OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

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Improving translation of publicly funded research for economic benefit

Summary of the workshop on 14 September 2009

Summary

- Across a range of measures, New Zealand's innovation performance lags behind that of OECD countries of similar size.
- The OECD has recently commented on the low uptake of publicly funded research by the private sector in New Zealand. The reasons for this are multiple, but may fundamentally reflect our low national recognition of the role of R&D and our relative lack of knowledge-intensive industry.
- This workshop focused on increasing the contribution of public-sector research to national economic performance while identifying some other barriers to private sector uptake of R&D
- Government can increase research uptake into the private sector by altering the settings of the public science funding system, by establishing programmes to assist technology transfer, and by incentivising business to increase expenditure on R&D.
- Staff in public research institutes should be incentivised to engage with the commercialisation of their work. In universities, this may require adjustment of the PBRF process to remove perceived career disincentives for academics who engage with the private sector. In CRIs, measures by which staff can benefit from the exploitation of their inventions should be put in place. Schemes to encourage interchange of staff between the public and private sectors, for example funding to 'buy out' time from teaching, would be of great value.
- Technology transfer is a diffuse and underdeveloped skill in New Zealand. Consideration should be given to developing a 'hub and spoke' model of technology transfer expertise centred on national centres of technology transfer excellence.
- Few of New Zealand's many SMEs access the infrastructure of the public research sector, and initiatives are required to facilitate such access, as cost and understanding are a real barriers.
- A balance of non-discretionary and discretionary business support of R&D is required. Business investment in R&D and use of R&D would be considerably enhanced by the development of a non-discretionary assistance package.
- There needs to be greater clarity and transparency in relation to discretionary business support programmes.

1. There is a concern as to whether the New Zealand science system is optimally translating public research for economic benefit. The Prime Minister requested me to consider whether there is any need for additional strategies to address this matter.

2. This workstream is informed by a workshop sponsored by the Office of the Chief Science Advisor in association with FRST, TEC, Business NZ, the Royal Society and the Treasury. It was held on 14 September 2009 and was attended by 50 representatives from universities, Crown Research Institutes, industry groups, technology transfer experts, research-intensive businesses and government agencies, and ministries. The attendees are listed in the Appendix to this report.

Background

3. It is essential at the outset to emphasise that the public science sector [primarily in Crown Research Institutes (CRIs) and universities] benefits New Zealand in many more ways than simply supporting private sector activity. Research is essential to improving our quality of life, to protecting our environment and to addressing many challenges we face, as well as providing the basis for a more innovative nation. The Government itself is a major user of research, and public knowledge transfer has been a dominant influence on our economic growth – for example in agriculture and the private sector. Exploitation of science involves both supporting current business and developing transformational new business.

4. Thus the role of research and development (R&D) in driving economic growth is threefold: first, as a direct generator of new and exploitable knowledge; second, as a key underpinning of 'absorptive capacity' (the ability of organisations to recognize and adopt new knowledge generated elsewhere); and third as the driver of social gains, evidence-based policy formation and protection of our environment, all of which indirectly improve our productivity.

5. New Zealand has an unusually low level of business expenditure on R&D (BERD as a proportion of GDP is about one-third of the OECD average). There are underlying structural reasons for this – the defence and pharmaceutical sectors, high investors in, and consumers of, R&D in other countries, are barely represented in New Zealand and we have a high proportion of small companies, which tend to invest proportionately less in R&D. Thus, outside of the primary sector, New Zealand does not have a strong culture of research-based commercial development.

6. As a result, a high proportion of national research effort (57% of gross expenditure compared with the OECD average of 30%) is financed by the public sector through the universities and research institutes. The public sector produces two-thirds of New Zealand's intellectual property applications. International comparisons show that New Zealand scientists rank highly in terms of publication output per research dollar spent. But even so, total public expenditure on RS&T is low. Further, the nature of the FRST funding processes

means that the New Zealand public research effort is more focused on business support than that in other countries. This may have several implications:

- First, a low volume of basic research is undertaken, which may mean that the ideas flow is insufficient to sustain a quality and vibrant innovation trajectory by the private sector.
- Second, the public funding of research being heavily end-user weighted may in some cases be creating perverse signals that lead to deficient investment in true research by New Zealand enterprise.
- Third, the low volume of public research over many decades has led to a research community focused on survival, and in turn this has created barriers against rather than connections to business.

