The Biomedical Sectors in Australia and Canada: Comparative Policy Analysis

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Introduction[1][2]

As countries, Canada and Australia have much in common. There is a shared heritage as new world British colonies and accordingly a similar culture, governmental institutions, living conditions, health and educational standards. Australia is somewhat smaller than Canada – its population of about 20m is 61% of Canada's. Both have high living standards although Canada's GDP per capita is marginally higher than Australia's. The countries also share many aspirations. One is to retain their technological edge, as innovative societies, through the commercialisation of their science base.

Little could illustrate this better than the release, within the space of a few months, of innovation strategies designed to enhance the innovation process in each country. In Australia's case, its plan was set out in *Backing Australia's Ability* (DEST 2001), which followed a number of related reports and white papers, and for Canada, the more substantial document *Achieving Excellence* (Government of Canada 2001). This provided not only a detailed analysis and assessment of Canada's innovation performance, but also identified quantifiable targets to guide future action by government and industry. Both documents focussed on similar things, strengthening R&D, accelerating its commercial application and developing and retaining skills. They also emphasised the importance of broader supportive and competitive economic settings. In both cases, the governments' policy initiatives were accompanied by substantial increases in government funding for R&D and associated support programs.

Comparison of the Key Characteristics of the Biomedical National Innovation Systems for Canada and Australia

A previous paper provided an outline of some of the key success factors, drawn from published empirical work, for commercialisation in the biomedical industry (Rasmussen 2004b). [3] This section discusses the comparative positions of Australia and Canada for each of these factors. It largely draws on data available from secondary sources, except for the work on alliances which has been undertaken by CSES.

The Life Science Base

Both countries would claim that their science base is a competitive advantage in establishing a biomedical industry. A recent analysis of the comparative positions of the two countries appears in the Third European Report on S&T Indicators (European Commission 2003) for the period 1995-99. This suggests that both countries have a relatively powerful life science base. Canada is ranked 6th in the world with 25,039

[1] This paper is one of a series of papers comparing the performance of the Australian and Canadian biomedical industries. Over this period new data sources have emerged and where relevant have been incorporated into subsequent analysis. The data discussed in the section 'Innovation Policy Settings' is currently under review, which may result in some revision to the results, but is unlikely to change the conclusions.

[2] The enthusiastic research assistance of Alison Welsh is gratefully acknowledged.

[3] See for instance Bagchi-Sen (2004), Calabrese et al. (2000), Hall and Bagchi-Sen (2002), Niosi (2002), Powell (1998), Powell et al. (2002) and Zucker et al. (1998a, 1998b).

publications while Australia is ranked 11th with 13,200 (about equal on a population adjusted basis). However Canadian research is cited more frequently, 8.9 times compared with 6.9 for Australia. This puts Canada up to 3rd in the world, while Australia remains 11th ranked. The mean field citation score in basic life sciences, considered the most accurate in levelling out various country size distortions, still has Canada ranked ahead of Australia, 6th vs 14th. A number of smaller European countries improve their positions, as does Singapore, based on this measure.

The number of biotech patents issued by the US Patent Office over the period 2000-03 totalled 305 for Australia compared with 913 for Canada. An analysis of patents prepared by CHI (ARC 2000) shows, for the period 1994-98, a similar pattern to that of scientific papers. Canadian patents in the pharmaceutical and biotechnology sectors tend to be cited more frequently than Australian ones. It is this citation by subsequent patents that has been found to correlate closely to the value of the technological advance made by that prior patent (ARC 2000, p. 24). To measure this, CHI constructed a 'current impact index'. For the biotechnology sector it was 1.02 for Canada and 0.88 for Australia. For the pharmaceutical sector it was 1.12 and 0.84 for Canada and Australia respectively. Each of these indices was relatively high in terms of country rankings – Canada was second, behind the US, in both the biotechnology and pharmaceutical sectors, amongst a group of 10 selected competitor countries listed in the report. Australia ranked 5th and 4th in the biotechnology and pharmaceutical sectors respectively.

This analysis suggests that while Australian science is certainly world class, it does not have the equivalent impact of the Canadian life sciences.

Both Federal and state government have instituted various programs to bring back Australian scientists from overseas. The work of Zucker et al. (1998b) indicates that the presence of the star scientist is not sufficient. It is necessary for them to be actively involved in the commercialisation process through links with local biotechs for these programs to be effective.

Public Spending on Life Sciences R&D

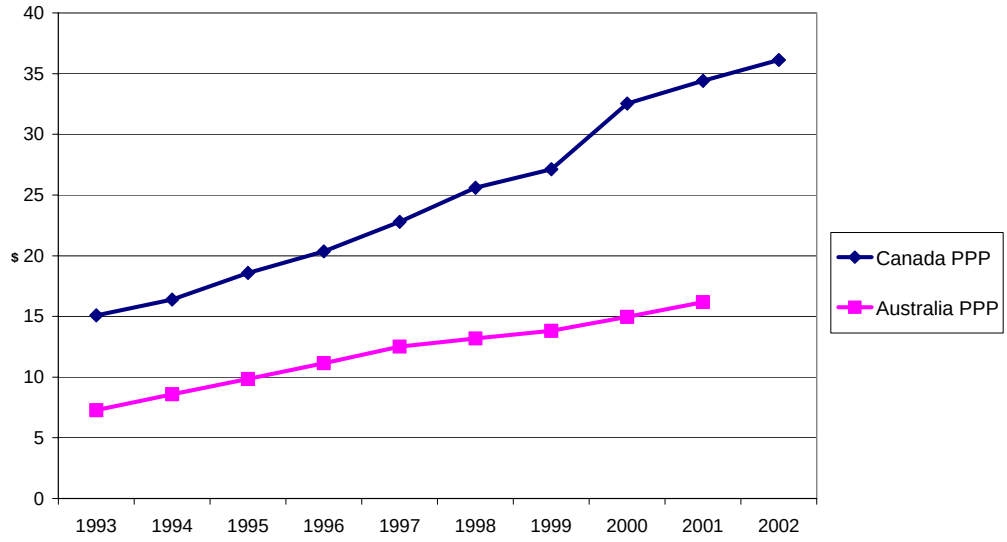
A previous paper provided a number of indicators of public expenditure on life sciences related R&D. The most comparable measure between the two countries is public expenditure on health R&D (Rasmussen 2004b). This showed for 2001, that Canada's expenditure was substantially higher, C$2.8b compared with Australia's of A$1.3b. This issue will be discussed further in the section on 'Innovation Policy Settings.'

