The Impact of Innovation Policy on Canadian Universities and the Migration of Skilled Canadians*

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I. Introduction and Background

The role of innovation in the well being of Canadians has become increasingly important in the new millennium. As the average living standard of Canadians decreased throughout much of the 1990s relative to that in the US, and national newspapers and certain think tanks bemoaned the loss of Canada's "best and brightest" to that country, policy makers began to look for answers to solve Canada's productivity slowdown, a key variable in the economic equation determining the standard of living of Canadians. Solving this productivity puzzle becomes even more important in light of the aging population which means a higher dependency ratio – fewer working Canadians to support the entire population – and also because of the phenomenon of economic globalization which has increasingly led to a decline of output and employment in the old, 20th-century smokestack model of economic development. The "New Economy" was to be the remedy for the lacklustre performance of the Canadian economy. This economy would be based on the intellectual capacity of the Canadian people and their ability to solve problems in new ways. The world was progressing whether Canadians liked it or not and we should jump on this innovation bandwagon or risk being left behind and having our precious Canadian institutions eroded or (worse) eliminated. The innovation strategy will touch Canadians either directly or indirectly since – as the saying goes – a rising tide will lift all boats.

Current Canadian innovation policy is very much a child of the 1990s, when productivity growth in Canada was sluggish and government deficits at the federal and provincial levels in the early 1990s meant less money for research and development.[1] The result was that a large number of Canadian researchers searched for greener pastures, often south of the 49th parallel. The federal government initiated a new long-term strategy for research and development in 1997, making universities the centrepiece. This strategy rested on four pillars: increased support for the direct costs of research; partial funding for the indirect costs of research; the purchase and operation of world-class infrastructure; and, the attraction and retention of world class talent. Making good on this strategy, the federal government then established or modified existing programs over the following two to three years. The result has been that programs such as the Canadian Foundation for Innovation, the Canadian Institutes of Health Research, the Canada Research Chairs Program, Genome Canada, increased direct funding for Canada's three main scholarly granting agencies,[2] and increases in funding for the indirect costs of research.

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[1] AUCC provides an excellent brief history of Canada's innovation policies. Much of what follows has been drawn from this source.

[2] These are the Natural Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and the Canada Council (which supports the fine arts).

Largely following the US model of innovation-led productivity growth, the federal government extended its vision of innovation policy to include the private and not-for-profit sectors, as well as the government research sector. Broadening the innovation agenda was an important step, because while there is widespread agreement that this leads to higher rates of productivity and economic growth, spending on R & D alone is a necessary but not a sufficient condition for this to occur as witnessed by higher rates of R & D expenditures as a percentage of GDP in countries such as Japan, coupled with relatively weak overall economic performance (Harris "Costing").[3]

This new vision was outlined in two key documents in February 2002. Entitled *Achieving Excellence: Investing in People, Knowledge and Opportunity*; and *Knowledge Matters: Skills and Learning for Canadians*, these documents supplied a blue print for innovation policy in Canada, and provided remedies to reverse the relative decline in productivity and Canadian living standards vis-à-vis the United States, as well as supplying the resources necessary to finance Canada's social programs. It also offered a number of quantifiable targets and a series of consultations with various stakeholders which culminated in the Innovation Summit later that same year. At this time universities, represented by the Association of Universities and Colleges of Canada (AUCC), promised to monitor their progress towards the government targets set out in the two documents, while the federal government committed to provide the resources necessary to obtain their goals. This fundamental policy has been followed since.

In *Achieving Excellence*, the path by which knowledge is transformed into products or services – in other words, innovation – is identified as

> the process through which new economic and social benefits are extracted from knowledge. Through innovation, knowledge is applied to the development of new products and services or to new ways of designing, producing or marketing an existing product or service for public and private markets. The term 'innovation' refers to both the creative process and the outcome of that process (4).

Whereas innovation used to be viewed as something that happened in the laboratories across the country, "we [now] view innovation as something that can be encouraged as part of a deliberate strategy to improve national productivity growth and Canadians' standard of living (6)." To paraphrase, innovation encompasses both basic and applied research as well as commercialization of the ideas spawned by either.

The purpose of this chapter is to discuss some of the implications of Canada's innovation agenda as they relate to the research and teaching missions of Canadian universities, as well as the migration of highly skilled Canadians to the United States, both of which are inextricably related. Indeed it was the lack of R&D funding that many blamed for the loss of many Canadian scientists and scholars in the 1990s and, at least in part, provided a wake-up call to both the federal and provincial governments that something had to be done to make Canada more internationally competitive in the face of globalization and the rise of the knowledge economy.

II. Implications for Canadian Universities

A key component of Canada's innovation strategy since 1997 has been research at Canadian universities, since these institutions undertake the lion's share of basic research in Canada, as well as an increasing share of all R&D, from about 29.5 per cent in 1980 to about 38.1 per cent in 2004 (Figure 1). Although Canada's innovation strategy involves both universities and private

[3] While the causal link between university activities and economic growth is taken as a logical link by most researchers, there is virtually no proof of this proposition (Beach). There is in fact a large literature on the rates of return to public and private funding for both applied and basic research and – although there is not yet a consensus on its efficacy – most observers do agree that it does have positive externalities or spillovers and thus benefits society as a whole. It is outside of the scope of this work to present these arguments. For good reviews of the debates and the issues surrounding innovation policy in general see Salter and Martin, and Adams. For reviews specifically related to Canada, see Cochrane, Head and Reis, Laidler, "Renovating", and Wolfe and Salter.

sector firms, it is undoubtedly universities that will continue to be the platform from which most innovation – especially basic research – takes place. McKinnon argues that Canadian firms do much less research than their American counterparts because they are much smaller and it is more difficult for firms of this size to support research. The corollary to this is that Canadian universities – which are not generally smaller than their American counterparts – do proportionately more research and thus any increase in funding for research will be directed disproportionately towards these institutions.

The foundation to any innovation strategy is education. Indeed at a recent Institute for Research on Public Policy "Agenda-Setters" Workshop, 12 public policy experts unanimously agreed that education was one of Canada's top public policy priorities, although there was some divergence, at which level point education was best targeted (Leonard, et al.). Still, any policy addressing innovation in the new economy must also seriously consider the implications for universities and evaluate whether any changes are in the best interests of the institutions involved and in the best interests of the nation as a whole.

Here I outline and evaluate three possible consequences for universities that flow from the government's innovation policy: the movement of resources into the sciences; the impact on the teaching mission of universities as a result of the increased emphasis on research; and, the allocation of research resources between applied and basic research.

A. Diversion of Resources into Science

While the recent increase in funding to universities across Canada has generally been welcomed, there have also arisen concerns that there will be an increase in specialization at universities as resources are increasingly diverted towards the sciences at the expense of the social sciences and humanities.

Laidler ("Incentives") argues that the overhead and maintenance costs of science programs are large, and he fears that social sciences and humanities programs will be cash cows for the universities and used to subsidize the sciences. This follows university administrators following the money and establishing and expanding existing programs to take advantage of these new resources, and also because the indirect costs of science in Canada still tend to be underfunded from public sources, thus diverting internal resources to these activities.

This is not unique to Canada. In the same volume, Ehrenberg notes that US universities have also followed the science and technology model which has drained resources from other disciplines, since much of these expenditures come from internal funds. This has resulted in higher tuition costs, larger student-faculty ratios, and increased use of part-time and non-tenure track faculty for teaching, all of which affect student quality.

While much of the evidence on innovation suggests that there are large international spillovers from research in science it technology, especially for a small country like Canada, and certainly because the country is so closely connected to the research juggernaut in the US, the same does not necessary hold for non-scientific disciplines. In other words, it is possible – though perhaps not desirable – for Canada to free-ride on the scientific research and innovation done in other countries, since science doesn't change across borders. However, research in the humanities and social sciences is generally country-specific. Laidler says "a country that relies on another jurisdiction to do its critical thinking for it on matters of values, and of their application to social questions, will in due course end up with no values of distinctive policies of its own, and will cease to be a distinct entity ("Renovating" 27-8) Transference of knowledge in these disciplines may not only be ill advised, given the differences in institutions between countries, but also dangerous since it may very well result in the application of inappropriate policy prescriptions.