7. Given our unusual RS&T funding profile and the international consensus that productivity and innovation depend heavily on science, New Zealand's future growth and competitiveness clearly depends on effective translation of publicly funded research. However, the OECD review of New Zealand in 2005 commented on the "low rate of collaboration and ideas flowing from universities and research institutions to business". Currently New Zealand ranks only 26th of 110 countries in the International Innovation Index and in terms of other OECD countries, including many of similar size to New Zealand, this is not compatible with a future in which New Zealand will have to face many challenges to improve its productivity and maintain its relevance to the world.

8. Underlying all of this may be the fundamental issue of New Zealand's attitude to knowledge. This is reflected in our historically low investment in both public and private RS&T over many decades and this in turn may influence our relative lack of knowledge-intensive industry. Exceptions are agriculture and the service sectors. In agriculture there has been a strong history of knowledge uptake directly from public science to the farmer and this has played a major role in the continuing improvements in productivity of that sector. There has also been evidence in areas such as horticulture and aquaculture of similarly fast adoption. The role of ICT has had major impacts on the service sector – the impact of EFTPOS on the retail sector is an obvious example. But getting beyond such examples is a major challenge that will be fundamental to transforming New Zealand to be more broadly innovation-based.

9. Previous reports[1] have taken a relatively narrow perspective on these issues and focused primarily on the perspective of business. But broader perspective and understanding of the whole value chain from initial discovery to exploitation is needed if the appropriate policy settings are to be established.

10. In practice, government's main tools to influence change through research are restricted to: (i) establishing signals through the public science funding systems, (ii) establishing programmes to assist technology transfer, and (iii) providing non-discretionary or discretionary support to assist business undertaking R&D.

[1] *Capitalising on Research* Summit 2006; Treasury 2008.

11. It needs to be emphasised that this problem is a global one – no country believes it has optimised the relationship but many do much better than we do. However, all these have larger science systems relative to GDP than does New Zealand.

12. There is also a wider concern that economic policy settings within New Zealand have failed to encourage investment in business, particularly over the longer time frames that are needed to exploit RS&T, and more specifically in innovative business that contributes to productivity growth.

Overview of factors that inhibit linkages between public sector research and private innovation

13. There are many factors to consider. Table 1 lists these.

Table 1. Factors to consider in improving the translation of research from the public to private sectors (derived from the briefing note to the September 14 meeting)

General factors

- The low volume of public sector research and the lack of clarity of mission and focus in the CRI sector
- The mix of companies in New Zealand
- The cultures of public science and the private sector are of necessity different and this needs mutual recognition
- The two sectors have differing performance measures and criteria for success and recognition and this impacts on human behaviour
- Lack of a base of entrepreneurial scientists, and conversely lack of science and technology background among senior business managers and directors
- Scientists think companies come to scientists too late and then only to seek solutions to already established problems, rather than involving scientists earlier when they may identify problems and strategies via new knowledge that might benefit the companies.
- Neither sector knows how to best access the other
- There is a level of unreality in the New Zealand science system that focuses on closed exploitation in the early stages of research; this leads to mutual loss of credibility
- Naivety on both sides about when IP is important. There needs to be ways to manage it with respect to both cultures. With this, there is general confusion about the relative roles of open versus closed innovation
- There is insufficient sharing of infrastructure
- Perverse incentives that can place the public and private sectors in competition rather than in collaboration
- There is a need for greater integration of science expertise and end-user interest when planning major R&D initiatives
- There is a lack of interchange of staff between the two sectors
- Immaturity over when and how to internationalise (e.g. the research stage or later) and go to scale
- Complexity of our science funding and research translational systems

Academic factors

- Researchers can be reluctant to let go of control of their knowledge
- Peer pressure to stay pure academics
- The effect of PBRF
- Implications for promotion – lack of recognition of value of commercialisation
- Consequences for careers of time focused on commercial activity (especially as it moves to development)
- Over-valuation of IP

