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Intentions For and Outcomes Following a Decade of Government Investment in Graduate Education

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Executive Summary

Over the past decade, the federal and some provincial governments have made major investments specifically in graduate education. This report investigates the changes in graduate enrolments and graduate degrees granted subsequent to those investments, by degree level, by gender, by immigration status (Canadian or visa), by province, and by field of study. While there are a number of other important aspects of graduate education that may have been affected by the investments, particularly completion rates and times and employment outcomes, we are unable to address those in light of the paucity of data pertaining to them nationally. We suggest that governments should spend the money to obtain and disseminate the necessary data to assess the accomplishments of their investments.

This summary addresses first the nature of and intentions for the investments, and then key points about changes in enrolments and degrees granted. The investments of interest are those made either in operating funding for universities specifically for graduate enrolment expansion, or in scholarships directly to graduate students. Certainly there have also been major investments in research, which is closely tied to graduate education. But those investments were made for purposes other than graduate education, and thus fall outside the scope of this study.

The federal investments of interest were the major increases in graduate scholarships awarded through the three granting councils, including the introduction and growth of the Canada Graduate Scholarships (CGS) starting in 2003. In total, this new funding peaked at nearly $270M in 2009, with total expenditures in graduate scholarships from 1999 to 2010 (beyond 1998 base amounts) exceeding $850 million. Overall, the number of students receiving a Tri-Council scholarship more than doubled from 2002 to 2010, although the increases were unevenly distributed across the three councils, with SSHRC’s number tripling, CIHR’s doubling, and NSERC’s increasing by only about 50% – a consequence in part of the number of scholarships each was already awarding in 2002. The federal objectives for this investment ranged from the immeasurable (develop “the most skilled and talented labour force in the world”) through the very specific (“increase the admission of Master’s and PhD students at Canadian universities by an average of 5 percent per year”) (Industry Canada, 2002, p. 60). Provincially, only British Columbia and Ontario provided additional operating funding specifically for graduate expansion. Alberta, Manitoba and Newfoundland made funding available for which universities could propose expansion at either the graduate or undergraduate level. The total increase for graduate expansion was on the order of $300M, with total expenditures on scholarships and operating investments targeted to graduate enrolment expansion (also beyond 1998 base amounts) totaling more than $1.9 billion over the period from 1999 to 2010. The other five provinces did not have explicit expansion funding, although operating grants did increase, and graduate enrolment did grow. Six provinces increased the amount of graduate scholarship funding available for students: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, and Prince Edward Island. The continuing increases exceeded $30 million as of 2011, primarily in Alberta and Ontario. A total of $338M above the year 2000 base amount was spent by the provinces on scholarships between 2001 and 2011. Stated provincial objectives similarly ranged from the immeasurable (“This new investment in graduate scholarships will enable these students to heighten Alberta’s expertise and knowledge as we prepare for the knowledge-based economy” (Government of Alberta, 2008)) to the quantitative (“In 2004-05, as part of the Reaching Higher plan, the Ministry announced the goal of expanding graduate enrolment by 14,000 student spaces (measured in FTEs))” (Ontario MTCU, 2009, p. 13).

Within this report, enrolment is looked at in five ways, separately for master’s and PhD: by gender, by Canadian or international, by province, by university category, and by field of study. Overall enrolment certainly increased following these major investments, and in seven of the eight years since the introduction of the CGS awards, the rate of growth in PhD enrolment has exceeded the rate of growth in master’s enrolment. Part-time graduate enrolment has declined more drastically at the PhD than at the master’s level.

At the master's level, the part-time decline is all in male numbers; female part-time numbers have continued to increase.

In terms of the gender distribution, women are increasing their share of graduate school enrolment. At the master's level, the female percentage of head count enrolment rose from 52.5% in 1998 to 55.3% in 2010. At the PhD level, female enrolment has risen from 44.4% to 46.9%, with all of the increase occurring after 2004.[1]

Looking at immigration status, international student numbers increased at a faster rate than Canadian numbers, such that international students made up 15% of total enrolment by 2010, up from 8.9% in 1998. Canadian males have not participated in the graduate expansion to the same extent as have Canadian females. When international students are omitted from the male/female percentage calculations, the female master's-level enrolment percentages become 53.8% in 1998 and 57.8% in 2010. At the PhD level, the corresponding percentages become 46.6% and 49.9%. Possibly contributing to this, women have consistently had higher success rates than men in SSHRC and NSERC scholarship competitions, although success rates are roughly equal for the two groups at CIHR.

Provincially, rates of growth in master's enrolment were higher after 2003 than they were before that year in only Saskatchewan, Manitoba, and Newfoundland; in all other provinces, annual averaged master's growth rates were higher prior to 2003. Since 2003, the rate of growth in PhD enrolment has always exceeded the rate of growth in master's enrolment, and has been higher in all provinces than it was prior to 2003. For the most part, the shares of national enrolment across the provinces stayed largely the same, with two notable exceptions. Ontario and British Columbia made up the shares that they had lost in the early 2000s; and since 2006 Ontario's share has been increasing while Quebec's has been decreasing.

In terms of the universities that benefitted most from graduate expansion, the bulk of the graduate expansion took place in the U15 and the next ten largest universities, although the percentage increase in enrolments was higher at the smaller institutions. Looking at changes by field of study, at the master's level STEM disciplines constitute only about 22% of the total enrolment and did not experience any change in this share during the period starting in 2003. At the PhD level, STEM disciplines did experience relative growth and now constitute nearly 44% of enrolment. Business has remained the most popular field of study at the master's level.

Turning from enrolments to degrees awarded, the number of master's degrees awarded rose throughout the decade (2000-2010), but in the early 2000s the number of PhDs awarded declined for several years just before the initiation of the CGS awards. Females earned 58% of master's and 46% of PhD degrees awarded to Canadians in 2009, which is broadly consistent with their share of enrolment as just discussed.

Overall, only a few of these outcomes are surprising. Provinces that invested in graduate expansion were successful in accomplishing it, and in some cases expanded their share of the national graduate enrolment. The CGS awards seem to have been successful in encouraging enrolment at the PhD level, but did not have the same effect at the master's level. What is surprising is the scarcity of measurable objectives identified at the start of the investments, and the lack of data to measure even some of those that were stated. Given the importance of graduate education to the nation's labour force capabilities, we would expect – and strongly recommend – a reasonable investment in data acquisition to assess the effectiveness of the increased investment and of the graduate education itself.

[1] There had been a small decrease in female percentage from 2001 to 2004.

1. Introduction

Over the past decade, federal and provincial governments have made major investments in graduate education, consisting of increases in graduate scholarship funding, and increases in provincial operating funding targeted explicitly at increasing graduate enrolment. There have not, however, been any investigations into how these investments have affected graduate education in Canada. As will be discussed in the literature review below, the federal granting councils have conducted some studies of their own scholarship programs (CIHR, 2009; SSHRC, 2009; NSERC, 2010), and there has been a report on Ontario's expansion efforts (Wiggers, Lennon & Frank, 2011), but these each look at only part of the picture, not the whole. This current report uses Statistics Canada data to look at where changes in enrolment and degrees granted have occurred subsequent to these investments. "Where" in this context means not only which provinces and which universities, but also which areas of study and which demographic segments.

While our analysis is more extensive than the earlier studies, it remains only a partial and limited look at graduate education due to a lack of information on the other items one might wish to consider. A thorough review of the effect of these investments on graduate education in Canada would consider the following, in addition to the numbers about enrolment and degrees granted that we are able to investigate.

- Has there been an increase in the topics available for graduate study?
- Has there been any change to the nature, conduct, or learning outcomes of graduate education, for example in the emphasis placed on coursework versus research, or on skills more easily transferred to a variety of work situations?
- Did completion rates improve as a consequence of the investment, or did expanding enrolment reduce completion rates?
- Were times to completion of graduate degrees improved (reduced) by the investments?
- Have there been changes in employment outcomes given larger numbers of graduate degree recipients?

Regrettably, Canada does not collect information that would allow one to address these questions. In the absence of such information, we have focused on the numerical data that are collected nationally, and have made use of information from a subset of universities (the U15) for the questions on completion rates and times. Given the size of the investments that have been made, it is disappointing to realize how little information is available to assess the consequences of the investments. As will be seen, the intentions for the investments were sufficiently vague that it is not surprising that there is an absence of data to assess their efficacy.

It is important to recognize at the outset that it is difficult to disentangle changes in graduate education from the university research context in which most of graduate education occurs. At the same time that the federal and provincial governments have been investing in graduate education, many of them have also been investing in research infrastructure and faculty positions. It will not be possible to assert that the investments in graduate education definitively led to whatever effects on graduate education are found. To modify a standard economics assumption, *ceteris* is far from *paribus.*

In this introductory section, we describe briefly the findings of the partial studies on graduate investment that have been completed to date. We then turn to two preliminary issues: start and end dates for the study period, and scope of investments to consider. Finally, we discuss in more detail the changes to graduate education listed above that one might wish to investigate, provide a short explanation of why we will not be addressing most of those, and then describe the two that we will discuss.

1.1 Review of Relevant Literature

Although Section 2 will describe the governments' investments in more detail, it is necessary to mention a few points here to provide context for the existing studies. The primary federal initiative was the Canada Graduate Scholarships (CGS) program, which was first implemented in 2003. An evaluation framework for these awards was established in 2007, with a survey of recipients occurring in 2008 and a report published early in 2009 (CIHR, 2009). As noted in that report, the fact that the study took place so soon after the implementation of the CGS program meant that most of the award recipients had not yet completed their degrees (p. 3). There does, however, appear to be a follow-up study on the CGS awards planned and possibly underway for 2011-2013 (CIHR, 2008). The conclusions of the 2009 report pertain solely to the CGS program and state that it should be continued for several reasons: the demand for highly qualified personnel (HQP) is and will continue to be high (p. 4), and the CGS awards slightly increased graduate enrolment (p. 5). No data are adduced in support of either of these statements.

In addition to the report on the CGS program, the federal granting councils have also produced reports on their other graduate scholarship programs, some of which also benefited from increased federal funding. One NSERC report was based on the comparison groups surveyed for the CGS study and did not obtain an independent sample (NSERC, 2010). Indeed, some of the wording is identical in the two reports, not only in the description of methodology, but also in some conclusions, such as the two reasons for continuation of the CGS program cited above, which were repeated for the PGS (postgraduate scholarships) program. Again, the NSERC report makes observations about the program's effect on graduate enrolments and completions, but does not provide data in support of those observations. A SSHRC report was also based on the comparison groups used for the CGS study and reached similar conclusions about the program (SSHRC, 2009).

A study of Ontario's graduate expansion is more comprehensive in the topics that it covers, but deals only in passing with what has gone on in the other provinces. Wiggers et al. (2011) note that for the decade starting in 1999, Ontario graduate enrolment grew noticeably more than the national average, 51% versus 38% at the master's level and 67% versus 61% at the doctoral level (p. 9). The authors, however, do not go any deeper than that into what was happening in the rest of the country. Their focus is on Ontario's growth. Following from their observation about relative growth rates, one might expect differential growth of graduate enrolments among the other provinces, because some explicitly encouraged graduate growth with targeted funding. We shall look at this issue in greater detail below.

Wiggers et al. report on the demographic characteristics of students in Ontario and on relative growth both across the universities and across different areas of study. In 1998, there were already more women than men in master's programs, while men were the majority in PhD programs.

1.2 Preliminary Considerations

There were two issues to resolve before starting the study: we had to define the start and end dates for the period of graduate investment, and determine the types of investments to be included in the analysis. On the first point, we have used 1998 as the start date for the analysis. We recognize that the federal Innovation Strategy of 2002 and the accompanying launch of the Canada Graduate Scholarships (CGS) program were milestone federal investments in graduate studies. Many provincial governments responded in kind. This would make 2002 a natural starting point to identify added investments, but in fact the first money did not flow until the 2003-2004 academic (and fiscal) year. In order to assess the impact of these and subsequent investments, a baseline is necessary from which to assess change. The year 1998 provides a five year lead-up to this increased investment, with an end date of 2010 contingent on the availability of data.

The other question pertains to the types of funding that are germane to the issue. The decision was made to restrict the study to government funding, and not to attempt to untangle numbers on universities' own increased contributions to graduate support, nor to identify increased philanthropic activity aimed at graduate students. The rationale for this limitation is that a number of governments made policy decisions to increase the investment in graduate education. The focus here is on identifying those investments and identifying some of the consequences of those decisions.

The study is also limited to the federal and provincial levels of government. At the provincial level, we include only those provinces that put forward funds explicitly for expansion of graduate education. This is an important qualifier. All provinces increased the general operating grants of universities over this time period, but that general increase is not of interest because it was not directed to graduate expansion.

There are two types of government funding of interest for this study. The first is operating funding from a province provided to universities specifically to expand graduate enrolment. The second is increased funding directly for graduate student scholarships, whether from the federal government (e.g., the CGS) or from a province (e.g., the Ontario Graduate Scholarships in Ontario or Queen Elizabeth II Scholarships in Alberta). Such scholarships are often intended to make graduate study more attractive and/or to increase the chances of successful completion of that level of study.

While increased funding for overall university research and innovation activity is not the focus of this study, some funding made available for that purpose has certainly contributed to the funding of graduate education. Indeed, in some instances, such as in British Columbia, the rationale for graduate expansion funding has been to enhance research capability. In other cases, such as in New Brunswick, funding for research assistantships has contributed to funding for graduate students even though graduate education was not the rationale for the funds. We have attempted to identify these differences in the discussions that follow.

1.3 Items Included and Excluded for Investigation

As identified in Section 1.1, there are seven items of interest that one could investigate as potential consequences of major investments in graduate education: changes in enrolment patterns; changes in numbers or patterns of degrees awarded; changes in the number and/or substance of graduate programs; changes to the nature or learning outcomes of graduate education; changes in completion rates; changes in times to completion; and changes in employment outcomes. We are able to investigate the first two in some detail, but three of the other five could not be dealt with at all in this report, and the remaining two can be described only partially. We will explain the reasons and then describe the ways in which enrolments and degrees awarded will be addressed.

With regard to changes in number or focus of graduate programs, the Wiggers et al. study (2011) reported that there were increases in the numbers of graduate programs in Ontario. This drew on data from the Ontario Council on Graduate Studies, which had records of all new program approvals. Since there is no central data source for this for Canada as there is within Ontario, it is not feasible to address this topic at a national level without seeking such information from each individual university.

Changes to the nature or conduct of graduate education are hard to identify because there are few if any forums in which they are discussed or recorded. The Canadian Association of Graduate Studies (CAGS) is one forum in which there have been regular conversations about transferrable professional skills for graduate students. CAGS has recently published a report on the status across Canada of professional skills training, which drew upon the websites of the graduate schools as its primary data source (Rose, 2012). While the report is useful in identifying change on this one topic, it also demonstrates the difficulties of relying on such websites for information about changes to the nature of graduate education. We have not attempted to pursue this avenue.

Degree completion rates or times to completion might reasonably be expected to be affected by government investments or incentives. For example, the period of tenure for federal CGS awards is shorter than the time normally required to complete a graduate degree. A master's CGS can be held for one year and a PhD CGS for three – both durations are roughly half of average times to complete the degree. Have the generous PhD CGS awards led to a reduction in time to completion? Unfortunately, most universities do not report such information, if they even collect it. The U15 research-intensive universities collect completion data and share them with each other. They have made summary information available to us (discussed in Section 4.1), but not at a level of detail that would allow this question to be addressed rigorously.

Data on employment outcomes are even more difficult to obtain. At least with times to completion, all of the information resides with each university. Employment information would have to be obtained from the graduate; despite its importance, this is rarely done by the university granting a graduate degree. There are three potential sources for such information, but none is robust enough to rely on for analysis in this report. During the OCGS periodic reviews of existing graduate programs in Ontario (which ended in 2010), employment placement of recent graduates was one of the requested pieces of information. However, the Ontario graduate deans we spoke with said that this information is sporadic at best, was provided via former supervisors, and may not be reliable or up-to-date. A second possibility would have been to draw on the Survey of Earned Doctorates, but unfortunately Statistics Canada produced that publication only between 2003-2004 and 2007-2008, so it does not cover a long enough time span to be of use here.

The third potential source consists of reports from the three federal granting councils, based on surveys of their past award holders. For our purposes, the limitation of these surveys to Tri-Council graduate scholarship winners is sufficient to rule these out as a source of information on the national impacts of the major investments. Both CIHR and SSHRC adopted a survey approach that NSERC had been using for several years. This involved university alumni offices sending a mail-back survey to the scholarship recipient's address of record. The NSERC surveys are not yet useful for assessing the effects of the federal CGS awards, since they were conducted nine years after an individual received a scholarship, and the CGS awards were implemented only ten years ago. In addition, there were sampling and response problems in some of the surveys. Over the nine different years that NSERC had been conducting the surveys, they had a response rate of 38% (NSERC, 2012, p. 3). The CIHR survey was conducted in 2009 and covers awardees who received their award as late as 2005. The response rate of only 23% of graduate scholarship recipients (CIHR, 2010, p. 3) may be affected by this short time frame, in that the survey was intended for people who had completed their degrees and many of the recipients may not yet have completed. In addition, an unknown number of recipients did not receive the survey request due to alumni offices not having current addresses for past awardees. SSHRC's 2010 survey contacted 2003 CGS master's award winners (7 years after the award) and pre-CGS doctoral award winners in 1997-1999 (11 to 13 years after the award). The reported response rate was roughly 30% of those receiving the survey and ignores the 11% of award winners who could not be found (SSHRC, 2011, p. 9). Including those individuals would drop the participation to 26% of award winners, a number comparable to that for the CIHR survey.