In a similar vein, Svedberg argues that competitiveness is not only derived from investments in science and technology, but also from cultural and societal institutions. Thus, the importance of the social sciences and humanities is actually increasing with the rise of economic globalization, and investments in the sciences "should not be financed by counterproductive cuts in the humanities and social sciences (20)."

The Canadian Association of University Teachers (CAUT) – an organization that purports to speak for the Canadian professoriate – has said that while this model of specialization in the sciences may work in the private sector, it is devastating in the academic environment. Students need a well-rounded education in order to be able to compete in the knowledge economy. The best engineering skills are worth less (although not necessarily worthless) without the ability to effectively communicate these ideas.

In her 2002 Killam lecture, UBC President Martha Piper, herself trained in the health sciences, argues that more funding is needed for the social sciences and humanities in order to build a civil society. She notes that the traditional thinking is to first establish a strong and innovative economy in order to have the resources to build a civil society. She cites the (now) well-known work of Richard Florida and his colleagues to argue that in order to have an innovative economy, "you must first have a civil society – one that is tolerant, culturally diverse, and humane – that in turn provides the stimulus for creativity and innovation (15)." Thus, she argues that "our values are moving away from the pursuit of material goals towards post-materialistic priorities – priorities rooted in the individual's aspirations to belonging, freedom, self-esteem, and quality of life (15-6)." It is these topics which are studied by social scientists and humanists, or what she refers to as the *human sciences*, and these are an integral part of a society's knowledge base:

> Research in the human sciences is as important to our advancement as a civil society as research in biochemistry is to the advancement of our health. And knowledge transfer in the human sciences – the transfer of findings into policy and programs – is as important as technology transfer is in the engineering and natural sciences (Piper 22).

While Piper applauds the government's increase in funding to the sciences, she suggests boosting funding in the human sciences in order to gain the full benefit of these investments in the sciences. The establishment of a strong civil society is also important in attracting both internal and international migrants to a region (discussed below).

Although the diversion of resources into the sciences, at the expense of other disciplines was and is a real concern, the available evidence – at least to date – is not supportive. The data in Table 1 (charted in Figure 2) show that total domestic expenditures on R & D has grown by 188.1 per cent between 1980 and 2004 in inflation-adjusted terms, with about one quarter of this increase occurring since 1997.[4] Since 1980, total funding to the sciences has increased by 195.0 per cent; funding to the social sciences and humanities has increased by only 126.2 per cent. Still, since 1997, the growth rate in funding to the social sciences and humanities has been about 2.5 times that of funding to the sciences (101.9 versus 41.0 per cent). Undoubtedly, part of this is due to the decrease in R&D expenditures from the private sector, the result of the slowdown in the high technology sector since 2000. The net effect has been that much of the relative funding decreases in the 1980s and early 1990s to the social sciences and humanities have been made up: in 2004, these disciplines received almost 8 per cent of the total R & D funding in Canada, a much higher proportion than in most of the 1980s and throughout the 1990s. The same general pattern is found in Figure 3, which is limited to total R&D funding to the higher education sector (mainly universities). Compared to all sectors, the university sector has shown a constant growth in funds to both the sciences, and the social sciences and humanities. Although the increases to science were generally somewhat larger until 1997, the pattern thereafter is very similar. To address any internal diversion of funds, Figure 4 shows university allocation of R & D

[4] All data pertaining to research and development are from the author's calculations based on Statistics Canada CANSIM database, Table 358-001, gross domestic expenditures on research and development, by science type and by funder and performer sector; and Table 326-0002, consumer price index, 2001 basket content; Canada; all-items (index, 1992=100).

expenditures within universities. Again, the trend is almost identical to that shown in Figures 2 and 3.

This evidence shows that there does not appear to be a larger share of research funds going to the sciences at the expense of the social sciences and humanities in universities across Canada. These figures, however, are aggregate data and they may not be representative of individual institutions. Furthermore, we have no way of knowing the intra-disciplinary allocation of these research funds. For example, within the funding basket for the social sciences and humanities are commerce and law, and it is quite possible that an increasing proportion of research funds are directed towards these fields at the expense of, say, history and philosophy.

B. Teaching versus Research

As Canadian universities put increased emphasis on research – whether it is applied or basic, in the hard sciences or human sciences – there will likely be an effect on the teaching mission of these institutions that will affect the productivity of university trained students. For example, a common use for grant or contract money is to buy course relief, allowing the researcher a greater amount of time to pursue her research. This could have a negative effect in the sense that the professor is now teaching fewer students. However, the effect might also be positive if this same professor hires her best students to work on research projects and/or devotes more of her time to specialized courses (with presumably smaller numbers of students) in her area of specialization. Thus, while fewer students may be taught, qualitatively they may be better.

Davenport discusses the delineation of knowledge discussed by Lloyd-Ellis and Roberts*: frontier knowledge* and *transferable knowledge*. The former is knowledge that is acquired through research; the latter is the knowledge embodied in human beings and is transferred from one generation to the next. Sustained economic growth requires both, since frontier knowledge alone will encounter diminishing marginal returns without a complementary investment in transferable knowledge. Yet, it is frontier knowledge in which the government has focused its strategy, to the detriment of transferable knowledge. This is because research monies cannot generally be used to hire new faculty members, but rather are used for research assistants, lab equipment, lab space, etc. These indirect costs of research mean that resources must be diverted from other parts of the university, and it is often the teaching mission of the university that suffers. The Canadian government since 2001 has begun to finance these indirect research costs, but whether or not these monies are sufficient remains to be seen.[5]

While the data in the previous section imply that there has been little (if any) distortion in funding between disciplines, this does not mean that the teaching mission of the university has not been harmed. This might occur, for example, as university resources are used to hire new faculty in popular (and lucrative) research fields. If this were the case, we would expect to see changes in the relative shares of faculty members and students as well between fields. Unfortunately, publicly accessible data for Canada are not readily available.[6] Data are available, however, for student enrolments, which should be a reasonable proxy for the increase in faculty in various disciplines, assuming that an increase in R&D funding will attract more students. Table 2 presents data on university enrolments for the 1997/98 and 2003/04 academic years, with the total numbers loosely grouped in the sciences and social sciences and humanities. There has been a 23.0 per cent increase in the social sciences and humanities, and a slightly higher increase of 23.9 per cent in the sciences. Thus, the growth in enrolments has been spread fairly evenly over these disciplines. Within these broad categories, however, the number of students enrolled in mathematics and computer science, and in architectural and engineering fields has grown much

[5] The AUCC, for example, has argued that the government's rate of funding is too little ("Indirect").
[6] Comparable figures for the US, which is experiencing the same phenomenon as Canada in academia, do not show a discernable movement of faculty resources across disciplines, based on the author's calculations from the following sources from National Center for Education Statistics: http://nces.ed.gov/programs/digest/d04/tables/dt04_234.asp and http://nces.ed.gov/programs/digest/d05/tables/dt05_233.asp, 16 June, 2006.

faster than average. The most phenomenal growth has occurred within the management and related fields category: 37.2 per cent relative to the mean of 23.0 per cent

C. Basic versus Applied Research

With the provincial and federal government funding cutbacks to university operating budgets in the 1990s, these institutions many times turned to the private sector to make up for budgetary shortfalls (Robertson). Although support from industry can take the form of donations, scholarships, etc., it can also be industry-financed research. While recent increases in funding for basic research through Canada's three granting agencies is welcome news for Canadian universities, it may be too little too late, now that the industry funding to universities has begun. Federal and provincial government funding reductions to Canadian public universities in the 1990s left universities with little choice at times but to seek outside funding, and even though the public taps have again been turned on, it is unlikely that the relationship forged between the university and private sector will diminish once they have been established. Indeed the AUCC, in a recent press release, said:

> Canadian universities have attracted the highest share of private sector research of any of the G-7 countries . . . Even as the private sector has reduced its overall investments in research and development early in this decade, they continued to increase their investments in university-based research ("Research").