Availability of Finance

Comparative measures of sources of finance for the biomedical sector are at best patchy. For instance a survey of Australian venture capitalists (AVCAL) indicates that venture capital investment in Australian biotechs was A$257m in 2001, while the Canada Statistics survey of Canadian biotechs suggested that the Canadian figure was C$363m. Such figures are however subject to considerable year-by-year variation. The Australian figures for 2000 and 2002 are A$41m and A$53m. Comparable data are not available since the Canadian survey was not conducted for those years.

Another view of the availability of finance comes from private expenditure on health R&D – largely expenditure on pharmaceuticals and medicines, which may exclude some relevant biotech R&D. For a number of years, comparable data for the two countries dating back to 1993. This data on a per capita basis are shown in Chart 1.

Chart 1. Private Per Capita Expenditure on Health R&D in Canada and Australia ($PPP)*



Source: Access Economics 2003 and Statistics Canada 2003a.

Canada's private expenditure on health R&D on a per capita basis has been consistently above Australia's, although over the decade 1993 to 2002, shown in the chart above, the growth rates of the two countries have been much the same. Per capita expenditure in 1993 was $15 for Canada compared with $7 for Australia and by 2001 it had grown to $34 for Canada and $16 for Australia. While coverage by this data series of the total biomedical sector is an issue, this pronounced and persistent difference has doubtless had a significant impact on the relative development of the biomedical industry in the two countries.

Strategic Alliances

An analysis of strategic alliances for Australia and Canada based in Recap data[4] was presented in an earlier paper (Rasmussen 2004b) and showed a considerable gap between Canada and Australia. Rather than attempt to provide the same comprehensive analysis of the earlier paper, the following discussion focuses on areas of greatest difference and significance over the period 2000-03. Data are provided for alliances between biotechs (biotech biotech) as well as between pharmaceutical companies and biotechnology companies (pharma biotech)

The area where the difference is most marked is in later stage alliances – those either in clinical trial or at the approval phase. The starkest contrast between the two

[4] See Rasmussen 2004a and 2004b for discussion of data sources and issues.

countries is for payouts.[5] While Canada has attracted later stage alliances with US$1889m in payouts, Australia has just $51m. Most of this difference arises from payouts from pharmaceutical companies, which total over US$1.6b for Canada compared with zero for Australia.

The difference between the two countries is less marked when measured by *number* of later stage alliances, but the majority of Australia's alliances are with biotechs and therefore relatively low value. Further examination of the data indicates that all of these alliances are either phase 1 or 2. Alliances formed at phase 3 attract higher payout levels, partly because the cost of phase 3 trials is the most expensive but also because the likelihood of success is more assured.

Table 1. Later Stage Drug Development Alliances, Australia and Canada, 2000 to 2003

	Number		Total Payouts	
Alliance Parties	**Australia**	**Canada**	**Australia**	**Canada**
			US$m	US$m
Biotech – biotech	7	36	51	268
Pharma – biotech	2	42	0	1621
Total Later Stage	**9**	**78**	**51**	**1889**
% of total Drug Development	**29%**	**44%**	**19%**	**86%**

Source: Recap, CSES.

Moreover, alliances at phase 3 and approval stage have a greater focus on distribution. It is noteworthy that while about one third of Canadian alliances involve marketing and distribution only one Australian alliance is in this category. At this later stage the value of the drug can be more accurately forecast and incorporated into the payout value.

One of the reasons for Canada's relative success in establishing high value alliances may be its proximity to the United States. It is doubtless more convenient to establish partnering relationships with Canadian companies, than Australian. However while Table 2 below illustrates the strength of partner relations with the United States, with 31 out of 70 pharma biotech alliances and $585m in payouts, and a further 50 biotech biotech alliances, the engagement with Europe is at least as strong. There are a total of 60 alliances with European companies with total payouts of US$1200m, US$1101m of which is for pharma biotech alliances.

In contrast, Australia's small number of pharma biotech alliances is relatively concentrated on the United States (7 out of 11). On the other hand there are 8 out of 20 biotech biotech alliances with European companies.

[5] The Recap database contains information about the financial size of alliances and related transactions, including mergers and acquisitions, where this information is publicly available. The financial terms of an alliance may remain confidential so in such cases the anticipated payouts would not be recorded in Recap. The financial structure of alliances can vary widely, and may incorporate equity investments and outright product purchases, as well as the more usual licensing arrangements. The dividing line between alliance and acquisition is not always clear. Nonetheless, we have filtered the database to remove mergers and acquisitions and similar transactions.

Canada also has a relatively large number of internal biotech biotech alliances (15 out of 102) with payouts totalling US$193m.