While the results of those surveys are not useful for an overall assessment of the investments, it is nonetheless interesting to note differences in the results for the three councils. NSERC recipients reported industry and university as their most likely employer at 45% and 32% respectively, and 62% report research and development as at least one of their job activities. For CIHR awardees (both master's and PhD) 55% report employment in the university sector, 22% in industry, and 18% in government, with 42% reporting research and development as a main activity of their job. For former SSHRC Doctoral Fellowship award holders, 78% reported employment at a university.

The number of ways in which enrolments and degrees awarded will be investigated is as follows. First, one can, and probably should, distinguish between master's and PhD degrees. It is unlikely that patterns of enrolment and degrees awarded are the same for the two. Second, following Wiggers et al., this report will consider changes in the gender composition of graduate student enrolments during the period of graduate expansion. The third aspect investigated is the effect on these enrolment changes of international student numbers. The fourth is a comparison across provinces. In light of very different provincial approaches to funding graduate expansion (or not funding it), has this had an effect on relative enrolments provincially?

Fifth, of potentially greater significance to the state and nature of graduate education in Canada are changes in the relative share of national graduate enrolment that different types of institutions now have, relative to what they had at the start of the analysis period. One obvious categorization is institution size. In this regard, Wiggers et al. found that over the past decade, the graduate enrolment at the seven smallest Ontario universities grew by 7%, at the five mid-size universities grew by 5%, and at the largest three grew by only 4% on average (2011, pp. 14-15). A second size categorization would compare the U15 group of self-identified research-intensive institutions to the other universities. A third possibility might be to draw upon some of the published rankings of universities (e.g., the Academic Ranking of World Universities (ShanghaiRanking Consultancy, 2012); or the Times Higher Education World University Rankings (Times Higher Education, 2013)) and compare growth at the Canadian institutions listed with those not listed (or not in the top 500, for example). An alternative approach that includes all Canadian universities might draw on HESA's recent bibliometric analysis of Canadian universities (Jarvey & Usher, 2012). A further advantage of the Jarvey and Usher analysis is that it looks at NSERC and SSHRC disciplines separately, rather than considering enrolment university-wide. However, as Jarvey and Usher say (p. 17), "the top [SSHRC] scores are restricted to schools with large enrolments", and the U15 universities dominate in NSERC fields. An investigation based on HESA's rankings is not likely to produce different results than one done by the U15 and size categories. For that reason, we have not pursued this third possibility for categorizing universities.

The sixth way in which enrolment and degrees awarded can be investigated is in terms of disciplines or areas of study. Did all grow at the same rate, or did some benefit more than others from the expansion funding? It will also be of interest to look at the effects of gender and international students within some of the areas of study, particularly the STEM disciplines, given a focus on that area of some of the investments.

Thus, although this study will be limited to investigating only the changes in enrolment and degrees awarded subsequent to the major government investments, there are quite a number of topics of interest within that limited sphere.

The report first describes, in Chapter 2, the magnitude and types of investments made by governments and their stated intentions (if any) at the time of making the investments, first at the federal level and then for each province in turn. Chapter 3 considers changes in enrolments over time for each of the master's and PhD, by gender, by Canadian or international, by province, by university category, and by field of study. Chapter 4 then turns to degree completion rates, discussing first the U15 data on completion rates and times mentioned above, and then turning to analyses of master's and PhD degrees awarded, using the same characteristics addressed in Chapter 3. Chapter 5 assesses whether stated government investment intentions were accomplished and summarizes the main findings from the analyses of enrolments and degrees awarded.

2. Government Investments in Graduate Education

This chapter begins by covering the federal initiatives and considers the scholarship expenditures of each of the three granting councils in turn. The discussion then turns to the provinces, from west to east, and reviews their graduate-student-specific initiatives, covering both operating funding and scholarships. The final section of the chapter brings together the statements about intentions for these new funds from both levels of government, to help focus the analysis of consequences in the succeeding chapters. Rather than breaking up the flow of the text by identifying a source for every sentence in this section, we have provided a list acknowledging our primary informants at each funding agency and provincial government.

2.2 Federal Investments

The major federal investments in graduate education began with Canada's Innovation Strategy, announced in February 2002. The two documents setting out the Strategy identified a number of goals specifically pertaining to graduate education and identified the rationale behind them. "The proposed goals, targets and federal priorities would help Canada to develop, attract and retain the highly qualified people required to commercialize and adopt leading-edge innovations." One goal was to "[d]evelop the most skilled and talented labour force in the world." To this end, a target was set "through to 2010 to increase the admission of Master's and PhD students at Canadian universities by an average of 5 percent per year" (Industry Canada, 2002, p. 60).

The government was not interested solely in higher enrolment, but also wanted a higher number of graduate degree recipients. The same document goes on to identify "Government of Canada Priorities" as follows:

> **1. Produce new graduates.**
>
> ***Priority:*** The Government of Canada will consider the following initiatives to **increase the number of students obtaining graduate and post- graduate degrees** [emphasis added], help universities retain the best graduate students in Canada and attract top international students, and improve the quality of research training at the graduate level:
>
> - Provide financial incentives to students registered in graduate studies programs, and double the number of Master's and Doctoral fellowships and scholarships awarded by the federal granting councils" (Ibid, pp. 60-61).

Several other initiatives were included but are outside the scope of this analysis.

Our focus in this section of the report is on the increased graduate scholarships awarded by the three federal granting councils. The 2003 federal budget introduced funding for the new Canada Graduate Scholarships. The value of these new scholarships was set at $17,500 for a master's student and $35,000 per doctoral student per year, the latter a considerable increase over the existing value of Tri-Council awards.[2] The initial allocation of the CGS funding to the three councils was made proportional to graduate student enrolment in the three areas of study. This was an important decision, with consequences for achieving the doubling of awards quoted above.

The objective of increasing the number of graduates was reiterated in 2007 in *Mobilizing Science and Technology to Canada's Advantage*, which stated that "[m]ore individuals with graduate degrees in science and engineering will be needed to replace retiring workers and meet stronger demand for S&T skills from the private sector, universities, colleges, and government" (Industry Canada, 2007, p. 78).

[2] The existing Tri-Council awards were valued at $17,300 for master's (available only through NSERC) and $20,000 (SSHRC), $21,000 (NSERC) or $22,000 (CIHR) per year for doctoral students.

In the 2007 budget, the government invested an additional “$35 million over two years, and $27 million each year thereafter, to expand the Canada Graduate Scholarship program. When the new scholarships are fully in place, the councils will support an additional 1000 scholarships per year” (Industry Canada, 2007, p. 99). These new funds were distributed evenly across the three councils.

In 2008, the government contributed another $25 million to the CGS program and established the Vanier doctoral scholarships, which were first awarded in 2009. These were the first Tri-Council scholarships available to international students as well as to Canadians or landed immigrants. They are valued at $50,000 per year, for up to three years of doctoral study, and were specifically intended “to strengthen Canada’s ability to attract and retain the world’s top-tier doctoral students” (Government of Canada, nd).

In addition to these increases in budgetary expenditures for graduate education, the government also made a change to the tax regulations that slightly reduced the income tax paid on scholarships. In the 2006 budget, the government stated that the full value of a scholarship was deemed to be tax free, while only the first $3,000 had been previously. This had the effect of considerably increasing the after-tax value of large awards, such as the CGS. This “tax expenditure” is impossible to track, however, in terms of the value added for graduate scholarship holders, so it will not be discussed further here.

The next three subsections deal with each of the three granting councils in turn, looking at the change in their level of funding for graduate student scholarships following the introduction of these new federal awards.

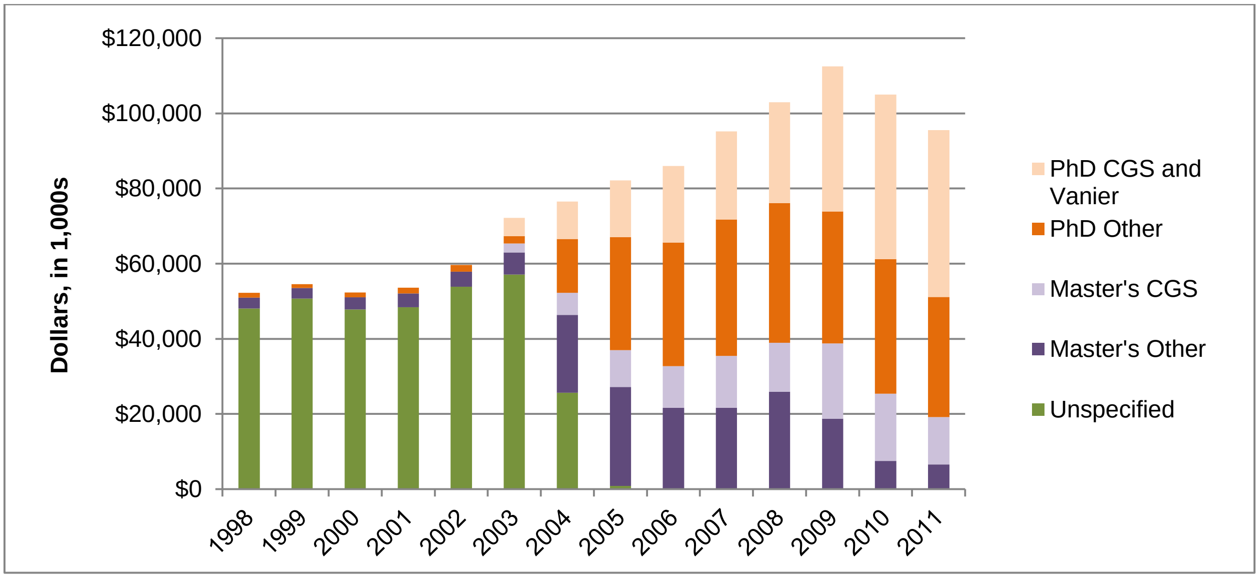
2.2.1 Natural Sciences and Engineering Research Council (NSERC)

NSERC has been providing direct scholarship funding to graduate students for longer than either of the other two councils. As Figure 2.2a shows, in 1998 they were already providing over $50M in graduate scholarships directly to students.[3] In addition, since NSERC’s inception in 1978, it has provided considerable indirect support for graduate students through the research assistantships received from grants made to university faculty members. More recently, NSERC introduced the CREATE (Collaborative Research And Training Experience) program, in which 80% of the grant funds must go to graduate student support. In its first year, 2009, this program distributed over $30M in awards to faculty members, to be spent over five years. While these types of indirect funding are important to graduate students, they lie outside the scope of this study.[4]

[3] More complete details are provided in Appendix A-2.1, which not only specifies what the “other” categories are but also identifies the number of recipients of each award type.

[4] The decision to exclude the CREATE program from this analysis is contrary to NSERC’s view that this too is scholarship funding, even though it is faculty, not students, who apply for it. Indeed, the CREATE program was funded in part by the transfer of funds from NSERC’s PGS-M program. At the 2012 annual meeting of the Canadian Association for Graduate Studies, Dr. Suzanne Fortier, the president of NSERC, stated that the CREATE program “has complementary goals” to NSERC’s scholarship program and is supporting the same number of students as would have been supported by the funding shifted from the scholarship budget to fund CREATE.

Figure 2.2a: NSERC total dollars of graduate scholarship support by program



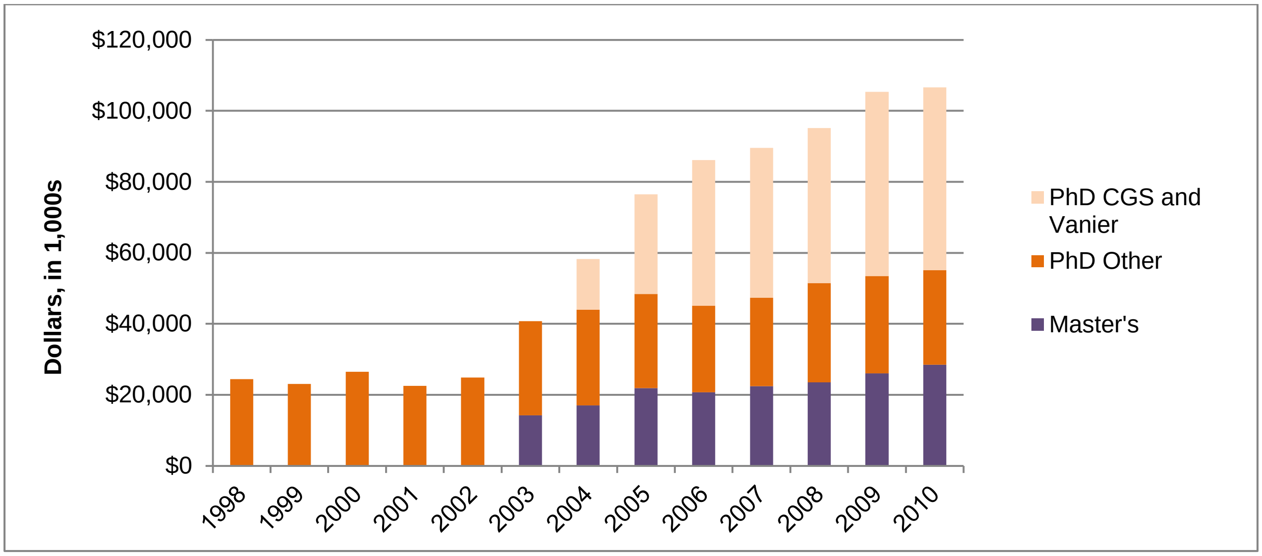
Prior to the introduction of the CGS awards in 2003, NSERC's data do not differentiate between funds expended on master's degree students and those expended on doctoral students. Scholarship money certainly existed for students at both degree levels, but they are simply listed together as "Postgraduate Scholarship", or PGS. After 2004, the amount spent for the two degree levels was reported separately. Thus 2003 expenditures on PGSs (degree unspecified) were over $57 million, and the amount shown for that category decreased by half in 2004, while the amount in the "other" categories for both master's and PhD increased by a comparable amount (which is almost entirely PGS awards – see Appendix A-2.1). From 2006 on, the amount in the "unspecified" degree level becomes vanishingly small on the graph.

The next thing to note in Figure 2.2a is the total invested by year. This jumped from the low $50Ms per year in the period 1998-2001 to nearly $70M in 2003, the first year of the new CGS awards, and continued to increase to over $110M by 2009, the first year of the Vanier awards and the high point of the total. Overall, NSERC scholarship funding doubled between 1998 and 2010. In 2009, the government provided some one-time funding for scholarships as part of its economic stimulus plan, which was used primarily to increase the number of CGS awards. The Vanier awards added an additional $2.7M in that year. The drop in total funding between 2009 and 2010 reflects the loss of the one-time stimulus funding. There was a major reduction in the "Master's other" category in 2010, which was primarily the PGS master's awards (see Appendix A-2.1 for the details), as well as a small reduction in the CGS master's awards. The elimination of second-year funding for master's students and the transfer of some funds to the CREATE program contributed to the drop in PGS master's awards.

2.2.2 Social Science and Humanities Research Council (SSHRC)

The first item of note in Figure 2.2b is that the total funding paid directly to graduate students remained below $25M until the introduction of the CGS program in 2003, at which point a steady increase in funding began, continuing through 2010 to a high of $110M, more than four times what it had been in 1998.

Figure 2.2b: SSHRC total dollars of graduate scholarship support by program



Two things stand out in looking at the master's degree category. SSHRC provided very little funding for master's students prior to the introduction of the CGS – too little to be visible on the graph – and it still provides minimal funding to master's students other than through the CGS.[5]

SSHRC's direct scholarship support of doctoral students in 1998 was roughly $25M, and the non-CGS support has remained at that same level even after the introduction of the CGS program. The funding for the CGS doctoral awards clearly shows the three-year phase-in, growing from $14M to $28M and then $42M between 2004 and 2006. The CGS program has been the source of almost all of the increase in SSHRC support to graduate students over the past decade.

