new KIWI fruit described earlier), marine farming and the production of therapeutic compounds using genetically altered animals and plants. Investment in science, technology and innovation is vital if New Zealand is to maintain its competitiveness in these sectors, increase their productivity and create opportunities for innovation further up the supply chain. The review team received the impression that New Zealand has not exploited opportunities for developing innovative value-added products in natural-resource-based sectors as fully as it might.

4.3. Technological infrastructure, R&D and innovation

A country's technological infrastructure consists of those institutions – universities, other institutes of higher and further education, public research institutes and laboratories, commercial laboratories, technological consultancies, professional bodies, etc. – which supply research results, undertake contract R&D and provide advice on science, technology and engineering to firms and public bodies. In New Zealand, the universities, polytechnics and Crown Research Institutes (CRIs) are the major elements.

The role of these bodies is not just, or even mainly, to undertake research which business then exploits. Discoveries made in public-sector laboratories play a key role in innovation by providing enabling science and technology and making scientific breakthroughs which have a fundamental long-term impact on innovation by business firms. However, instances in which a specific discovery in a university or public research institute leads directly to a new product or process are comparatively rare. They are most likely to be found in biotechnology or information technology, two sectors in which New Zealand has a presence, but in other areas of technology they are quite rare.

New Zealand lacks the large high-technology firms which are responsible for a large part of business R&D in the more advanced OECD countries. Resource-based sectors and the firms that supply them play an important role in the New Zealand economy and it is in these sectors that many of New Zealand's larger firms are found. Such sectors are low-technology in the sense that they do relatively little R&D. However, they can still be very innovative, relying on science and technology imported from public-sector research institutes and specialist suppliers. Sectors such as agriculture are based on science that is normally the work of public-sector research institutes, large agrochemical companies and specialised small and medium-sized suppliers. Agriculture also buys equipment from the agricultural machinery sector which tends to be dominated by large multinationals. Otherlow-technology sectors similarly rely on technology acquired from elsewhere.[70] Box 4.1 describes the role of public research institutes and universities in innovation.

Box 4.1. Role of universities and public research institutes in innovation

Innovating firms draw on the stock of scientific and technological knowledge of which they are aware and understand in order to address the needs of customers or solve a problem in product or process design. Universities and public research institutes participate in this process in the following ways:

- They add to the stock of S&T knowledge on which firms draw.
- They educate and train the scientists, technologists, engineers and researchers which firms use to absorb scientific and technological knowledge and exploit this knowledge to innovate.
- They help firms solve the technological problems encountered in innovation and the operation of complex technology.
- They spin out new firms to exploit new science and technology developed in the research base. Companies spun out from the public-sector research base have been regarded in recent years as a major indicator of the extent of knowledge transfer. More recently, however, such companies been seen as relatively fragile and not necessarily the best route to the exploitation of the results of public scientific research.

Effective knowledge transfer between the institutions that make up the technological infrastructure and firms depends on:

- The orientation of the public-sector research and technology institutions towards the needs of firms, including the nature of the research they undertake and whether they possess the people, knowledge, organisational structures and sources of finance needed to interface with firms.
- The extent and nature of the links between these institutions and business.
- The ability of commercial firms to absorb and exploit the people, knowledge and expertise which public-sector S&T institutions possess and the research results they generate. This depends on the technological knowledge base of the firms, the skills and expertise of their workforce, their ability to develop new technology, including the resources devoted to R&D and technology development and whether they have the complementary commercial assets to exploit the results successfully.

Government policy often concentrates on the second of these three conditions, but unless the third is satisfied and firms have the capacity to absorb and exploit the knowledge, etc., that is on offer, such policies may have limited results. If the first and third conditions are satisfied, many of the necessary links will probably develop without much government intervention.

70. For an analysis of the sources of technology used by different sectors see Pavitt (1984).

Given that New Zealand's economy relies heavily on low-technology sectors and, like other countries, has many small firms that rely mainly on external sources of technology, it is hardly surprising that BERD is a small share of GDP. This is largely in line with what may be expected given the sectoral breakdown of New Zealand business and the preponderance of small firms. This does not mean that R&D performance cannot be improved. Modern developments in science and technology offer plenty of scope for creating high-technology businesses in traditionally low-technology sectors. If the right conditions are present, a significant proportion of these firms can grow much larger. Even low-technology businesses can innovate by exploiting advanced technology, although the expenditures may not always be classified as R&D.

4.4. The role of government and the design and governance of innovation policy

The role of government and the public sector in the innovation system can be separated into two parts. In areas such as education and scientific research, public institutions play a core role in the NIS, but in areas such as R&D undertaken by firms, the government intervenes at the margin to influence activities which are primarily the responsibility of other agents and institutions. This section looks at government policy in both areas; comments on more detailed aspects of policy can be found throughout the chapter.

Data from Statistics New Zealand show that innovation is widespread across the economy. A major reason for the discrepancy between BERD and innovation is the role played by the technological infrastructure in developing and adapting technology for exploitation by commercial firms. Since New Zealand business is more reliant on external sources of technology and relatively lacking in in-house capability to develop and adapt technology, the institutions and organisations that make up the technological infrastructure, such as the CRIs and universities, play a more important role than in an economy with a strong body of large high- and medium-technology firms.

The overall framework for New Zealand's current policy towards science, technology and innovation was first set out in *Growing an Innovative New Zealand*, published in February 2002. It became known as the Growth and Innovation Framework (GIF), the main elements of which are:

- A vision of New Zealand as a great place to live, learn, work and do business, where diversity is valued and where people invest in the future and embrace change.
- The objective of returning New Zealand per capita income to the top half of the OECD rankings.
- A proactive government that supports economic growth, works co-operatively with other sectors, and emphasises the importance of sustainability.
- A government effort to strengthen the foundations (framework conditions) for economic growth and effective innovation.
- Greater government effort to support the innovative efforts of individuals, firms and public-sector bodies.
- Greater efforts to develop skills and talents and to increase global connectiveness.
- Limited government resources focused on areas in which the impact is likely to be greatest. These areas – biotechnology, ICT and creative industries – are supported by the New Economy Research Fund (NERF).
- Ministers who provide leadership through all relevant portfolios to ensure that the whole of governments is working together.
- Establishment of a private sector Innovation Advisory Board to monitor progress and identify new opportunities.

The review team considers that the main elements of this framework remain valid. However, like all such frameworks, it needs to be constantly updated to take account of changing conditions. Also, some stakeholders find New Zealand's innovation policy unclear, and the effects of various government policies that influence innovation do not seem as coherent as they might be. The inheritance of the arm's-length policies and programmes of the 1980s is not always helpful. As indicated in Chapter 3, the staff of the ministries most concerned with S&T and innovation impressed the review team with their knowledge of the areas for which they are responsible, but other ministries seemed insufficiently aware of their potential role and impact in these areas. In addition, there is a lack of clarity between the roles of MoRST and MED and between those of their funding agencies FRST and Technology New Zealand.