Table 2. Client Country: Drug Development Alliances, Australia and Canada, 2000 to 2003

Client Country	Pharma biotech alliances				Biotech biotech alliances			
	Number		Payouts US$m		Number		Payouts US$m	
	Australia	Canada	Australia	Canada	Australia	Canada	Australia	Canada
Australia		3			5	1	23	
Canada		1				15		193
Asia	2	4	0	163	1	7	0	0
Europe (incl. UK)	2	31	3.5	1101	8	29	28	109
United States	7	31	218	595	6	50		49
Total	11	70	222	1858	20	102	51	351

Source: Recap, CSES.

This analysis serves to illustrate the relative integration of the Canadian biomedical sector into the global drug development network, through high value alliances with pharmaceutical companies located in the US and leading European countries. Compared with Australia, Canadian companies have a number of large alliances with major pharmaceutical companies. There are six such alliances in Canada with payout values over US$100m compared with the single alliance in Australia between Merck and Amrad of over US$100m.

Relatively speaking, Australia's strength is in platform technologies, diagnostics and devices, but even in these, compared with Canada, Australia is low, with 125 biotech biotech technology alliances formed over the period 2000-03 compared with 305 formed by Canadian companies.

Regulatory Environment

As is widely recognised, the regulatory environment for the biomedical sector is fundamental to the conduct of the industry. This covers patent protection, product approval and sales approval by national and provincial agencies. Both Canada and Australia offer similar levels of IP protection and this should be competitively neutral between the two countries. The key regulatory authority for product approval is the US FDA, which stands guard over the world's largest market. Companies in both countries therefore, seek approval through much the same process.

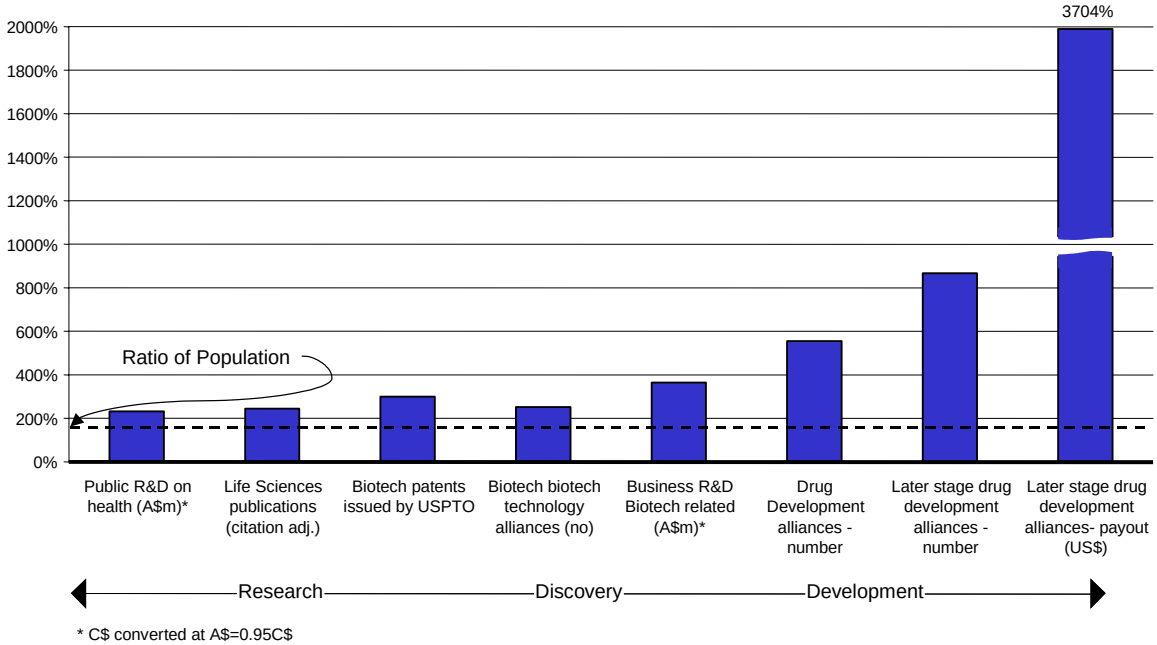
The sale of drugs is controlled, in both Canada and Australia, by governmental bodies and the key issues are delays in the approval of drugs available for sale and the price of those drugs. The price of drugs for the Australian market is set under the Pharmaceutical Benefits Scheme and Canadian prices are set by the Patented Medicine Prices Review Board. Sweeny (2003) shows that Australian prices are 30-40 %, and Canadian prices are some 50-60%, respectively of US levels. Canadian prices are however above those generally prevailing in Europe. It has been suggested that the low level of Australian prices acts as a disincentive for pharmaceutical

companies to support Australian biomedical research and product development. Certainly the higher relative prices in Canada may act to its advantage.

Comparative Overall Performance

Canada appears to be ahead of Australia across a broad range of measures from public support for health R&D to the number and value of drug development alliances. The relatively high drug prices also helps to support an industry, which is significantly larger than Australia's. Chart 2 draws together the key indicators used through the course of this paper to measure the relative size of particular aspects of the sector in the two countries.

Chart 2. Ratio of Key Canadian to Australian Indicators for the Biomedical Sectors



* C$ converted at A$=0.95C$

Note: See Appendix A for details of measures used.

The indicators are presented according to their approximate position in the value chain, from the level of public investment in health sciences, to measures of research outputs and business inputs and finally, the value of alliances, at the later stages of the drug development pipeline. The reservations and qualifications that pertain to each of the indicators were discussed in the previous paper (Rasmussen 2004b).

