Experiment and Evolution in Science and Technology Policy: Recent Australasian Experience

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For most of the 1980s, Labor governments were in power in both Australia and New Zealand. The period saw a sea-change in policy-making in both countries, change more rapid and radical in New Zealand than Australia, but change in each case motivated by the urge to enhance economic efficiency domestically and sharpen competitiveness internationally.

In each country, market deregulation and the dismantling of protective barriers became favoured instruments to pressure producers to cut costs and induce firms to innovate in order to survive. The importance of technological innovation and of using existing technology better was increasingly emphasised, and policy makers put their minds to encouraging the generation, diffusion and absorption of new scientific and technological knowledge in the private and public sectors.

The Labor government of New Zealand survived until 1990 but flowing from reforms legislated in 1988–9, major changes to the science system have been taking place ever since. Labor started changing the face of Australia's science and technology (S&T) system rather earlier in the 1980s and held government longer—until 1996. Since power changed hands in Australia, major reviews have reported or are at work to examine the entire higher education sector[1], priority setting in the S&T system[2] and programs supporting industry innovation. The national innovation systems of Australasia are thus continuing to evolve and reviews in hand, and in the future, will be well positioned to draw on a growing mass of evidence about policy for research and development (R&D), S&T and innovation which has been accumulating in Australia and New Zealand over the last decade and a half. The papers in this volume examine how policy has attempted to influence the direction and intensity of scientific and technological advance in Australasia, factors which are shaping the impact of such policy, and some of the general lessons to be learned.

Policy in this area has been forged, as noted above, in an environment which focused interest primarily on enhancing international competitiveness, for reasons (right or wrong) associated with addressing balance of payments problems and promoting economic growth.[3] Payments-related issues received more attention through the 1980s as governments worried about the size and growth of their countries' international indebtedness. Economic growth moved to the forefront of debate later, with rising unemployment the bogey of the early 1990s and so-called 'New Economic Growth' theory apparently offering a remedy through increased R&D.[4] This message appealed especially to the science and education lobbies worried at the prospect of cuts in public sector

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spending in these areas. And it looked as if it might be particularly relevant to countries like Australia and New Zealand which both had R&D:GDP ratios which were well below the Organisation for Economic Cooperation and Development (OECD) averages.[5,6] Actually, the policy implications of this work are less obvious than many had hoped, though empirical estimates suggest that national economic returns to R&D may be substantial.[7] Gerry Freed's paper in this volume draws out the complexity of the relationships between policy for industrial R&D and effects on the performance of Industrial R&D (IRD).

Is more R&D necessarily and always for the best? The policy issue may be not so much getting more R&D done as trying to ensure that the return on every extra dollar's worth of R&D compares favourably with the return on alternative potential uses of that dollar. It would be very easy in a purely mechanical or arithmetical sense to increase the ratio of gross expenditure on R&D to gross domestic product (GERD/GDP) to, or above, the OECD average: government would merely need to divert to publicly funded R&D the required resources from roads, or social security, for example—or raise taxes to pay the bill. In each case, however, there is an opportunity cost to increasing R&D: the socio-economic benefits lost by not spending the equivalent amount on roads or social security, or not leaving it to taxpayers to spend.

In both Australia and New Zealand, politicians have focused over the last decade or so on what they perceive as the inefficiency of the public sector relative to the private in performing almost any economic activity. This is discussed, for example, by Peter Winsley and Laurie Hammond in relation to the system-wide reforms which have taken place in New Zealand, and by Stefan Markowski, Peter Hall and Albert Dessi in connection with Australia's defence R&D. Increasing R&D through direct public provision has therefore not been a favoured option,[8] much effort has been devoted to finding a rationale for the basic research performed by universities,[9] and there has been increasing emphasis on evaluating the returns to the R&D still performed by government research agencies.[10] There has been a major focus in Australia on encouraging private sector innovation through tax concessions, competitive grants, small business management support, specific industry assistance—and by attempts to strengthen the links between private sector firms and public sector research institutions.