CRI factors

- Confusion over mission and performance measures of CRIs
- The potential inhibitory nature of premature closed innovation and immature handling of IP
- The competitive nature of CRIs, given their focus on funding and fiscal outcomes
- Lack of involvement of CRI staff in commercial upside

Technology transfer factors

- Valuation
- Lack of expertise in this skill in both public and private sector
- Most private sector companies have no experience in accessing academic R&D
- Variable approaches in CRIs and universities to technology transfer
- Variable quality and experience of technology transfer staff in universities and CRIs
- Too many agencies in the pre-seed/seed space
- The unresponsiveness of the available venture and pre-seed funds
- Do we need to consolidate expertise and capacities (e.g. like Denmark)
- What is the role of clustering/incubators?

Business factors

- New Zealand business has few science literate individuals in senior managerial or directorial positions
- The size of New Zealand businesses and the cost of development
- Lack of R&D managerial skills in both start-ups and in established businesses
- The lack of a capital base for New Zealand business
- New Zealand business operates on very short time lines and fails to recognise opportunities from R&D
- Fettered access to university and CRI information
- Recognition that CRIS and universities are key sources of innovation
- The cost of doing research in a university or CRI appears to be too high because of the full cost recovery model. Are there forms of non-discretionary incentive that can bring the two sectors closer?
- What is the role of non-discretionary assistance and discretionary grants?

14. There are structural factors in the New Zealand science system that promote over-competitive behaviour and inhibit closer linkages between public and private sectors, including:
    - lack of a national science and innovation strategy
    - lack of national science infrastructure planning
    - a complex and fragmented science funding system, which itself has a number of perverse incentives within it
    - an immature capital market and fragmented access to pre-seed, seed and venture funds.

15. The cultures of science and business are inherently different, although an overarching aspirational focus of using science to lift prosperity should help to bridge different perspectives. In general, most researchers in the university sector place high value on solving problems of high societal significance and disseminating their results as widely as possible. They value publications and peer recognition as indicators of success, and a proportion consider commercialisation activity as a diversion from these core goals. The issues within CRIs are confused by the lack of certainty as to mission – are they in support of or in competition with the private sector? Conversely, the private sector focuses on the economic outcomes of trading in products and services that are often the result of incremental, rather than transformational, advances in

knowledge. There is a need to develop and institutionalise ways of bridging these cultures.

16. One approach is to promote joint or rotating appointments across the sectors. Another would be to encourage greater scientific capability on private and public sector boards of directors by encouraging organisations to place senior scientists on their boards, having assisted their directorial up-skilling[2].

17. While there is debate as to its relative importance as a factor, some argue that there is insufficient incentive for staff to engage with the commercialisation of their work. In the universities, the nature of assessment is on the individual rather than on groups, and this is reflected in the focus on CVs and individual rating in the Performance Based Research Fund (PBRF) evaluation process. Despite the stated intent of the PBRF, the personality factors at stake in the process give great weight in practice to conventional measures of academic output for personal and institutional advancement. The UK model gives greater emphasis to the whole department rather than to individuals. While the PBRF is meant to give weight to translational activity, in practice it is rarely given particular significance. Further, in a grant application a CV light on papers and heavy on commercial activity is never likely to succeed.

18. On the other hand, it can be opined that the most intellectually successful scientists tend also to be those most willing to assist in their research being translated. Thus, the most successful technology transfer from universities has come from groups of critical mass where there is a good mix of academic research and application, resulting in focused activity without compromising individual career development. This suggests that greater weight should be given to building critical mass around key academic leaders and may provide an argument for more Centres of Research Excellence (CoREs), which invariably attract proven entrepreneurial academic leaders. There may be value in reviewing current FRST funding approaches so as to include more CoRE-like structures available to both CRIs and universities. These considerations are not arguments for down-sizing investment in 'yet to be applied' (basic) research or traditional academic research – rather they are arguments for acknowledging that we have had chronic under-investment.