The data in Figure 5 show that the business share of total university R & D has increased, especially throughout the 1990s, more than doubling from about 3.9 per cent in 1980 to 8.7 per cent in 2004. The share of internally financed research increased during the 1990s, at the same time that funding from governments decreased. The natural sciences and engineering continue to receive most of money from business with its share increasing from 5.2 to 10.3 per cent over the 1980 to 2004 period (Figure 6).

While the total amount of business R&D money at universities is small, it is obviously increasing in importance. The most simple argument against this type of applied research is that if a researcher (or a team of them) is working on commercially valuable ideas, the opportunity cost is the academic knowledge that they might otherwise be creating – research that is destined for the public domain. Contracts between academic researchers and private firms, by contrast, may result in research being directed in a certain direction and/or prohibitions or delays in the publication of results in peer-reviewed journals.

According to van Loon, technology transfer can occur in one of two ways: it may lead directly to patents and licensing agreements; or it may occur through a general increase in the stock of knowledge. He argues that the latter is probably the more important in the long run since it has long been considered that applied research will exhaust all technological opportunities in a field. Van Loon then argues that this requires the continual augmentation of the stock of basic knowledge, and that Canadian universities are the ones that are the major source of this knowledge. In other words, applied research will not continue without basic research and it is Canadian universities that generally supply it. He further notes that in 2004 the revenues to Canadian universities from patents and licensing agreements amounted to some $51 million; not a trivial amount, but only some 0.25 per cent of the total university revenues in that year, and perhaps below the cost to universities of supporting these activities. Granted, this benefit-to-cost ratio could change, but given the inherent risk in successfully profiting from technological developments at a university, this seems unlikely.

Salter and Martin review the literature and find that there are considerable economic benefits to the public funding of basic research, they write:

> These benefits are often subtle, heterogenous, difficult to track or measure, and mostly indirect. Publicly funded basic research should be viewed as a source of new ideas,

> opportunities, methods and, most important, trained problem solvers. Hence, support for basic research should be seen as an investment in society's *learning capabilities* (528). (emphasis in original)

It is these indirect effects of basic research – such as the (appropriate) training of graduate students (who may go on to work in industry) and making research results available in the public domain – that are important. It is also the short-term intangible nature of these benefits that is questioned by governments, policy makers and the public. Still, Salter and Martin note that nations or regions cannot free ride on the world scientific system but must have, at the very least, the ability to understand the knowledge produced by others (and at times contribute to it) and this can only be developed by performing basic research.

While few would disagree that training students is an important component of any research funding – indeed, Canada's public granting agencies weight this component of grant applications heavily – it is often not possible with the current status of intermittent funding, especially with research funding that comes from industry. With this type of "soft" funding, the number of scientists hired on short-term contracts increases, and the number of tenured faculty members may decrease. Courses may now be taught by sessional instructors, and the ability to build good programs that provide solid training to the next generation of scholars may be severely compromised in such an environment. Indeed, the data do show that the number of full-time faculty in Canada decreased throughout the 1990s while the number of part-timers increased (Omiecinski).

Of course, there may also be overlap between basic and applied research, although often there is almost a clash of cultures between academic and commercial activities (Goldfarb and Henrekson). Recent thinking, however, has underlined the importance of the externalities created by both basic and applied research. Indeed the "linear model of innovation" – in which basic research flows into commercial products and which has long dominated both thinking and policy making – must be changed according to Svedberg. He argues that the process is not linear, but rather "feedback loops" exist, so that commercial activity also influences basic research. He generally favours the academy having a role in the new economy and being involved in the commercialization of knowledge. He concludes: "The key thing to remember is our need to balance the university's growing economic role with our long standing concerns for academic freedom and excellence in scholarship (36)." Evans echoes this: "The classical sequence of university discovery research followed by commercial development has given way to telescoped and interrelated academic and commercial research and development (26)." Like Svedberg, he favours pushing forward with these types of activities but without risking the fundamental focus of the university.

Ironically, it is often government policy that pushes universities into alliance with the private sector. Cuts to university funding in the 1990s resulted in universities seeking more private money, and more recently programs such as the Canada Foundation for Innovation (as well as various provincial government programs) call for universities to find partners in the private sector to provide funding. Beach, et al. write:

> These have the effect of privileging applied practical scientific research, diverting funds away from fundamental and long-horizon research, leveraging university activities to become more aligned with specific corporate research priorities, and shifting resources from non-science/technology/medical areas which have traditional provided liberal education training and where most undergraduates and faculty are located (5).[7]

[7] CAUT, on its website, similarly notes: "CAUT believes that tying universities and colleges more closely to commercial interests impedes the development of new knowledge and innovation. A greater reliance on private funding narrows the focus of universities and colleges to teaching and research programs that have a market value. Corporate interests and research ethics can easily conflict, and financial ties to industry can bias research outcomes ("Opposing")."

Davenport expands on this line of reasoning and argues in essence that basic and applied research must be separate:

> It is vital to understand . . . that it is precisely the distance of universities from the market which makes them such valuable collaborators with competitive firms in the knowledge economy. When the discoveries of fundamental research run dry, the innovative companies of the private sector have no fuel in their pipeline. While technology transfer and industrial collaboration are important, if universities ever lose the focus on basic, fundamental research, the knowledge economy as a whole will suffer (49-50).

Wolfe and Salter too warn about the long-term losses to society when too much focus is placed on applied research: "taken collectively, the body of evidence reviewed in this report provides a strong indication of the social and economic benefits that accrue to a country's innovation system for public funding from basic research (47)." The authors cite a number of US studies which warn against the reduction of public funding for this type of activity in favour of the perceived shorter term benefits of commercially oriented research, since doing so would dry up the basic research on which commercialization feeds.

While applied and basic research may enhance one another, as suggested above, it is also quite probable that basic research feeds off itself. The late Canadian Nobel Laureate, Michael Smith, notes the importance of attempting to predict the future of discovery for planning and funding purposes, but cautions against the hazards in predictions "because the basic fascination of research, inseparably bound to the thirst for knowledge, is the total unpredictability of the events of discovery (13)." Thus, basic research too results in spillovers that beget more basic research. Similarly, Betts and Lee argue that universities are a necessary but not sufficient condition for knowledge spillovers to occur and to result in economic growth. "Technology commercialization is a very different beast than knowledge creation; a region needs both to thrive. To be blunt, if anything, there is a tendency in the literature to perhaps overplay the role of universities and underplay the role of the private sector in generating innovative technology clusters (150)." For example, Mike Lazardis, founder, president, and co-CEO of Research in Motion, the makers of the ubiquitous Blackberry, notes: "In the 20-year history of Research in Motion, I have licensed exactly two technologies from university research teams (3)."

Masked in all the arguments and statistics is the issue of academic freedom and how research money is directed. While it is usually industry grants to universities that are cited as diverting resources away from basic research and into narrow applied fields, funding from public sources may have similar effects. This subtle argument suggests that funding – regardless of its source – may not directly impinge upon academic freedom, per se, but may still indirectly harm academic freedom by limiting "how problems are defined and research activities organized (Svedberg 23)." In other words, commercial funding for research may be redirecting the direction of inquiry, without limiting what occurs within these activities, but nonetheless limiting academic freedom. This is not to say that government funding may not have a similar effect on research. Laidler ("Renovating") points out that governments are no more willing than others to remain at arm's length from the activities that they fund and increasingly seek to influence the activities that the research activities take. One need look no further than the number of "strategic initiatives" launched by Canada's funding agencies have been supported generously in recent years. Laidler writes:

> if research productivity in universities is, like productivity elsewhere, a matter of "mushrooms" rather than "yeast," then public support for research would be better concentrated on researcher-initiated and curiosity-drive projects than, as at present, on centrally designed strategic initiatives (33).

Similarly, Bernard Shapiro questions the diversion of resources to areas which may have (at best) significance in the short-term:

> We should also worry about the cult of relevance, which is that the only reason for doing something is because it seems to be immediately useful to something else. In other words, we should worry that we far too frequently translate utility into market value. It is as if we actually knew or actually know, for example, what will be useful in the future. All of our experience, however, tells us that we did not and we do not (17).