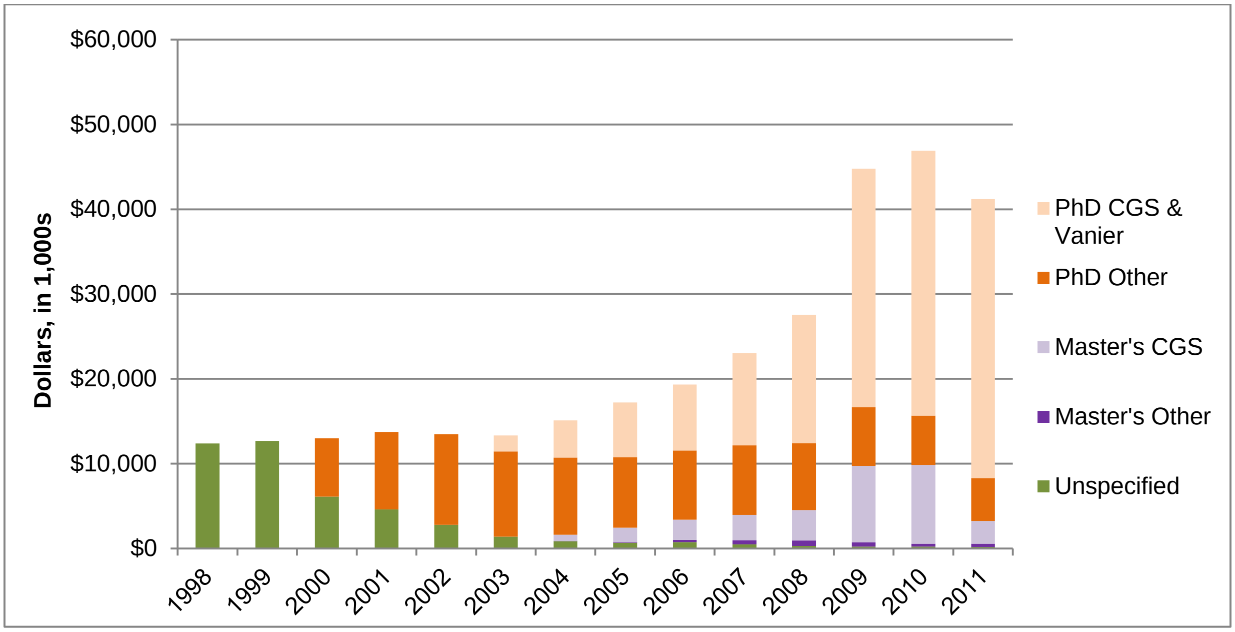
2.2.3 Canadian Institutes of Health Research (CIHR)

Although the act establishing CIHR was approved only in April 2000, the council took over the responsibilities of its predecessor, the Medical Research Council (MRC), which is why Figure 2.2c contains data prior to the establishment of CIHR. CIHR provides awards directly to graduate students, but the bulk of CIHR's graduate student funding has been provided through research grants to faculty members, and since 2002 from training grants made to faculty members or groups under the Strategic Training Initiative In Health Research (STIHR). STIHR support to graduate students was nearly $6M in 2011. These indirect training program grants are outside the scope of this study and are not reflected in Figure 2.2c.[6]

[5] Complete details are provided in Appendix A-2.2, which specifies what the "other" categories are and identifies the number of recipients of each award type.

[6] The decision to exclude the STIHR program from this analysis is contrary to CIHR's view that this too is scholarship funding, even though it is faculty, not students, who apply for it. The Strategic Training Initiative In Health Research (STIHR) program provides a six-year grant to a group of mentors (usually faculty members) to organize an interdisciplinary training program. The grant is used to recruit and support trainees, for trainee exchanges between participating institutions, and for developing educational materials. Following a positive evaluation of this program, a second round of 50 STIHR grants was jointly funded from institute and global budgets in 2009, an investment of $89M over six years (CIHR Internal Assessment Report for the 2011 international review).

Figure 2.2c: CIHR total dollars of graduate scholarship support by program[7]



As with the NSERC data described above, CIHR's data do not differentiate between scholarships for master's degree students and those for doctoral students prior to the introduction of the CGS awards in 2003. Direct funding certainly existed for students at both degree levels, but it is simply categorized as "Studentships" and reported here in the "Unspecified" category. After 2003, the amount spent for the two degree levels has been reported separately.

For CIHR, the non-CGS category is considerably more complex for both PhD and master's than it was for either SSHRC or NSERC, as it includes strategic funding initiatives from CIHR's thirteen institutes. Appendix A-2.3 provides the same kind of breakdown for CIHR as Appendixes A-2.1 and A-2.2 do for the other two councils. From Figure 2.2c, it appears that the non-CGS direct funding for doctoral students has decreased by more than 50% since the introduction of the CGS, although the increases in the value of the CGS-D have more than made up for this in terms of the overall doctoral support levels. The unspecified total in Figure 2.2c includes summer programs, as well as training initiatives that may span more than one degree.

There has clearly been a significant increase in the total dollar value of awards made directly to students, from approximately $13M prior to 2000 to well over $40M most recently. This is a three-fold increase, less than the quadrupling experienced by SSHRC but greater than the doubling that occurred at NSERC. Similar to NSERC, there was additional one-time money for awards in 2009 and 2010. The drop in 2011 reflects the loss of that funding.

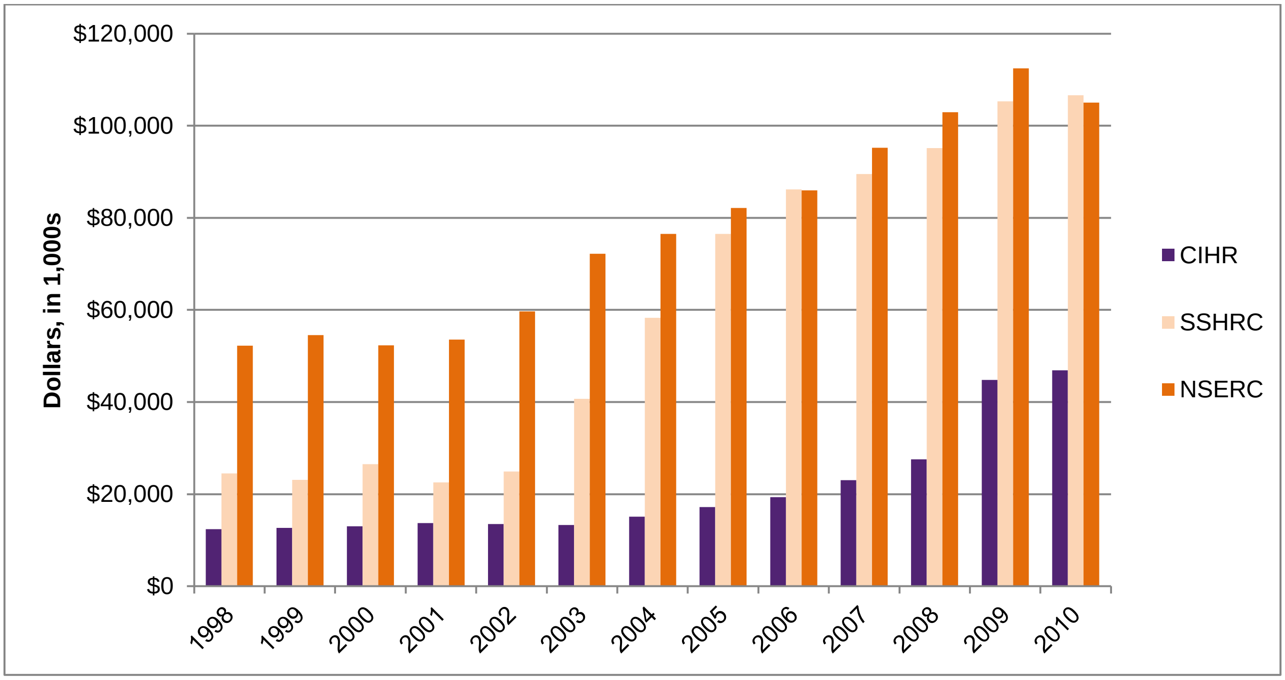
2.2.4 Summary of Direct Federal Investments in Graduate Education

As noted at the beginning of this chapter, the 2003 Innovation Strategy committed itself to "double the number of Master's and Doctoral fellowships and scholarships awarded by the federal granting councils." Our analysis

[7] Note that the vertical axis on this figure reaches only half the amount on the previous two figures.

has focused on the dollar value of awards, which quadrupled for SSHRC (from $23M in 2001 to $107M in 2010), tripled for CIHR (from $14M in 2001 to $43M in 2010), but only doubled for NSERC (from $52M in 2001 to $104M in 2010). The comparative picture for the three councils appears in Figure 2.2d, which shows that SSHRC funding grew through 2003-2005 to roughly equal NSERC's direct awards to students, and that CIHR is now at roughly half the amount of each of the other councils. Relatively, then, NSERC has not gained as much as the other two councils, a consequence primarily of the 2003 decision to provide CGSs in proportion to enrolment, which benefited SSHRC. The Innovation Strategy's stated intention of doubling the number of scholarships is ambiguous as to whether that was in total or for each granting council, but the decision to award the funding to councils in proportion to enrolment was clearly not consistent with the idea of doubling awards within each council. The 2007 initiative, *Mobilizing Science and Technology to Canada's Advantage*, did provide NSERC with a larger share of the increase over the next few years. Each council received an equal share of the Vanier awards, to the relative benefit of CIHR.

Figure 2.2d: Federal scholarship funding totals by granting council



The dollar value, however, does not directly address the wording of the Innovation Strategy, which spoke to the number of scholarships and fellowships awarded. Appendices A-2.1 through A-2.3 contain details on the number of students receiving awards. If we take 2001 as the base year, which represents the most recent data available at the time that the Innovation Strategy was written, the increase in the number of awards made up to 2010 has been as follows: NSERC from 3190 to 4807; SSHRC from 1334 to 4610; and CIHR from 798 to 1905. The numbers more than doubled overall, but the increase was unevenly distributed among the three councils. At CIHR, the numbers more than doubled, while SSHRC's tripled. NSERC increased by only 50% for two reasons. First, it was already directly supporting more graduate students than the other two councils combined. It is easier to double a lower number than a higher one. Second, as noted above, the government's 2003 decision on distribution of the CGS funds disadvantaged NSERC relative to SSHRC, leaving it with less new money to award.

Having now seen these Tri-Council data, our decision to begin the analysis with 1998 seems fortuitous. The scholarship situation from the councils was relatively stable between 1998 and 2002, the last year before the introduction of the CGS awards.

2.3 Provincial Investments

The investigation of increases in provincial investments in graduate education looks at two components of that investment: provincial scholarship support, continuing with the type of funding covered in the previous section, and operating funding, the provincial money going to universities for teaching students. In most cases, the operating funding for expansion has been paid on a per student basis, but there are also some cases in which a fixed sum was provided to a university or system rather than a per capita amount. Some provinces include international students in the tally of students on whose behalf operating funding is provided to the universities. Others, including Ontario, exclude international students from any count that is funded. With this in mind, it will be interesting to see if there is differential growth in Canadian or international student numbers across the provinces.

At the provincial level, our assumption of a stable funding and enrolment situation between 1998 and 2003 was incorrect, as several provinces were funding graduate enrolment growth during those years. When possible, increased investments are shown by year, to allow for comparisons with annual enrolment growth numbers, but information at this level of detail could not be obtained for all expansion programs. Table 2.1 shows the increases in operating funding expenditures specifically for graduate enrolment growth by province and by year. Table 2.2 similarly shows increases in graduate student scholarship funding by the provinces. Note the change in the nature of these tables from the figures for the Tri-Council scholarships: where the previous figures showed total expenditures, these next two tables show incremental investments relative to the amount of funding available as of 1997, the year prior to the beginning of these investments.

Table 2.1: Increases Specific to Graduate Enrolment in Operating Funding Expenditures Beyond the 1997 Base by Province and Year (in thousands)

Prov	Funding	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BC	2007										12,500	25,000	37,500	50,000	50,000
	Health						876	1,627	2,505	3,281	4,423	5,075	5,935	6,451	7,268
	Doubling the Opportunity					2,100	4,200	6,300	8,400	8,400	8,400	8,400	8,400	8,400	8,400
	Surrey					800	200	200	see text for remainder of years						
AB										90,163	83,417	114,986	112,273	106,698	106,698
SK															0
MB		0	71	71	71	71	71	405	232	134	248	288	277	214	
ON	Access to Opportunities Program	1,014	2,029	3,043	4,057	5,071	6,086	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100
	Nursing				702	1,415	1,412	1,975	4,565	6,068	7,617	7,616	6,553	6,553	6,553
	Graduate Accessibility Envelope				5,800	5,100	20,200	17,528							
	Reaching Higher (RH) Budget								19,000	70,000	170,000	170,000	187,200	204,400	221,600
	RH Actual								15,805	45,638	118,057	159,803	186,008	198,055	198,776
	RH Master's								4,346	15,333	72,197	93,591	103,233	107,095	107,783
	RH PhD								11,460	30,305	45,860	66,212	82,775	90,960	90,993
QC															0
NB															0
NS															0
PEI															0
NL															0

Table 2.2: Increases in Graduate Student Scholarship Funding Beyond the 1997 Base by Province and Year (in thousands)

Prov	Scholarship	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	on-going increase
BC	Michael Smith Foundation for Health Research				600	1,400	1,800	2,300	2,900	3,500	3,700	3,800	2,100	1,400	500	0
	Pacific Century										2,500	2,500	2,500	2,500		0
	Pacific Leaders Graduate Student Fellowship Program										320	420	120			0
AB	Ministy of Enterprise and Advanced Education						373	320	3,386	3,298	7,659	17,805	18,095	12,828	12,622	12,622
SK									350	420	500	500	500	500	500	500
MN								353	705	1,358	2,000	2,000	2,000	1,955	2,250	2,250
ON	Ontario Graduate Scholarship					5,300	5,300	5,300	5,300	5,300	5,300	5,300	5,300	5,300	15,300	15,300
	Ontario Graduate Fellowships							100,000	0	32,500	0	10,000	0	0	0	0
QC																0
NB																0
NS																0
PEI													160	320	400	400
NL													1,000	1,000	3,000	3,000

In this instance, it seems appropriate to summarize in advance the detailed discussion that follows. Two provinces, British Columbia and Ontario, instituted operating funding increases explicitly for graduate expansion. Three other provinces, Alberta, Manitoba and Newfoundland, made expansion funding available for which the universities could choose to apply at either the graduate or undergraduate levels (but Newfoundland's is not shown in Table 2.1 for reasons explained later). Five provinces, Saskatchewan, Quebec, New Brunswick, Nova Scotia and Prince Edward Island, did not have funding explicitly for expansion of graduate enrolment during the time frame of interest, although in most cases operating grants did increase, and there was also an increase in enrolment.

With regard to scholarship funding, seven provinces increased the amount and/or number of graduate scholarships available directly to students: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Prince Edward Island, and Newfoundland. For British Columbia, Alberta, and Ontario, the increase exceeded $10M over the period of interest. The remaining three (Quebec, New Brunswick, Nova Scotia) did not increase direct scholarship support, but in some cases made more funding available to researchers that was to be used as graduate student support, a type of support not considered in this report.

Prior to the full discussion, it is helpful to have some sense of the scale of the investments. To do so, we have drawn on total enrolment data from Chapter 3, as well as Statistics Canada population data (Statistics Canada, 2012b). Figure 2.3a displays the non-zero information from Table 2.1, the increased operating funding for the four provinces that had such. Clearly Manitoba's increased funding is small relative to the other three provinces. Figure 2.3b puts these absolute amounts in perspective by showing the increased operating funding on a total population per capita basis, while Figure 2.3c shows it on a per graduate student basis.

