

The University Research Environment

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In this manuscript we shall provide a brief analysis of the strengths, weaknesses, opportunities and challenges for the research environment in Canadian universities, particularly from the standpoint of the Province of Ontario. We shall draw upon examples from the University of Toronto, in the belief that the general principles have applicability across the Provincial and National system. We shall argue that the research-intensive universities occupy a special place in the Canadian higher educational system, and that Canada has a requirement for a handful of research universities that is truly world class by any measure. The economic impact of university-based research is substantial, both directly in terms of jobs for students, fellows, technicians, faculty, administrative and support staff, and indirectly. The ripple effect of research at the University of Toronto contributes at least another billion dollars annually to the economy. We shall argue that university researchers complement and in part underpin the teaching mission of Canadian universities at both the graduate and undergraduate level. Finally, we shall argue that the Federal and Provincial government initiatives in support of the research enterprise over the past five to seven years have had a tremendous impact and have altered the international perspective of Canadian universities to one where they are regarded as being highly desirable and supportive institutions. This position has taken time to become established. The trick now, as political priorities change, is to sustain that early momentum, the levels of productivity, and international reputation. As Canadian universities continue to evolve in their research activities, they will need to resolve the competing demands of research in the interests of new knowledge, and research that aligns with commercialization objectives established through industrial and political innovation agendas.

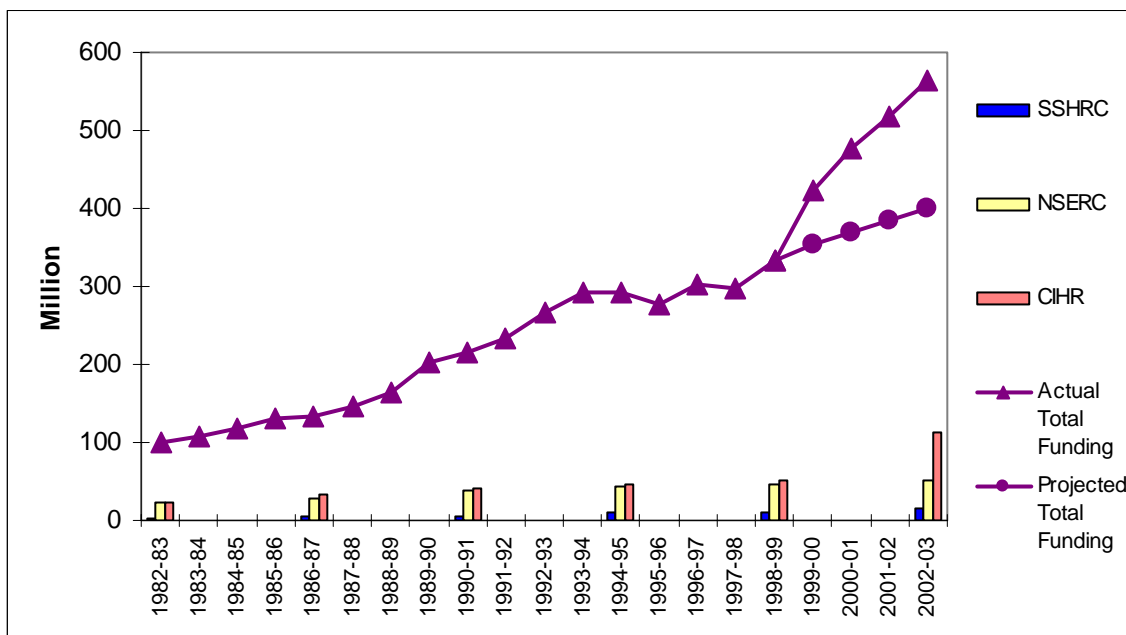
We have endeavoured to evaluate different metrics that characterize the research environment, and to establish appropriate research performance markers that allow benchmarking against international peers. Clearly one measure is represented by the research funding input to the institution. Output measures include commercialization metrics, measures of publications and citations, national and international honours, and contributions to public policy and societal good. Others include the training of highly qualified personnel, graduate students, postdoctoral fellows, and specialists in a variety of areas. We recognize that none of these measures is ideal, nor is any one of these measures satisfactory for a broad spectrum of investigative disciplines. We continue to seek appropriate measures, particularly for colleagues in the Arts and Humanities, where traditional indicators of publications, citations and commercialization outcomes have much less meaning than in the Sciences.