It is therefore hoped that within the context of its new Economic Transformation Agenda (ETA) the New Zealand government will take the opportunity to produce a coherent, comprehensive and up-to-date statement of science, technology and innovation policy. The recent MoRST document, "Science for New Zealand", seems a useful step towards providing such a statement which should:

- Provide an overarching vision of what national policy towards science, technology and innovation is about.
- Set out how the various policies and programmes which affect S&T should interact and reinforce one another.
- Describe the roles of the various players in the NIS – firms, universities, CRIs, polytechnics, government departments and agencies, etc. – and how they should interact with one another.
- Provide a benchmark against which the expected impacts of proposed new individual policies and programmes should be appraised and evaluated.

Some suggestion on how this task might be approached is set out in Annex A of *Innovation Policy and Performance: A Cross-country Comparison* (OECD, 2005c) which contains descriptions of innovation policy making in six member countries. However, it is important for New Zealand to undertake this process by involving all the main stakeholders so that they feel that they understand what the policy is about and feel some degree of ownership.

In a recent paper, "Public Policy Framework for the New Zealand Innovation System", Smith (2006) proposed "a small, effectively organised and focused agency that systematically collects, assesses and processes the information that is relevant to (innovation) policy debate and development". The proposed agency would complement a revamped science, technology and innovation policy. A key function of the proposed unit should be to connect the New Zealand innovation policy community with the extensive academic discussions of innovation and innovation policy (including science and technology policies) that are taking place around the world. It would need an appropriate budget to enable it to carry out this task. This would help to derive more benefit from New Zealand's participation in the OECD Committee on Scientific and Technological Policy (CSTP) and the Working Group on Technology and Innovation Policy (TIP).

There are other areas in which a lack of coherence in innovation policy causes problems, in particular:

- Support for the innovation activities of firms needs to be rationalised; there are too many small innovation support programmes with too great a variety of objectives and rules. Apart from the risk of confusion among applicant firms this sometimes results in rapid exhaustion of individual programme budgets and a very low proportion of successful applications. This in turn leads to an unnecessary waste of time and effort for the firms that submit unsuccessful applications. It may also deter firms with potentially worthwhile projects from applying and firms may find that they have insufficient time to prepare applications properly. Fewer, better-funded programmes should improve the average quality of the supported projects and spread support funding more evenly over time. It should also make possible savings in administration costs.

- Support for the spread of business best practice is also fragmented and requires rationalising. There seems to be no lack of commercial sources of business advice but, as in some other OECD countries, small firms are reluctant to use them despite the availability of government grants. A solution which has been tried in many OECD countries, including the United Kingdom, is to provide the full cost of, say, the first three days of consultancy to enable a firm to ascertain more fully what its needs are and whether it would be worthwhile proceeding with a longer and more expensive period of consultancy. The experience of OECD countries also shows that instruments should be easily accessible to SMEs with a minimum of bureaucracy. Small grants for spreading business best practice might be more effective if administered locally; business representative associations such as Chambers of Commerce might play a useful role in their design and delivery. In New Zealand, TechNet is funding business enterprises for limited periods of consultancy with experts from CRIs, universities and other research organisations. Currently it appears to operate on a rather small scale.

- The funding, management and governance of CRIs is not fully appropriate for the important role they play in innovation and in maintaining the long-term scientific and technological capabilities necessary for New Zealand's economic prosperity and social well-being.

The last of these points is explored in more detail below.

As pointed out above, public-sector bodies such as the CRIs, universities and polytechnics play a central role in undertaking R&D that meets the needs of business firms and in supporting innovation generally. This role should include not only the undertaking of applied research but also the provision of technical services, training, advice and problem solving. Both collaborative research with private firms and co-operative R&D projects undertaken on behalf of a group of firms have a role to play. CRIs should aim to understand and anticipate the needs of the firms (and public institutions) within their area of responsibility which may need help in articulating their needs. The CRIs (and universities) need to develop the organisational structures that underpin these activities and to train their staff accordingly.

The CRIs, universities and polytechnics appear to be carrying out many of these functions already but it would be better if they undertook them in the context of a clear national strategy that defines their role. For each public research organisation, the national strategy should set out a clear strategy, including its mission statement, functions and objectives. This strategy should be agreed between the government, client firms and the public organisations and the CRI, university or polytechnic. It should form the basis of regular performance reviews and evaluations of activities undertaken.

A more strategic role for the CRIs will require shifting their funding from the current very high proportion of contestable funding towards more core funding. The system whereby CRIs compete for a large percentage of their funding has been very successful in encouraging them to undertake projects which meet the expressed needs of users but is probably less effective for encouraging them to undertake longer-term projects which try to anticipate those needs. It has also encouraged an entrepreneurial attitude towards creating new business opportunities based on their applied research. However there is a distinct risk that continuation of the current funding system will make them more and more like profit-seeking businesses, and that they may neglect the maintenance and development of the core stock of applied scientific and technological knowledge on which their role in helping businesses and society must ultimately rest. The system also creates uncertainty among the researchers themselves and makes co-operation between research institutes more difficult. These comments acknowledge the proposals put forward by the Minister for Research Science and Technology in his statement of 4 May 2006. These include a tranche of negotiated funding of up to 30% of total investment in NERF, RfI, and Environmental Research, an increase in the CRI capability funding and a review of funding of the New Zealand research infrastructure.

Public funding of R&D in New Zealand follows the Rothschild customer-contractor principle, with the government purchasing research on an arm's-length basis from a contractor either on its own behalf or on behalf of business and society more generally. The weakness of this approach is that the contractor is often in a very good position to advise on what governmental, business or societal needs might be and that the capabilities needed to undertake the research in question can often only be built up over a period of time and in expectation of a regular flow of future work.[71] This needs to be recognised by taking a more co-operative approach along the lines suggested above while recognising that a "top-down" perspective is essential to prioritise investments and minimise overlaps in government programmes. The discipline that the Rothschild principle aims to provide should be supplemented or replaced by regular and systematic evaluation. The approach suggested here is not very different from that followed by large firms when they sub-contract key parts of innovation projects to suppliers. While the ultimate sanction – dropping the supplier – remains in the background, the normal relationship is, and should be, one of close co-operation.

Measures to strengthen the public-sector elements of the technological infrastructure should not preclude efforts to encourage the development of commercial technological consultancies and private R&D contractors and laboratories. All have a role to play. Nor should it prevent the implementation of policies, like those discussed above, to increase the ability of New Zealand firms to absorb and develop new technology and to innovate in the widest sense. This is desirable in its own right and, as argued above, is important if business is to make best use of what the public and private organisations that make up the technological infrastructure have to offer.