19. Indeed, science is about excellent and trained minds working with appropriate infrastructure. Innovation increasingly occurs at the interface between disciplines. The New Zealand science system as a whole is deficient in identifying, capturing and retaining such excellent minds (the intellectual entrepreneur), has no coherent plan around infrastructure and no coherent overview of strategic priority setting leading to critical mass development. Instead we have an over-competitive rather than a collaborative system – this is not appropriate for a small nation trying to be increasingly productive in a highly competitive world which is increasingly knowledge-dependent.

[2] Overseas, scientist and academics are often on public and private sector boards even in companies well away from their disciplinary expertise because they bring a different appreciation of knowledge and its application.

20. In the CRIs, in spite of their sectoral orientation, the lack of a clear mission and science-focused performance measures has meant that both internally and externally there is confusion as to their mode of operation and their role. Business itself is uncertain as to whether the mission of CRIs is to be collaborative or competitive with business. This arises because CRIs, despite their original intent, are now almost exclusively focused at board and ownership level on the 'return on investment'. This has warped their intent and the mission retreat in some cases has meant that opportunities have been lost. In turn, some have entered into activities best placed in the private sector. Others have prematurely undertaken closed innovation when open innovation would have benefited the private sector better.

21. In general, CRIs do not have the same incentives in place as universities for their staff to undertake spinout or commercialisation activities. CRI staff should be able to benefit to some extent from invention exploitation in a manner analogous to university staff, provided this does not compromise the need for CRIs to have a major role in open innovation.

22. The high proportion of SMEs among New Zealand businesses suggests a deficit in absorptive capacity – the ability to recognise, acquire and adopt existing knowledge from elsewhere. SMEs often face specific technical barriers to innovation, and the public research sector is in a strong position to assist them to acquire the necessary specialist knowledge. In spite of this, only about 5% of SMEs engage with pre-seed and seed funding or the public research sector, and recent experience suggests that many SMEs are unaware that such assistance is available to them. Given that the bulk of RS&T infrastructure lies within the public sector and that few companies in New Zealand are large enough to support their own research activities, tools should be developed to encourage companies to access the public research infrastructure and to incentivise proactive engagement of public sector research providers with firms.

23. There is a need to develop processes that encourage access of companies to the extant knowledge base through the expertise of CRIs and the tertiary sector (knowledge access and transfer).

24. Technology transfer – that is, the translation of science to business and thence to public utility – is grossly underdeveloped in New Zealand, and there is a need to enhance national expertise and capacity in this area. This is a particular skill in high international demand and New Zealand has few experts. Technology transfer activity is characterized by an initial need for proximity to, and dialogue with, the researcher with availability of flexible pre-seed funding (the 'capture and nurture' stage), followed by more centralised investment activity (the 'hub and spoke' model). The latter stage requires a sophistication of knowledge about a variety of translation models. This includes:
    - the capacity to think about early stage mergers comprising disparate activities
    - the ability to create more-viable propositions than the obvious
    - the capacity to get beyond discovery capture (whereby the scientist believes he/she has the best knowledge of the development stage) to include commercial and market perspectives

- a realistic knowledge of valuation and skills regarding patenting and intellectual property (which in the technology space is a very particular skill)
- knowledge about and access to funds at the pre-seed and seed level.

Opportunities can be lost because of premature attempts to market without access to technology transfer expertise. In some cases the appropriate translation approach requires access to an incubator setting.

25. There is a consensus that it is not possible in a country this size to have 30 individual technology transfer offices meeting all these competencies. While the front end needs distribution, there needs to be a move to a 'hub and spoke' approach with more clustering of true expertise[3]. Singapore, Denmark and Queensland have moved to a variety of 'hub and spoke' operations; the Australian Commonwealth Commercialisation Institute is a further example of a development aimed at up-skilling.

26. A more mature approach to intellectual property (IP) issues is needed to promote collaboration and ensure that all participants in the innovation chain have a proper appreciation of the costs and benefits of IP rights. At times research can even move prematurely to closed innovation which paradoxically has in some cases limited commercial opportunities.