The magnitude of the research enterprise at the University of Toronto is substantial. The “University” includes nine independent, affiliated teaching hospitals, the federated universities, and is spread across three campuses: UT Mississauga, UT Scarborough and, downtown, UT St. George. Total research expenditures in fiscal 2002-03 were approximately \$560 million per annum. If one adds targets at 40% for recovery of academic salaries and 40% recovery of the indirect costs of research, the total research enterprise is almost \$1 billion annually. In other words, at the University of Toronto we conduct approximately \$3 million of research each day. This level of activity exceeds the budgets of CIHR (base plus Canada Research Chair component approximately \$650 million) Science and Engineering Research Canada (NSERC, \$700 million) and the Social Sciences and Humanities Research Council (\$200 million). It is slightly greater than the

annual budget of the National Research Council. The level of research funding at the University of Toronto has risen progressively over the last twenty years from approximately \$100 million per annum in 1982-83 to the current figure (Figure 1). The funding curve flattened during the difficult period of the mid-nineties, but then showed an accelerated increase with the introduction of new Federal and Provincial research funding programs beginning in 1997-98.

Figure 1

Research Funding Trend – Two Decades in Current Dollars. University of Toronto, Including Affiliates



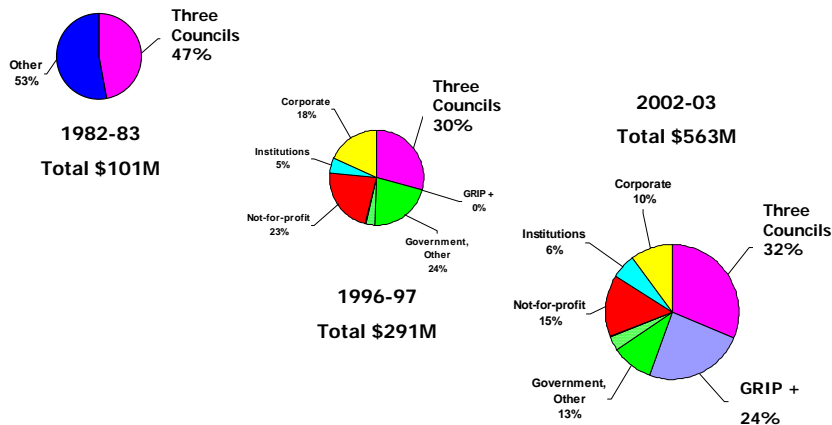
Note: projected total funding values were forecasted based on 1982-83 to 1998-99 values.

The proportions of budget attributable to the Tri Councils have decreased overall from approximately 50% in 1982 to 30% in 2002 (Figure 2). The amounts of monies from SSHRC and NSERC have remained relatively stable over the past fifteen years whereas there has been an almost doubling in the amounts of money from CIHR between 1999 and

2002-03, coincident with the dramatic increase in funding for the Canadian Institutes of Health Research.

Figure 2

Research Funding by Source – University of Toronto and Affiliates



The introduction of new Provincial and Federal funding programs, beginning with the announcement of the Canada Foundation for Innovation (CFI) in 1997 has changed radically the research landscape in Canadian universities and research institutes. The range of different programs and opportunities is truly impressive and the combination of personnel support through the Canada Research Chair program, infrastructure support through CFI, start-up and operating support (CFI and Tri Council sources respectively) graduate student support (Premier’s Research Excellence Awards) and recognition of the need to provide indirect costs have produced an atmosphere of enlightenment and enthusiasm for research across the country. These programs place the Canadian research enterprise at a distinct advantage in the international recruitment of scholars from overseas. This circumstance has been exacerbated by Homeland Security measures in the United States Post 9-11, visa requirements and security demands.