The experience of the last decade or so has thrown up a number of major issues and tensions in S&T policy-making, many of which are discussed in this volume. On the question of returns, it will always be hard to obtain the data required to be confident about estimates.[11] And it is especially hard to obtain sensible estimates of *marginal* R&D expenditures: average returns often seem the best we can find—but such estimates are unhelpful in resource allocation exercises. The same argument applies to decisions at the aggregate level (between spending more on S&T or public transport, for example) and to choices between one project and another at the micro-level. Assuming the political process can take care of the high-level problem, prioritisation must still be undertaken *within* the S&T budget (unless there is more money than the value of proposed projects). But if calculating explicit numerical returns is thought unreliable, another sort of process may be needed. Don Aitkin traces the evolution of thinking on priority-setting in Australian in this issue, highlighting nicely the reluctance of the research community to recognise that there are always competing claims on public funds, and that demonstrating the potential scientific quality of a project is a necessary but not sufficient condition for obtaining funds. As Aitkin notes, a major effort at establishing a process for prioritising research area at the national level[12] lost momentum in the early 1990s. Nonetheless, and in the newer guise of 'foresighting', national priorities were again being discussed (at least implicitly) within a few years.[13] And in his report on Australia's S&T

system (see note 2), Dr John Stocker, Australia's Chief Scientist, recommends that government define and implement national S&T priorities and develop further the framework and methods for identifying priorities.

The value of such exercises will always be controversial. They are costly to undertake and need to be repeated quite often if their conclusions are not to be overtaken by unforeseen events. Their main benefit may ultimately lie not so much in the specific forecasts they yield as the process by which such forecasts are generated. If the process encourages individual research and groups of researchers to participate actively in forming a shared vision about national problems, needs and opportunities, that may well be a benefit worth having.[15] But at the end of the day, a healthy national innovation system also depends on freedom to experiment and freedom to dissent from the consensus. The resource issue is to recognise that reality while at the same time continuing to back the best research and researchers if they are performing well in the context of well established developments.

Another set of issues flows from the central economic rationale for policy intervention—that, left to itself, the market is likely to generate both the 'wrong' quantity and the 'wrong' type of innovation-related investments in new knowledge, new human capital and new equipment. Of course, as Clem Tisdell points out in his paper, to put the matter this way presupposes both that there is an ideal quantity and composition of such investments and that we could, at least in principle, know what they are. Given the essentially evolutionary nature of technological progress and the unknowability (in specific detail) of technological and economic futures, major uncertainties cloud the identity of such ideal states, if indeed it is even logical to assert their existence.

Despite this, just about all supporters of public sector performance of R&D and government intervention in support of R&D want to claim that the market will *under*-invest relative to what is socially desirable. The argument is that the economy and society at large gain substantial benefits from innovation-related investments which do not flow back as profit or economic reward to those initially responsible for resourcing them. This tends to discourage the market from generating as much investment as society could benefit from, given the so-called beneficial *externalities* which arise.

In fact there is a well-established line of argument that implies *over*-investment (duplication) may sometimes occur in the market,[16] and there is evidence that public sector decision-makers pick 'losers' at least as often as do their counterparts in private sector business. But given the presence of externalities as a central policy issue here, the question is nonetheless, how to tackle it.

In Australia, government research agencies like the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Science and Technology Organisation (DSTO) directly perform research with the aim of ensuring that identifiable national research needs are met, irrespective of private market decisions. (Markowski, Hall and Dessi discuss the interesting case of the defence provider, DSTO.) In the past, a similar function was performed in New Zealand by the Department of Scientific and Industrial Research and the Ministries of Agriculture and Fisheries, and Forestry. The experiment of corporatising many of those activities through the vehicle of the Crown Research Institutes is explored by Peter Winsley and Laurie Hammond. The issues here run far beyond establishing that the relevant organisations do what they do as cost-efficiently as possible. Major policy concern has focused in recent times on whether there are appropriate mechanisms for deciding *what* such organisations should do, how their tasks should be prioritised, and how their work should be integrated with the activities and needs of private (and public) sector institutions elsewhere in the national innovation system. The same sorts of question may also be asked about the institutions of tertiary education, and especially the universities.[17]