III. Implications for International Migration

The 1990s witnessed an increase in the number of skilled Canadians going to the United States. The so-called "brain drain" from Canada was blamed on a variety of factors from higher Canadian taxes, to sluggish employment growth in key sectors, to the booming American economy.[8] Indeed, evidence did point to the fact that Canadians entering the United States were amongst Canada's most educated and highest income earners (Frank and Bélair; Zhao, et al.; Mueller, "What Happened"), and many came from amongst this country's science and engineering ranks (Schwanen).[9] Furthermore, returns to education increased dramatically in the United States and – related to this phenomenon – the distribution of income widened. This did not occur in Canada during this period (Mueller "Changes" and "Is Canada"; Card). Riddell has shown that there had also been an increase in demand for highly skilled labour in Canada in the 1990s, but this has been matched by an increase in supply, thus moderating the pressure on income inequality, while keeping the returns to education in Canada high.

The implication of these factors meant that well-paid scientists and scholars in Canada could markedly improve their standard of living by working in the United States (Mueller and Hunt). The implementation of the Canada-United States Free Trade Agreement in 1989 (and its successor the North American Free Trade Agreement or NAFTA) facilitated this exodus by implementing a special class of visas for educated workers from either country wishing to work on the other side of the border. The booming US economy, especially in the knowledge sectors, simply exacerbated this flow, as did government cutbacks in research expenditures to both universities and the private sector in Canada.

Although the migration of Canadians to the United States is hardly novel in Canadian history, it was the *composition* of this migration flow of the 1990s that worried many commentators. Harris ("Costing") notes that these highly talented individuals create plenty of knowledge spillovers which are becoming increasingly important in the determination of living standards. In a profoundly Canadians reference, he calls this the "Wayne Gretzky" model of migration. The analogy is a good one: Canada has always sent talented hockey players to the United States, but when the game's best player went from Edmonton to Los Angeles in 1988, his new team gained not only his talent (measured by goals), but also his spillovers (measured by assists) as he contributed to the productivity of his teammates. The same argument holds for talented scientists and scholars.

Indeed, the concern over the brain drain has largely diminished in the past few years; the combination of Canadian innovation policies, increased government spending in key sectors such as education and medicine, all combined with a strong Canadian economy, a soaring dollar, and weaker economic growth south of the border. Finnie ("Evidence") finds that the departure rate from Canada has declined since 2000, at the same time that the return rate has been increasing; thus the net flow of Canadians to the United States has decreased.

The AUCC has applauded the direction of Canada's innovation policy and noted that the increase in both provincial and federal funds to universities has helped to attract and retain researchers in this highly competitive international marketplace ("Momentum"). Programs such as Canada

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[8] See Finnie ("The Brain Drain") and the associated comments for a review of this debate.

[9] Whether this migration was temporary or permanent is still the matter of some debate. In the former case, there is also debate about whether this really represents much of a loss to the Canadian economy; migrants could return to Canada with new skills, ideas, connections, etc., all of which would be beneficial to Canada.

Research Chairs and the Canadian Foundation for Innovation have attempted to attract and retain the best and brightest, which includes stemming the flow of talented academics out of the country as well as attracting ex-patriot Canadian and international researchers. The provinces have also responded with many programs of their own, but with the same goals in mind.

Complementing the increased funding to Canadian universities has been an increase in the number of students (see Table 2). Part of this is the result of an increase in the number of foreign students (Mueller "What Happened"); the short-term reason for this could be financial for university administrators – foreign students pay higher tuition – but the longer term benefits could accrue to Canada since many of these foreign students choose to live and work in Canada following graduation. Helliwell argues that this method of "building" brains – rather than buying them (through immigration) or sharing them (through outsourcing or foreign labour embodied in traded goods and services) – is a cost-effective way to build Canada's stock of knowledge workers, especially those with graduate education. This also represents a way to avoid the cumbersome problems of immigration and recognition of foreign credentials. The fact that Canada's capacity for graduate education has grown, makes this so much easier today. The post-September 11th period in the United States also presents a window of opportunity to attract foreign students (Eden; Gera and Songsakul).

This idea of building brains is also expressed by Mike Lazaridis who says that universities have no business in pursuing the patent game since resources are diverted away from undergraduate teaching, training graduate students, pursuing novel theories, and interaction with international colleagues, all of which contribute to the stock of knowledge. He argues that Canada must focus on and fund basic research and provide infrastructure to attract the best and brightest from within Canada and around the world, and to train students with the latest knowledge and techniques. The training of highly skilled individuals is the main contribution of universities to the new economy and this is the critical contribution of universities to Canada in the knowledge economy, especially given the rather lacklustre record of university success in commercializing research.[10]

Related to the attraction foreign students -- especially graduates students – is retaining talented Canadian students, the pool from which the scientists and scholars of tomorrow will be drawn. As Gibson notes, there are an increasing number of students going from Canada to the United States, and a large number of these are attending graduate and post-graduate professional schools. While inherently this is not really an issue, the fact that subsequent employment recruiting tends to take place regional and locally, means that many of these gifted young people will begin (and perhaps complete) their careers in the United States. Indeed there is evidence that many of those studying for doctoral degrees in the US intend to remain following their studies (Johnson and Regets; Finn). Furthermore, it is well documented that scholars and professionals educated in the United States often facilitate further migration to the US through the networks that are created between foreign nationals and foreigners educated in the United States (Cheng and Yang).

Building (and keeping) the necessary number of brains will be a challenging exercise. Evans expresses the oft-repeated number of 30,000, the number of new faculty members that will be needed in Canadian universities over the next few years as enrolments increase and established faculty retire. Given the fact that these, as with all knowledge workers, are so mobile, coupled with the fact that most of Canada's competitors are following their own innovation strategies, may be problematic in terms of Canada's ability to attract and retain these highly skilled workers. While Canada cannot compete with the deep pockets of US universities, especially the leading

[10] Putting his money where his mouth is, Lazaridis has (to date) put well over $100 million into both the Perimeter Institute for Theoretical Physics in Waterloo, Ontario, and the Institute for Quantum Computing at the University of Waterloo; the intent of which is to attract a critical number of scientists who will perform basic research, push the frontiers of knowledge, and train talented young students. In other words, it is by building the appropriate cluster of specialists performing cutting edge research that Canada's capacity to compete in the global knowledge economy will be enhanced.

research universities,[11] it can compete with the appropriate quality of colleagues, research resources and organization culture. For example, academic researchers highly value the quality of their colleagues, and the ability to efficiently and properly conduct their research; both of which mean that better-organized institutions are better able to attract and retain better faculty. This has led some scholars to recommend the concentration of highly skilled individuals into research clusters. For example, Head and Reis review the literature and find that the location of internationally mobile resources (IMRs) which include foreign direct investment, research and development, and university-educated workers is determined jointly, and that attracting one resource will draw more of each.

A recent roundtable on the migration of highly skilled individuals goes one step further and suggests that resources are attracted to high concentrations (or clusters) of skilled labour, and not by the abundance of capital and/or low-skilled labour (Eden). The latter model is very much an antiquated model of regional development whereby capital would go to areas where its rate of return was the highest and low-skilled labour would follow. The fact that the highly skilled today are so much in demand, and that quality of life considerations rate highly, means that capital is now chasing skilled labour, much the same way that low-skilled labour once followed capital.[12] This means that it is not simply money that attracts skilled Canadians to the United States (or elsewhere). Even if Canada cannot compete on salaries this does not mean that the country cannot offer competitive packages to both attract and retain skilled individuals. The main drawback is that the payoffs to these types of research clusters could be large, but they could also be nil. No one knows *a priori* who the winners will be.

Reform of the research and development sector in Canada, and especially its universities is a key part of Canada's innovation policy, but this sector is but one actor in the process. Canada's immigration system has long put emphasis on the potential labour market success of applicants when adjudicating admissions decisions. Nonetheless, the immigration system is not without its problems. One of recommendation of the Government of Canada ("Achieving" 86) was to modernize the Canadian immigration system too maintain higher immigration levels, increase the number of highly skilled immigrants, and to make Canada the destination of choice for these immigrants. Still, while Canada has received numerous highly skilled immigrants, at least on paper, many have found that the recognition of their foreign education and experience is problematic in the Canadian economy. The Canadian government seems to have heeded this recommendation by making it easier for foreign faculty to take appointments at Canadian universities, and there is ongoing discussion on how to appropriately recognize foreign education and training. There have also been recent reforms to Canada's immigration policy regarding foreign students aimed at promoting Canada as an attractive destination to study.