However what is striking about the ratio of Canada to Australia for each indicator is how a relatively modest difference between the two at the beginning of the pipeline, develops to be of such a magnitude towards the end. The benchmark could be considered to be the difference in population between the two countries (163%). The additional investment made by Canadian government agencies is reasonably significant at 232%, but the indicators of research output is higher, 245% for publications and 299% for patents issued. Technology alliances typically focus on the discovery or early development stage of the drug pipeline and is an area where Australia is not so weak, with the ratio of the number of alliances being 252%. The majority of business R&D, which in Australia and Canada tends to be invested early

in the development stage, has a ratio of 365%. Drug development alliances provide support for biotechs over each of stage of the pipeline, but most of the differences emerge in the later stages (phase 3 and approved) when the ratio in the number of alliances increases to over 8 times and that for total payout value to 37 times.

This suggests that compared with Australia, Canada's biomedical sector enjoys a virtuous circle in which a relatively small but significant difference in public sector investment appears to produce a very substantial difference in industry performance in the later stages of the drug development pipeline. At each stage the differences between the two countries are magnified.

This would be consistent with an innovation system that is characterised by a series of positive feedback loops. Relatively higher levels of public R&D expenditure in Canada produces a greater number of drug candidates, which encourages relatively higher levels of venture and other private capital, which finances drug projects to an advanced stage attractive to a well funded pharmaceutical alliance. Relative success at each stage appears to be self-reinforcing. Compared with Australia, the magnitude of pharmaceutical alliance commitments would provide domestic capital participants with confidence that exit opportunities were available reinforcing the inclination of venture capitalists and others to invest in the industry.

This would of course be only possible if there were suitable projects to support. Although we lack comparable figures of the complete product pipelines in each country, the Canadian pipeline appears to be significantly larger. Ernst and Young suggests that there were more than 30 products in Phase 3 and 60 in Phase 2 in Canada in 2003. Our own estimates of the Australian pipeline for 2002 indicated that there were about 5 at Phase 3 and over 20 at Phase 2 (Rasmussen and Sweeny 2002). Again the differential is much larger than explained by population or GDP differences, suggesting a more productive research and commercialisation process than Australia.

Innovation Policy Settings

Institutional Differences

It is not possible from available data to identify programs of support directed to the biomedical sector separately from other R&D intensive sectors. Accordingly this section seeks to compare the general level of government support for science and innovation in Canada and Australia.

The first challenge is to adjust the data available from each country to allow for institutional differences. As previously discussed both Australia and Canada are federations and accordingly responsibility for government activities is shared between the federal and provincial levels of government. In comparing the two countries, the major programs of support for science and innovation in both countries are at the federal level.

The greatest institutional difference is that in Australia, the federal government has taken over responsibility for universities, whereas in Canada this function remains largely with the provinces. For instance the Canadian equivalent of Australian

Government block funding for university research, is included in the provincial funds provided to the universities. However the Canadian federal government has assumed a significant role in supporting university research through the formation of various granting bodies (Canadian Institutes of Health Research (CIHR), Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC), which distribute research funds, largely on a competitive basis, to universities and other relevant organisations. Collectively these organisations have a similar role to that of the Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) in Australia.

The Canadian Government has expanded the role of this form of support by establishing new, independent funding agencies in the period since 1999. Of particular note is the Canada Foundation for Innovation and Genome Canada. Both have been established to help provide research infrastructure to universities and others engaged in research.

However they operate differently from Australian research granting agencies. They use their financial capability to leverage funding from the provinces and industry. Typically they provide only 40-50% of the cost of the relevant infrastructure. Provincial governments and industry are required to provide the remainder.

Both agencies enjoy a degree of independence from the vagaries of the annual appropriation process. Both had significant seed funding from the Canadian Government – C$800m for the Foundation of Innovation and C$160m for Genome Canada. These amounts have been topped up at regular intervals. Since their creation in 1999 and 2000 respectively the Canadian government has invested C$3.65b in the Foundation for Innovation and C$375m in Genome Canada. (Department of Finance, Canada 2004a) This has exceeded their immediate requirements and the surplus has been invested, so as to provide a substantial flow of investment income for each organisation. While the former has a general mandate to support R&D infrastructure, the later, as its name implies, is focused on the biomedical area.

One further difference is that a large proportion (half in 2002/03) of Australian Government support for science and innovation is allocated to federal government agencies directly engaged in research – eg the CSRIO and DSTO. In Canada less than a quarter of total funding for science and innovation appears to be allocated to agencies directly performing research. Of these, the National Research Council of Canada is the largest, although about 25% of its funding goes towards providing technological assistance to SMEs and disseminating scientific and technical knowledge more generally.

Both Federal Governments provide generous tax incentives for private R&D. These are a combination of enhanced tax deductibility for R&D, tax credits and more recently capital gains tax relief, targeted at venture capital investments. The provincial governments in Canada generally also provide some form of tax relief to local companies performing R&D. In addition both the Australian and Canadian governments provide grants to early stage companies to assist with R&D costs.

One initiative undertaken by the Canadian Government that has no parallel in Australia is the provision of loan guarantees totalling C$2billion through the Business

Development Bank of Canada for commercial lenders to R&D companies. The Canadian Government has also provided some C$190m to the BDBC in equity to help establish several venture capital funds. The Australian government established a small venture capital fund in 1997, which is managed by a number of private venture capital companies, but the government has not sought to provide loan guarantees for R&D intensive start up companies.

Cost of Federal Government Support for Science and Innovation: Australia and Canada

Table 3 provides in summary form, the cost of the major funding and support programs undertaken by the two governments. The Australian data is taken from the Science and Technology Budget Statement, which provides a comprehensive picture of the various components of Australian government expenditure supporting science and innovation, including an estimate of the R&D tax concession scheme. Most of the Canadian data is taken from the Public Accounts documents, which provide details of the expenditure by each government department by business line. This was supplemented by data available from the Budget Plan and the annual reports of the major research agencies. Most of the data is available for the period since 1994/5 except for the cost of Canadian tax incentives (sourced from Ernst & Young), which is available from 1996/7.