The Australian university system underwent massive structural change in the later 1980s as the so-called Dawkins reforms (named after the then Minister of Education, John Dawkins) did away with the pre-existing binary system of universities and non-university tertiary instituions such as the colleges of advanced education (CAEs), and replaced it with a unified system comprising university institutions only, 37 in all. For R&D this had important implications. Staff in the pre-Dawkins universities were expected to teach and undertake research; those in the CAEs mostly or only to teach. Differences in teaching loads between the two types of institution reflected this expectation. But when the number of institutions to be known as universities doubled overnight, the expectation was born that academic staff in the new Dawkins universities would now also have to become researchers. It quickly became clear that competition for research funds would become much fiercer and that new areas of research would start to emerge.

Almost all Australia's pure basic research is performed in universities, though as a proportion of all university research, pure basic fell from just over a half in 1978 to 40% in 1992, with strategic basic and applied rising to counterbalance.[18] To pay for this effort, the higher education sector receives from government non-directed funding from general operating grants; a much smaller amount provided specifically for research and allocated to institutions according to research performance; funds made available under the competitive grant programs of the Australian Research Council; and resources won from targeted schemes such as those run by the National Health and Medical Research Council. Of all university research funding other than that flowing from operating grants, perhaps as much as three quarters is government-sourced.[19]

University-based research in general, and most of Australia's pure basic research has thus been heavily dependent on government support for its maintenance. But over 3 years starting in 1996–7, the university sector was asked to take cuts in its overall government resourcing and while health and medical research enjoyed an increase in funding between 1996–97 and 1997–98, the rapid general increase in demand for research support in universities has put great strain on existing sources of funds. The demand will have to be met by searching out new sources of research support and reallocating resources with individual universities, across the sector, and internationally. This is already leading individual universities to identify and exploit specific areas of research strength rather than to try to cover the field; to sharpen their focus on the interests of their local regions, where new community sources of funding might also be found; to become involved in networks and collaborations that provide shared access to specialised or costly equipment; and to forge new research links with high quality institutions overseas.

The result is likely to be that universities as a whole will continue to diversify into whatever research areas offer the greatest potential for support. One part of the sector may attract most of the government funds beyond operating grants available for the basic research traditionally conducted in universities. Other parts may have to attract individual 'stars' to be sure of any non-operating grant government funding for pure basic research, look to industry and elsewhere for resources for more applied work, or construct a research agenda on their response to regional needs. With increasing urgency, universities are also likely to ask themselves: Should every academic be expected to be both a teacher and a researcher? Universities may well start to conclude that while the best teaching is done in communities which also research, not every individual in the community need be engaged in both types of activity.

At the same time, recent Australian policy has attempted to influence private business R&D decisions through a tax concession (150% from 1986–96; 125% currently), competitive grants and selective industry support. Crucial issues here are whether such schemes actually encourage R&D which would not otherwise have occurred; and whether the socio-economic benefits of any additional R&D outweigh the total costs of the scheme, including efficiency losses incurred elsewhere in the economy as a result of allowing concessions and paying subsidies to innovating firms[20]. Gerry Freed in this issue discusses the potential for such schemes given that business decisions are increasingly made in a global-business context in which strategic imperatives for R&D may have little to do with the marginal incentives offered by national fiscal systems.

A further nexus of issues surrounds the role of competition and contestability, a distinction based on the difference between the actuality and threat to suppliers of their facing alternative providers. It is widely believed by economists that market power or lack of competitive pressure dampens the enthusiasm of private sector firms for achieving cost efficiency, and for undertaking costly and risky innovation investments. Exposing firms to greater competition (through deregulation and the dismantling of protection) should tend correspondingly to encourage efficiency gains and stimulate business innovation.[21] Advocates of contestability suggest that even the threat of competition has similar effects. There is evidence in favour of these propositions in Australia. On the other hand, a well-respected strand of economic argument responds that even though competition encourages more efficient use of existing technology, too much competition can actually undermine the prospects of economic gain from technological innovation.[22] In Australia, business R&D has soared[23] at a time of deregulation and tariff cuts. But additionality calculations also suggest the tax concession and grants played their part too.[24]