While many observers lament the loss of talent from Canada, others have suggested that this may not be as detrimental to the Canadian economy as previously thought. The old migration model of the uni-directional permanent flows of skilled individuals may no longer be valid, since many of these individuals often return home or migrate in and out of a country (Harris "Labour"). This *brain circulation* model means that human capital is (at worst) only a temporary loss and (at best) a gain for the source country since these individuals bring back new ideas, techniques, and social capital which allows them to increase their productivity as well as those around them (i.e., knowledge spillovers). In other words, knowledge flows in both directions along with the people that embody it. There seems to be evidence that the brain circulation model is more robust. Finnie ("Effects"), for example, notes that Canadians who left the country and then returned after

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[11] The fact that research grants in the United States tend to be much larger than in Canada compounds the problem. American university faculty generally work on nine-month contracts, and granting agencies south of the border allow faculty salary to be written into grant budgets (so-called "summer money"). Not so in Canada. Pritchard noted that this American pre-eminence in research presents a problem for all countries in attracting and retaining skilled scholars, but especially for Canada given our geographic proximity and the ease at which Canadians can live and work in the US.

[12] See Richardson for an in depth portrait of the biotechnology sector in British Columbia. She provides evidence that lifestyle choices are important in attracting people to the Vancouver area, as is the political climate in the US for returning expatriate Canadians.

2 to 5 years had higher earnings than those who did not leave, although the result is not very robust. However, Finnie only considered private rates of return and not the social rates of return, which could be higher.

V. Conclusions

Canada's innovation policy is very much designed in the spirit of the 1990s when Canadian productivity growth lagged that of the United States, in particular. Despite the high standard of living Canadians enjoy, there was concern in Canada that the lack of innovation over time would result in declining standards of living. The outlook in mid-2006 is quite different. With the appreciating Canadian dollar and worries that the US has been living beyond its means (via its large trade deficit and the declining value of the US dollar), these worries are largely behind Canada. Despite a dearth of convincing evidence, the prevailing wisdom suggests that innovation is the key to the long-term prospects of the Canadian economy and is necessary to preserve the lifestyles and institutions of Canadians. Indeed the knowledge economy may just be the latest fad in economic development. Laidler ("Renovating"), for one, cautions that this knowledge-driven, US innovation model of productivity growth is the latest in a long line of models which include the Swedish, Japanese, and French models, none of which are discussed any longer. Whether this current model proves to be more durable remains to be seen.

Despite the possible shortcomings of this model of development and the policies to promote it, governments around the world continue to move rapidly to implement what they see as the precondition to move economies forward. We must note that the innovation process is a complex one and there is no predetermined path as an idea makes its way from its infancy through to design, manufacturing, marketing, and finally to a commercially successful product or service.

In fact, while it is a rare that an idea even makes it to a final product or service, let alone a successful one, everyone agrees that education is hugely important in this entire process, even if there is little evidence on the composition of education required (Hanel). Any innovation policy is highly dependent on the skills of the people involved, especially in the knowledge economy, but only some of these can be taught or nurtured within a formal education environment. Many of the assumptions of innovation policy regarding the best use practices for universities in particular beg for more research. That said, it seems obvious that this process will not likely lose any momentum in the near term.

Since the lynchpin of innovation is considered to be higher education, policy could have a profound effect on the way that Canadian universities conduct research and teaching. Furthermore, given the decline in Canadian birth rates, immigration policy (both in terms of attraction and retention) is going be a more fundamental component of innovation policy, and thus these two policies ought to be coordinated (Gera, Laryea, and Songsakul).

The data presented above is generally not supportive of a wholesale transformation of universities from teaching and basic research institutions which concentrate on a wide range of disciplines, including the liberal arts, to applied research factories where students and faculty are dependent on the whims of industry, this does mean that the pressures on universities to transform as such will abate. Although the ivory tower model of higher education may be antiquated, its replacement in the extreme is probably less desirable. Forcing faculty and students to forgo pursuing discovery based purely on intellectual curiosity in favour of short-term relevance – however this may be defined – is likely to fail. What seems necessary is balance. Balance between applied and basic research, the later being the lifeblood of the former. Balance between the liberal arts and the applied sciences since, while scientific knowledge does not respect international borders, knowledge disseminated by the social sciences and humanities tends to be country specific and understanding how a nation's institutions work is arguably as important as the number of patents generated. Similarly, balance between the research and teaching missions of universities is important; the creation of knowledge is not worthwhile unless others are able to understand and contribute to it.

We also do not have a firm idea of the impacts of either immigration to Canada, or emigration from Canada. While the traditional models of migration put the emphasis on earnings differentials as the main motivators behind human movement, more recent research focuses on additional determinants such as various components of lifestyle. Furthermore, we are unsure if the old uni-directional flow of human capital model is still relevant. If knowledge does not travel well, then the loss of Canadians to the US or other third countries is a significant problem, especially because those who migrate tend to be the most skilled. If knowledge does transcend international boundaries and/or if the migration of skilled Canadians is temporary, then we need not be so concerned. Likewise, putting faith in the immigration of highly skilled individuals to Canada, at least the way that current policies are designed, might also be called into question. Many immigrants are unable to use their foreign education and experience in the Canadian economy, which is a waste of human resources and certainly having an impact on the generation of knowledge, regardless of how this knowledge is applied.

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Table 1: Real Gross Domestic Expenditures on R & D, Sciences, Social Sciences and Humanities, and Total, 1980-2004
(millions of 1997 dollars)

Year	Total	Natural Sciences & Engineering	Share of Total	Social Sciences & Humanities	Share of Total
1980	7,341	6,604	90.0%	737	10.0%
1981	8,065	7,344	91.1%	722	8.9%
1982	8,565	7,791	91.0%	774	9.0%
1983	8,591	7,822	91.0%	769	9.0%
1984	9,362	8,590	91.8%	772	8.2%
1985	10,021	9,229	92.1%	792	7.9%
1986	10,396	9,594	92.3%	802	7.7%
1987	10,496	9,688	92.3%	808	7.7%
1988	11,477	10,605	92.4%	872	7.6%
1989	11,506	10,643	92.5%	863	7.5%
1990	11,833	10,972	92.7%	860	7.3%
1991	11,762	10,895	92.6%	866	7.4%
1992	12,200	11,311	92.7%	889	7.3%
1993	12,878	12,010	93.3%	868	6.7%
1994	14,073	13,214	93.9%	860	6.1%
1995	14,203	13,366	94.1%	836	5.9%
1996	14,038	13,227	94.2%	811	5.8%
1997	14,636	13,810	94.4%	826	5.6%
1998	15,941	14,945	93.8%	996	6.2%
1999	17,175	16,037	93.4%	1,138	6.6%
2000	19,464	18,224	93.6%	1,240	6.4%
2001	21,014	19,730	93.9%	1,284	6.1%
2002	20,227	18,819	93.0%	1,408	7.0%
2003	20,493	18,966	92.5%	1,527	7.5%
2004	21,146	19,479	92.1%	1,668	7.9%
% change					
1980-2004	188.1	195.0		126.2	
1997-2004	44.5	41.0		101.9	