In health research the increase in funding available with the transformation of the old Medical Research Council of Canada to the new Canadian Institutes of Health Research has been dramatic. The CIHR Act was passed in 2000; the 13 virtual institutes began activity in January, 2001. At that time the total CIHR funding was \$339 million spread across the four pillars of population health, health services, clinical research and biomedical research. By 2003-04, the budget had increased to \$576 million. Proportionate increases in population health and health services research were 500% and 600% respectively. Support for biomedical research had increased by almost \$200 million over this period, a 200% increase. CIHR was able to combine strategic, targeted initiatives through its Institutes, with core individual investigator-based discovery programs. The introduction of training grants and call for applications in that area, in 2001, was a watershed in Canadian health research. Fifty-one applications were funded in the first round of competition with partnerships from a wide variety of provincial, private sector, and not-for-profit organizations. The increase of funding available in CIHR has inevitably created increased application pressure. Hence, although the actual number of grants funded has increased dramatically, the success rate has declined marginally. The President and Council have worked hard to sustain an acceptable level of success (approximately 30%). This has become the envy of colleagues in the United States and in parts of Europe. In addition to an increase in the absolute number of grants funded, the average value of open operating grants has risen from \$92,000 per annum in 2000-01 to \$106,000 per annum in 2003-04. This is consistent with the President's stated objective of achieving levels of research funding that are truly internationally competitive. This position, however, will require rapid attainment of the goal of a total budget exceeding \$1 billion,

the ability to carry over funds from year to year, and long-term stability and commitment to the funding base.

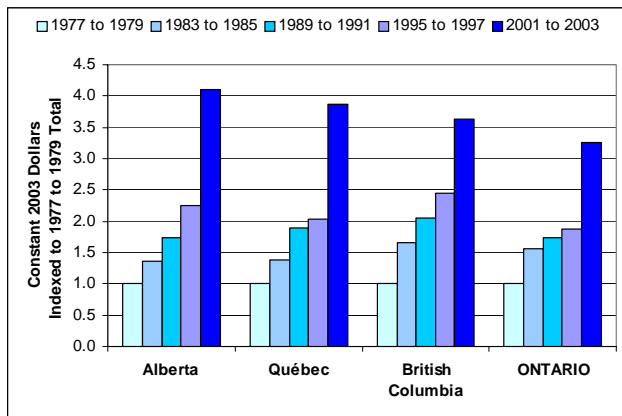
Across the Provinces there has been a modest increase, consistently, in the level of research funding from Federal Government sources to Universities. There was a dramatic increase between the periods 1995-97 and 2001-03, for the reasons cited previously, coincident with the introduction of new programs. When these values are expressed in constant 2003 dollars, indexed to 1977-79 total funding, the increased support to universities in the province of Ontario has been less than that in Alberta, Quebec or British Columbia. Conversely, the increase in federal funding during the period 2001-2003 was particularly marked in Alberta and Quebec (Figure 3). This pattern is clearly evident in Figure 3b. Provincial funding in Ontario has lagged dramatically behind that in Alberta and British Columbia, and is somewhat less than in the province of Quebec. It is particularly noticeable that provincial support to universities in Alberta was 3-fold higher, expressed in this way, than in Ontario during the period 2001-2003. This remarkable growth has provided a magnet attracting new colleagues to Alberta.

Figure 3

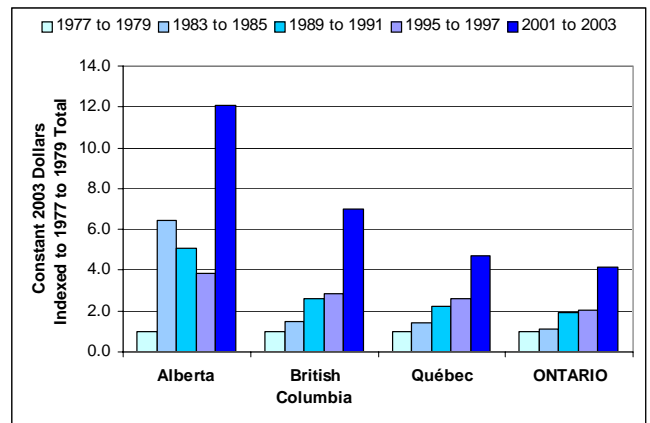
Total Research Funding Universities in Constant 2003 Dollars Indexed to 1977 to 1979