71. An example is measurement standards, for which the assessment of future business needs requires expert knowledge of current and likely future developments in the relevant technologies both domestically and abroad. Such knowledge will only be possessed by researchers working in the field and a limited number of firms producing highly specialised machine tools and equipment. Maintenance and development of measurement standards also requires expensive, highly specialised equipment which can only be amortised over a relatively long period. In the United Kingdom, the Department of Trade and Industry has developed extensive processes of consultation and detailed technical appraisal of proposed work to help decide what activities should be funded under the Measurement Standards Budget. Although the aim is to use competitive tendering wherever possible, the existence of economies of scale and scope and the need to build up expertise and facilities over a long period of time means that the UK National Physical Laboratory remains the principal performer of this work. Agreed programmes are the product of extensive discussion between all the interested parties, with the government acting as a proxy rather than an actual customer on behalf of national economic and social requirements. Similar considerations are likely to apply in the case of technologies used in complex product systems, *e.g.* medical technologies and technologies used across wide segments of the economy such as new materials.

4.5. Evaluation

Appraisal of new proposals, monitoring of current activities and *ex post* evaluation of the various government policies and programmes to support science, technology and innovation play an essential role in ensuring that such policies and programmes make the best possible contribution to New Zealand's economic growth, prosperity and social well-being. The government sees evaluation as an integral and essential part of the policy development process. Changes made in 2004 to New Zealand law pertaining to accountability in public expenditure require reporting of outcomes by government agencies; evaluation is seen as a key source of high-quality information on outcomes. In the case of policies and programmes that provide support for science, technology, innovation and economic development, evaluation is expected to provide an evidence base on policy impacts and effectiveness. The Minister of Economic Development (MED) has appointed an associate minister with specific responsibility for evaluation in his area of responsibility.

The organisations responsible for the principal innovation policies and programmes – MED, MoRST, FRST, the Royal Society of New Zealand (RSNZ) and the Health Research Council (HRC) – undertake evaluations on a four-to-five-year cycle. The scope and methodologies used are largely determined by evaluation units within the relevant agencies, although a consultation process ensures that they will be relevant to policy priorities and analysis. Most of the major programmes seem to have been evaluated at some stage, in some cases by experts from abroad. Other evaluations have been undertaken by New Zealand consultants, by in-house evaluation units or some combination of the two. Serious efforts appear to have been made to ensure that the evaluations are independent and carried out in line with international best practice. Evaluation work has been underpinned by the collection of relevant national statistics and the assembling of appropriate indicators.

Evaluations have sought to measure effectiveness and efficiency, but the necessary information is sometimes lacking. The effects of support for research and technology development may take years, or even decades, to appear, and the processes involved are usually complex. This can make attribution of outcomes very difficult. There is frequently a trade-off between the timeliness of an evaluation and waiting to achieve the ultimate objectives of the programme. None of these problems is unique to New Zealand.

Box 4.2. Evaluations of programmes: selected examples

The ***New Economy Research Fund (NERF)*** was evaluated by Abt Associates Inc. in 2005. The evaluation found that the supported projects had the people and network contacts to carry out research to international standards. The main focus was on biotechnology, in which New Zealand is strong at the basic end of the research spectrum, although most projects involved some technology development. Several new companies that have emerged in the past five years can be, in part, attributed to NERF. In 2004-05 about 60% of funding went to CRIs, 30% to universities, and 10% to commercial organisations, many of which are start-ups that have come directly out of CRIs or universities (this has led to suggestions that these organisations are using public funds to compete with commercial firms). A more detailed discussion of NERF is contained in Chapter 3.

Research for Industry (RfI) was evaluated in 2003. Strategic public good research, carried out mainly by the CRIs on behalf of industry, has increasingly aimed at producing research outputs that will lead to successful commercial products and services. There was some suggestion that such funding supported short-term investments for quick specific gains rather than longer-term research for the good of industry as a whole. RfI-funded research was found to deliver surprisingly direct benefits, through discovery, development and commercialisation although it was a lengthy process. A faster form of technology transfer was CRI provision of consulting services to firms – revenue from consulting was growing. More recently NZD 25 million of RfI funding has gone into ten research consortia (see Chapter 3).

Technology NZ helps firms invest in R&D and thereby expand their business. An evaluation was completed in March 2001. The largest component is Technology for Business Growth (TBG) which accounts for about 70% of the NZD 60 million spent in 2004-05. TBG co-funds projects that enable firms to move towards high value-added high-margin technology-based products, usually with the help of a technologically sophisticated partner such as a CRI. Grants for Private Sector R&D (GPSRD) provides R&D grants to SMEs to take their R&D capacity beyond current capacity. The evaluation found that TechNZ has built business-enhancing relationships between firms and research providers by exposing the staff of the latter to the realities of commercialisation. However there is considerable scope to expand the number of such relations. TechNZ has a relatively low rate of penetration into its potential market and tends to rely on a relatively small number of technologically advanced companies. The number of GPSRD grants has declined in recent years, perhaps because of the strict eligibility criteria. The TechNZ application procedure is regarded as onerous but focuses firms on the need to plan projects rigorously.

The ***Marsden Fund*** provides support for research project chosen for their scientific excellence and promote a broadening and deepening of the New Zealand research skills base. It was evaluated in 2004. The evaluation identified some tension between these two objectives. However Marsden funds research which enhances the reputation and capabilities of the research teams involved, which would not otherwise have been undertaken in New Zealand and which appears to establish new research directions that subsequently attract other funding. It also fosters new research collaborations. In spite of success rate of 10%, low by international standards, it has had a significant impact on the morale of New Zealand scientists although a negligible influence on scientists' decisions to remain in or return to New Zealand.

Evaluation results are aggregated and synthesised into summary reports for wider consumption by government ministers and other stakeholders. Individual evaluations are reported to ministers and their conclusions are reflected to varying degrees in the policy advice and analysis provided to ministers. The incorporation of relevant and clear-cut evaluation evidence in policy recommendations to ministers faces similar problems to those encountered in other OECD countries. Box 4.2 provides examples of recent evaluations of major programmes.

The results of this extensive evaluation activity do not necessarily reach or influence as they should all concerned policy makers and stakeholders. The evaluation programme appears somewhat *ad hoc*; it tends to focus on routine reporting of outcomes and demonstrating that money has been spent in line with the intended purposes and agreed plans. There is insufficient emphasis on improving policy design and implementation.[72] Commissioning of evaluations needs to be more firmly embedded in an overall innovation policy strategy. While this is true, at least to some extent, of many other OECD countries, New Zealand would benefit from a more systematic integration of evaluation into the innovation policy process.[73] It is not possible in this report to set out in great detail how this should be done, but a suitable approach is briefly set out in Box 4.3 on the following page.