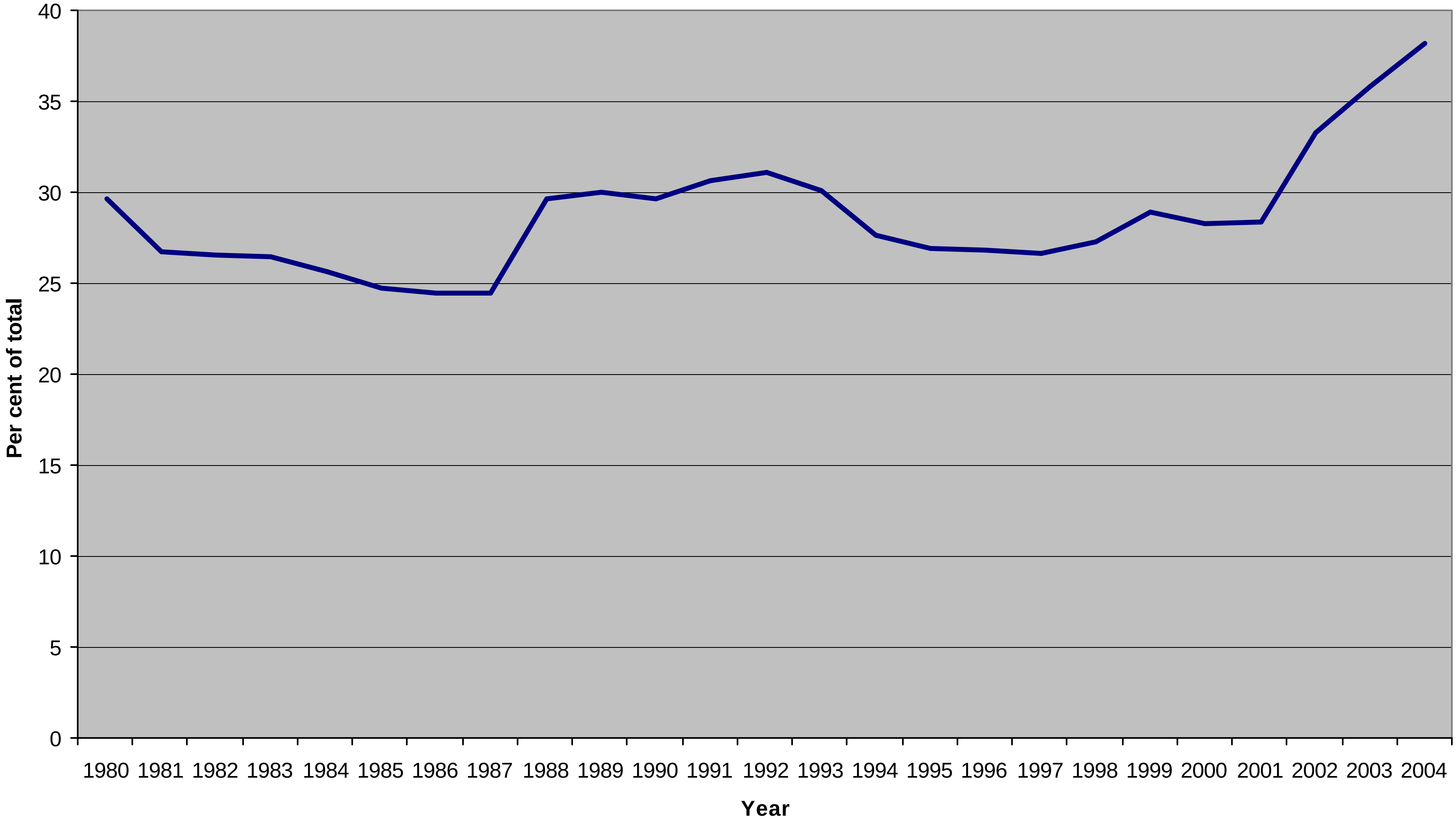
Source: Statistics Canada, CANSIM database and author's calculations.

Table 2: University Enrolment by Field of Study, 1997/98 and 2003/04

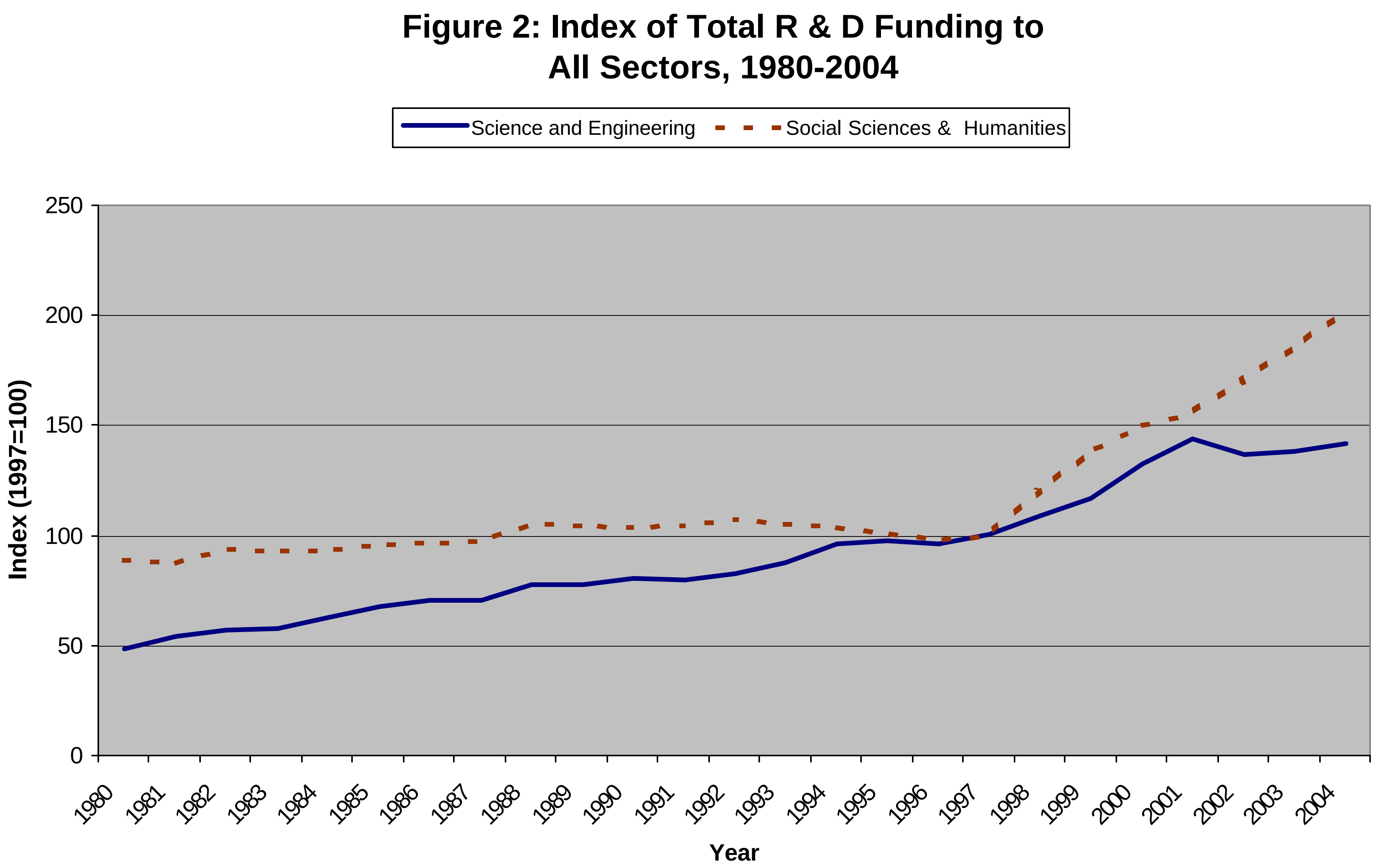
	Total		
	1997/98	2003/04	% change
Personal improvement and leisure	0	100	…
Education	67,600	76,300	12.9
Visual and performing arts, and communications	25,000	30,900	23.6
Humanities	130,000	148,800	14.5
Social and behavioural sciences, and law	132,100	162,300	22.9
Business, management and public administation	124,600	170,900	37.2
Social sciences and humanities total	479,300	589,300	23.0
Physical and life sciences, and technologies	76,500	92,200	20.5
Mathematics, computer and information sciences	34,400	43,700	27.0
Architecture, engineering and related technologies	63,400	86,900	37.1
Agriculture, natural resources and Conservation	16,700	14,400	-13.8
Health, parks, recreation and fitness	74,800	91,400	22.2
Personal , protective and transportation services	400	1,200	200.0
Sciences total	266,200	329,800	23.9
Other	77,100	71,300	-7.5
Grand Total - all disciplines	822,800	990,400	20.4

Source: Statistics Canada, *The Daily*, October 11, 2005, and author's calculations.