A valid comparison between the two countries is complicated by currency and price movements. Accordingly, the raw data in local currencies has been converted to USD, using a constant price PPP series for each country. Over the period since 1994/5, both currencies have declined against the USD. However the AUD has declined relative to the CAD and this has had the effect of reducing the growth of the Australian local currency series, relative to the Canadian local currency series.

Table 3 groups the programs under three major headings – funding provided to federal research granting agencies, federal research agencies and support for business.

Federal research funding agencies for Canada include NSERC, SSHRC, CIHR, the Canada Foundation for Innovation and Genome Canada, while for Australia the agencies are the ARC and NHMRC. Included in this category for Australia is funding for the CRC program and that for the Canada Research Chairs program.

The principal research agencies for Canada are, the NRCC and the Canada Space Agency, while those in Australia are the CSIRO and the Defence Science and Technology Organisation (DSTO). This category excludes the activities of government departments and other specialised research agencies. Whereas for Australia, a comprehensive picture of total Federal Government support for science and innovation is assembled each year in one of the budget documents, the data for Canada is drawn from many sources and departmental expenditures on science and innovation are not available.

As previously indicated support for business comprises the tax incentive scheme and various start grants and similar schemes designed to assist business with R&D expenses in the start up phase. For Canada it includes the Technology Partnership

program that helps fund the commercialisation of new R&D projects, often in partnership with industry.

Table 3. Federal Government Support for Science and Innovation: Australia and Canada (US$m Constant Price PPP)

	1994/5	1995/6	1996/7	1997/8	1998/9	1999/00	2000/1	2001/2	2002/3	CAGR from 1996/7
Grants to Research Funding Agencies										
Australia	235	361	386	414	428	428	533	505	556	6.3%
Canada	649	631	620	622	740	934	1,171	1,609	1,784	19.3%
Grants to Federal research agencies										
Australia	482	487	506	500	524	559	579	600	629	3.7%
Canada	578	579	558	587	761	818	915	1,091	1,031	10.8%
R&D support to business										
Australia	603	679	472	413	450	566	613	672	600	4.1%
Canada	0	0	852	892	1,106	1,318	1,261	1,392	1,462	9.4%
Total										
Australia	1,320	1,527	1,364	1,326	1,402	1,552	1,725	1,777	1,785	4.6%
Canada	0	0	2,029	2,101	2,607	3,070	3,347	4,092	4,277	13.2%

Note: $m in PPP at constant prices sourced from OECD.
Source: Australian and Canadian Government Budget Statements (http://www.budget.gov.au/past_budgets.htm and http://www.fin.gc.ca/access/budinfoe.html), various research agency annual reports (including NSERC, SSHRC, NRCC, CIHR), Public Accounts of Canada reports and Ernst & Young.

According to Table 3, for the period since 1996/7, Canadian government support for science and innovation grew at 13.2% pa, from $2.0b to $4.3b in 2002/3, compared with a 4.6% pa increase for Australia, from $1.4b to $1.8b in 2002/3. While growth for each category is significantly higher for Canada than Australia, it is especially marked for increases in grants to research funding agencies, which grew from $620m in 1996/7 to $1784 in 2002/3 at a growth rate of 19.3% pa. This compares with a growth rate for Australia of 6.3% pa from $386m to $556m over the same period. This reflects the creation by the Canadian government of new granting agencies, the Innovation Fund of Canada and Genome Canada, which have received a total of over C$4b in the period since their establishment in 1999 and 2000 respectively, as well as funding increases for the established granting agencies, NSERC, SSHRC, and CIHR. In addition the Government established a new competitively based Research Chairs program in 2000, which received C$360m in the period to 2002/3.

Canada has also spent generously on its two principal research agencies, National Research Council and the Canadian Space Agency with a total funding increase from $558m in 1996/7 to $1031m in 2002/3, a growth rate of 10.8% compared with an increase from $506m to $629m, largely for the CSIRO and the DSTO in Australia, at a growth rate of 3.7%.

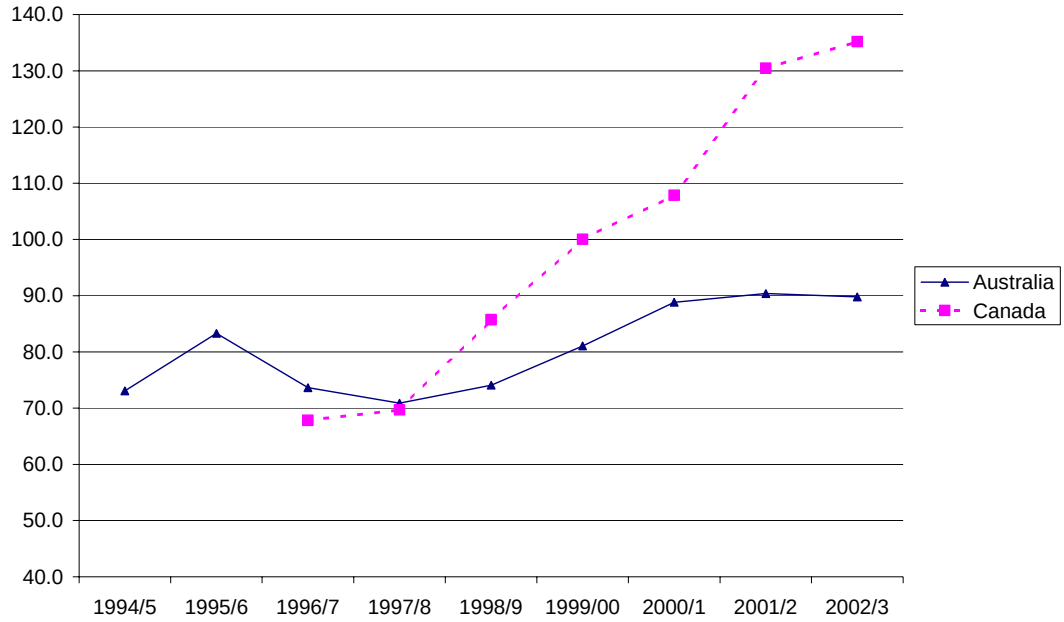
The difference in the level of support for innovation by business between the two countries has been quite marked for the whole period, although the growth in Canada since 1996/7 is also higher, 9.1% compared to 4.1% for Australia. Both countries have