In making this suggestion, the review team acknowledges the proposal of the Minister for Research, Science and Technology (6 May 2006) that all RS&T programmes be subject to a technical review. Technical reviews will place greater emphasis on a programme's track record and on the actual delivery of outcomes over its lifetime. The information gathered during the technical review will be used "to adjust milestones to better target resources within programmes, inform possible collaborations, and provide an evidence base to aid future investment decisions". Technical reviews will be led by funding and investment agents, consulting collaborators and end users when relevant. Although the details of this proposal have not yet been worked out it would seem to point in the right direction.

72. Policy and programme monitoring and evaluation serves a number of purposes: (a) it enables more effective management and implementation; (b) it improves policy and programme design in order to make it more appropriate and effective; (c) it improves the allocation of budgets in order to increase the resulting likely benefits; (d) it demonstrates to the various stakeholders that the funds were spent in line with the intended purposes and that the outcomes are likely to justify the resources expended, and, (e) it provides as a by-product information about how the economy and society work.

73. New Zealand already has an "Intervention Logic" framework. What is being suggested here is in effect modifications/additions to the way in which this framework is applied in the science, technology and innovation policy area. See for example: *http://io.ssc.govt.nz/pathfinder/documents/pathfinder-BB3-intervention_logic.pdf.*

Box 4.3. Components of a systemic evaluation

1. *Ex ante* evaluation or appraisal. This should result in a business plan or statement which describes what the scheme or programme is designed to do, how it is going to do it and the objectives against which success or failure will be judged. It should described why the government/public funding needs to involved and why market forces and the unaided efforts of firms would not achieve the desired results (rationale). It should assess the expected net national benefits of going ahead. The objectives will normally be of three kinds: high-level objectives (*e.g.* raise national productivity or growth); meso-level objectives (*e.g.* increase R&D in assisted firms); and operational objectives (*e.g.* fund collaborative R&D projects). The statement should be agreed between the programme managers, the government budget holder and other relevant stakeholders and set the framework for concurrent monitoring and subsequent *ex post* evaluation. However it is generally not possible to draw up a detailed *ex post* evaluation plan at this stage. The statement should draw on the results of *ex post* evaluations of past similar schemes.

2. Concurrent or "in-flight" monitoring. Once the programme is under way progress should be monitored against the operational objectives and any other relevant indicators. It is important to ensure at this stage that information needed for subsequent *ex post* evaluation is collected at the appropriate time.

3. *Ex post* evaluation. This often has to begin before the programme ends in order to inform decisions about possible follow-on funding. At this stage only an impact evaluation focused on meso-level objectives is possible. An early *ex post* evaluation is often necessary for worthwhile soliciting of participants' views – a few years on they may have moved elsewhere. Later, it may be possible to track progress towards the high-level objectives although the ultimate effects may have to be inferred from analysis of the workings of the innovation system.

These three elements should be seen as an integrated whole, a core part of the process of policy design and implementation. In principle all programmes, policies and public-sector institutes should be evaluated. However when there is a multiplicity of small programmes and schemes this is neither feasible nor cost-effective. There is considerable literature and much international experience about how evaluation of S&T and innovation policies should be conducted.

4.6. Commercial infrastructure

The size of New Zealand not only limits many firms' domestic market but also inhibits the development of commercial infrastructure and the associated external economies of scale. An important problem is the provision of finance to small new knowledge-based firms. Venture capital is still at an early stage of development, as is provision of seed capital by private individuals (business angels). The New Zealand stock market is relatively small and lacks breadth and depth. As a result it is not always well placed to provide the exit route which is a vital part of the venture capital business model. The country's clearing banks tend to be foreign-owned (*i.e.* Australian) and to confine their activities to short-term and secured lending, neither of which may be appropriate for rapidly growing small high-technology businesses whose assets are mainly intangible and whose prospects lie in the future. Credit scoring of New Zealand companies seems to take place in Australia, which suggests that banks do not base lending decisions very much on local knowledge of the business concerned.

The innovation survey carried out by Statistics New Zealand in 2003 found that over 95% of leading and "new to market" innovators sourced funds from within the business.[74] "Active adopters" sourced finance from banks, family and friends, while leaders in the "new to market" category accessed shareholders funds and government assistance. While the reluctance of entrepreneurs to give up equity will have no doubt contributed to this picture, it also reflects the relatively under-developed state of domestic capital markets. External funding of more radical innovation by SMEs tends to be a problem in most OECD countries, and, given the relative undeveloped nature of New Zealand's capital markets, there is no reason to believe that the situation is any different. This problem tends not to be picked up by statistical surveys, as SMEs will not even attempt to undertake innovation if they know that external finance is not available.

Another key element of the commercial infrastructure is the availability of external sources of business advice, particularly for small firms, of which New Zealand has a great many. Such advice may be available from a variety of sources *e.g.* banks, accountants, lawyers, consultants and government agencies. There seems to be no shortage of potential sources of routine business advice in New Zealand but small firms do not always use them

74. In advanced industrial countries as a whole innovation is largely funded from internal resources. However this overall picture is dominated by the activities of large firms of which New Zealand has relatively few. Small firms, particularly new fast-growing technology-based firms, are generally much more reliant on external funding of innovation.

effectively or to the full extent. This is a problem shared by other OECD member countries; SMEs tend to be shy of paying for external advice because they find it difficult to assess its value in advance (a standard information market failure) and often do not trust those who offer to provide it. Solving this problem is an objective of SME policy in a number of OECD countries but one that is not very effectively addressed in New Zealand.

Established sectors can enjoy significant external economies of scale. Suppliers of a wide range of goods and services, many specific to a sector, arise to meet their needs. Financial institutions develop appropriate lending expertise and procedures, premises are designed and built to meet their needs and networks develop along which useful information flows and which may facilitate access to educational, training and research institutions. New sectors and firms enjoy none of these advantages and it may sometimes be appropriate for government to help fill the gap. For example, incubators help entrepreneurs develop new commercial enterprises by providing appropriate accommodation and access to a range of basic business services. The government can help firms overcome the disadvantages of small size by promoting co-operation, by providing public meeting spaces, by helping to establish working links to knowledge institutions and by trade promotion. It is generally held that governments cannot create clusters but they can try to foster those that begin to emerge.[75] NZTE has been managing small-scale programmes to support cluster development and incubators.[76] New Zealand should devise a clear strategy for developing support environments and infrastructures for innovation. This can be particularly important in a country with relatively few large enterprises. Large firms provide entrepreneurs opportunities to create high-technology and knowledge-intensive firms that meet their particular needs. Large customers may in turn help these emerging small firms by acting as a source of trained and experienced managers, by providing expertise and access to technological knowledge, and by acting as informed and demanding customers.