In similar vein, Tisdell argues that increasing the competition for R&D grants at the expense of formula-based block grants could be detrimental to net benefits gained in the long run. Tisdell applies his argument to the agricultural sector in particular where Rural Research and Development Corporations have been one of the more successful institutional innovations in recent years. They are credited with giving farmers and horticulturists a sharper appetite for the value of commissioning R&D for their industry as government has matched dollar for dollar producers' levies up to a specified ceiling.[25] Agricultural research remains a staple for CSIRO, set up in the first place to discover more about Australia's unique flora, fauna and ecology. The RRDCs help foot the bill. Whether agricultural research still deserves the support from public revenues it receives is a matter of ongoing debate.

Finally, Australia has been in the forefront of institutional experiments designed to strengthen linkages among the varied players in the innovation game. Its involvement illustrates the growing conviction that socio-economic benefits from R&D depend as much on how a national innovation system is articulated as on how much R&D is done.[26] In this volume, Tim Turpin reports on the experience of the Cooperative Research Centres (CRCs), first conceived in the late 1980s to enhance cooperation and contact between the universities and CSIRO and ultimately charged with linking up with industry too. Given the relatively generous levels of subsidy built into government support for CRCs, it is hardly surprising that they have rapidly grown in number—to 62 by 1997. Also unsurprisingly, as centres start coming up for review, apologists are pleading for the long view to be taken in assessing their impact.[27] With $140m going into the CRCs each year, governments may, however, feel they need convincing rather more urgently[28].

Notes and References

1. The Higher Education Review Committee was set up early in 1997 under the chairmanship of Roderick West. It is due to report by March 1998.
2. Department of Science and Technology, *Priority Matters*, AGPS, Canberra, 1997. The review leading to this report was conducted by Dr John Stocker, Australia's Chief Scientist.
3. For a useful collection of essays in this area see Philip Lowe and Jacqueline Dwyer (eds), *International Integration of the Australian Economy*, Reserve Bank of Australia, Sydney, 1994.
4. P.A. Romer, 'Endogenous technological change', *Journal of Political Economy*, 98, 5, 1990, pp. S71–S102.
5. In 1992, the ratio of Gross Expenditure on R&D (GERD) to GDP was 1.56 in Australia and 0.88 in New Zealand. The OECD average was 1.91. Over the previous decade the GERD/GDP ration grew, on average in the OECD, at 5.3% p.a., in Australia at 6.9% and New Zealand at 0.1%. (Industry Commission, *Research and Development: Report No 44*, Australian Government Publishing Service (AGPS), Canberra, 1995, p. 105). By 1994/5, Australian's GERD:GDP was 1.61%.
6. The causal relationships between R&D, economic growth and national welfare in a small open economy (like Australia's or New Zealand's) remain controversial. Most of the work on 'new economic growth theory' has been done on the assumption of a large closed economy, though important exceptions include G. Grossman and E. Helpman, *Innovation and Growth in the Global Economy*, MIT Press, Cambridge, Mass, 1991; and S. Dowrick, 'Openness and Growth', in Lowe and Dwyer, *op. cit.*, Ref. 3, pages 9–41; and 'The determinants of long run growth', in Palle Andersen, Jacqueline Dwyer and David Gruen (eds), *Productivity and Growth*, Reserve Bank of Australia, Sydney, 1995.
7. Recent work for Australia suggests the rate of return on Australia's R&D effort might range from 25% to 90%, and possibly reach even 150%. The Industry Commission, which undertook this work (Industry Commission, *op. cit.*, Ref. 5, Appendix QB) cautions, however, that these figures are 'likely to overstate the returns to actual R&D' (*ibid.*, p. 9).
8. International comparisons are rendered somewhat difficult by variations in measurement methodology. But while government and university R&D in Australia comprised about 0.9% of GDP in Australian in 1992, the international average was nearer 0.6% (Industry Commission, *op. cit.*, Ref. 5, p. 107).
9. Australian Research Council (ARC), *The Strategic Role of Academic Research*, AGPS, Canberra, 1994.
10. CSIRO, *Rural Research—The Pay-off*, CSIRO, Canberra, Occassional Paper no. 7, 1992.
11. Z. Griliches, 'Productivity, R&D and the data constraint', *American Economic Review*, 84, 1, 1994, pp. 1–23.
12. Australian Science and Technology Council (ASTEC), *Setting Directions for Australian Research,* AGPS, Canberra, 1990, and *Research and Technology: Future Directions*, AGPS, Canberra, 1991.
13. ASTEC, *Developing Long-term Strategies for Science and Technology in Australia*, AGPS, Canberra, 1996.
14. CSIRO, *CSIRO Priority Determination 1990, Methodology and Results, Overview*, CSIRO, Canberra, 1991.
15. Industry Commission, *op. cit.*, pp. 890–1.
16. P.A. Dasgupta and J.E. Stiglitz, 'Industrial structure and the nature of innovative activity', *Economic Journal*, 90, 1980, pp. 266–93.
17. National Board of Employment, Education and Training, *Crossing Innovation Boundaries: The Formation and Maintenance of Research Links between Industry and Universities in Australia*, AGPS, Canberra, 1993.
18. Industry Commission, *op. cit.*, Ref. 5, pp. 344–5.
19. Industry Commission, *op. cit.*, Ref. 5, p. 358.
20. For an analysis of these schemes and their net benefits see P.H. Hall, 'Incentives for industrial R&D: The Australian experience', *Science Policy*, 23, 4, 1996, pp. 215–28. Selective industry support for R&D has been most marked in recent years in the 'Factor F' scheme applied to the pharmaceutical industry. The scheme was exhaustively reviewed by the Industry Commission (Industry Commission, *The Pharmaceutical Industry*, AGPS, Canberra, 1996).
21. P.A. Geroski, 'Innovation, technological opportunity, and market structure', *Oxford Economic Papers*, 42, 1990, pp. 586–602.
22. Dasgupta and Stiglitz, *op. cit.* Ref. 16.