attractive and relatively generous tax incentive schemes. Australia's scheme combines a rate of 125% deductibility for total R&D and 175% deductibility for incremental R&D, with a tax credit arrangement for loss making companies. Similarly Canada allows deductibility for total R&D and operates a tax credit scheme that allows the tax deductions to be cashed out. The relative costs of the two schemes can probably be largely explained by the level of business expenditure on R&D, which is substantially higher in Canada than Australia. Both countries have complemented their tax concession schemes with more targeted assistance programs. The largest program of this nature in Canada is the Technology Partnership program operated by Industry Canada. It has received funding over recent years of C$190m pa. The Australian Government provides somewhat similar levels of support for business R&D through its R&D Start and other similar programs

Per Capita Analysis

The differences in strategy between Australia and Canada are shown to be more pronounced when considered on a population-adjusted basis. Chart 3 shows the per capita trends in total support for innovation by the federal governments in the two countries.

Chart 3. Total Per Capita Federal Government Support for Science and Innovation, Australia and Canada ($US PPP constant prices)



Source: As for Table 3.

This shows that on a per capita basis, Australia in the mid 1990s was providing a similar if not higher level of support for science and innovation than Canada. The reduction in per capita support in Australia between 1995/6 and 1997/8 is due largely to the reduction in the tax concession scheme in 1996/7. From 1997/8 however, Canadian support grew rapidly while Australian support on per capita basis plateaued from 2000/1 onwards.

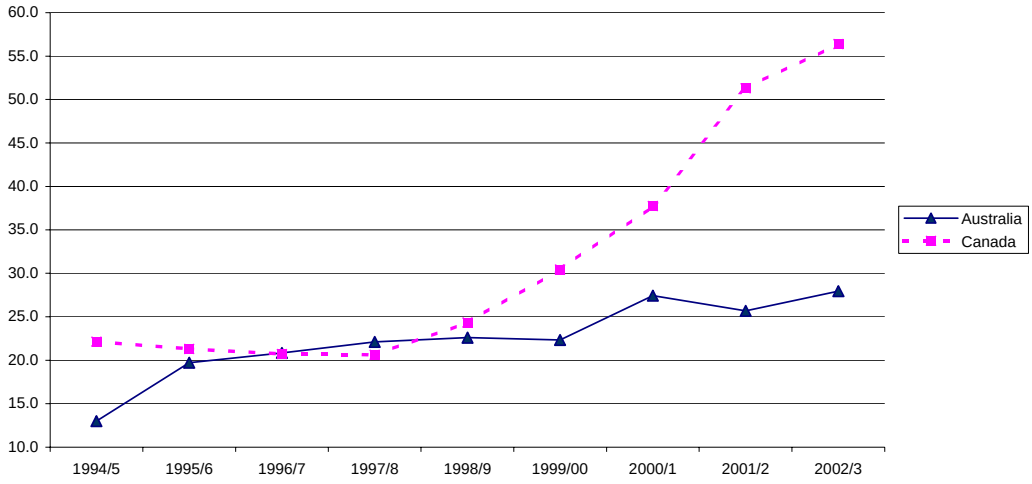
Table 4. Total Per Capita Federal Government Support for Science and Innovation, Australia and Canada ($US PPP constant prices)

	1996/7	2002/3	CAGR from 1996/7
Grants to Research Funding Agencies			
Australia	20.9	28.0	5.0%
Canada	20.7	56.4	18.2%
Federal research agency and other			
Australia	27.3	31.6	2.5%
Canada	18.6	32.6	9.8%
R&D support to business			
Australia	25.5	30.2	2.9%
Canada	28.5	46.2	8.4%
Total			
Australia	73.6	89.8	3.4%
Canada	67.8	135.2	12.2%

Note: $ per capita in PPP at constant prices sourced from OECD.
Sources: Australian and Canadian Government Budget Statements, various research agency reports (including NSERC, SSHRC, NRCC, CIHR) Public Accounts of Canada reports and Ernst & Young.

As shown in Table 4, in the mid 1990s the level of Australian government support was at least as high as Canada across all three program areas – research funding agencies, federal research agencies and support to business. Per capita grants to federal research agencies was considerably higher in Australia in 1996/7 than Canada, $27.3 vs $18.6. By 2002/3, this gap had been closed. Other programs also grew more rapidly in Canada over the period. This was particularly the case for grants to research funding agencies, which grew to be twice the per capita level in Canada in 2002/3, compared with Australia

Chart 4. Per Capita Federal Government Grants to Research Funding Agencies, Australia and Canada ($US PPP constant prices)



Source: As for Table 3.

The rapid acceleration in per capita grants to the research funding agencies from 1998/9 in Canada is shown on an annual basis in Chart 4. For the period 1995/6 to 1998/9, grants to federal funding agencies on a per capita basis were comparable, but with the establishment of new funding agencies and new funding initiatives being channelled through the existing agencies as noted earlier, grants to Canadian research funding agencies increased rapidly.