a) From Federal Government Sources

b) From Provincial Sources



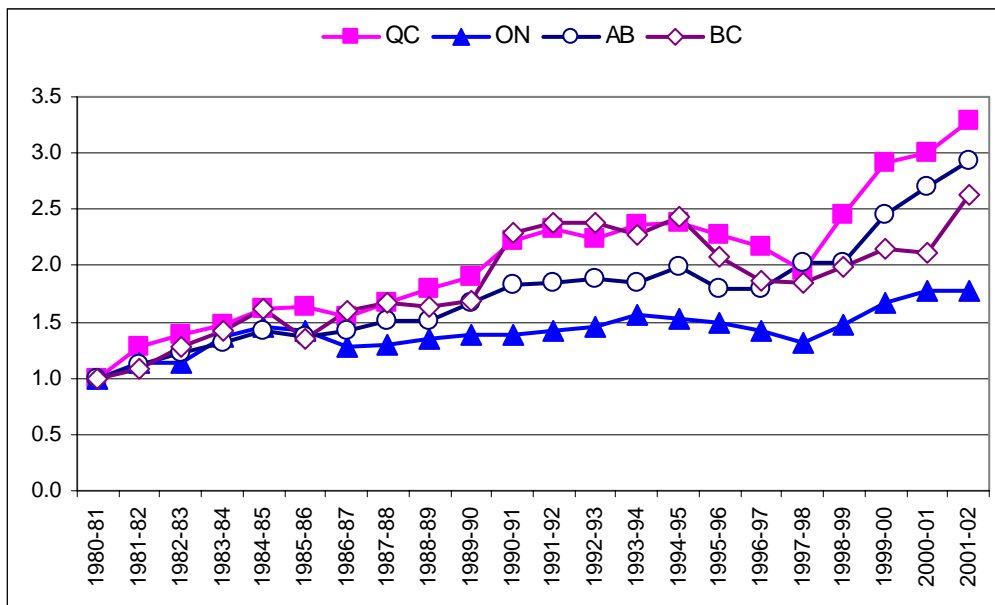
Source of data: CAUBO



The time-trend analysis of research funding from the federal granting councils, expressed in constant 2002 dollars, indexed to 1980-81, shows a similar pattern (Figure 4). Funding to universities in Quebec, Alberta and British Columbia is consistently higher than funding to universities in Ontario. Indeed, the Ontario university system has remained relatively constant over this period of time, whereas each of the other three major provinces have shown approximately 3-fold increases, when the data are expressed this way. There are several reasons that may underlie these different trends, but in particular it is noticeable that in at least two of these provinces, Quebec and Alberta, there are strong provincial research programs that provide recruitment and start-up monies for outstanding colleagues, particularly in health sciences. British Columbia, through the Michael Smith Foundation, has recently joined this elite group. The differences illustrated in Figure 4 show clearly the need for strong provincial funding of research-intensive universities in the province of Ontario if we are to avoid falling further behind other provinces.

Figure 4

Research Funding from the Tri-Councils to Universities in Constant 2002 Dollars Indexed to 1980-81

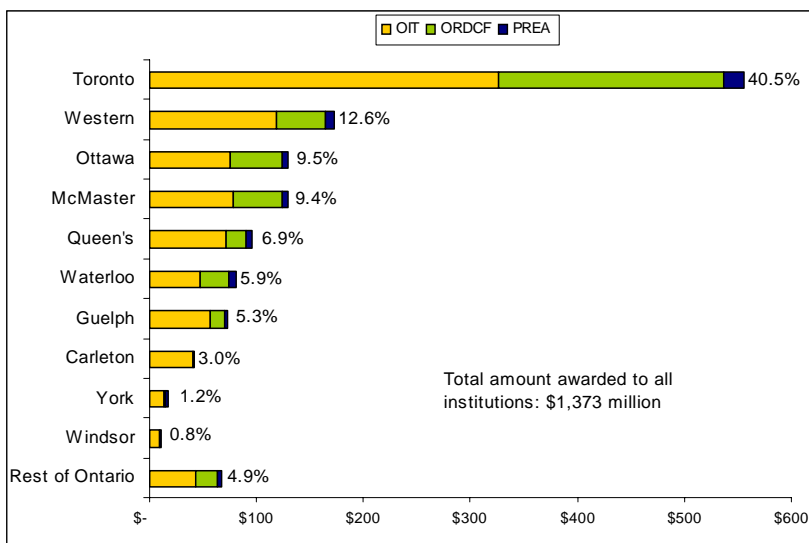


Sources of data: CAUBO and COU

What are the provincial programs that have made such a difference to colleagues in Ontario? These include the Ontario Research Development and Challenge Fund (ORDCF, introduced in 1997), the Premier’s Research Excellence Award (PREA, introduced in 1998), the Ontario Innovation Trust (OIT, introduced in 1999), and the Research Performance Fund (RPF, introduced in 2000). Figure 5 shows the cumulative investment in leading Ontario universities from these different funds.