4.7. Human capital

Another area in which the small size of the New Zealand economy may create difficulties is the supply of experienced managers capable of helping high-technology/high-value-added businesses to grow beyond the early stages of creation and growth under the founding entrepreneur. This is a problem in all OECD countries but may be exacerbated in New Zealand because the

75. Experience in Silicon Valley and Cambridge, England, indicates that mature clusters take several decades to emerge.

76. The NZTE's Cluster Development Programme was dismantled on 1 July 2006.

relative lack of larger companies in high- and medium-technology sectors means that managers lack domestic opportunities to learn the skills of managing change in growing, innovative businesses. New Zealanders wishing to pursue a career in the higher levels of management tend to go abroad. Against this, because New Zealand is an attractive place to live, expatriates are encouraged to return with the knowledge and skills they have acquired abroad and, if the level of salaries on offer is attractive, foreign managers may also be persuaded to move there.

The problem of the supply of highly qualified manpower and the associated issue of "brain drain" is discussed in Chapter 3. This is an OECD-wide problem: the international mobility of qualified scientists and engineers, other graduates and experienced managers is an important emerging feature of globalisation. The New Zealand Institute also rightly views it as an opportunity. The "New Zealand diaspora" might be called upon for knowledge of and contacts in foreign markets and immigrants to New Zealand might provide the same information about business in their countries of origin and be a source of foreign language skills as well.

4.8. Barriers to business growth

The challenges facing a growing innovative business cannot be over-estimated (see Barber *et al.*, 1989). As it grows, the number of its employees rise and informal management based on frequent direct personal contact needs to be replaced by formal management structures. At the same time, the number of separate business functions increases, requiring specialised managers for marketing, manufacturing, product development, purchasing, etc. In many cases the founder of the business is neither willing nor able to deal with the widening circle of control and function. Outsourcing these elements of the supply chain is likely to be more difficult in New Zealand than in larger economies. Some businesses, *e.g.* in the retail and restaurant sectors, are more easily scalable but even these do not completely escape the problems of growth.

Business expansion and innovation must be financed either from retained profits or from external borrowing or issue of share capital. The level and growth of profits depends on the level and growth of sales. For most innovative business in New Zealand, this means early entry into export markets. This creates additional challenges, including building a reputation in foreign markets, learning to cope with different business customs and laws, and being a reliable supplier from a long way away. One indicator of the difficulties involved, according to the New Zealand Institute, is that the returns to FDI by New Zealand firms are lower than on their investments at home. This might not be a problem for a large multinational able to exploit economies of scale but for a small or medium-sized company it can constitute a powerful disincentive to overseas expansion. Given the relatively underdeveloped state of New Zealand capital markets alluded to above, obtaining external funding will also be more difficult than in a number of other OECD countries. Under these circumstances, finding a foreign partner or even selling to a foreign firm may well become the preferred or even the only option.

New Zealand's geographical situation does have some advantages. New Zealanders are self-sufficient and resourceful and there seems to be no shortage of entrepreneurs able and willing to set up new businesses. In addition, as seen in Chapter 2, the New Zealand research base is strong, world-class in some areas, and able to generate the new science and early-stage technology that can form the basis of new high-technology/high-value-added business potentially capable of competing in world markets. Both CRIs and universities (*e.g.* through UniService at the University of Auckland) have succeeded in transferring the results of their research to the commercial sector, often by encouraging the establishment of new businesses. The key challenge for innovation policy is to create the conditions under which the potential of high-technology/high-value-added new businesses, whatever their origin, for productivity and economic growth can best be realised.

Too many small businesses grow too slowly, strapping themselves by relying on internal finance and their own resources more generally. To some extent this strategy reflects the founder's desire to retain control and avoid limitations on his/her lifestyle objectives. It is said too that some are reluctant to expand their businesses beyond the point at which they can afford the "three Bs": a BMW, a Batch (a house on the beach) and a Boat. However, it must also reflect the external barriers to growth described above. There are examples of companies using this strategy to reach the stage at which they can leverage external resources to develop internationally sustainable businesses capable of rapid growth to large size. However in fast-moving areas of science and technology, small businesses need to grow rapidly if they are to realise the full potential of the S&T breakthroughs they were formed to exploit.[77] Some New Zealand high-

77. Small firms play an important role in innovation. They are a major source of new ideas and are flexible and capable of rapid response. They play a particularly important role in the early stages of development of new technologies and sectors and an important on-going role in niche markets. In contrast, large firms, while slower to respond, have the range of business capabilities and the market reach required to exploit new products and services on a large scale. They tend to dominate the later stages of development of sectors and technologies and are responsible for a high proportion of process innovations. In the long run it is the larger firms that tend to be responsible for the bulk of economic benefits from new products, processes and services.

technology start-ups have achieved such rapid growth with the aid of foreign partners and capital but this carries the risk that such businesses may migrate abroad on terms that leave too little of the value added in New Zealand.

Enabling more small high-technology/high-value-added companies to grow quickly and reach a larger size within New Zealand will increase the rate of productivity growth. It will also create the conditions under which entrepreneurs can put their companies under the control of professional managers and outside investors at an earlier stage, thus freeing their time and capital to do what they do best, *i.e.* starting up and developing new businesses. Successful entrepreneurs who have made their fortune can play an important role as business angels or venture capitalists. Not only have they the funds to invest but they also have invaluable experience and knowledge to pass on to those running the companies they back. Both serial entrepreneurs and successful entrepreneurs turned hands-on investors are a feature of more mature high-technology clusters such as Silicon Valley and Cambridge, England. There are indications that such people are beginning to emerge in New Zealand.

Experience of clusters abroad shows that an increasing mass of small, rapidly growing, high-technology companies stimulates the growth and development of specialised business services to meet their needs. These include specialised legal and accountancy services, management consultants with specialised knowledge, IPR-related professional services and venture capital. Networking develops between entrepreneurs, investors, scientists, business professionals, etc. Markets in highly qualified manpower develop as well. Similar symbiotic developments can be expected in New Zealand when conditions are right.

Given the characteristics of New Zealand's economy and the nature of its innovation system, it is to be expected that a relatively high share of high-technology/high-value-added small businesses will only grow beyond a certain point before they sell out or enter into a partnership with foreign interests and/or invest abroad. A key objective of innovation policy, and economic policy more generally, should be ensure that, for as many companies as possible, this stage should only be reached when the possibilities for growth and innovation begin to diminish. Government cannot make small companies grow – that is the business of the owners/managers and employees – but it can do something to lower the obstacles that inhibit firms' own efforts. Such obstacles affect not only small firms operating in emerging industries but also those small innovative firms whose main markets correspond to New Zealand's current comparative advantage, and they should be eligible for similar help. Some of the main policy issues that need to be addressed are:

- The relatively underdeveloped state of domestic capital markets would suggest that small high-technology SMEs in New Zealand are more likely to be inhibited by capital market failure than their counterparts in many other OECD countries. This points towards a coherent, dependable and effective system of support for R&D and analogous innovation expenditures. The present system of R&D grants struck the review team as too fragmented, with too many small schemes with limited budgets and too short a duration. An R&D tax credit could well play a useful part, while grant support could focus on the most deserving cases.