Figure 2.3a: Increases in operating funding by province

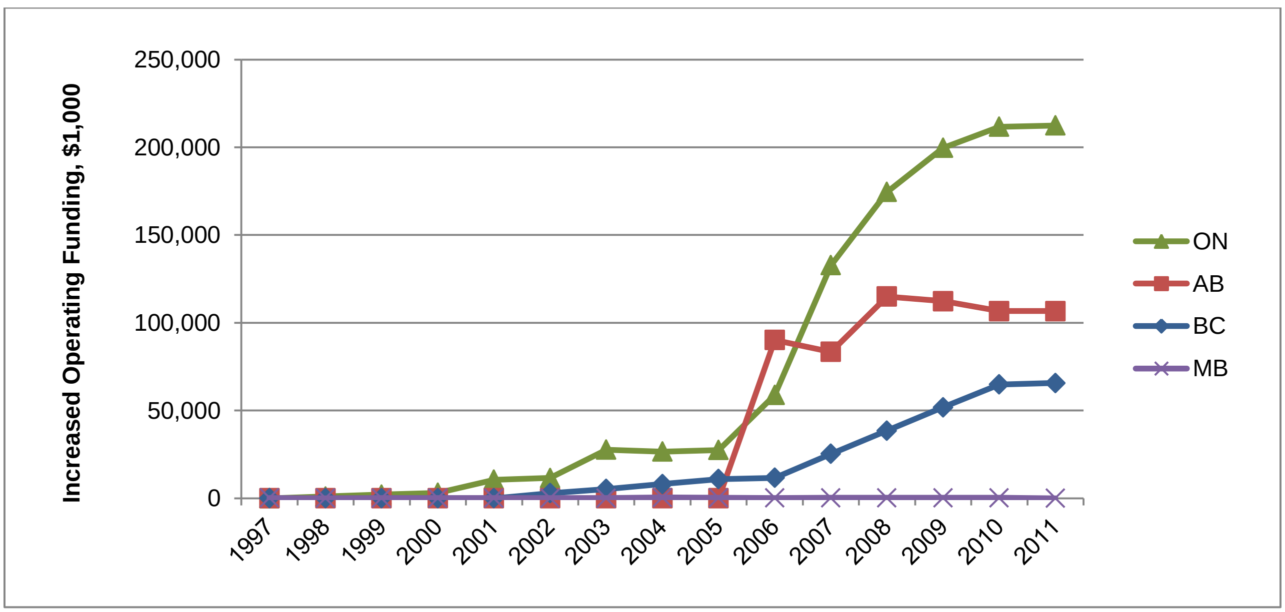


Figure 2.3b: Increases in operating funding per capita by province

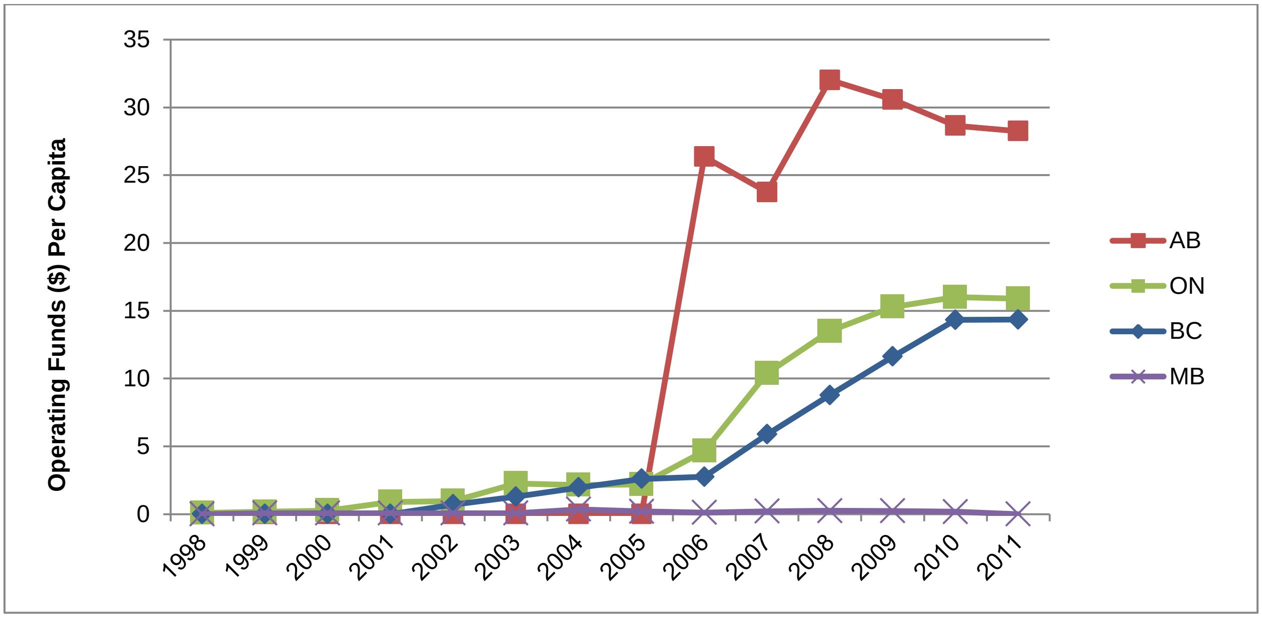
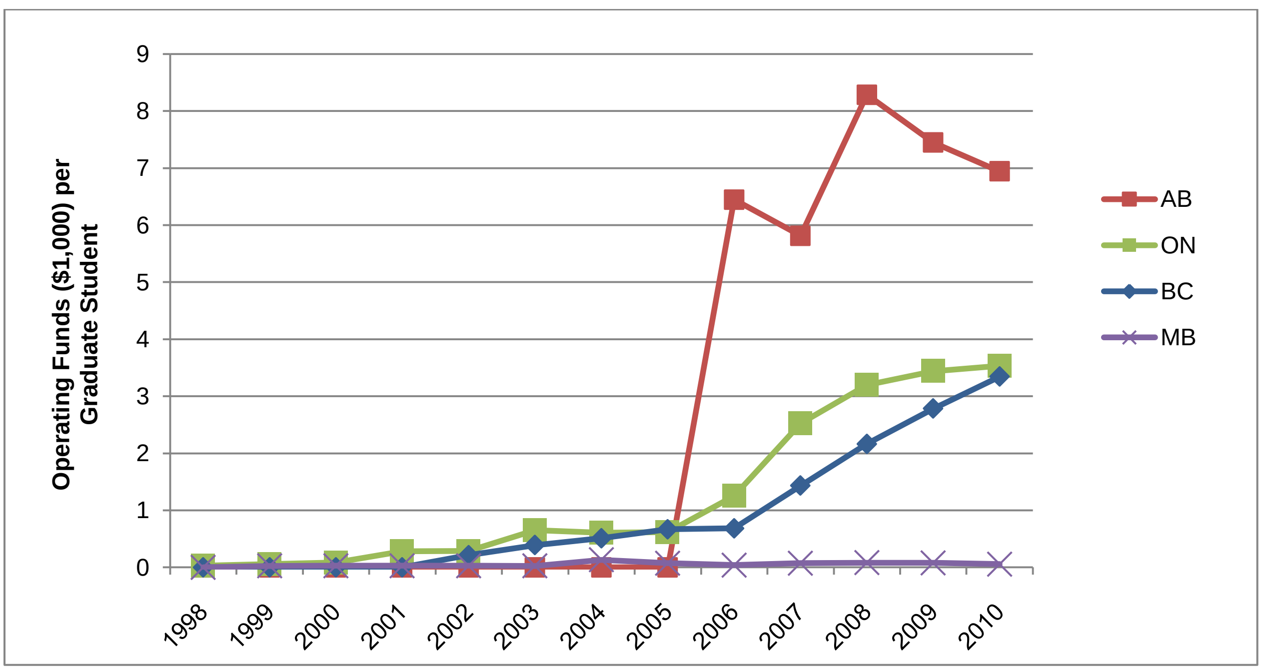
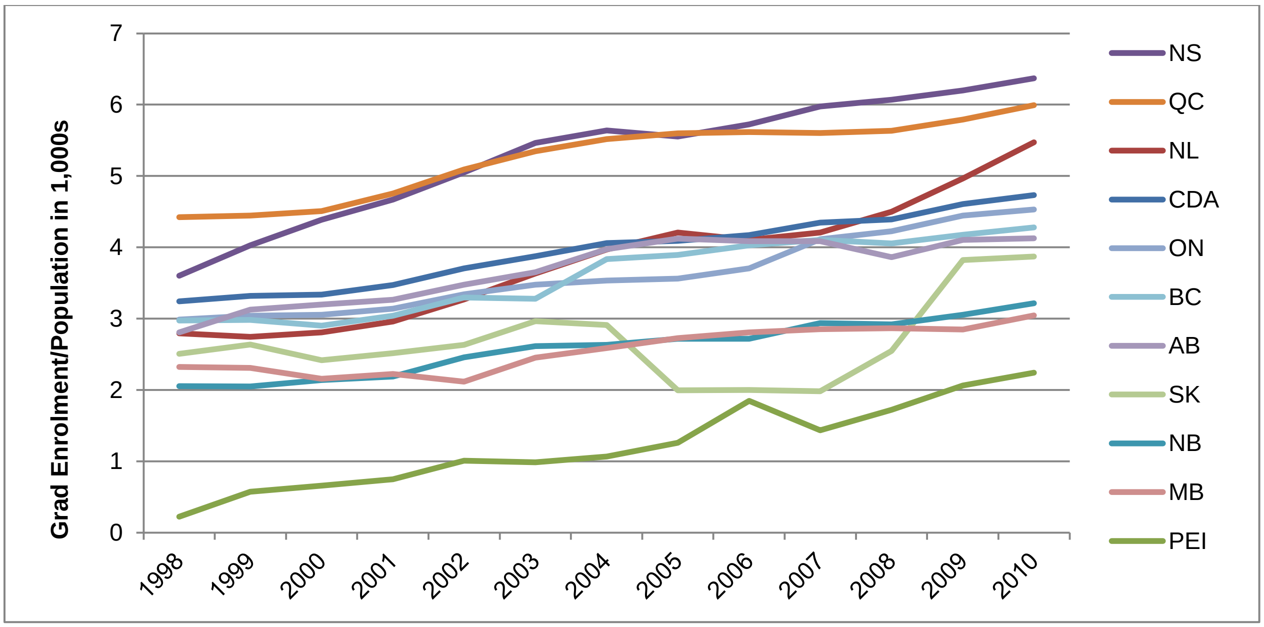


Figure 2.3c: Increases in operating funding per graduate student by province



The similarity of the graphs based on population and on graduate enrolment leads one to ask what the relationship might be between those two ways of measuring size in this context. Figure 2.3d provides the answer to this question and is intriguing in at least three ways. First, the line for all ten provinces tends upwards over time, which is to say that the number of graduate students per 1,000 population has increased over the decade. (The Saskatchewan line dips downward because data for the University of Regina are missing for several years.) Second, most provinces are clustered in the middle, around the national average. And third, while the outliers at the top end (more graduate students per 1,000 population) are Quebec and Nova Scotia, the outliers at the bottom end are Prince Edward Island by a large margin, and then New Brunswick and Manitoba (ignoring Saskatchewan because of questionable data). Nova Scotia is not a surprise: many out-of-province students study there at the undergraduate level, and no doubt many stay for an advanced degree. Quebec is interesting especially in light of the recent turmoil about tuition fees and university funding. Overall, this graph offers an explanation for the close similarity between Figures 2.3b and 2.3c.

Figure 2.3d: Graduate enrolment per 1,000 population by province



Looking at scholarship increases in the same way, Figure 2.3e shows the non-zero information from Table 2.2, scholarship increases, and shows how much Ontario and Alberta stand out. Only a single graph is necessary to consider scholarship increases on a per capita basis given what was observed in the previous paragraph, and in this case it seems sensible to look at it per graduate student. Figure 2.3f shows that when considered this way, Alberta is still at the top, Ontario falls back to the middle of the group and Manitoba is seen to be a strong contributor.

Figure 2.3e: Increases in scholarship funding by province

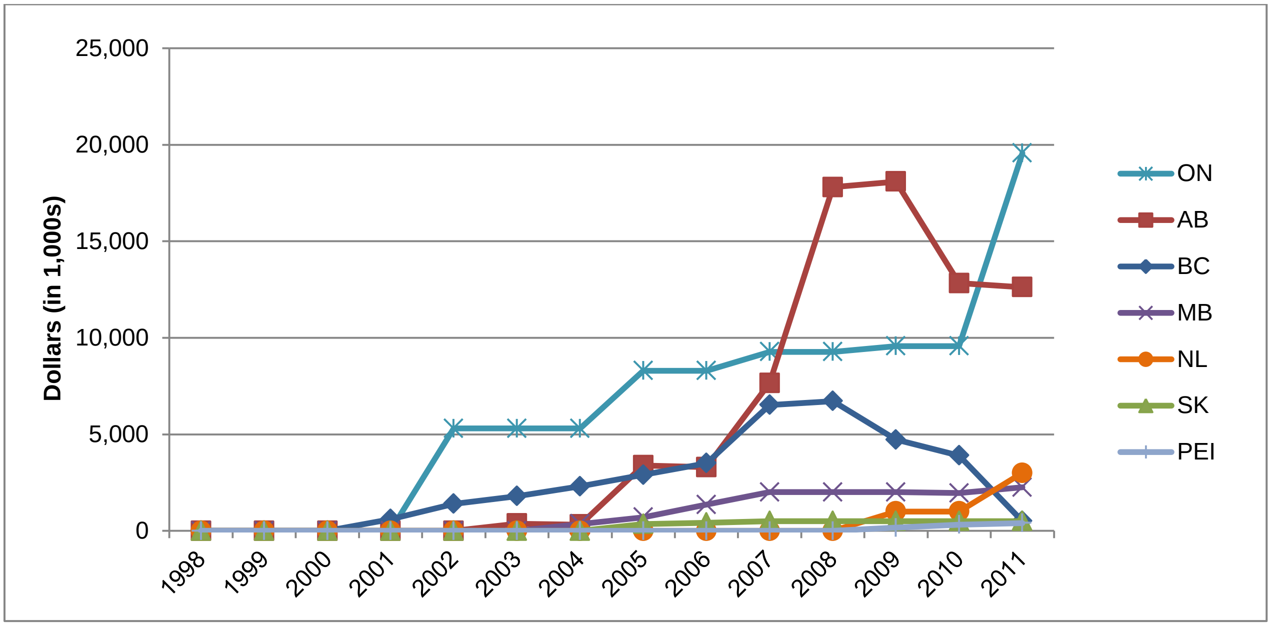
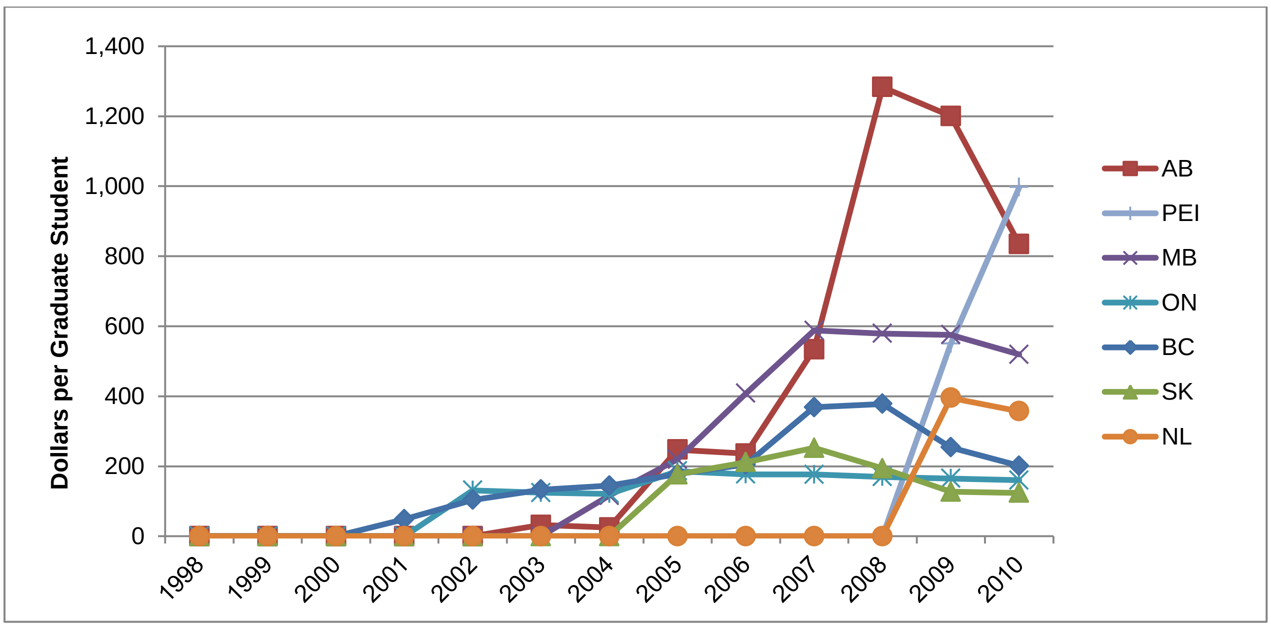


Figure 2.3f: Increases in scholarship funding per graduate student enrolled by province



The sources of the funding data in these figures will be explained in the remainder of this chapter. The sources of the enrolment data are covered in Chapter 3.

2.3.1 British Columbia

Although a major investment by British Columbia started in 2007, there were also three earlier graduate growth initiatives. The first was a health-focused expansion, running from 2001-2002 through 2011-2012 and funding a total of 424 new spaces. This initiative received a total of $7.3M but not on an FTE basis. The disciplines or degrees funded were MSc in nursing, nurse practitioner, graduate nursing generally, OT/PT, and speech and language pathology and audiology.

The second initiative was known as “Doubling the Opportunity”, or DTO, and was specific to computer science, and electrical and computer engineering. This funded a total of 420 graduate spaces at $20,000 per space per year and was phased in over four years, from 2002-2003 through 2005-2006, at the rate of 105 spaces per year. The third initiative was an effort specific to the Surrey campus of Simon Fraser University and resulted in 437 graduate spaces at SFU Surrey, with 60 of those spaces funded specifically at $20,000 per space and an additional 377 graduate spaces created through funding that was not on a per capita basis. This additional funding covered both undergraduate and graduate student spaces at SFU Surrey, such that the precise amount for graduate spaces cannot be identified. Each of these three initiatives is shown as a separate line in Table 2.1.

In 2007, British Columbia started funding four years of graduate growth to total 2,500 net new students, for which the universities would be paid $20,000 per student per year. This led to total new funding in year four of $50M, which has been added to the base funding for the province's universities. The universities were required to specify in their proposals to the Ministry the fields and degree levels in which the growth would occur. The growth was confirmed through audited FTE reports. It is worth noting that in 2006 several of the universities already had graduate enrolment exceeding the number for which the province was funding them. This excess did not count toward the growth targets. Instead, the actual enrolment in 2006 served as the base from which growth was measured.

The province expected expansion proposals to address numerous issues, including the expansion of the province’s research and innovation capacity; the fit with the institutions’ strengths; improvement of the province’s competitive position vis-à-vis other jurisdictions; and the fit with the province’s Research and Innovation Framework, which focused on the key sectors of life sciences, information and communication technology, clean technology, and natural resources (B.C. Ministry of Advanced Education and Ministry Responsible for Research and Technology, nd).