Figure 5

Ontario Government Research Infrastructure Programs – 1997 to 2004



Source of data: websites of OIT, ORDCF, and PREA

Monies from OIT have been crucial to provide provincial matching support for awards made available from CFI, and the CFI match to the Canada Research Chair program. The availability of these monies has allowed Ontario universities to attract rising stars and distinguished colleagues into this province and has sent a message worldwide that this province is supportive of university-based research and values intensely this activity. In 2004, the Liberal government of Ontario announced that these programs had been terminated and would be repackaged in a new Ontario Research Fund. At this time of

writing, details of the Fund and its administration are not available. However, one hopes that the total money available will be not less than the sum of the current constituent funds. Further, it will be crucial to assure flexibility in the areas of research supported by the Fund, in a manner that allows universities to recruit consistent with their own strategic plans, rather than simply with a government agenda based around commercialization opportunities. These matching monies from the province (whether they are regarded as matching or as leverage) have allowed Ontario universities to maximize opportunities afforded through the new federal programs previously, and it seems likely that they will be crucial to realize opportunities from future federal initiatives.

It is perhaps important that in Alberta, Quebec and British Columbia, the major provincial funding agency has been established at arm's length from government, whereas the new Ontario Research Fund appears to be destined for administration within the Ministry of Economic Development and Trade. Given that reality it is not surprising that early discussions around the administration of the Fund focused on its use in particular commercialization foci related to materials, information technology, life sciences, the environment and nanotechnology. University administrators have argued strongly for a broadening of these criteria to include the social sciences and humanities, and to include areas of basic science where the commercialization opportunities of research might not be immediately apparent. Nevertheless, it is in those areas from which fundamental new knowledge is likely to arise that will drive the pipeline of an innovation agenda.

The availability of these funds is crucial in the development of career pathways of colleagues at our universities. Our younger investigators are getting older as they take longer to finish their degrees, and embark upon extended periods of post-doctoral training.

These “young” colleagues have to be committed to a career in academia. Often faced with a significant personal debt load, it will be some years before they earn salaries greater than even \$40,000 per annum and then move into the ranks of Assistant Professors. It is of concern, perhaps, that many of these potential new academics are finding far more lucrative positions in industry or commerce. This circumstance is even worse for those graduates of Medical School with substantial debt loads accumulated through years of first and second level undergraduate education, often combined with an additional period of post-graduate education. With potential debt loads of greater than \$100,000 at graduation, it is little wonder that the career of an academic clinician-investigator is less attractive today than it might have been some years ago. The lifestyle sacrifices may not seem worthwhile.

Start-up monies available through provincial awards and federal leverage are clearly crucial to provide infrastructure and operating support for young investigators. These colleagues require the availability of start-up monies and assistance in generating their first peer-review research awards, and the renewal of those awards. In doing so, they will be faced with an extraordinary complexity of grant deadlines and opportunities. Indeed, one might argue that in some areas there are simply too many deadlines and too many different competitions and announcements. For example, a young entry-level faculty in Medical Genetics might, within the space of 5 months, be required to write applications for a CFI New Opportunity, a not-for-profit sector operating and personnel support, a CRC Tier II award, addendum, and OIT-CRC submission. He or she will have two opportunities in that period for submission to the CIHR individual operating grants competitions, and potentially opportunities to apply to a CIHR Institute-specific strategic initiative, and an

award from Genome Canada. Our young investigators spend 30% or more of their time writing grants and rewriting the same grant; their colleagues then spend another 30% of *their* time reviewing the grants that have been submitted. It seems that this is an extraordinarily unproductive use of time. Our young investigators should be doing more research, and our mid-career reviewers would welcome the time in their laboratories or in the library. There is a real need and opportunity in this country to develop a common curriculum vitae, a common grant application, a common entry portal and review process. There is an obvious opportunity to coordinate application for infrastructure, salary, operating and indirect costs. We applaud the early discussions of the Prime Minister's Science Advisor, Dr. Arthur Carty, and the Presidents of the Research Councils to establish such a process. We recognize that to do so will not be easy. However, to achieve such an objective would be a watershed moment in Canadian, and indeed in international science.