Innovation Policies: Australia and Canada

Any review of the economic policy statements of either government would reveal a strong interest in science and innovation. In Australia's case, its plan was set out in *Backing Australia's Ability* (DEST 2001), which followed a number of related reports and white papers, and for Canada, *Achieving Excellence* (Government of Canada 2002). This provided not only a detailed analysis and assessment of Canada's innovation performance, but also identified quantifiable targets to guide future action by government and industry. Both documents focussed on similar things, strengthening R&D, accelerating its commercial application and developing and retaining skills. They also emphasised the importance of broader supportive and competitive economic settings.

Canada

While Canada's major innovation policy statement did not occur until 2002, the Government had in fact made its intentions clear much earlier. The previous section of this paper has revealed that for Canada, the material shift in financial support for science and innovation occurred in 1998/9. Table 3 for instance shows that in constant PPP terms Canadian expenditure on science and innovation rose 24.1% from $2.1b in 1997/8 to $2.6b in 1998/9. Prior to that the government had been financially constrained. The Canadian Liberal Government came into office in 1994 and its first three budgets were devoted to bringing the very sizeable deficit under control. As shown in Table 3, this resulted in somewhat reduced funding for the major research agencies, from $1227m in 1994/5 to $1178m in 1996/7. In the 1995 Budget, a range of Industry Canada subsidies to business were targeted for reduction or abolition.

With the deficit reduced to more modest proportions, the Government began to reverse these expenditure reductions. The 1995 Budget indicated that some of the savings from business subsidies were to be spent on joint private/public sector initiatives in high growth sectors. The 1996 Budget Plan reallocated C$270m to encourage technology and innovation, with a substantial grant to Technology Partnerships Canada to facilitate high technology commercialisation.

The Martin Budget of 1997 announced the formation of the Canada Foundation for Innovation, with an upfront investment of C$800m, although funding for research did not begin to flow from the Foundation until the 1998/9 financial year. The 1998 Budget marked the return to annual increases for the major research agencies and by 1999, a series of government initiatives in science and education were beginning to have a significant impact on total funds available. In addition to the funding through the Innovation Foundation and other research agencies, the Medical Research Council was revamped to form the Canadian Institutes of Health Research, with significant

additional federal funding and a mandate to revitalise health research in Canada, with particular emphasis on commercialisation.

In the 2000 Budget, support for innovation had moved to centre stage. The need 'to build a stronger, more innovative economy' (Budget in Brief, Department of Finance, Canada 2000, p. 4), had advanced in status from being a supporting policy initiative, to one of the central propositions underlying the Budget. The 2000 Budget provided C$900m over 5 years for 2000 new research chairs and $160m to establish Genome Canada, as well as increases to existing programs. In addition corporate tax rates were reduced for small business and capital gains tax relief granted in the form of tax-free rollovers from one small business to another.

With the 2000 Budget, the Canadian government completed the introduction of most of its science and innovation initiatives. By and large, subsequent budgets have focused on increasing funding levels for these established programs. In particular, grants to the research funding agencies were increased by 37.4% in 2001/2, as shown in Table 3. A large increase occurred in funding for the Canadian Institutes of Health Research (C$134m) and the Government allocated C$200m to meet indirect research costs in universities.

Australia

As indicated above, the Australian Government's financial support for science and innovation has increased steadily, but in a less spectacular fashion than the Canadian Government. Early in the period under review, Australia's per capita expenditure was higher than Canada's. In the mid 1990s, when Australia was spending over $80 (PPP) per capita, Canada was spending less than $70 (PPP) per capita as shown in Chart 3.

The position reversed rapidly, not only because Canada's expenditure levels increased rapidly from 1998/9 onwards, but also because Australia cut its support for business R&D by 30.3%, from $679m in 1995/6, to $472m in 1996/7. This was largely a result of the new Liberal Government's action in reducing the attractiveness of the R&D tax concession arrangements in the 1996/97 Budget. The premium was reduced from 150% to 125% at an estimated cost saving of A$430m, one of the most significant savings of that Budget, and R&D syndication abolished. An offsetting but much less generous grant scheme was introduced. These decisions were in a way reversed in 2001 through the introduction of the 175% incremental R&D tax concession scheme and a Tax Offset scheme. These initiatives made Australia's R&D tax concession scheme (along with Canada's) among the most attractive in the OECD (OECD 2002).

Apart from the Budget of 2001/02, which coincided with the policy announcements contained in *Backing Australia's Ability* it is rare, in the Australian budgets since 1996/97, to find much reference to innovation or R&D. In contrast to the Canadian Budgets of the same period, which were grounded in the language of the knowledge economy, with an emphasis on skills, learning, research and innovation, the consistent themes of Treasurer Costello's budget speeches were reducing the deficit and taxation, benefits for older Australians, programs for regional Australia, defence and health. Indeed such was the relative novelty of significant increases in research funding, that the Treasurer could claim as 'an historic commitment' the Government's decision to 'invest an additional $614m over the next six years into health and

medical research' (Budget Speech 1999-00). A significant part of this was to 'enhance the national genomics capacity'. An amount of just over $100m per year pales beside the C$800m commitment of the Martin 1997 Budget for the Innovation Fund of Canada or the C$160m Genome Canada and C$900m (over 5 years) Research Chairs initiatives of the 2000 Budget.

The focus of Australian economic policy has been the macroeconomic framework, such as transforming the deficit to a surplus, lowering taxes and reducing interest rates. The Australian government has had only a very modest interest in support for science and innovation. While, the Canadian government was just as concerned in achieving similar macroeconomic objectives, it also appeared to be very driven to improving Canadian living standards through increases in knowledge and skill and investment in innovation. The threat to Canada's retention of 'its best and brightest', represented by the differential in living standards with the United States, seems to have added urgency to the Canadian policy initiatives, that has been lacking in Australia.