Figure 1: University R&D as a Percentage of all R&D in Canada, 1980-2004

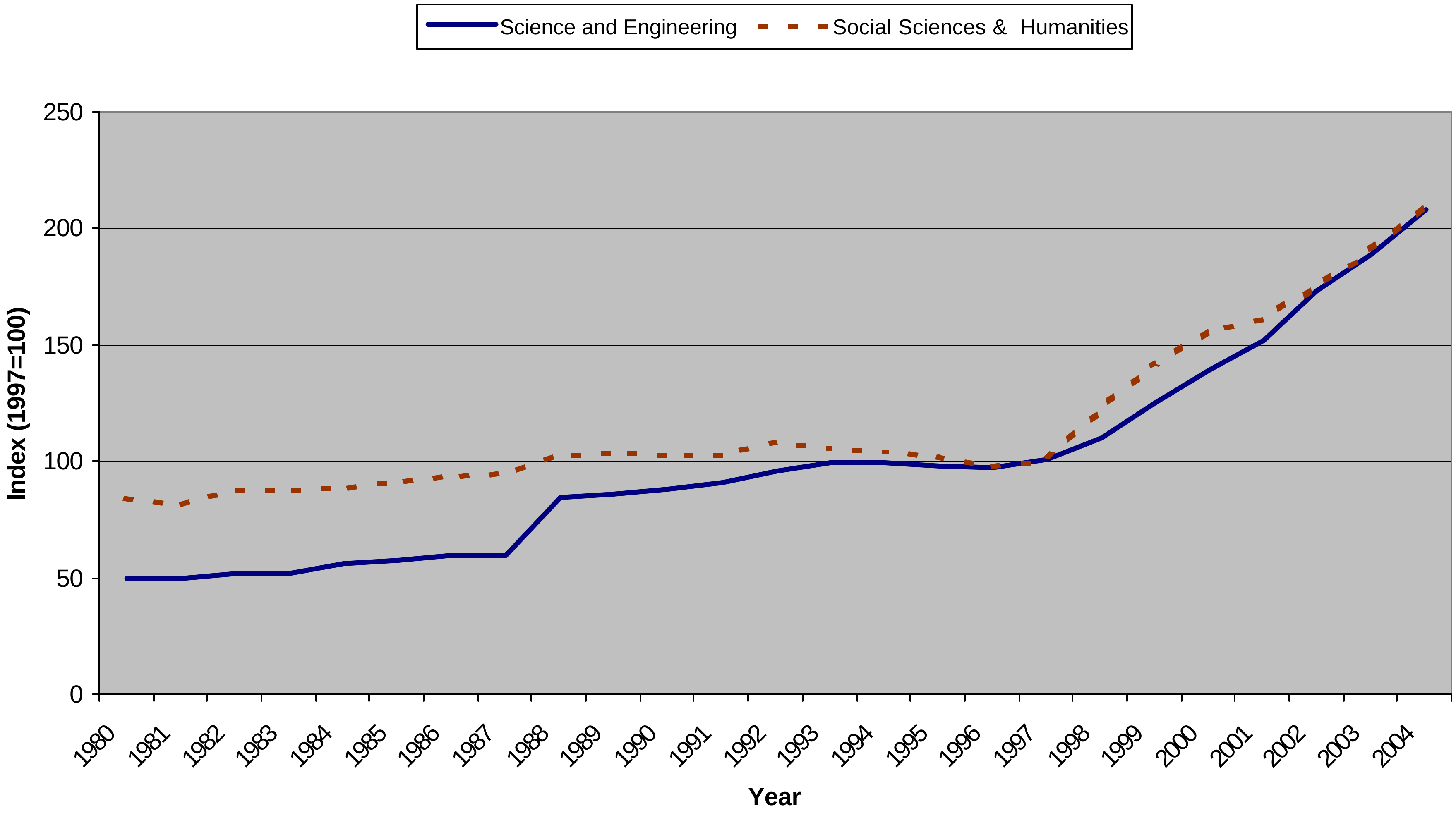


Source: Statistics Canada CANSIM database.



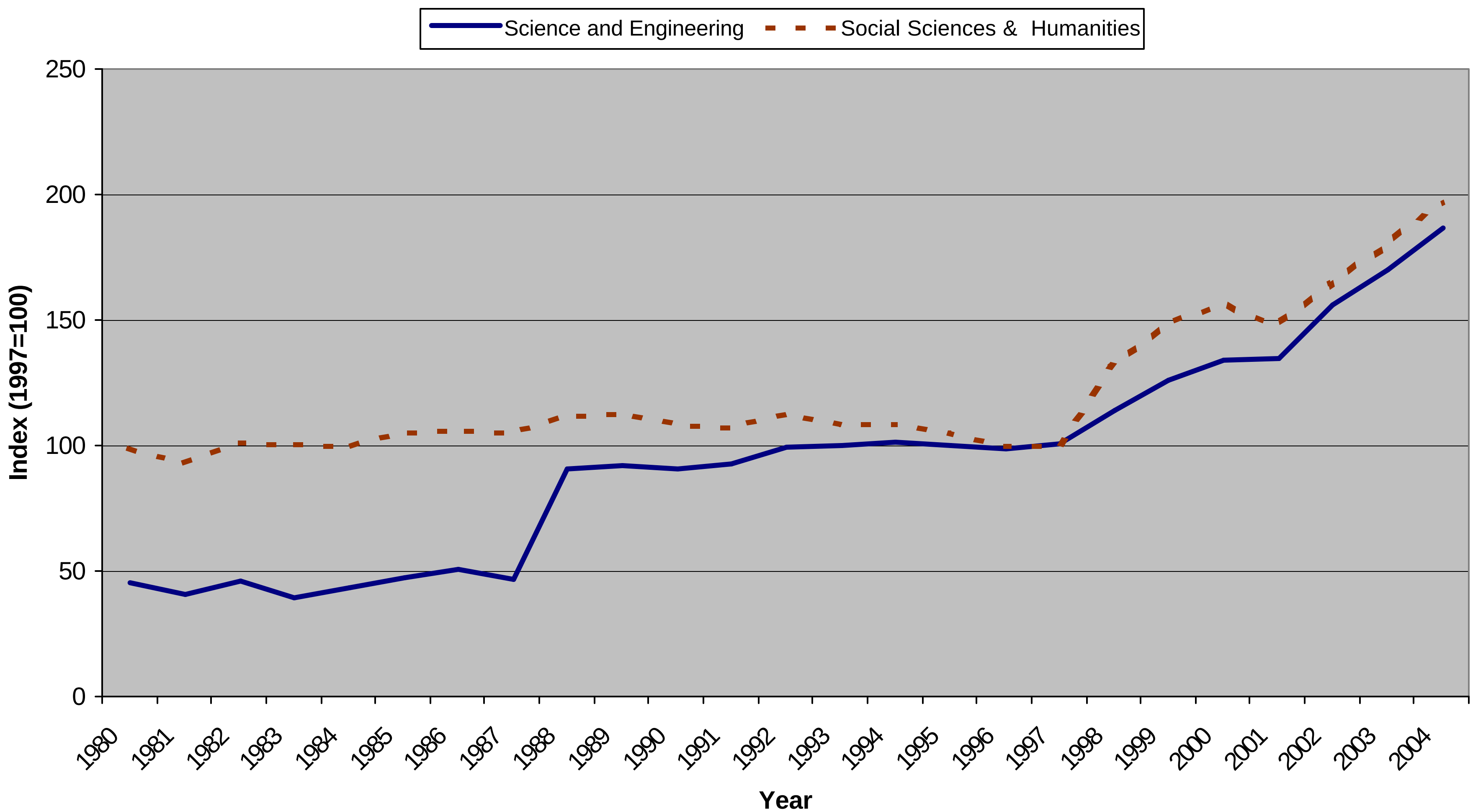
Source: Statistics Canada CANSIM database.