- The Venture Investment Fund (VIF) programme seems well designed but will need careful monitoring. The creation of a sustainable venture capital market will take time and may well encounter problems. The impact of the tax system on venture capital should be carefully watched.

- Innovation is not just about new science and technology; changes in markets business practices, activities and organisation play a vital role. All small companies, not only fast-growing high-technology SMEs, need help with the adoption of new business practices, etc. As stated above, there appears to be no shortage of commercial sources of business advice in New Zealand but, as in other OECD countries, many small firms are reluctant to use them. This issue needs to be addressed. Government support for the provision of business advice seems to have arisen in an ad hoc fashion and needs rationalising.

- Skilled and highly qualified manpower play a crucial role in innovation and business competitiveness.

- The high cost of acquiring and defending intellectual property rights (IPR) is a problem for high-technology SMEs in all advanced industrial countries. Securing and managing IPR is also an issue for universities and research institutes, and good quality IPR is essential for raising venture capital. The small size of the New Zealand economy means that licensing plays a very important role in enabling the country to profit from the quality of its academic research and the innovativeness of its entrepreneurs. It is important for firms, universities and CRIs to have access to good quality help and advice on the management and exploitation of the intellectual property they create.

- Innovative firms in all sectors need access to sources of appropriate science, technology and engineering and good technical advice. New Zealand's technological infrastructure is discussed in more detail above.

These and other problems facing rapidly growing small innovative companies need to be tackled in a co-ordinated fashion.

4.9. Services

Like all OECD countries, New Zealand has a large and growing services sector. In New Zealand's case, development of tourism is a particular attractive option. Innovation in the services sector is not intrinsically different from innovation in manufacturing in that both involve some combination of changes in technology, design, marketing, organisation, knowledge and skills. However, in the case of services there is much less emphasis on the development and acquisition of new technology and much more on the so-called "softer" aspects of innovation. Also, the language in which innovation is described may be somewhat different in the case of services. Innovation may be just as difficult and risky in services as in manufacturing and offer a similar prospect of high but uncertain returns. Most but not all services are low-technology in the sense that they rely on technology acquired from other parts of the economy. However, some absorb and exploit that technology in extremely sophisticated ways (*e.g.* collection and delivery of small packages). In addition, many "knowledge-intensive services" (*e.g.* information technology companies, design houses, many aspects of health provision) are technologically highly sophisticated and on a par with R&D-intensive goods. The boundary between some business services and manufacturing is changing and many manufacturing businesses now include a significant service element in what they deliver to customers. For example aero-engine companies now sell hours of operational flying time in addition to the engine. Moreover, some services (*e.g.* design or software development formerly supplied by manufacturing companies themselves) are now outsourced. Thus innovation by a manufacturing company may often require complementary innovation by its service suppliers.

Innovation in services is widespread and very important for national productivity and growth. It is therefore vital to take the needs of the services sector fully taken into account when innovation policy is designed and implemented. This means an approach to innovation policy that takes a broad view of the innovation process and does not focus narrowly on the creation and exploitation of new technology. Encouraging the diffusion of technology and of promising business practices must be seen as equally important, as should the spread of appropriate non-technological knowledge and skills. It is only recently that policy makers in OECD countries have begun to see innovation in services in this way, and the process of broadening the innovation policy agenda has only just begun. New Zealand needs to play an active role in this exploratory process so that its innovation policy can draw on what other member countries have learned in order to address the specific needs of its service businesses.[78]

4.10. Promotion of high-value-added knowledge-based businesses

Finally, beyond the traditional segmentation used in policy analysis (manufacturing *versus* services, high technology *versus* low technology, small *versus* large firms, etc.), a cross-cutting objective of New Zealand innovation policy should be to promote high-value-added knowledge-based businesses (Box 4.4).

Box 4.4. The high-value added knowledge-based businesses – engines of growth

Increased productivity and hence economic growth depend crucially on a country's ability to transfer resources from businesses with low value added to those with high value added. It is these that command high prices for their products and services relative to the total costs of production. They are thus able to pay their employees higher salaries and/or earn higher profits for shareholders. Both serve to raise the per capita contribution of the business's workforce to GDP and net domestic product. Growth in the scale of the activities of such businesses helps national output to grow. To the extent that such businesses can repeat their success in overseas markets, national output will grow faster still. It is therefore in a country's interest to create the conditions under which high-value-added businesses are able to prosper, export and grow and absorb resources from less productive parts of the economy.

High value added businesses tend to exhibit one or more of the following characteristics:

- They have a unique long-term source of competitive advantage which is difficult for prospective competitors to replicate or overcome. This advantage may be created through persistent innovation and greater efficiency, may reflect a natural monopoly or may be the result of anti-competitive practices. Generally speaking, the second and third generate high value added at the expense of other sectors of the economy and do not add to national economic welfare.
- They are successful serial innovators able to generate temporary spells of competitive advantage which are constantly refreshed by the continuous introduction of new products and/or services.
- They operate in rapidly growing markets in which demand tends to outpace supply and the rates of innovation, technological change, learning by doing and creation of economies of scale and scope are all rapid.

…/…

78. This section draws on studies commissioned by the UK Department of Trade and Industry in connection with a forthcoming economics working paper on innovation in services. See also the chapter on "Fostering Innovation in Services" in OECD (2005d).

Box 4.4. The high-value added knowledge-based businesses – engines of growth *(continued)*

High profits and rapid growth of sales together finance the investments to expand, innovate (including entry into new markets) and create and maintain competitive advantage. Enhanced competitiveness in turn enables the firm to gain market share and to increase sales. Competition in the market place, mostly driven by technical progress, serves to erode the value added earned by companies unless they continually raise their game in response. Even if they appear to have a permanent, unique competitive advantage, market forces may eventually find a way to nullify or reduce its value.

In the 21st century the main source of competitive advantage is the business activities that a firm knows how to do well. Factories and equipment can always be bought, employees hired and technology licensed in, but unless the firm and its management know how to combine and exploit these resources effectively, a viable and competitive business will not be created. The knowledge which the firm possesses, its "knowledge base", thus plays a key role in the firm's survival, innovativeness, profitability and growth. Firms possess a number of different types of knowledge: scientific and technological knowledge, knowledge of their markets and customer base, knowledge of sources of supply of materials and components, employees' knowledge and skills, etc. Firms need to know how to organise various activities such as procurement, production, marketing, after-sales service, innovation, etc., and how to combine these to secure the profitable delivery of competitive products to the market. The firm also needs to know how to recruit and develop skilled employees and managers, to motivate them to work effectively and to encourage them to co-operate in the best interests of the firm as a whole.