27. The issue of going to scale is critical for a small country far from its potential markets. Consideration must be given to what stage in the innovation chain should international partnering opportunities be sought on the way to market. The norm to date has been for New Zealand to go it alone and then attempt marketing overseas after complete development and commercialisation. This may be appropriate in some sectors and for some companies; in other cases this approach, which has been encouraged, may be inappropriate. Indeed, given the parallel nature of knowledge discovery, there may be more to be achieved by joint international development from the discovery stage and certainly by the stage of pre-seed investment. Given the immature state of New Zealand capital markets we are more likely to avoid the 'valley of death' which accompanies under-capitalised knowledge-based commercialisation if New Zealand science is linked to international partners at the pre-seed stage. If there are offshore partners involved in discovery, with the likelihood that later stage capital will be more accessible in other jurisdictions, then having science partners from the discovery stage will be a real asset in going to scale. In turn, offshore early-stage investment will give greater confidence to our relatively immature investment community. This would require reconsideration of our international research strategies, and there are obvious opportunities in both Australia and particularly Asia.

28. Although it is generally accepted that business R&D is a driver of innovation and productivity, and that government incentives to increase business expenditure on R&D are desirable, the optimum balance of discretionary and

[3] Auckland Uniservices is generally seen as a good example of a technology transfer operation in New Zealand. It has the advantages of critical mass and an association with a seed fund, and itself clusters with several Australian universities for expertise.

non-discretionary measures is less clear. Many countries provide some level of non-discretionary assistance. Current policy settings in New Zealand give preference to discretionary measures.

29. The rationale for when and how to give discretionary assistance is not always transparent. The balance of investment between large and small companies and between sectors, and the stages of investment, are issues in designing discretionary systems and clear and transparent policy is required.

30. The underpinning principle of government support for business R&D should be to have a range of incentives appropriate for different segments, for example:
    - discretionary grants for SMEs to undertake research to solve specific technical problems
    - discretionary grants from TechNZ to support firms in their development of new products or processes. Where these are substantive there is an issue of whether these are grants or should be some form of long-term loan repayable if there is long-term success and written off in the event of failure[4]
    - a non-discretionary scheme to promote business investment in RS&T (see paragraphs 28 and 31).

31. The cost of access to the infrastructure and expertise of universities and CRIs is high because of the need of those parties to charge fully loaded costs. For SMEs in particular this cost has become quite inhibitory and has had attitudinal effects on the public-private sector relationship. For large enterprises it has meant going offshore, and for international enterprises it has meant not entering New Zealand. A simple, non-discretionary and non-rortable scheme would involve support of business R&D by co-funding of indirect costs charged by publicly funded research providers[5].

32. Alternative non-discretionary schemes include use of the tax system or the provision of vouchers. These merit consideration alongside that proposed above. Each has different effects and merits, and these need to be assessed carefully in a country with a relatively immature private sector R&D culture

33. Government has a continuing role in assisting the venture capital industry to develop through NZVIF.

Final comments

34. The issues raised in this paper cannot be considered in isolation from the overall issues within the New Zealand science system. The key matters are the need for a simplified system with greater clarity of expectations, a reduction in unproductive competitive behaviours, the need for a coherent strategic set of priorities underpinning the public sector investment in science, the need to recognise the essential human nature of research, the need to have coordinated infrastructure, and the need to clarify the role and expectations of CRIs. But most importantly there is a need for the Government to be the leader in ensuring

[4] Analogous approaches have been used elsewhere (e.g. Israel) particularly in the start-up sector.
[5] This has been the subject of an earlier paper to the Prime Minister.

that New Zealand appreciates that science is at the heart of New Zealand's economic development.

35. Significant cultural change is needed, and it is only with that cultural change that business will advance in its use of knowledge and the public research sector will advance in its ability to supply that knowledge. Government has a leadership role in that change.