It is pertinent here to comment on the profile of research funding as a function of faculty age. This relationship is important given that tri-council support in Canada is crucial, not only as the gold standard for research funding, but as the dictator of the numbers of Canada Research Chairs and the allocation of indirect costs to our universities. At the University of Toronto, colleagues in the age group of 45 to 55 are the recipients of the majority of CIHR funding, and there is a decline in total CIHR funding in later age groups. However, at SSHRC and at NSERC the pattern is quite different. Here, it is colleagues between 50 and 65 who hold the lion's share of council support. As these members of the professoriate retire (if, indeed, they do retire) we shall need very clearly to increase the level of funding for younger colleagues in order to maintain our market share

of tri-council support. We shall need to do that in order to maintain our share of Canada Research Chairs and of federal indirect costs for research. One anticipates that other universities across the country may be in a similar position. For those that are not, however, the population dynamics of our professoriate might offer an unexpected windfall.

The introduction by the federal government of the indirect costs program was an extraordinarily important initiative. For every dollar of direct costs awarded by the tri-councils, it costs the universities \$0.50 to \$0.60 to create and support the research environment necessary for the conduct of the research. Without indirect costs the only source of those monies was the core university operating grant, which would otherwise have been used in the support of undergraduate education. Thus, one strong argument to expand the indirect costs program is that, indirectly, it enhances availability of resources for undergraduate education.

The provision of indirect costs in Canada from the central government has been tied to tri-council support, and the ability to increase indirect costs has been tied to a commercialization formula. There are clear implications from these relationships. First, our university Vice Presidents, Research preach to our colleagues, “Apply to the tri-councils; that is essential for your university to sustain Canada Research Chairs and to generate indirect costs.” In so doing, applicants may be persuaded not to seek support from the not-for-profit sector or from other government sources. Furthermore, agencies within the not-for-profit sector may fail to provide indirect costs on the assumption that these flow directly from the federal government, and are not necessary. Clearly this argument fails to appreciate the way in which these monies are utilized, and the real costs of the conduct of research. It is absolutely crucial that the monies available for indirect costs recovery should

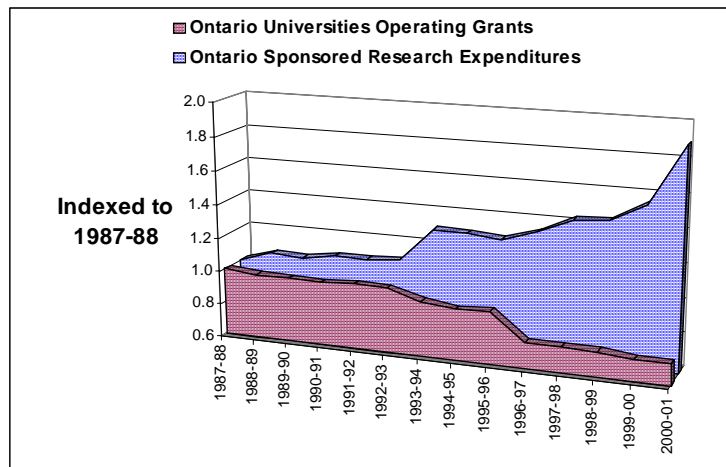
accrue to reach at least 40% of the direct costs of research, and this is particularly true at Canada's larger research-intensive universities. The formula that was established by AUCC for the allocation of indirect costs ensured that a higher proportion would be paid on the first \$100,000 and the next \$900,000 of research monies accrued. Hence, smaller universities are already recovering indirect costs at 60% to 80% of the direct cost value, whereas at the University of Toronto we recover, on average, only 18.4% of these monies. Across the country, the median recovery of indirect costs is already 60%, but that occurs to the disadvantage of those very universities where the research enterprise is most developed. It is the Canadian way!