In addition to the funding for new spaces, British Columbia also provided several forms of increased scholarship support to graduate students. The largest amount was provided through the Michael Smith Foundation for Health Research (MSFHR), which from September 2001 through August 2012 distributed $24M to master’s and PhD students undertaking research in the health sciences. During this decade, the MSFHR was primarily focused on building capacity for health research in British Columbia. The general intent of the scholarships was to support highly qualified graduate students to prepare for careers as independent health researchers. As Table 2.2 shows, the annual amount for these awards peaked in 2008-2009 at $3.8M. Awards are not currently being made to master’s and doctoral students, but only to postdoctoral researchers.

In 2007-2008, the British Columbia government distributed $10M of new scholarship funds to the province’s four research universities.[8] This was intended to create 1,000 graduate scholarships of $10,000 each, called

[8] The University of British Columbia (UBC), the University of Victoria (UVic), Simon Fraser University (SFU), and the University of Northern British Columbia (UNBC).

the Pacific Century Graduate Scholarships. The purpose of these funds also was to help attract top students and to promote the research programs in the universities. Universities could spend the money over four years, with two years of funding available for a master's student and three years for a PhD student. The universities received the full funding up front and could use any interest earned on the funds in addition to the initial amount. For the purposes of Table 2.2, it was assumed that these funds were expended in equal amounts over the four years, starting in 2007-2008.

The Pacific Leaders Graduate Student Fellowship Program also began in 2007-2008, awarding primarily $20,000 fellowships to students at the same four universities. In the first year $320,000 was awarded, with $420,000 awarded in 2008-2009. The amount in 2009-2010 was $120,000, thus totaling $860,000 over the three years.

The British Columbia government also invested in internship programs for graduate students through MITACS, totaling $16.1M between 2004 and 2012, as another way to promote research programs within the province.

In summary, British Columbia had four separate initiatives that provided increased operating funding for graduate enrolment growth, starting in 2001 and ending in 2012. In total, these initiatives funded more than 3,700 new graduate spaces. Most of this funding was targeted to key sectors identified by government, even when the universities were able to propose areas for growth. In addition, British Columbia provided increases to graduate student scholarships beginning in 2001, with funding increasing through several programs and peaking in 2007 and 2008 before dropping off through 2011.

2.3.2 Alberta

Unlike British Columbia, Alberta did not have any initiatives specifically for graduate growth, but some general growth initiatives did allow universities to propose growth in either graduate or undergraduate areas. Because these proposals required government approval, we have attempted to identify how much funding was distributed in support of this government-approved graduate expansion. Unfortunately, the Ministry of Enterprise and Advanced Education (EAE, previously the Ministry of Advanced Education and Technology, AET) was unable to provide that information, so we have estimated it from their annual reports.

In October 2005, the government of Alberta created the Access to the Future Fund, whose purpose was "to support innovation and excellence by enhancing and expanding opportunities for Albertans to participate in accessible, affordable and high-quality advanced education opportunities" (AET, 2006, p. 74). In 2006-2007, the four universities[9] received $14.2M in total new money from this fund for enrolment expansion, in addition to an increase in the regular operating funding. However, the other public postsecondary institutions in the province received nearly $26M from the same fund, so it is clear that its focus was not solely graduate education (AET, 2007, p. 88). A similar payment of $14.2M was made in each of the next three years, except for a reduction of 0.15M to one university starting in 2008-2009.

The 2006-2007 annual report of the Alberta Ministry of Advanced Education and Technology also notes,

> [i]n support of its core businesses and goals, Alberta Advanced Education and Technology pursued the following activities in 2006-07… Created more than 2,400 new certificate, diploma, undergraduate and

[9] In 2006-2007 there were only four provincially funded universities in Alberta: the Universities of Alberta, Calgary, Lethbridge, and Athabasca University.

> graduate spaces at Alberta's post-secondary institutions through the Enrolment Planning Envelope, increasing learner access to Alberta's post-secondary system. Of these new spaces, 200 were created for Aboriginal students, with the majority being created outside of the seven major urban centers close to Aboriginal communities (p. 12).

This envelope included graduate growth, but was not focused specifically on it. It would be up to individual universities to decide how much of the growth that they proposed would consist of graduate students. In 2006-2007, this fund expended $213M (AET, 2007, p. 77) on all new spaces. A similar amount was authorized in 2007-2008, but only $196M was expended (AET, 2008, p. 76). The number increased in 2008-2009 to $275.7M (AET, 2009, p. 78) but dropped slightly again in 2009-2010 to $268.9M (AET, 2010, p. 59). In 2010-2011, this envelope disappeared and the funding was rolled into the base operating grant.

To attempt to estimate how much of the expansion funding from these two initiatives was spent in support of graduate enrolment, a pro rata share was calculated based on the growth in undergraduate and graduate full-time (not full-time equivalent) enrolment from 2005 to 2009. Graduate growth was 2,239 and undergraduate 3,403 in Alberta (University of Calgary, 2010), so graduate growth was 39.7% of the total, which is reflected in Table 2.1 for each of those years.

It is noteworthy that in 2006-2007 the Ministry of Advanced Education and Technology added a new performance measure for the system, the number of graduate students studying in the province. Targets for this measure were set in the 2007-2010 business plan (AET, 2007, p. 34), but it does not appear that any operating funds were set aside specifically to enhance graduate enrolment (though there was an increase in scholarship support, as detailed below.) In the AET 2010-2011 annual report, this measure was further described as "an indicator of Alberta's progress in developing a knowledge-driven economy." A new measure was also added to this category: the "percentage of graduate students studying in priority areas is an indicator of Alberta's research and innovation capacity in areas of focus" (AET, 2011, p. 15). The priority areas are identified as "energy, life sciences, nanotechnology, and information and communications" (p. 91).

With regard to graduate scholarships, the government of Alberta funding through what is now called the Ministry of Enterprise and Advanced Education (EAE) increased fourfold between 2002-2003 and 2011-2012, from $4.0M to $16.4M, having hit a high point of $22.1M in 2009-2010. The major initiatives contributing to this increase were as follows.

- The iCORE awards, worth a total of $2M, were introduced in 2005, and the total value was increased to $3 million in 2007.
- The Queen Elizabeth II Graduate Scholarships were also introduced in 2005 in the ratio of 1 for every 30 students, an increase from the 1 in 40 ratio for the predecessor Province of Alberta Graduate Scholarships.
- Nanotechnology Scholarships totaling $3M were introduced in 2007.
- In 2008 the ratio of the QEII awards was increased to 1 award for every 10 eligible students and the values were increased: from $9,300 to $10,800 for a full-year master's award and from $10,500 to $15,000 for a PhD award.
- Also in 2008, the value of the 1,000 Graduate Student Scholarships (for second-year master's students) was increased from $2,000 to $3,000.

The net effect of these and other smaller changes is shown in Table 2.2, where the total value of graduate scholarships in 2002 is taken as the base and has been subtracted from the total spent in each of the other years. Thus Table 2.2 shows the increases in total direct graduate student support in Alberta in each year relative to the amount in 2002. As the table shows, there was a reduction in graduate support in 2010-2011 from the high point in 2009-2010, but the remaining total increase since 2002 is still above $12M.

The province's rationale for these increases in scholarship funding can be summarized with press releases from two of the Ministers of Advanced Education. In 2006, Advanced Education Minister Denis Herard said, "These award recipients represent Alberta's future. Every piece of knowledge or skill they acquire, whether in astrophysics or ancient art, builds the intellectual capacity of our province. This adds to Alberta's knowledge wealth and enhances our ability to remain competitive in a variety of fields" (Government of Alberta, 2006). Two years later, in September 2008, then-Minister of Advanced Education and Technology Doug Horner added, “This new investment in graduate scholarships will enable these students to heighten Alberta's expertise and knowledge as we prepare for the knowledge-based economy” (Government of Alberta, 2008). Consistently, then, Alberta's scholarships are seen as a way to build expertise, knowledge, and competitive position as a province.

In addition to this EAE funding, the government of Alberta has also provided direct scholarship support to students (as well as indirect support through research grants to faculty members) through what is now called Alberta Innovates – Technology Futures (AITF). This support is in excess of $4M per year, but has not been shown in Table 2.2 because it has been relatively constant over the time period of interest. These awards were meant both to provide attractive top-ups to NSERC scholarship winners, and also to create full scholarships for foreign students and Canadian students not eligible for NSERC awards. The disciplinary focus has been on topics relevant to energy, the environment, bio-economics and health. Interestingly, the intention of these awards has been not simply to attract top Canadian and international graduate students to Alberta but also to retain them within Alberta's work force as highly qualified personnel. AITF has tracked the retention rate for this last part of the objective and reports that it is now at 79%.

In summary, although not targeted specifically to graduate growth, Alberta funding initiatives for enrolment expansion allowed universities to propose at what degree levels to focus their enrolment growth. Our graduate growth funding and enrolment numbers have been estimated using information from Ministry annual reports. This funding was initiated in 2005 and was rolled into base operating grants in 2010-2011. It does not appear that this funding was linked to specific sectors although the AET 2010-2011 annual report identifies priority areas in the energy, science and communication fields. Alberta also increased graduate scholarship funding several times starting in 2003. This funding peaked in 2009 before dropping slightly.

2.3.3 Saskatchewan

The government of Saskatchewan did not provide any new funding specifically for graduate expansion during the period of interest.

The Centennial Merit Scholarship program was first introduced in 2004-2005 and phased in over four years to a total of $1.4M from the government, to be matched equally by the university. Table 2.1 contains only the provincial portion of these scholarships. In the first year, the funds were available only for undergraduates. In the second year, funding was added to allow graduate students to be included in the initiative, but there was no directive as to how much should go to graduate students, nor was one added as the funding increased in years three and four of the program. By 2007-2008 and in each year thereafter, it appears that approximately $500,000 of the total was used for graduate students. The funding was extended to graduate students to help increase competitiveness in recruitment in the face of what were seen to be lucrative scholarships offered in other jurisdictions.

2.3.4 Manitoba

Although there was funding for newly approved programs in Manitoba between 1997 and 2008, that funding was no longer available after 2008. While the funding was not explicitly put forward by the government for new graduate programs, it could be used to this end if such proposals were approved by the Council on Post-Secondary Education (COPSE). Hence this was not funding that was targeted by government for graduate expansion, but is funding that was used to expand graduate enrolment, similar to the situation in Alberta discussed above.

Seven new graduate programs were approved for funding between 1997-1998 and 2007-2008. Three of the programs received new operating funding, which was rolled into the university's base funding, at a fixed level from their initial year. One of the programs received only start-up, development funding over five years but no new continuing operating funding thereafter. The remaining three programs received both start-up, one-time funding and continuing operating funding. The total expansion funding rolled into continuing operating funds was $828,100; the total of one-time start-up money was $1.48M. The Manitoba row in Table 2.1 reflects both types of funding.

In 2004, the government of Manitoba introduced $2M of new graduate scholarships, which had been promised during the 2003 election campaign as part of the HOPE Manitoba umbrella. The amount was increased to $2.25M in 2010-2011. As Table 2.2 shows, it took a few years to ramp up the expenditure on these scholarships, but by 2007 the full amount was being spent annually, with one small shortfall in 2010. The graduate scholarships were "designed to ensure that Manitoba's best students continue their education at home, to foster research that will lead to economic growth, and to attract excellent students to study in Manitoba"[10] (J. Zuk, personal communication, September 20, 2012).

2.3.5 Ontario

During the period covered by this report, there have been four growth initiatives affecting graduate education in Ontario: the Access to Opportunities Program (ATOP) starting in 1998; a Graduate Nursing expansion starting in 2001; a Graduate Accessibility Envelope (GAE) begun in 2001; and the Reaching Higher (RH) initiative beginning in 2004.

The Access to Opportunities Program (ATOP) began in 1998-1999 and was introduced to address shortages in specialized skills in the high-tech sector. Specifically, ATOP aimed to double entry-level undergraduate enrolments in computer science and high demand fields of engineering by 2000-2001 and to increase graduate program enrolments as well. By 2005-2006, the program had reached maturity and supported 817 spaces at the graduate level. The Ministry of Training, Colleges and Universities (MTCU) provided $47.3M in continuing funding to universities for ATOP, which is now included in the Basic Operating Grant. Regrettably, it is not possible to identify the funding attributable specifically to graduate growth. For the purposes of Table 2.1, a crude estimate has been made based on the 817 graduate spaces compared to the total of 10,993 new university spaces, and taking into account that graduate funding is about double that for undergraduates. This suggests that $7.1M of the $47.3M was used for graduate expansion, an amount that has been determined by simply assuming equal growth in each of the seven years of the program.

[10] Very similar wording appears on the University of Manitoba's website: "The Government of Manitoba has provided funds to ensure that Manitoba's best students continue education at home, to foster research that leads to economic growth and to attract excellent students to study in Manitoba." http://umanitoba.ca/faculties/graduate_studies/funding/index.html

The Graduate Nursing expansion was initiated in 2001 to support the transition to baccalaureate (as opposed to diploma) nursing in the province, and consisted of $12.6M to be spent over seven years to increase the number of nurses in programs for the Master of Science in Nursing. These funds went both to operating funding and to tuition grants for students. Beginning in 2004, a Nursing Faculty Fund was also created, consisting of $4M over four years for further expansion of graduate nursing programs at both the master's and PhD levels. Table 2.1 contains the sum of both of these initiatives as it is presented in Appendix 2.6 of the Funding Manual (Ontario MTCU, 2009, p. 78), from which we have included the operating funding for master's and PhD, as well as the tuition waivers.

The Graduate Accessibility Envelope (GAE) was small relative to the Reaching Higher (RH) initiative, but set the stage for the latter in two ways: it established the base year for RH, and it helped establish principles for allocating funding for graduate growth. The GAE was initiated in 2001-2002 with $5.8M of funding, which was distributed to universities in proportion to their existing graduate enrolment. The next year the funding level was set at $5.1M. A new allocation procedure was used based on five performance-based indicators as proposed by the Council of Ontario Universities.[11] In 2003-2004, the final year of the GAE, $20.2M was made available to universities for graduate growth (Ontario MTCU, 2009, pp. 12-13; 77). There were increases in graduate enrolment prior to these GAE years, and larger growth during the GAE years than was funded by the province. The Ministry of Training, College and Universities' funding allocation was not the driver of most of this growth. The universities that expanded their enrolments did so as a matter of institutional choice and with no guarantee that government would come to the table with sufficient additional funding.

The Reaching Higher (RH) initiative began in 2005-2006 but established the base year for its expansion as the year after the first GAE initiative. As described in the Funding Manual (Ontario MTCU, 2009, p. 13),

> In 2004-05, as part of the Reaching Higher plan, the Ministry announced the goal of expanding graduate enrolment by 14,000 student spaces (measured in FTEs) by 2009-10 compared to 2002-03. In February 2009 this target was modified to 15,000 spaces by 2011-12 compared to 2002-03. Additional funding of $15.6 million (2005-06), $45.8 million (2006-07), $118.7 million (2007-08) and $164 million (2008-09) was provided to institutions for actual enrolment growth achieved under this program. In 2008-09, growth to 2007-08 was rolled into base.

Universities had difficulty reaching these ambitious targets on time. Table 2.1 shows the budgeted amounts for RH and also the actual expenditures, with those subdivided into master's and PhD dollars. The funding was dependent on enrolment growth actually being achieved, but it was not until 2009-2010 that enrolment growth caught up with the funding that had been made available – and then growth slipped behind funding again the next year. Universities have been given an extra year to reach the growth called for by 2011-2012 funding.

The first four years of RH were conducted in large part as an extension of the allocation principles established under the GAE. Seventy per cent of an institution's allocation was based on the indicators that had been used

[11] "The following five indicators, each with an equal weight, and averaged over three years, were used…:
• Graduate FTE Enrolment as an indicator of existing capacity and hence the ability to sustain expansion in graduate studies;
• Graduate Basic Income Unit (BIU) which not only provides an indication of existing capacity, but also recognizes the difference in BIU weighting between master's and doctoral programs, and also provides a measure of institution's ability to sustain expansion in graduate studies;
• Research Funding from the federal government's research granting councils14 to provide an indicator of peer-reviewed, competitive funding support for research, and indirectly, an indicator of funding available to support graduate students;
• Graduate Degrees Granted, to provide an indicator for output adjusted for Masters and Doctoral FTEs; and
• Graduate Awards to provide an indicator of success in attracting top graduate students" (Ontario MTCU, 2009, pp. 12-13).

in 2002-2004 (as listed in footnote 2 previously, but updated with the most recent data). The remainder was allocated based on an evaluation of proposals made by each university, and an MTCU assessment of each institution's capacity to expand accordingly. This process led to the major research universities being assigned the target that they requested, and the remainder of the growth being assigned to all of the other institutions.

For 2008-2010, MTCU again requested proposals from universities for their expansion intentions and abilities. By 2008, the system had achieved only 82% of the 12,000 FTE growth target for that date, and most universities had not met their master's and PhD targets. This second part of RH increased the overall graduate target to 15,000 spaces, but universities were given longer – until 2011-2012 – to reach the targets. Despite the need to extend the target date, MTCU feels that the graduate expansion has been largely successful: as of 2011-2012, graduate enrolment had grown by 14,204 spaces compared to 2002-2003, and the Ministry is confident that the final target of 15,000 will be met in 2012-2013.