Figure 3: Index of Total Real R & D Funding to Universities, 1980-2004



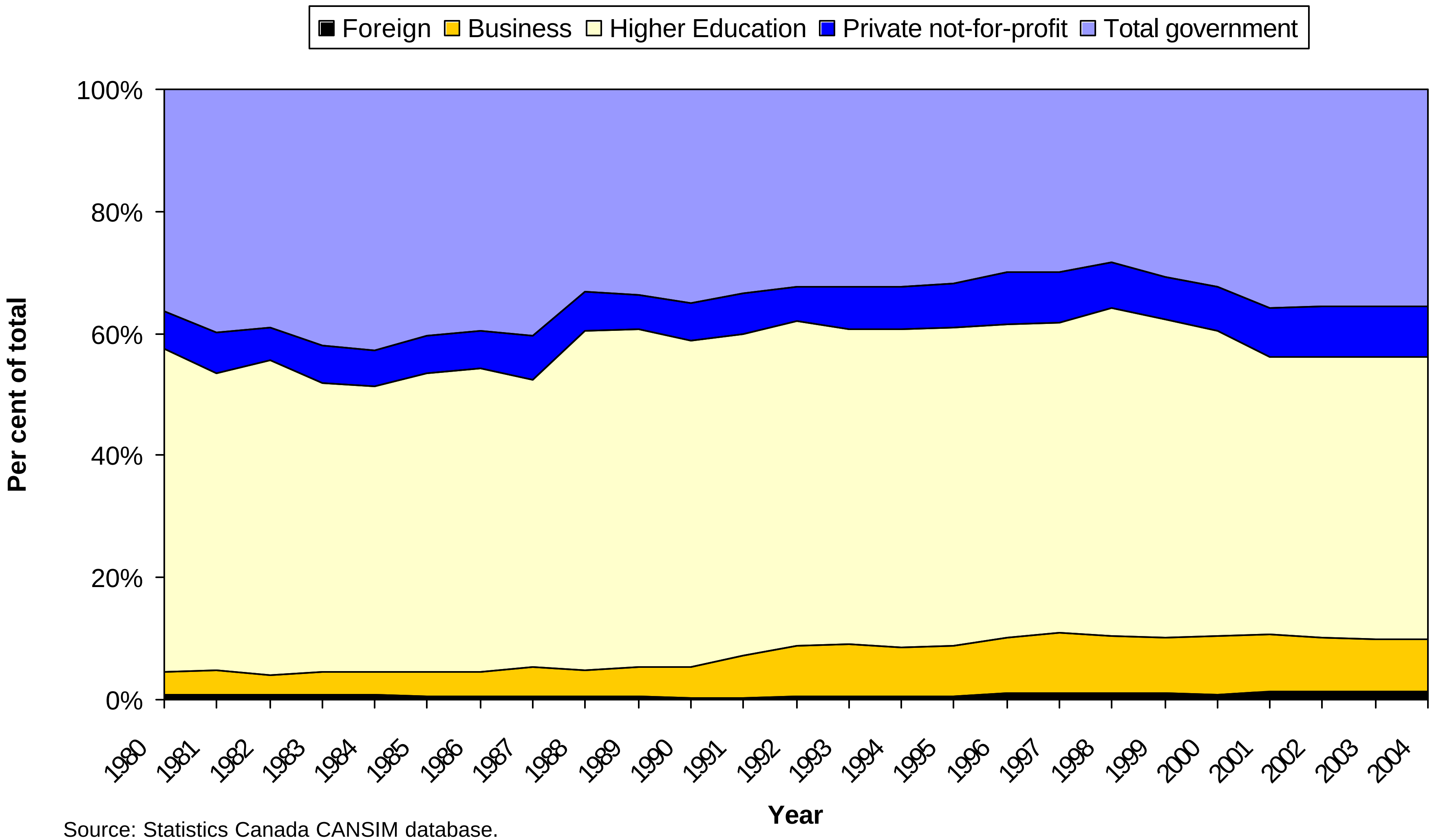
Source: Statistics Canada CANSIM database.

Figure 4: Index of Real University R & D Funding, 1980-2004



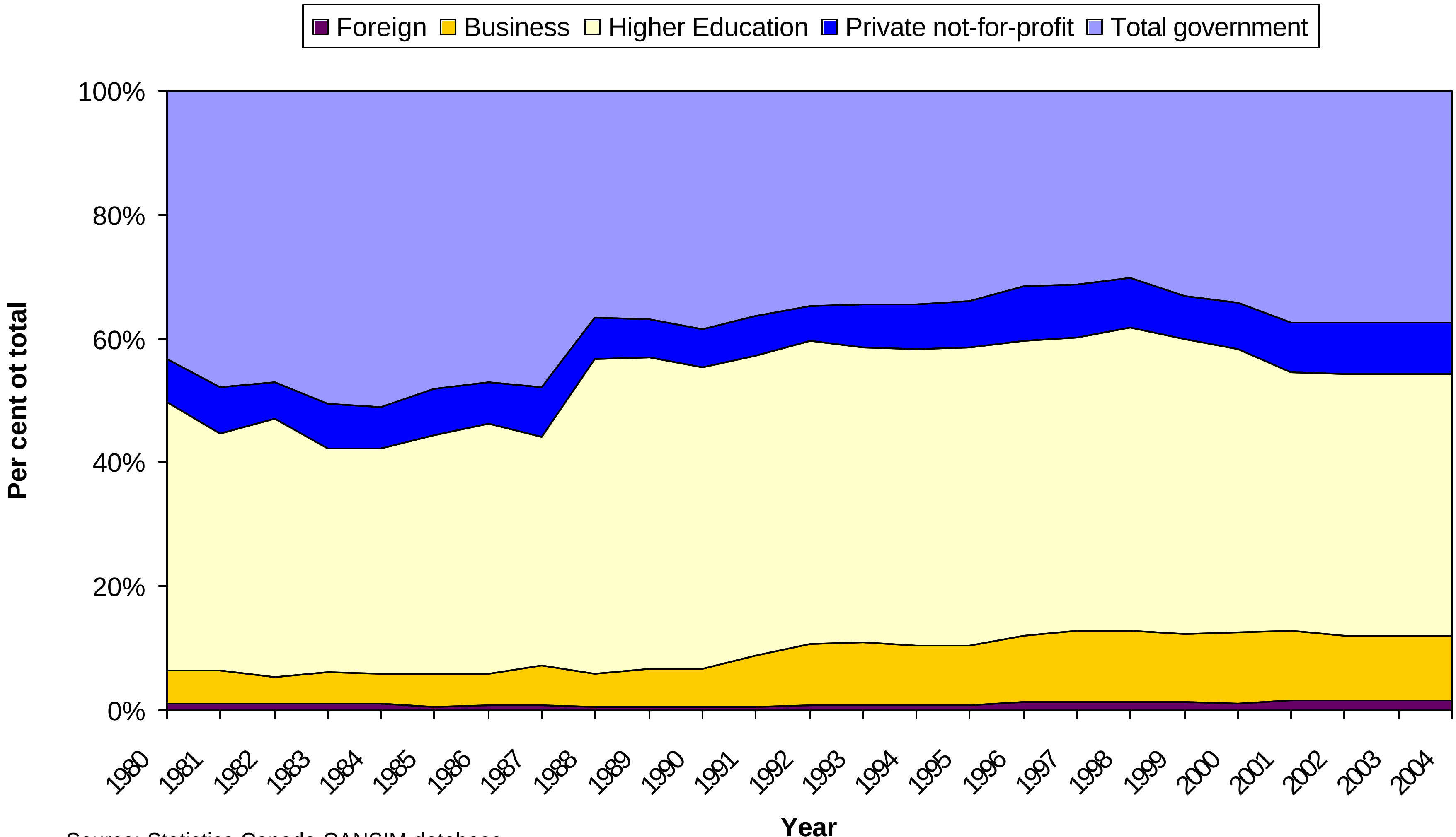
Source: Statistics Canada CANSIM database.

Figure 5: Sources of Total R & D Funding to Universities, 1980-2004



Source: Statistics Canada CANSIM database.

Figure 6: Sources of Total Natural Science and Engineering R & D Funding to Universities, 1980-2004



Source: Statistics Canada CANSIM database.