The indirect costs formula was established in a manner that monies for hospital research activities flowed through the affiliated university. The effect of this partitioning has been to further disadvantage research-intensive universities and their affiliated teaching hospitals. This situation is particularly severe at the University of Toronto, with its 9 fully-affiliated teaching hospitals, which lose in aggregate approximately \$3+ million annually of indirect costs, to which they would have been entitled were they to have been regarded as distinct entities. Clearly, this should be the time to reconsider the manner in which the program is operated. A far simpler and equitable model would be to guarantee a base level of indirect cost support for smaller universities, and then above a floor value of, say \$1 million, flow indirect costs directly with grants from the tri-councils. This would allow central government to show how these monies are being utilized directly in support of research. It would also establish strongly the principle of the importance of indirect costs to those other agencies and sources of research funding that currently have been reluctant to recognize their necessity.

These monies, of course, not only support research but they allow reallocation of resources in order to enhance the overall university enterprise, including teaching. Our researchers are also our teachers, and often amongst our very best teachers. Our researchers are key to the provision of new undergraduate research programs that might provide the impetus for a new student to consider a lifetime career of investigation. At the University of Toronto, federal personnel research awards support 10% to 15% of our faculty. This support buttresses the decline in the university operating grant. Figure 6 shows how, as the operating grant has declined over the last 20 years, research expenditures, including salary support for the research-focused professoriate, have increased.

Figure 6

University Operating Grants and Research Funding in Ontario In Constant 2003 Dollars, per FTE Student, Indexed to 1987-88



These divergent patterns have meant that the ability of the university to sustain its faculty complement has come to depend increasingly, not on the operating grant, but on the soft money provided through *research* career awards. If that funding for research from

federal and/or provincial sources were not available, our universities would have fallen into decline at a much earlier stage.

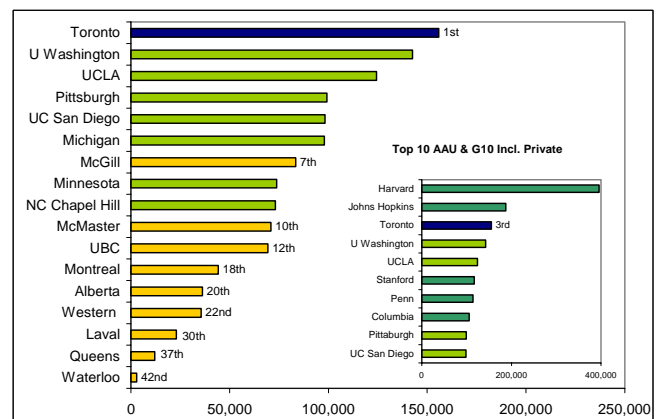
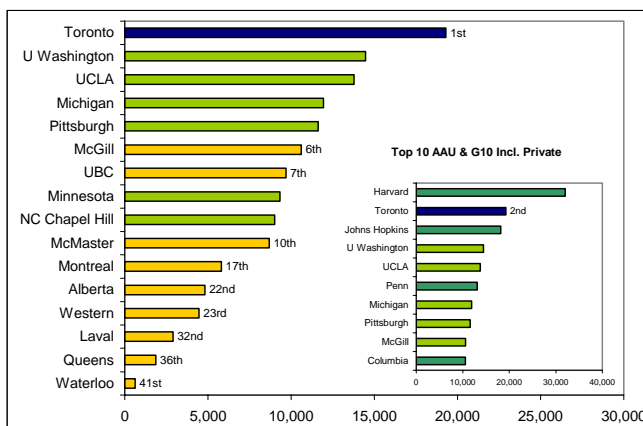
We would like briefly to mention output performance measures. A traditional area of assessment of university research productivity is through publications and citations. These are easier to measure in the sciences than in the humanities. In health sciences in particular, publications and citations are considered to be a reasonably robust measure of research output. Figures 7a and 7b show the numbers of publications for public AAU universities and G10 institutions. The inset includes private institutions. In both categories in health sciences, amongst public universities, the University of Toronto is situated in 1st place, just ahead of the University of Washington and UCLA. With the addition of the private universities, the University of Toronto ranks second to Harvard in numbers of publications, and third to Harvard and The Johns Hopkins University in numbers of citations.