Table 2.1 shows considerable variation by year in the dollars accrued on behalf of master's or PhD funding. In the first two years of RH, PhD funding was at least double the master's funding. PhD students attract roughly double the per student funding of a master's student, so this would suggest that there was approximately equal enrolment growth in the two degree levels. From 2007 onward, funding for master's students exceeded that for PhDs, suggesting that most growth was then taking place in master's programs. This may reflect difficulties universities encountered in expanding research-focused PhD programs. In the 2008 allocation round, MTCU emphasized an increase in the number of PhDs, and Table 2.1 shows that the funding for PhD places had increased from its 2007 low of 64% of master's funding to 85% in 2010.

In addition to the increased operating funding, Ontario also provided several increases to available graduate scholarship funding. As of 2000-2001, MTCU's budget had $14.7M for Ontario Graduate Scholarships (OGS), which were worth $11,859 for a full year of study. This amount was sufficient to fund 1,300 scholarships, since not all students held them for the full year. In 2001-2002, the Ministry changed all three of these numbers: their budget increased to $20M, the number of awards to 2,000, and the value of an award to $15,000. Obviously, $20M was not enough to cover the full cost of all these awards. Part of the change was to require universities to cover one-third of the cost. The money could come either from new funds from private donors or from existing undesignated endowment funds. Institutions were not permitted to use funds from operating grants or from the student aid set-aside from recently approved tuition increases. In 2011-2012, the number of awards was increased again to 3,000, with the universities again covering one-third of the cost. Table 2.2 shows only the amount of increased funding beyond the base levels in 2000-2001. Consistent with what was done for Saskatchewan, the table shows only the province's portion of these scholarships. Over the period in question, PhD students have received more than half of the OGS awards, with their percentage ranging from 62% in 2000 to 50.3% in 2008. For most of the time when the awards numbered 2000, PhD students received about 55% of them.

In addition to the OGS awards, the province also instituted the Ontario Graduate Scholarship in Science and Technology (OGSST) in 1998-1999, which were renamed as the Queen Elizabeth II awards (QEII-GSST) in July 2010. These are also worth $15,000 per student and reflect a 2:1 provincial match, but in this case the universities had to raise private funds for their share. The annual provincial investment in these awards has been $5 million regularly since 1998-1999. As a result, they are not shown in Table 2.2, which is intended to reflect increases in funding since the base year of 1998-1999.

The largest provincial investment in scholarships has been the creation of endowments to establish the Ontario Graduate Fellowships. In 2004-2005, the government provided $100M to universities for this purpose. An additional $32.5M was committed in 2006-2007 and a further $10M in 2008-2009 to expand these endowments. The income from them is to be used to support graduate students. Universities have the discretion to set the value of individual fellowships. However, the OGFs are not to exceed $4,000 per term, which makes them less valuable than the OGS and QEII awards. Table 2.2 identifies these endowments as one-time investments by Ontario.

Other investments have also been made by Ontario in university research and education that are not shown in Table 2.1 because they are neither operating funding specific to graduate growth nor graduate scholarships. The largest of these is the Graduate Expansion Capital Grant Support Program, with $550M allocated over twenty years beginning in 2007-2008 for construction of new or enhanced facilities to support enrolment increases.[12] In 2005, the government also provided $25M to endow eight new Ontario Research Chairs.

It should also be noted that since 2008, Ontario (like British Columbia) has invested over $20M in research and training programs (in particular graduate internships) run by MITACS to improve quality in Ontario's postsecondary education and training systems.

In summary, Ontario had a number of operating funding initiatives specific to graduate expansion, with the first (Access to Opportunities) beginning in 1998 and the most recent (Reaching Higher) continuing through 2011. The RH funding was explicitly tied to the governments graduate expansion goals but not to specific fields of study, and led to an increase of nearly 15,000 graduate FTEs by 2011-2012. Ontario also provided increases to direct scholarships to students in 2002 and 2011, as well as endowments provided in 2004, 2006 and 2008 to universities for additional graduate scholarships.

2.3.6 Quebec

There has not been any new funding in Quebec specifically for graduate expansion, at least since 2000. There have, however, been several significant increases in the funding for universities, although this does not appear to have been tied to any increase in enrolment as it was in Alberta (Section 2.3.2 above). For example, on a base budget of $1B in 2000-2001, there were increases totaling $600 million over the next three years ($120M in 2000-2001, $180M in 2001-2002, and $300M in 2002-2003). Again in 2006, further increases totaling $240 million were announced for the period of 2006-2009. In conjunction with these latter increases, the government and universities agreed (in December 2006) on a revision to the funding weights for programs. The new weights were based on costs during the 2002-2003 year and had the result of making graduate education more attractive financially for Quebec universities. For example, the funding weight for PhDs in science and medicine increased from roughly 8.2 to 10.7, and for the arts from about 5.2 to 6.4. There was also a slight increase for master's students. Given that an increase of 1 is equivalent to about $3,500 per student, one could see this as an incentive to increase graduate enrolment. However, this increase in graduate student funding weights was the result of cost analysis and not based explicitly on a strategic objective related to graduate enrolment.

With regard to scholarship funding, there are three principal agencies within Quebec that provide scholarships directly to graduate students: Fonds québécois de la recherche sur la nature et les technologies (FQRNT); Fonds québécois de la recherche sur la société et la culture (FQRSC); and Fonds de la recherche en santé

[12] The decision to exclude the Graduate Enrolment Expansion Capital Grant Support Program from this analysis is contrary to the MTCU's view that this too is enrolment growth funding even though it is a capital grant rather than operating funding. The decision had been made early on however to limit the analysis to scholarship and operating funding, and to exclude other types of funding such as for capital and research. From 2007-2008 to 2011-2012 MTCU distributed $193M under this program.

du Québec (FRSQ). The budgets for these agencies (at the master's, doctoral, and post-doctoral levels) remained relatively constant between 2002 and 2007, averaging $7.9M for the FQRNT, $13.2M for the FQRSC, and $9.6M for the FRSQ. The funds increased beginning in 2008 as a consequence of contributions from the newly-created Quebec Strategy for Research and Innovation. The average budgets since then have been $12M for the FQRNT, $16.2M for the FQRSC, and $12,5M for the FRSQ. Consistent with the increase in funding, the number of grants awarded has also increased. These funds are available as scholarships to students and as grants to researchers. The data do not allow us to distinguish between these two groups and we therefore cannot quantify the amount targeted to graduate students. But again, this increase comes not as the result of an explicit intention to increase graduate enrolment but as a consequence of a focus on research and innovation. Hence while there have been increases in both operating and scholarship funding in Quebec, they have not been part of an explicit effort to expand graduate enrolment, so Tables 2.4 and 2.5 both show zeroes for Quebec.

2.3.7 New Brunswick

There has not been any new funding in New Brunswick specifically for graduate expansion, at least since 2005. The only new scholarship money was provided through the New Brunswick Innovation Fund for research assistantships, which are awards that flow directly to the researchers who apply for them. Because these awards are made to faculty members and can be used for either graduates or undergraduates, they have not been included in our tally of investments in graduate studies.

2.3.8 Nova Scotia

There has been no direct policy focus on the expansion of graduate enrolments in Nova Scotia since 2002 (to the collection of data for this report in August 2012). Funding to Nova Scotia universities has increased by 62% since 2002, and graduate enrolments are weighted more heavily than undergraduate in the funding formula. In this respect, there has been increased funding for graduate enrolment but it did not result from a direct policy focus on graduate education so is not included in the tabulation in this section. Increases in graduate enrolment were funded by the universities from within this overall increase in operating funds and from tuition paid by the students.

2.3.9 Prince Edward Island

As with the other Maritime provinces, there was no direct focus on graduate expansion in Prince Edward Island. The university in Prince Edward Island is not funded on a per student basis, but there has been a general increase in the level of funding over the past decade. The only investment specific to graduate education was the establishment in 2009 of a Graduate Students and Postdoctoral Fellowships program through Innovation Prince Edward Island, which provides $20,000 each per year to four master's and four PhD students, tenable for two years at the master's level and three years at the PhD. The awards are "designed to support and develop highly skilled researchers in the strategic sectors of bioscience, information technology, aerospace and renewable energy" (Government of Prince Edward Island, 2012).

2.3.10 Newfoundland and Labrador

While the province of Newfoundland and Labrador did not have a program intended to expand graduate education in general, it has made a number of specific investments in particular program areas and has also increased the funding for graduate scholarships. In 2008, $915,000 was provided for the expansion of social work programs at both the master's and bachelor's level, but the amount for each was not specified, nor is it feasible to separate the two after the fact. Hence this amount is not included in Table 2.1. In addition, during the period of 2010-2012, new funding was provided for the PhD in psychology, growing from $223M to $485M. Since this funding was allocated simply to maintain the program rather than to increase enrolments, these funds do not appear in Table 2.1. Additional money was provided for competitive graduate fellowships as well: $1M in 2009, increasing to $3M in 2010. This funding is shown in Table 2.2.

2.4 Focus on Governments' Intentions

The intentions of the eleven governments in making investments in graduate education have been phrased in different ways and called different things. For example, the federal Innovation Strategy identified goals, targets and priorities. Table 2.3 summarizes the identifiable statements that pertain directly to graduate students, in most cases repeating a phrase that was reported above. When no statement was made about graduate students, a more general phrase has been used. Some of the statements in the table are very specific; a few are easily measured; many are quite general and impossible to measure quantitatively in the context of this report.

Table 2.4: Governments' Stated Intentions for Graduate Investments

Federal (Industry Canada, 2002, p. 60, 61; Industry Canada, 2007, p. 78)	- "through to 2010 increase the admission of master's and PhD students at Canadian universities by an average of 5 per cent per year" - "increase the number of students obtaining graduate and post- graduate degrees" - "retain the best graduate students in Canada and attract top international students" - "double the number of master's and doctoral fellowships and scholarships awarded by the federal granting councils" - "more individuals with graduate degrees in science and engineering will be needed"
British Columbia (B.C. Ministry of Advanced Education and Ministry Responsible for Research and Technology, nd)	- Increase capability of research programs - Improve the province's competitive position vis-à-vis other jurisdictions (e.g., addressing the shortfall in the number of graduate students in sciences compared to other provinces) - expanding the number of graduates who will support the following key sectors of the province's economy: life sciences (health and biotechnology); technology (information and communication, new media and wireless); clean technology (alternative energy and sustainable technologies); and natural resources (forestry, agriculture, fishing, mining, oil and gas)
Alberta (Government of Alberta, 2008)	Increased scholarships "enable the students to heighten Alberta's expertise and knowledge as we prepare for the knowledge-based economy"
Saskatchewan (K. Veitenheimer, personal communication, August 28, 2012)	Help increase competitiveness in recruitment in the face of lucrative scholarships offered in other jurisdictions
Manitoba (J. Zuk, personal communication, September 20, 2012)	To "ensure that Manitoba's best students continue education at home, to foster research that leads to economic growth and to attract excellent students to study in Manitoba"
Ontario (Ontario MTCU, 2009, pp. 24; 13)	- "an increase of up to 50 percent of 1997-98 total enrolment in core ATOP disciplines" - Expand graduate education by 15,000 spaces (Reaching Higher)

Quebec	NA
New Brunswick	NA
Nova Scotia	NA
Prince Edward Island (Government of Prince Edward Island, 2012)	Scholarships “support and develop highly skilled researchers in the strategic sectors of bioscience, information technology, aerospace and renewable energy”
Newfoundland	NA

A consistent theme across many of the comments is the need to improve competitiveness for a province (or the country), developing (as stated in the federal Innovation Strategy) “the most skilled and talented labour force in the world.” In addition to the federal government, British Columbia, Alberta, Manitoba and Prince Edward Island all referred to this general objective. Unfortunately, success in reaching this goal cannot be addressed or reliably quantified within the scope of this report.

Other objectives refer specifically to competition among the different provinces for graduate students. British Columbia, Saskatchewan and Manitoba all say something of this kind as a rationale for increased investment in scholarships. This objective too cannot be easily assessed, even with the detailed enrolment data analyzed in the next chapter. There is no way to compare current numbers with what might have happened had the new scholarship funding not occurred.

Ontario is the one province to identify quantifiable objectives. These certainly can be assessed.

Two of the federal objectives can also be assessed using the enrolment and degree completion data provided in the next two chapters: increase enrolment by an average of 5% a year; and increase the number of degrees received, especially in science and engineering. Accomplishment of one of the federal objectives was already assessed, that calling for a doubling of the number of federal scholarships. We found this objective to have been achieved for SSHRC and CIHR, but not for NSERC.

3. Changes in Enrolment Following Government Investments in Graduate Education

Statistics Canada produces the Postsecondary Student Information System (PSIS), which is based on an annual national survey and provides detailed information on enrolments and graduates of Canadian postsecondary institutions (Statistics Canada, 2012). HEQCO purchased extracts from the PSIS; these extracts constitute the source of all of the enrolments and degree data analyzed in Chapters 3 and 4.[13] In producing extracts from PSIS, Statistics Canada rounds all numbers to the nearest multiple of 3 in order to protect the confidentiality of individuals. This rounding is done on a probabilistic basis, with the result that the sum of a set of numbers may not add to the total that PSIS also reports (Statistics Canada, 2010). Hence

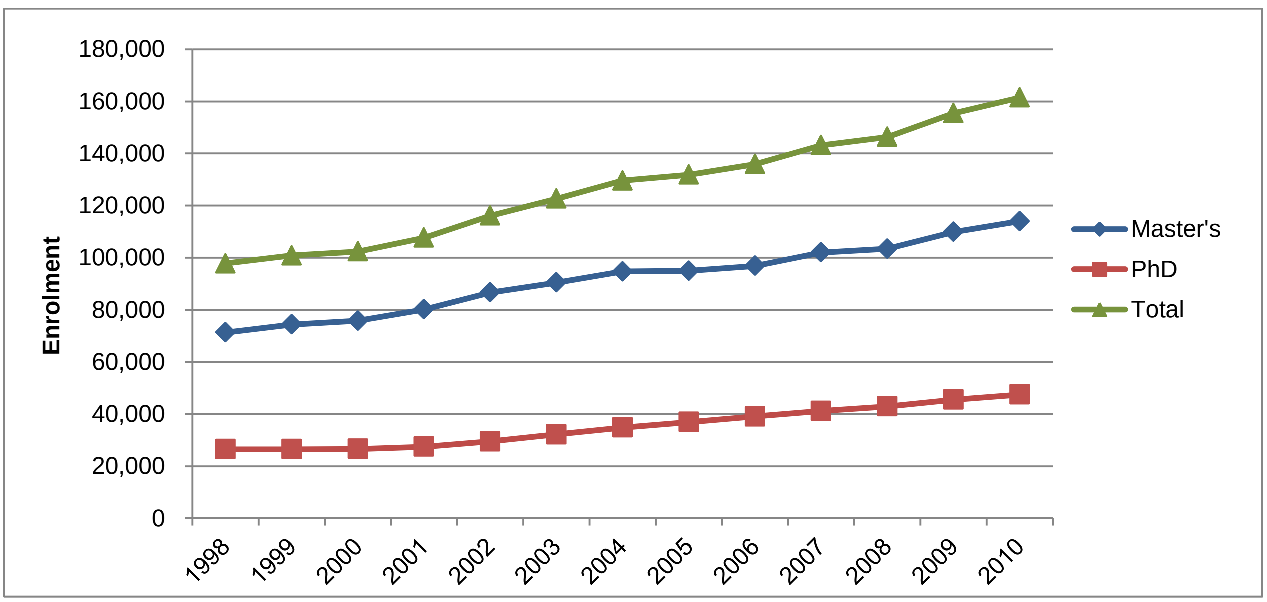
[13] The data used in this report are derived from the version of PSIS produced by Statistics Canada in September 2012 and January 2013. The January 2013 data added 2010 data and corrected errors in the 2009 data, including missing enrolment or field of study data for 2009 for some institutions.

there may be some apparent discrepancies in the data, but these will be at a level not visible in the graphs that will be presented here.[14]

3.1 Total Enrolment Changes

The first question that arises in looking at enrolment changes is whether our assumption holds true that there were stable enrolments before the start of the major federal investments in 2003. The second question is whether growth in total enrolments occurred after those investments and whether the magnitude was in line with federal targets. From Figure 3.1a, it would appear that PhD enrolment was relatively flat from 1998 to 2000, but master's enrolment was already on the increase in 1999 and 2000.[15] Several things stand out in the percentages of increase (Fig 3.1b): PhD and master's enrolments grew at different times, and the largest percentage growth in master's enrolment occurred in 2002, the year *before* the federal investment started in 2003. Since the increased investment in Tri-Council scholarships began, the master's growth rate has exceeded 5% in only two years. By contrast, the PhD growth rate exceeded 5% in all *but* two years. Master's growth rates exceeded PhD rates prior to 2003; since then the PhD growth rate has always been higher than the master's rate except in 2009. These differences between the patterns of master's and PhD enrolment growth are sufficiently large that each should be considered separately in subsequent analyses.