Some of this knowledge can be purchased in the market place or by investing in activities such as R&D.[79] This knowledge is often codified, so that it can be written down and easily absorbed by someone with the necessary complementary knowledge and expertise. If not protected by some form of intellectual property rights or by secrecy it can be readily acquired by competitors. In contrast, other types of knowledge are only acquired through experience of the business concerned, through "learning by doing". Such knowledge is often "tacit", not easily written down or communicated except by direct human experience, and is not easily acquired by competitors who must create such knowledge for themselves. Much organisational knowledge is of this kind. Tacit knowledge is a major source of competitive advantage for firms. If the exploitation of easily transferable knowledge requires complementary knowledge (or other assets) which is (are) difficult for competitors to acquire then it is effectively protected as well. Innovation involves the creation of new knowledge and/or new combinations of knowledge which can then be exploited profitably.

…/…

79. A research programme on the Evolution of Business Knowledge (EBK) has just been completed under the aegis of the UK Economic and Social Research Council (ESRC). See *www.ebkresearch.org/home.html.*

Box 4.4. The high-value added knowledge-based businesses – engines of growth *(continued)*

The importance of knowledge in firms' competitiveness and economic activity is not new. However the changes involved in the transition to a "knowledge based economy" are greatly increasing the importance of knowledge in economic activity and the competitiveness of firms. They are also changing the kinds of knowledge which firms need to possess, the way that knowledge is acquired and managed, the way firms are organised and the kinds of knowledge and skills required of employees. The increasing importance of knowledge is shown by the fact that in many sectors investment in intangible assets is now much greater than those in fixed capital equipment.

The number of technologies used in the production of a given product or service is increasing and firms need expertise in a broader range of technologies than before. Combined with the accelerating pace of scientific and technological change, this means that firms increasingly resort to R&D collaboration and outsourcing to acquire the technologies they need. Development of leading-edge science and technology is now undertaken in many more locations and, with the increasing globalisation of markets, this means that firms must be prepared to seek technology relevant to their business wherever in the world it is to be found.

Three decades ago, advanced industrial economies were dominated by sectors that invested large amounts in plant and machinery. By contrast, the rapidly growing sectors of the last two decades, such as electronics, pharmaceuticals and telecommunications, invest mainly in R&D, software and information technology, advertising and training. Some emerging sectors, such as those associated with the Internet, hardly invest in fixed assets at all. Managers and workers now need to be much better educated and much more highly trained. The increasing speed of technological and organisational change means that employees need to be much more flexible and require much more training and upgrading of their knowledge and skills during their lifetime. There will need to be a mutual commitment between firms and their employees so that firms have an incentive to invest in training while employees have an incentive to acquire knowledge and skills specific to the firm in which they work.

New Zealand's main opportunities for creating and fostering high-value-added knowledge-based businesses are in the following areas:

- Using New Zealand's expertise in areas of science and technology relevant to agriculture, fishing and other primary sectors to develop high-value products in those sectors, improve the efficiency and effectiveness of the processes used in those sectors, and to develop novel equipment, services, software and other inputs provided by the domestic supply chain.

- Fostering the creation, growth and development of businesses based on the strengths of the New Zealand research base and on existing technological, design and organisational strengths of New Zealand businesses. Anything New Zealanders know how to do really well (*i.e.* they possess unique competence) can form the basis of a value-added business, providing that steps are taken to maintain and develop the initial sources of competitive advantage.
- Exploiting New Zealand's other advantages, such as its scenery and geography, to create value-added products and services and take advantage of one-off opportunities for establishing competitive advantage, such as the winning of the Americas Cup.

The businesses created in this way can be said to be knowledge-based in the sense that the competitive advantage that enables them to generate high value added mainly depends on the possession of unique knowledge or combinations of different kinds of knowledge which it is hard for competitors to replicate, at least within a commercially relevant time scale. They might also be said to be more knowledge-intensive in terms of the number of "bits" of knowledge the business possesses. However this is beside the main point. It is the sum of the derived market value of the different kinds of knowledge that the firm has its disposal that is reflected in its value added. Given the importance of combining knowledge, the total value of the knowledge stock of a successful firm is likely to be significantly greater than the sum of the parts.

These suggestions are not a prescription for the future structure of the New Zealand economy – opportunities for innovation leading to the creation of value-added businesses and activities can be found in all parts of the economy[80] – but a strategy for promoting innovation and the development of high-value-added businesses. They need to be supplemented by programmes/policies designed to raise productivity throughout the rest of the New Zealand economy. They do not represent a departure from current policies and programmes that cover, in one way or another, the same territory; rather they are suggestions about how such policies might be conducted within a more systematic framework based on promoting innovation in the context of today's "knowledge economy".

An essential component of this approach is to enable high-value-added businesses to enter foreign markets and address the needs of demanding foreign customers. Without success in this area the development of successful businesses will be impeded and their potential contribution to the economy will not be fully realised. Many will operate in specialised niches,

80. See for example von Tunzlemann and Acha (2005).

where the achievement of a market of viable size requires exporting from an early stage in the company's development. They may need help to develop partnerships with foreign-based companies to the advantage both of the firm and of the economy as a whole. Also, carefully targeted encouragement of inward investment can provide a means to persuade foreign companies to establish high-value-added businesses in New Zealand and provide significant benefits to the domestic economy.

Current efforts to upgrade education and training clearly have a very important role to play. The knowledge and skills of the New Zealand population represent its most important asset. Access to excellent electronic communications is also vital since they facilitate the digital delivery of knowledge and skills to remote locations and enable firms based in New Zealand and individuals to co-operate much more effectively with overseas partners. New Zealand has much to gain from the "death of distance". and many of the opportunities for creating new high value-added activities will involve the Internet in one way or another. A range of other innovation-relevant policies discussed in this report also have an important role to play, including those that support scientific research, promote the use of IPR and improve access to risk capital.