Figure 7

Health Sciences - Top 10 Public AAU and G10 Institutions – 1998-2002

a) Number of Publications

b) Number of Citations



Source of data: Institute for Scientific Information (ISI)

We are continuing to refine and evaluate these performance metrics. They are important in establishing the university's reputation as it recruits new faculty, post-doctoral trainees and graduate students. In particular, the availability of these figures are important in attracting international recruits, and especially international graduate students to a university. Often, the best way of judging a truly "international" university is in its ability to attract international graduate students and post-doctoral fellows. We need to build, within Canada and within Ontario, a scholarship program that supports and nurtures these highly skilled individuals, many of whom may wish to remain in Canada in the longer term, and make lifelong contributions to our economy and society.

At the University of Toronto we have also placed great importance on faculty recognition through national and international awards. Within Canada these would include Steacie Awards and Fellowships in the Royal Society of Canada. But internationally, these would include Fellowships in the American Academy of Arts and Sciences, the National Academy of Sciences, the Royal Society of London and, of course, the Nobel Prize. Canadian universities in general have a wonderfully qualified professoriate, the stars of which are often not recognized proportionately through such international honours. We need to nominate colleagues for such awards, and then explain the value of such awards to politicians and to the general public. It seems axiomatic that an explanation of the international value of a particular piece of university research should contribute to enhanced understanding of the importance of research in general to a lay audience and to the general public.

Finally, we have begun to consider commercialization outcomes as an indication of the effectiveness of university research activity. These are discussed elsewhere in this

Symposium by other speakers, and we will refer here briefly to our ongoing studies.

Overall, it is apparent that the pre-eminent standing of universities such as the University of Toronto in scholastic achievement, measured through publications and citations, is not reflected in our standing in relation to commercialization activities. We have assessed indicators such as gross commercialization revenues, and numbers of new licenses compared to G10 and US peer institutions. Ontario universities have much to learn from American institutions such as the University of Washington, the University of Minnesota and the University of Illinois. It is our position that issues around commercialization will be paramount as the universities of Ontario consider their evolution. Already, our government funding is being linked to commercialization outcomes, and influences the universities' strategic plans.

The University of Toronto has recently commissioned a report on its commercialization activities, conducted for the past 20 years through the University of Toronto Innovation Foundation. The report team was chaired by former Industry Minister, the Honourable John Manley. The Manley review team has charged this University with matching its commercialization performance to its fundamental research achievement. It has asked the University to build a culture of disclosure and to seek coordination and integration with other partners in the city, including the teaching hospitals. It has suggested that we re-examine our intellectual property policy in a way that is more favourable to faculty inventors, and indicates University support for commercialization activity. Importantly, it has asked us to examine the fundamental question of the role of the university in commercialization. Should our role simply be one of revenue generation, or should our role be one of facilitation in taking new information into the commercialization

pipeline, but without necessary expectation of financial reward? In Toronto, the developments within the Discovery District, the new research facilities and the Medical and Related Sciences (MaRS) complex, with 1.5 million sq. ft. of laboratory incubator space are a signal that we take seriously the opportunities to link universities, innovation and commercialization. Developments such as MaRS will afford partnerships between universities, venture capitalists, and the private sector. They will also facilitate linkages between clusters and between groupings of universities to build their commercialization enterprise and relationships. These developments will, over the next few years, facilitate the evolution of industry partnerships with universities on university campuses. In turn, these nodes of university-industry activity should provide an environment that is conducive to further training opportunities in basic research, linked to commercialization outcome and application, in technology transfer, and in industrial application. We believe that Canadian universities will face their most demanding challenges, yet exciting opportunities, as they develop relationships with the business sector. Such relationships are not without threat to the university, yet surely are entirely consistent with our mandate of knowledge acquisition and information translation and transfer.

We have tried here to summarize some aspects of the importance of research at Canadian universities. In this brief article we have illustrated some of the challenges that Canadian universities face in seeking adequate research funding, and emphasized some of the extraordinary opportunities for Canadian universities in the future. That future is very much around advocacy, facilitation, differentiation and integration of our research enterprise in a way that will ensure that our universities are recognized as key players in the economies of our cities, provinces and country in the 21st century.