PD Gluckman
19 October 2009

Appendix: invited participants at the workshop on 14 September 2009

Name	Position	Organisation
Mr Paul Alexander	Advisor	DPMC
Dr Helen Anderson	Chief Executive Officer	MoRST
Mr Nick Bain	Manager, Commercialisation	NIWA
Mr Murray Bain	Chief Executive Officer	FRST
Ms Franceska Banga	Chief Executive	New Zealand Venture Investment Fund
Dr Alan Beedle	Chief of Staff	Office of the Prime Minister's Science Advisory Committee
Mr Michael Bird	Director, Industry Policy & Procurement	Ministry of Economic Development
Ms Frances Blyth	Principal Advisor	Tertiary Education Commission
Dr Rick Boven	Director	New Zealand Institute
Dr Bob Buckley	Manager, HTS Group	IRL
Dr Garth Carnaby	President	Royal Society of New Zealand
Mr Paul Cheever	Consultant	Access Capital Advisers
Dr Andrew Cleland	Chief Executive	IPENZ
Mr Shaun Coffey	Chief Executive Officer	IRL
Dr Bryce Cooper	General Manager, Strategy	NIWA
Mr Michael Daniell	Managing Director and Chief Executive Officer	Fisher & Paykel Healthcare
Mr Gary Dunnet	Manager, Business performance & agriculture statistics	Statistics New Zealand
Mr John Errington	Chief Executive	Victoria Link Ltd
Ms Kirsty Flannagan	Senior Analyst, Research & Innovation	The Treasury
Professor Sir Peter Gluckman	Chair	Office of the Prime Minister's Science Advisory Committee
Dr Stephen Goldson	Chief Scientist	AgResearch
Mr David Grant	General Manager — NZ Operations	Rakon
Professor Brendan Gray	Dunedin City Chair in Entrepreneurship	University of Otago
Mr Andy Hamilton	Chief Executive Officer	The ICEHOUSE
Mr Colin Harvey	Director	Ancare Scientific
Professor Harlene Hayne	Deputy Vice-Chancellor, Research and Enterprise	University of Otago
Dr Jeremy Hill	Group Director, Technology	Fonterra
Dr Wynn Ingram	General Manager, Innovation Networks Group	MoRST
Ms Benedikte Jensen	Research Director	The New Zealand Institute
Dr Peter John	Director Research and Commercialisation	Lincoln University
Dr Andrew Kelly	Executive Director	BioPacificVentures
Mr Chris Kelly	Chief Executive	Landcorp Farming

Dr Michael Lay-Yee	General Manager International Market Development	Plant & Food Research
Dr Peter Lee	Chief Executive Officer	Auckland Uniservices
Mr Geoff Lewis	Principal Advisor	The Treasury
Professor Nigel Long	Assistant Vice-Chancellor (Academic & Research)	Massey University
Dr Felicia Low	Research Fellow	Office of the Prime Minister's Science Advisory Committee
Mr Robin Martin	Chief Executive Officer	Plastics New Zealand
Dr Di McCarthy	Chief Executive Officer	Royal Society of New Zealand
Professor Stuart McCutcheon	Vice-Chancellor	The University of Auckland
Mr Grant McPherson	Group General Manager, Business Solutions	NZTE
Mr John Morgan	Chief Executive	NIWA
Mr Paul Morgan	Executive Committee member	Federation of Maori Authorities
Dr Bret Morris	Director of Enterprise	University of Otago
Professor Paul Moughan	Distinguished Professor / Co-director, Riddet Institute	Massey University
Mr Wayne Mulligan	Chief Executive	FOMANA Capital
Mr Phil O'Reilly	Chief Executive	Business New Zealand
Professor Tony Reeve	Director, Cancer Genetics Laboratory	University of Otago
Dr Tom Richardson	Chief Executive Officer	Scion
Ms Siobhan Routledge	Manager, Industry Policy	Ministry of Economic Development
Professor Roy Sharp	Chief Executive	Tertiary Education Commission
Professor Alison Stewart	Bio-Protection and Ecology Division	Lincoln University
Mr Mark Stuart	Chief Executive Officer	WaikatoLink
Ms Sue Suckling	Chairperson and Director	HSR
Mr David Talbot	Acting Chief Executive Officer	ESR
Professor Ian Town	Deputy Vice-Chancellor	University of Canterbury
Dr Jim Watson	Founder Scientist	Genesis
Dr Colin Webb	Deputy Chief Executive	Tertiary Education Commission
Dr Andy West	Chief Executive Officer	AgResearch