23. Between 1981 and 1992, real business expenditure on R&D (BERD) grew at an annual rate of 13% p.a., though the BERD/GPD ratio for Australia still lies well below the OECD average. (Industry Commission, *op. cit.*, Ref. 5, pp. 105–6).
24. Every dollar of tax revenue forgone is estimated to have induced between 60 cents and one dollar of business R&D under 150% tax concession. (Bureau of Industry Economics, R&D, *Innovation and Competitiveness: An evaluation of the Research and Development Tax Concession*, Canberra, AGPS, Research Report 50, 1993.)
25. Department of Primary Industries and Energy, *Review of Rural Research, Report of the Task Force on Review of Rural Research*, Canberra 1994; and Industry Commission, *op. cit.*, Ref. 5, Section E.
26. OECD, *Technology and the Economy, The Key Relationships*, OECD, Paris, 1992; National Board of Employment, Education and Training, *op. cit.*, Ref. 17.
27. Dr Mark Sceats, CRC Association Chairman, quoted in *Sci Tech* 17, 1, 1997, p. 1.
28. In July, 1997, Mr David Mortimer (Chairman and Chief Executive of TNT Asia Pacific Region) presented his government-commissioned report *Going for Growth: Business Programs for Investment, Innovation and Export*, AGPS, Canberra, to the Minister for Industry, Science and Tourism, the Hon. John Moore. He recommended that public funding cease for CRCs for which there was predominantly a private benefit, and be limited to $20 million per annum for new CRCs and CRCs with predominantly 'public good' collaborative science programs. The Mortimer Report also recommended further changes to industry innovation support, *inter alia* re-setting the R&D tax concession at 100%, but with an additional innovation rebate; consolidating rural R&D support into the hands of a single R&D corporation; and increasing the external funding requirement for government research agencies like CSIRO.