Comparative Policy Assessment

It is difficult, in assessing the policy settings of the two countries, to find a 'silver bullet' or a single policy program, which might help explain the superior performance of Canada compared with Australia. What emerges from this review is that from the 1990s support for science and innovation was at the very core of Canadian economic policy. The Budget Statements imply that success in innovation is central to the prosperity and survival of Canada. Comparisons are constantly drawn (favourable and unfavourable) between its R&D and productivity performance and that of the United States and other G7 countries. There is no sense that the Australian Government holds a similar view, which is reflected in the modest tones in discussion about the subject in the Budget Statements and the moderate expenditure increases accorded to the Government's science and innovation programs.

Each new initiative of the Canadian government appears to address every possible identifiable weakness in its national innovation system. None of it appears as tokenism. Each initiative is sustained, comprehensive and backed with considerable resources.

For instance, the need for properly focussed research infrastructure has been addressed with regular investments, totalling over C$4billion, in the Innovation Foundation of Canada and Genome Canada, with a requirement that they be matched by industry and the provincial governments. Genome Canada was created to ensure that biotechnology received particular focus. The need for dedicated senior research staff in the universities was addressed through the $900m Research Chairs program. Research funding to universities and others through competitive processes has increased substantially. The importance of ensuring proper collaboration between universities, institutes, the national research agencies and industry has been addressed in the revamp of medical research arrangements and programs operated by Technology Partnerships Canada and the National Research Council.

That the private sector be given every incentive to participate in the innovation process has also been addressed. The R&D tax concessions are generous by OECD

standards. They include a tax credit scheme for companies not making a profit so some of the refund is available in cash. Capital gains tax relief is available for the sale of small businesses to help encourage venture capitalists and business angels to invest in small early stage companies and corporate tax rates, especially for small business, are low by OECD standards.

It would therefore be surprising if this comprehensive and well resourced innovation policy was not having an important effect on Canada's innovation performance, relative to Australia, as evidenced by the size and relative success of its biomedical industry.

An Assessment of the Two Biomedical Innovation Systems

Within the constraints of the data limitations a number of observations can be made about the two innovation systems. Canada's biomedical innovation system has enjoyed a much higher level of commercial success than Australia's. Even based on the partial data we have, the number of drug candidates in Phase 3 is many times that of Australia. The relative level of private sector funding, whether by venture capital or in later stage alliances, is indicative of greater commercial success.

The Australian innovation system seems to be characterised by long-term systemic failure in private sector support for the biomedical industry compared with Canada. Is this a supply or demand side problem? Australia is proud of its science base, which does appear to be world class, but is nonetheless shaded by Canada's as measured by citation adjusted publications and patents. So is there a sufficient supply of 'investable' projects? Australia's per capita public expenditure on health R&D is lower than Canada although the difference is not as large as for other innovation system indicators.

Is Australia lacking effective linkages between science and industry? Do Australia's scientists play the same role of star scientists in the commercialisation process, as Zucker et al. (1998b) have identified as a critical success factor for US biotechs?

Compared with Canada, Australia has significantly under-invested in private R&D in health and while the growth rates for the last decade have been about the same, the gap has remained large. Over this period the Commonwealth has significantly wound back its funding for the pharmaceutical industry with the Factor (f) scheme being replaced at a much lower level by P3.

P3's objectives are laudable. It focuses 'on the develop[ment] of medicines for global markets and [to] encourage multinational firms to foster partnerships with local players' (DITR 2004). It has available $150m over 5years to support expenditure on R&D. First round offers have been made, to both large pharma and Australian biotech, for amounts up to $10m. Its objective is to encourage the formation of partnerships, but whether its scale is of sufficient size too to have a serious impact remains to be seen.

Australia's policy initiatives appear faint hearted by international standards. Both countries have intense competition from US states outside the dominant clusters, seeking some share of the biotech 'boom'. Most US states have attractive tax related

incentive schemes and a myriad of other initiatives aimed at achieving commercial returns from biotechnology. Florida recently committed US$500m to recruit the Scripps Florida Biotechnology Research Institute (Battelle 2004).

If Australia's biomedical innovation system was to match the performance of Canada's, this analysis suggests that industry policy could usefully focus on three aspects:

- Public expenditure on health and biotech related R&D.
- Funding to complement private financing of commercial development.
- Policies designed to attract large pharmaceutical companies to partner biotechs.

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Appendix A

Table A1: Key Indicators for the Canadian and Australian Biomedical Sectors

Indicator	Year	Australia	Canada	Canada % Aus
Population (a)	2003	19.7	32.2	163%
Public R&D on health (A$m)* (b) (c)	2000/01	1284	2984	232%
Life Sciences publications (citation adj.) (d)	1995-99	91080	222847	245%
Biotech patents issued by USPTO (e)	2000-03	305	913	299%
Biotech biotech technology alliances (no.) (f)	2000-03	121	305	252%
Business R&D biotech related (A$m)* (g,h)	2001	647	2359	365%
Drug development alliances (i)				
- number	2000-03	31	172	555%
- payout (US$)	2000-03	273	2209	809%
Later stage drug development alliances (j)				
- number	2000-03	9	78	867%
- payout (US$)	2000-03	51	1889	3704%

Sources:

(a) CIA 2003.
(b) Ernst and Young 2001.
(c) Access Economics 2003.
(d) European Commission 2003.
(e) USPTO.
(f) ReCap.
(g) ABS 2002.
(h) Statistics Canada 2003b.
(i) ReCap.
(j) ReCap.