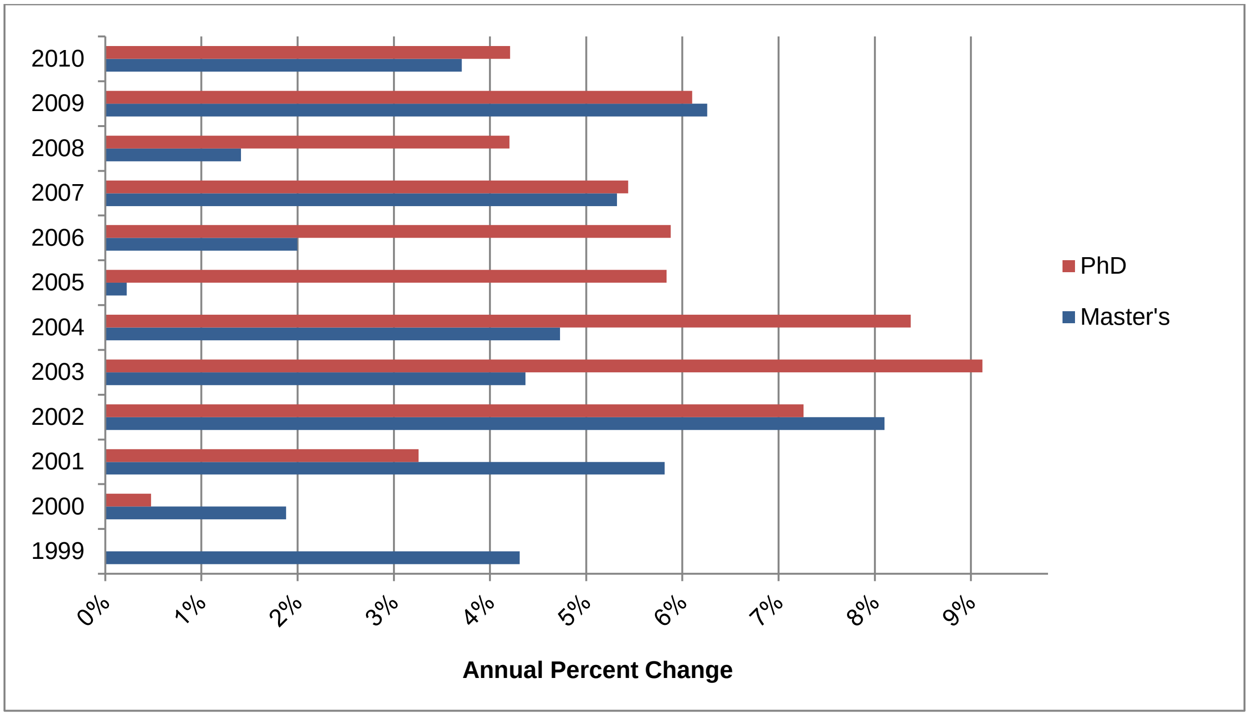
Figure 3.1a: PhD, master's, and total head count enrolment



[14] An additional consequence of this probabilistic rounding is that extracts from PSIS produced at different times or for different clients may not be identical. In addition to HEQCO, the Canadian Association for Graduate Studies (CAGS) also obtains 2012 PSIS extracts on similar data. We have compared our numbers with those in their 40th Annual Statistical Report and find occasional discrepancies in total enrolments, but not of a magnitude to affect the results. We are indebted to Pascal Lemelin at the Observatoire des sciences et des technologies at UQAM and to CAGS for providing us an early version of that report.

[15] Appendix A-3.1 provides the actual numbers on which Figure 3.1a is based.

Figure 3.1b: Annual percentage change in head count enrolment for PhD and master's



3.2 Full-Time versus Part-Time Enrolment

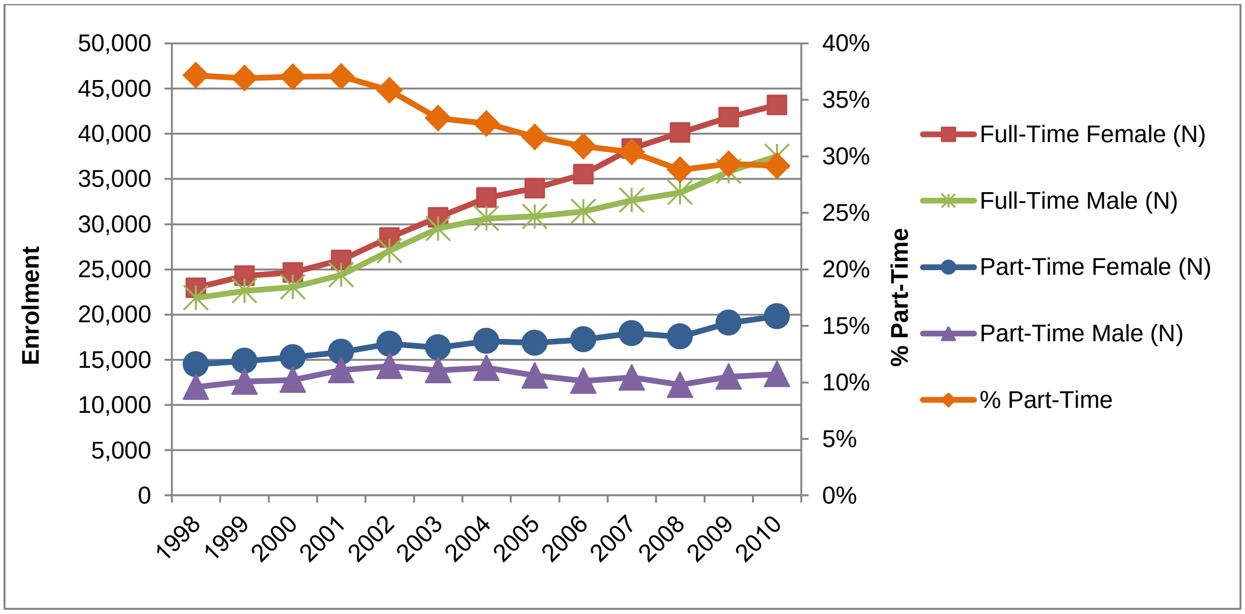
We first need to decide whether the remainder of the analyses should use total (head count) enrolment (as was used in Section 3.1) or should focus on only the full-time student numbers. The PSIS extracts are based on head counts and therefore treat full-time and part-time students equally. Most provincial funding is based on full-time equivalent (FTE) numbers, in which part-time students are counted as only a portion of a full-time student. The various provinces have different ways of combining part-time and full-time numbers. For example, in Ontario the weighting for a part-time student is 0.3 of a full-time (Ontario MTCU, 2009, p. 58). In other provinces, the proportion depends on the relative load carried by the part-time student (e.g., British Columbia Ministry of Advanced Education, Innovation and Technology, 2012, p. 3). Although one could calculate FTE with PSIS data using the Ontario method, one cannot do so with PSIS data and the British Columbia method. For this reason, it is not feasible to work with FTE numbers in this analysis. The choice is between head count and full-time numbers, both of which are available in PSIS.

The federal Tri-Council scholarships are available only to full-time students, so the federal initiatives of interest in this study will have had a direct effect only on full-time numbers. Provincial initiatives funded FTE increases. Head counts match neither the federal initiatives nor the provincial ones. But full-time numbers match only the federal initiatives; they do not match the provincial ones. Before deciding whether to use head counts or full-time numbers, it is useful to see what (or how many students) would be lost in relying on only the full-time numbers.

3.2.1 Master's Level

Part-time master's enrolment as a percentage of total enrolment has declined from over 37% in 1998 to just over 29% in 2010, but remains close to one-third of the total (Figure 3.2a, right-hand axis). The decline has been almost monotonic, with increases of the percentage seen in only 2000 and 2001 (a 0.1% increase in each year) and 2009 (a 0.5% increase). Figure 3.2a also shows that there has been a decline in part-time male master's enrolment even as full-time male master's enrolment increased monotonically over the whole period. Part-time male master's enrolment finished the period 885 students lower than its peak in 2002, and only 1410 higher than in 1998. When looking at master's enrolment in more detail in subsequent sections, it will be useful to keep in mind this divergence between full-time and part-time male enrolments. Female part-time enrolment increased relatively steadily over the period, but not at as high a rate as female full-time enrolment. It is also noteworthy that male full-time enrolment kept pace with female full-time enrolment until 2004, at which time the rate of increase in female full-time enrolment greatly exceeded that of male full-time enrolment. It is curious that this divergence occurs at the same time as the introduction of the CGS awards.

Figure 3.2a: Full-time and part-time master's student enrolment, and percentage part-time

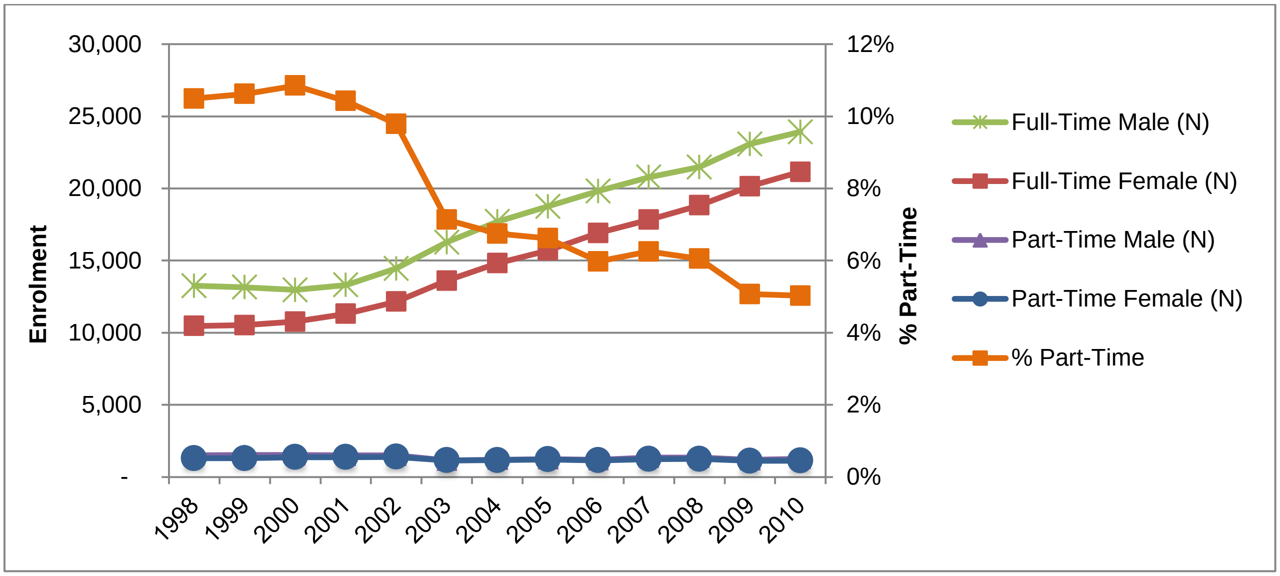


3.2.2 PhD level

Part-time PhD enrolment as a percentage of total PhD enrolment was much lower than at the master's level and declined from 10.5% in 1998 to 5.0% in 2010, monotonically from 2000 to 2006. Given the vertical scale of Figure 3.2b and the enrolment numbers, the lines for male and female part-time PhD students overlap almost completely, such that only one line can be seen. Both of them decreased overall during the period. This contrasts markedly with the full-time numbers, which climbed rapidly in 2002 and 2003 and maintained relatively steady growth thereafter. The difference between male and female full-time PhD enrolment is numerically still close to what it was in 1998: 2,769 now, 2,778 then. Starting in 2002, full-time PhD growth exceeded the federal government's 5% target in every year except 2008 and 2010.

There is a good chance that many of the part-time PhD students began their studies on a full-time basis and changed to part-time study either when funding ran out or when they obtained a full-time job. The decrease in their numbers (and percentage) may reflect improved federal and provincial scholarship funding for the PhD.

Figure 3.2b: Full-time and part-time PhD student enrolment, and percentage part-time



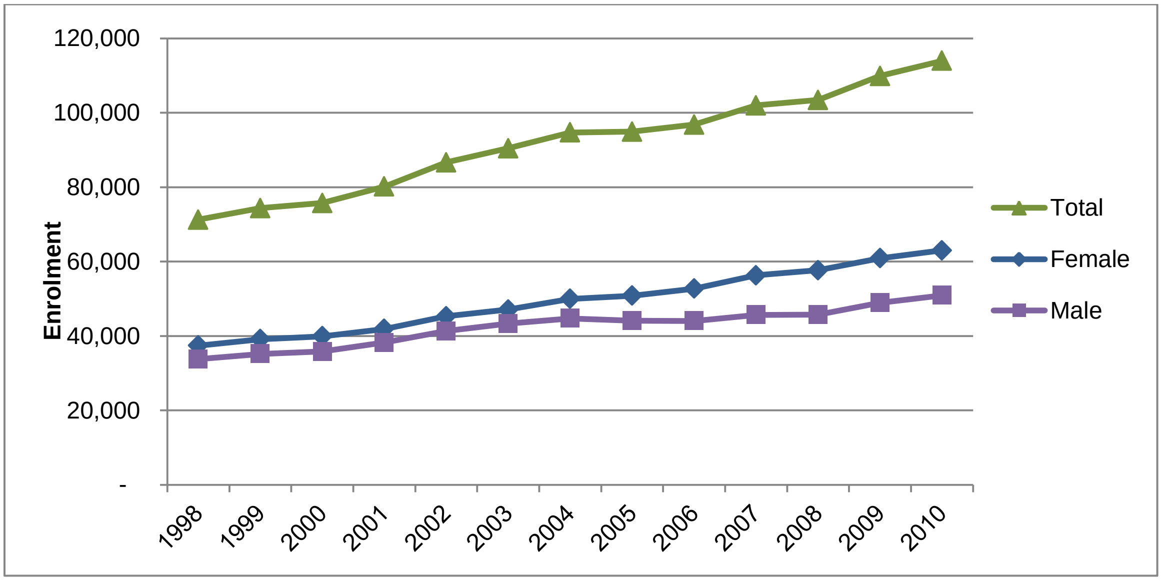
3.2.3 Head Count or Full-Time Numbers?

Numerically, the part-time numbers are important at the master's level but could be considered negligible for the PhD. As a result, it seems unwise to ignore the part-time numbers at the master's level – and equally unwise to make a different decision for master's than for PhD. Hence we have made the decision to use the PSIS head count numbers throughout the rest of the report rather than to focus solely on full-time students, despite the issues raised at the beginning of this section.

3.3 Changes in Master's Enrolment

In 1998, at the start of our analysis period, female enrolment at the master's level exceeded male enrolment (Figure 3.3). The difference between the two enrolment levels did not change much through 2003; in fact, from 1998 through 2002 male enrolment increased by slightly more than 22% and female by less than 21%. But in 2004, female enrolment increased at nearly twice the rate of male enrolment (Appendix A-3.2). In 2005 and 2006, male enrolment actually declined, with the result that the difference between the two enrolments increased over the period of 2004 to 2010. By 2008, the difference between male and female enrolment was more than triple what it had been in 2003, with most of that increase occurring during exactly the period of the increased government investment in graduate education. Between 2002 and 2010, female enrolment grew by 17,709 while male enrolment grew by only 9,567. The percentage of master's enrolment that is female had increased from 52.5% in 1998 to 55.3% in 2010, hitting a high of 55.8% in 2008, an unexpected and presumably unintended consequence of the graduate investments. Ameliorating this trend is the fact noted in the previous section that part-time male master's enrolment decreased over the past half dozen years, so some of this increase in female percentage is related to the drop in part-time male enrolment. An additional contributor is our decision to focus on head count enrolment rather than only full-time, as discussed above.

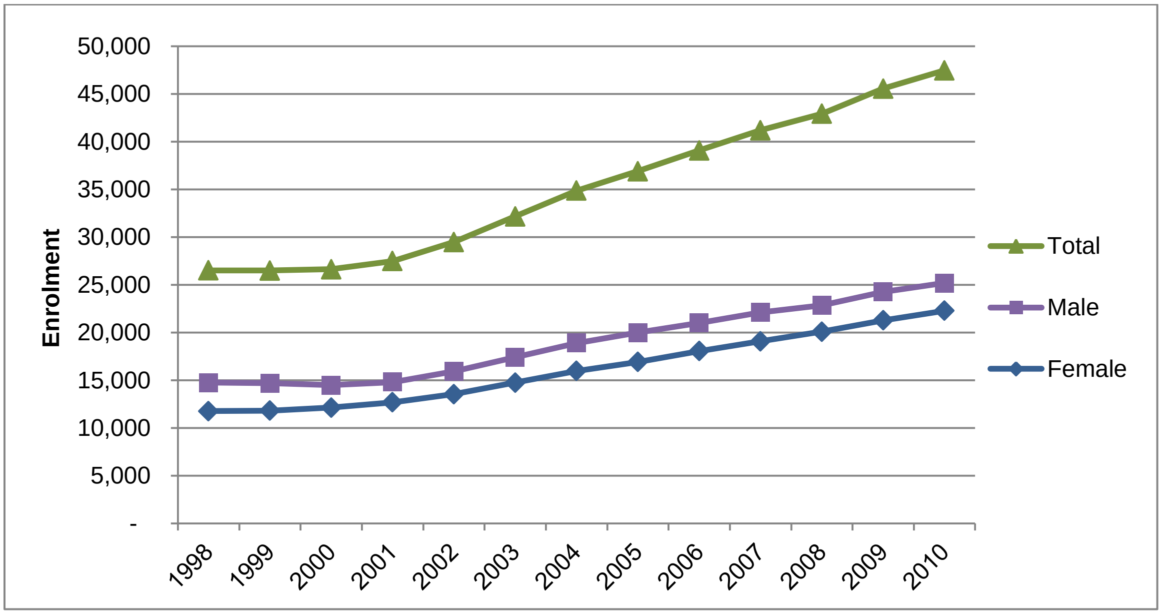
Figure 3.3: Master's enrolment by gender



3.4 Changes in PhD enrolment

As already noted at the total level, but as becomes even clearer when examined in detail, PhD enrolment behaves very differently from master's enrolment over the period of interest. Not only was male enrolment higher than female at the start, but for the first three years of the analysis (1998-2000), total PhD enrolment was flat, varying minimally around 26,500. Even in 2001, the total increase was less than 1,000 students, less than half of what it became over seven of the next eight years. The resulting line looks like the classic "hockey stick" shape (Figure 3.4). In all years except 2008, the rate of increase in PhD enrolment exceeded 5% (Appendix A-3.3). This started in 2002, a year before the federal initiative took effect, although during this time two provinces were already investing in engineering and computer science expansion. The difference between male and female PhD enrolments has stayed almost constant: 2,979 at the start and 2,898 in 2010, with a low of 2,124 and a high of 3,057 during the interval. At the PhD level, one could conclude that (1) our initial assumption of stable enrolments was close enough; (2) the federal objective of a 5% annual increase was met; and (3) the growth trends are as one might expect given the investments made.