Annex A

Table A.1. New Zealand government innovation-related funding schemes* (NZD millions), 2004/2005 financial year

Agency	Scheme	CRIs	Unis	Firms	Industry orgs	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
MED	Film New Zealand				0.7				0.7
MED	Large Budget Screen Production Grant			40.0					40.0
MED	Regional Initiatives Fund (RIF)	0.0				0.8		1.1	1.9
MED	Sector Initiatives Fund (SIF)	0.1		0.1	3.6			0.6	4.3
MED SUMMARY		**0.1**	**0.0**	**40.1**	**4.2**	**0.8**	**0.0**	**1.7**	**46.9**
NZTE	Australia-NZ Biotechnology Partnership Fund	0.6		1.9					2.5
NZTE	Cluster Development Awards			0.0	0.4	0.2		0.2	0.8
NZTE	Enterprise Culture, Skills and Activity Fund		0.1	0.2		0.7		0.8	1.7
NZTE	Enterprise Development Fund (EDF)			4.1	0.1				4.1
NZTE	Enterprise Network Grants	0.0	0.0	2.8	0.3	0.0	0.0	0.2	3.3
NZTE	GIF Industry Bodies Fund				1.6				1.6
NZTE	Market Development Assistance Scheme (MDAS)			6.7					6.7
NZTE	GIF Sector Projects Fund				1.0				1.0
NZTE	Growth Services Fund (GSF)			10.5					10.5
NZTE	Incubator Awards	0.3	0.3			0.8		1.8	3.1
NZTE	Regional Partnerships and Facilitation - Polytechnics						0.8		0.8
NZTE	Regional Partnerships and Facilitation					9.9			9.9
NZTE	Regional Partnerships and Facilitation - Inter Regional					0.4			0.4

Agency	Scheme	CRIs	Unis	Firms	Industry orgs	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
NZTE	Sector Strategies and Facilitation Fund - Strategic Investment Fund			1.9					1.9
NZTE SUMMARY		**0.9**	**0.4**	**28.0**	**3.4**	**12.0**	**0.8**	**2.9**	**48.3**
MoRST	New Zealand Venture Investment Fund (capital)			18.8					18.8
MoRST	Equity Investment Fund (capital)	5.0							5.0
MoRST	National Measurements Standards	4.9							4.9
MoRST	Australian Synchroton							1.2	1.2
MoRST SUMMARY		**9.9**	**0.0**	**18.8**	**0.0**	**0.0**	**0.0**	**1.2**	**29.9**
FRST	New Economy Research Fund (NERF)	42.7	22.4	8.0				0.3	73.3
FRST	Research for Industry (RfI)	130.3	16.6	33.5	0.2			21.9	202.5
FRST	Maori Knowledge and Development Research	0.8	1.1	0.1				1.2	3.2
FRST	Social Research		5.2	0.2				1.3	6.7
FRST	Environmental Research	77.8	5.5	8.3				1.4	92.9
FRST	International Investment Opportunities Fund (IIOF)	0.1	0.1						0.2
FRST	Supporting Promising Individuals: Post-doctoral fellowships							5.8	5.8
FRST	Supporting Promising Individuals: Tuapapa Putaiao Maori Fellowships							1.0	1.0
FRST	Pre-Seed Accelerator Fund (PSAF)	2.7	1.6						4.4
FRST	Non-Specific Output Funding (NSOF)	32.4							32.4
FRST	Technology NZ: Technology for Business Growth (TBG)			42.6					42.6
FRST	Technology NZ: Grants for Private Sector R&D (GPSRD)			7.6					7.6
FRST	Technology NZ: Technology for Industry Fellowships (TIF)			6.8					6.8

Agency	Scheme	CRIs	Unis	Firms	Industry orgs	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
FRST	Technology NZ: Techlink: SmartStart			0.9					0.9
FRST	Technology NZ: Techlink: TechNet			1.5					1.5
FRST	Technology NZ: Techlink: Other			0.5					0.5
FRST SUMMARY		**286.9**	**52.5**	**109.9**	**0.2**	**0.0**	**0.0**	**32.7**	**482.2**
RSNZ	Marsden Fund	5.8	29.1	1.2				0.6	36.7
RSNZ	James Cook Fellowships		0.7					0.1	0.7
RSNZ	Teacher Fellows							3.5	3.5
RSNZ	Science and Technology Promotion Fund								0.3
RSNZ	International Science and Technology Linkages Fund								0.4
RSNZ	Talented Young New Zealanders								0.1
RSNZ SUMMARY		**5.8**	**29.7**	**1.2**	**0.0**	**0.0**	**0.0**	**4.2**	**41.7**
HRC	Hercus (advanced post doc)		0.5					0.2	0.6
HRC	Maori Masters		0.1						0.1
HRC	Maori Post Docs		0.3						0.3
HRC	Maori Post Grad		0.2					0.0	0.3
HRC	Maori Ranaha Hauora (masters)		0.0						0.0
HRC	Maori Summer studentships		0.0					0.0	0.0
HRC	Pacific Masters		0.0						0.0
HRC	Pacific Post Docs		0.1						0.1
HRC	Pacific Post Grad		0.3						0.3
HRC	Pacific Summer studentships		0.0					0.0	0.0

Agency	Scheme	CRIs	Unis	Firms	Industry orgs	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
HRC	Girdlers (public health post-doc award)		0.1						0.1
HRC	General Summer Studentships		0.1					0.0	0.1
HRC	Maori Knowledge and Development Research: HRC/FRST Joint Research Portfolio		0.4					0.3	0.7
HRC	Maori Knowledge and Development Research: Health Research Projects	0.1	2.0					0.2	2.4
HRC	Maori Knowledge and Development Research: Strategic Development		0.4						0.4
HRC	Maori Knowledge and Development Research: Seeding Projects		0.0					0.0	0.0
HRC	Maori Knowledge and Development Research: Programmes		0.6						0.6
HRC	Indigenous International Research		0.1					0.0	0.1
HRC	Partnerships							2.1	2.1
HRC	Pacific Seeding projects		0.0						0.0
HRC	Projects		23.5					1.4	24.9
HRC	Programmes		18.0					0.6	18.6
HRC	Strategic Development		0.5					0.1	0.6
HRC	International Investment Opportunities Fund		0.0						0.0
HRC SUMMARY		**0.1**	**47.3**	**0.0**	**0.0**	**0.0**	**0.0**	**5.0**	**52.5**
TEC	Performance Based Research Fund (PBRF) - contestable fund only		30.5				0.3	0.1	30.9
TEC	Partnerships for Excellence (capital)		1.1						1.1
TEC	Institutes of Technology and Polytechnics Business Links Fund						2.3		2.3
TEC	Innovation and Development Fund (IDF)		0.4		0.8		1.7	0.1	3.0

Agency	Scheme	CRIs	Unis	Firms	Industry orgs	Local authorities and regional EDAs	Institutes of technology and polytechnics	Other	Total
TEC	Growth and Innovation Pilot Initiatives		1.7		0.4		0.1		2.2
TEC	Centres of Research Excellence (CoREs)		23.7						23.7
TEC	Top Achiever Doctoral Scholarships							9.1	9.1
TEC	Enterprise Scholarships							1.5	1.5
TEC SUMMARY		**0.0**	**57.4**	**0.0**	**1.2**	**0.0**	**4.4**	**10.8**	**73.8**
MAF	Sustainable Farming Fund	0.0	0.0	0.1	2.9	0.0	0.0	6.6	9.7
SUMMARY OF SCHEMES		**303.7**	**187.3**	**198.1**	**11.9**	**12.8**	**5.2**	**65.2**	**784.9**

* Does not include EFTS research top-ups.

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