Figure 3.4: PhD enrolment by gender



3.5 International versus Canadian Student Enrolment

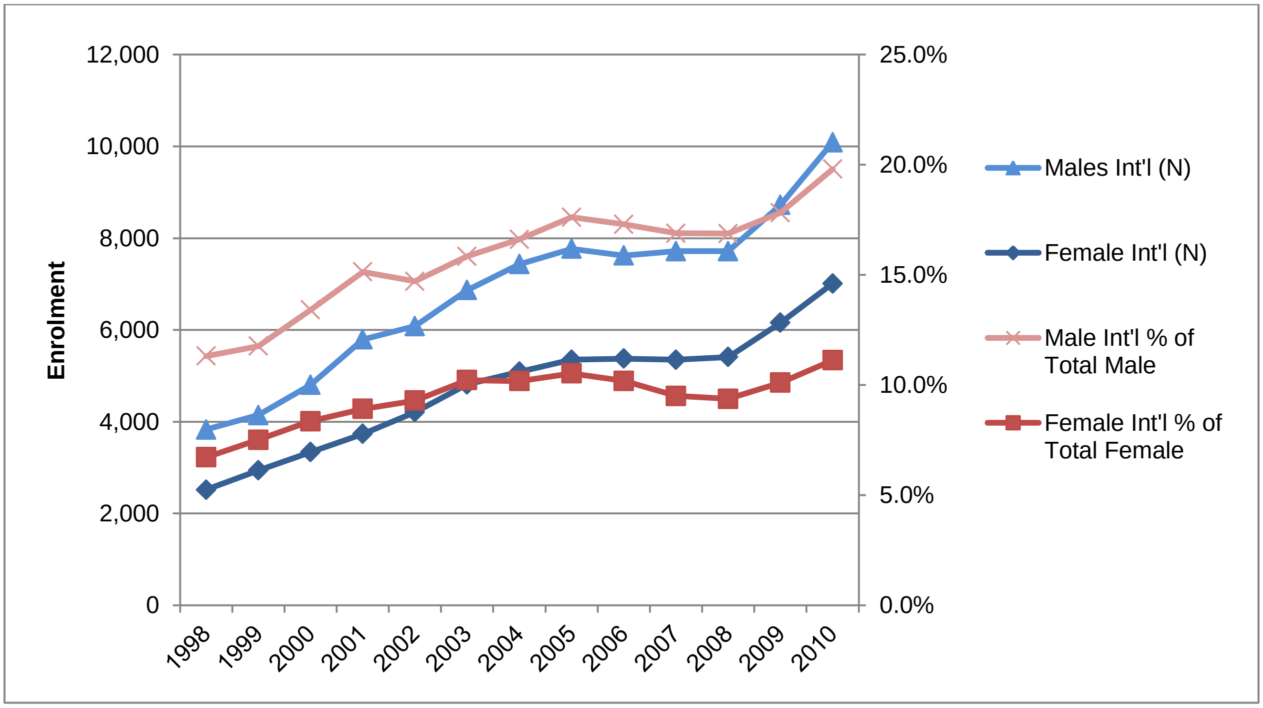
3.5.1 International Enrolment

Although the federal initiatives do not specifically target an increase in Canadian (or permanent resident) students, those were the only ones eligible for the Tri-Council scholarships until the Vanier scholarships were created in 2009, so the 5% target would implicitly relate only to Canadians. The numbers considered so far have included international students as well as Canadian students. It is important to see how much of the overall growth took place in each category, especially in light of the fact that some provinces fund universities on behalf of international graduate FTEs (e.g., British Columbia and Alberta), while others do not (e.g., Ontario). International students are defined in PSIS to include four categories: those with a student visa, those with another visa (e.g., diplomatic), non-Canadian students of unknown status, and non-Canadian students without a visa (such as studying by internet and not in Canada). These four categories have been combined for the purposes of this analysis.

The number of international master's students registered in Canadian universities increased over the period of interest for both males and females, with a few years of minor decreases (Figure 3.5a). From 2006 to 2008, there was a decline in the percentage of master's students who were international, for both males and females. The 2005 percentage was not reached again until 2009 for males and 2010 for females. Absolute numbers of international students decreased from 2005 to 2006 for males and from 2006 to 2007 for females. It was not until 2009 that male numbers reached the 2005 levels again, although female numbers bounced back in 2008. This seems to be a uniquely Canadian phenomenon: the numbers of international applications and admissions to U.S. graduate schools fell year over year for several years after 2001 (which may have contributed to an increase in those years in Canada), but from 2005 on, applications and admissions to U.S.

schools increased annually[16] (Bell, 2012, Figure 1). It would appear that international demand for graduate study did not decline in the years when international student numbers decreased in Canada.

Figure 3.5a: International student master's enrolment and percentage of total by gender



In 1998, international students comprised 8.9% of the total master's student enrolment. In 2010, this percentage had increased to 15%.[17] Between 1998 and 2010 domestic master's enrolment increased by 49% (36% for men and 60% for women), whereas enrolment of international students increased by 170% (164% for men and 178% for women). Despite the higher percentage increase, international students made up only 25% of the total increase in enrolment from 1998 to 2010. These data also suggest that Canadian males have not participated as fully as Canadian females in the graduate expansion: international students comprised 37% of the total male enrolment increase and only 18% of the female increase.

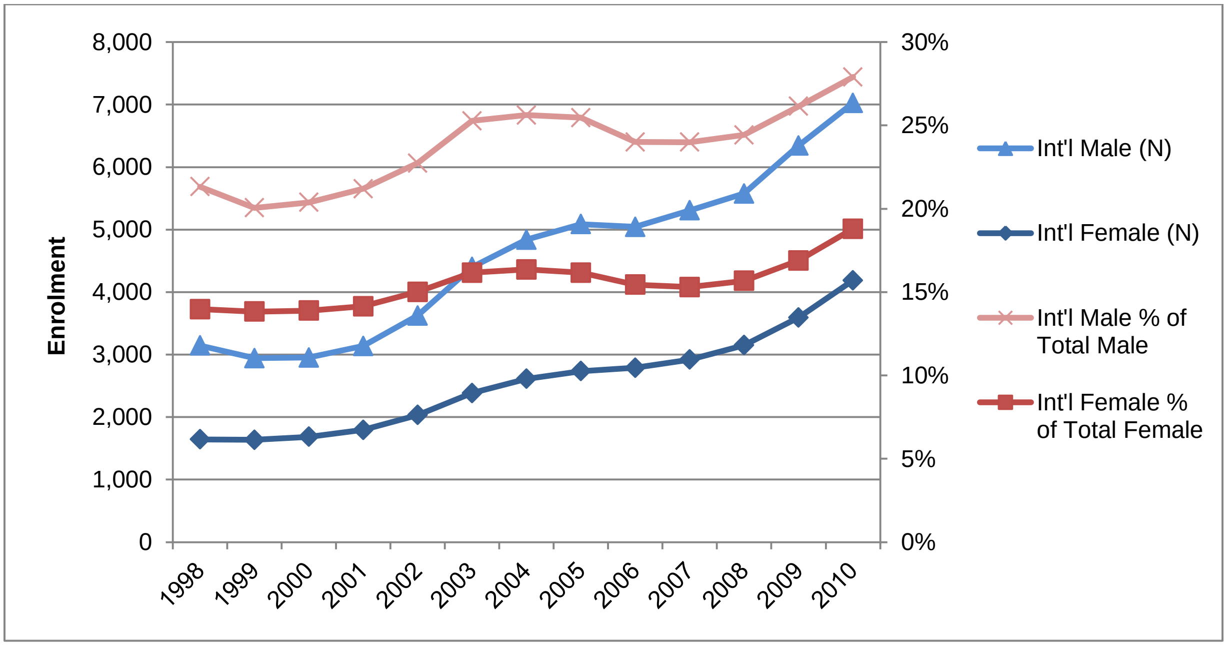
At the PhD level, the percentage of international students has consistently been higher than at the master's level, starting with 18.1% in 1998, dropping for the first few years and again in 2006 to 2008, then climbing to a high of 23.6% in the most recent (2010) data. The pattern for male and female international students is almost identical, except that the female percentages are only about two-thirds those of the male (Figure 3.5b).

[16] The exception is 2008, when admissions fell by 1% despite applications rising by 4% over the previous year.

[17] Given the difficulties with the data regarding citizenship and visa status for the 2010 degrees granted, discussed in Section 4.3 below, we looked quite closely at the nature of the increase in international students between 2009 and 2010, looking specifically for large numbers of individuals classified as "non-Canadian, [visa] status unknown", which was the source of the problem in degrees granted. (It appears that anyone for whom a citizenship was not specified in a PSIS file submitted to Statistics Canada is classified this way, which means it could include a number of Canadians as well.) For these enrolment data, the number of such students almost doubled from 2009 to 2010, going from 750 to 1,395. However, the 2010 number of 1,395 is less than 5% of the total international student enrolment in 2010 (which was 28,335), so we accepted the increase in international student enrolment as being valid.

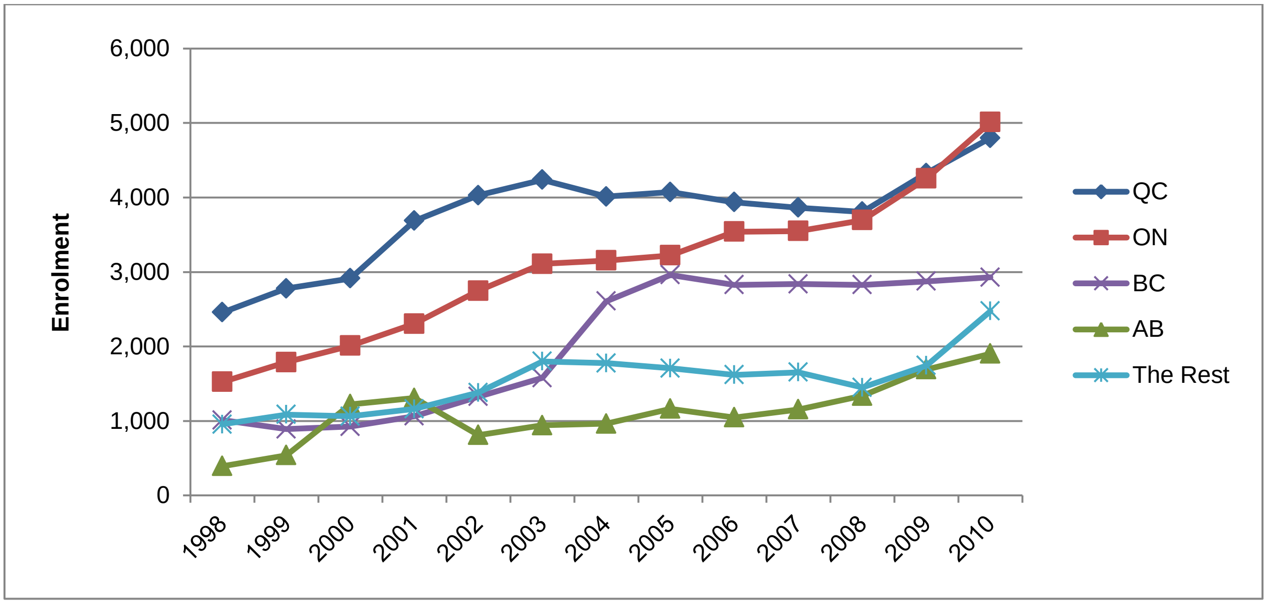
The decrease in percentage from 2006 to 2008 was accompanied by a small decrease in male absolute numbers only in 2006; female numbers continued to increase throughout.

Figure 3.5b: International student PhD enrolment and percentage of total by gender



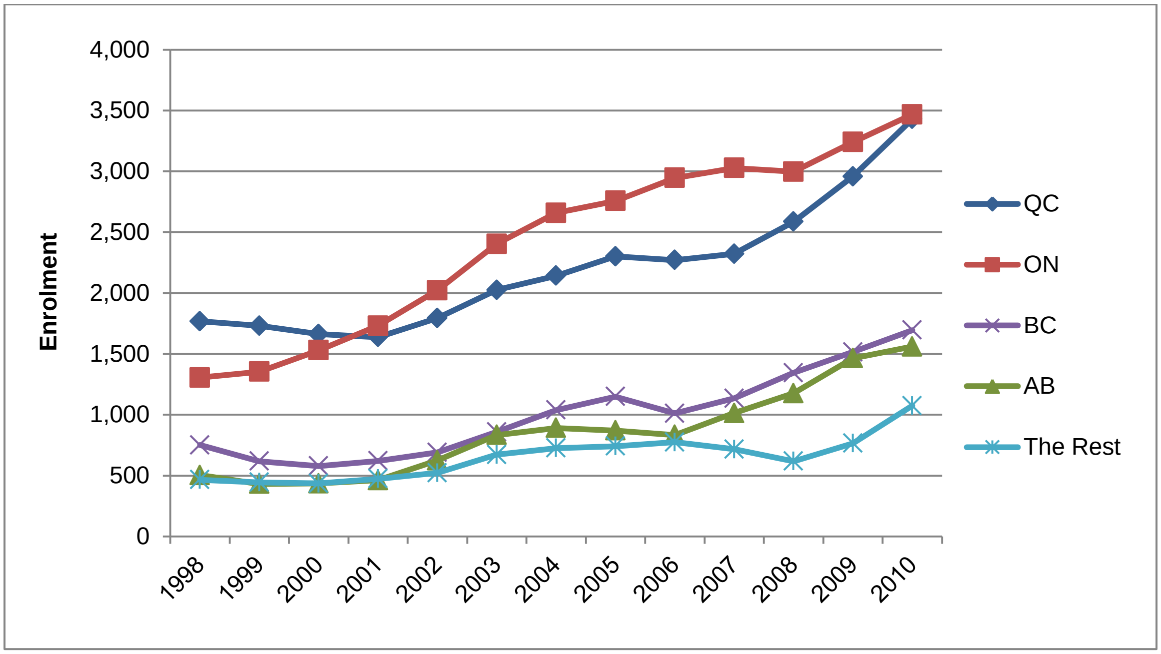
The period discussed in the previous paragraphs includes five years prior to the major investment increases in graduate education. The international student situation was not stable during that early period as we had hypothesized. To what extent did the major investment increases in 2003 for federal scholarships, 2005 for Ontario, and 2007 for British Columbia result in an increased focus on domestic students and a concomitant decrease in international enrolment (or its rate of increase)? From Figure 3.5a, it looks as if there was no effect in 2003 at the master's level, where in fact the lines restart their upward trend that year, but there is a change in slope to negative after 2005. That is, international students became a smaller percentage of the total master's enrolment in 2006, 2007 and 2008 – years that do not exactly coincide with the start of any of the major funding initiatives. These years do, however, correspond with major increases in Ontario's operating investment in master's enrolments (refer to Table 2.1 earlier), and Ontario is a province that does not fund universities for international students. There is a plausible causal relationship here, especially given the continued increase in applications from international students shown in the U.S. data. However, as Figure 3.5c shows, this hypothesized relationship is not supported by provincial-level data. Ontario's international student numbers continued to increase throughout these years, even if only by small amounts, as did British Columbia's and Alberta's. It was Quebec and the rest of the provinces that showed decreased numbers of international students after 2003.

Figure 3.5c: International student master's enrolment by province



At the PhD level, there is a change in both 2004 (where the lines level off) and in 2006, which is the first year of a decreased percentage of international students (Figure 3.5b). In 2003, the first year of the federal CGS awards, there was a 7% increase over 2002 in domestic numbers (those eligible for the CGS), but nearly a 20% increase in international student numbers (who were not eligible for CGS awards). In 2006, the second year of the Ontario initiative, international student numbers (not funded in Ontario) increased by less than 1%, while domestic student numbers increased by 7%. Again, the major changes in international student percentages do not coincide with the start of the major investments but might be affected by Ontario's ongoing investment in graduate expansion. However, this is not borne out by the numbers (Figure 3.5d): the only drop in Ontario's international PhD student numbers was in 2008, and even then only by 30 students.

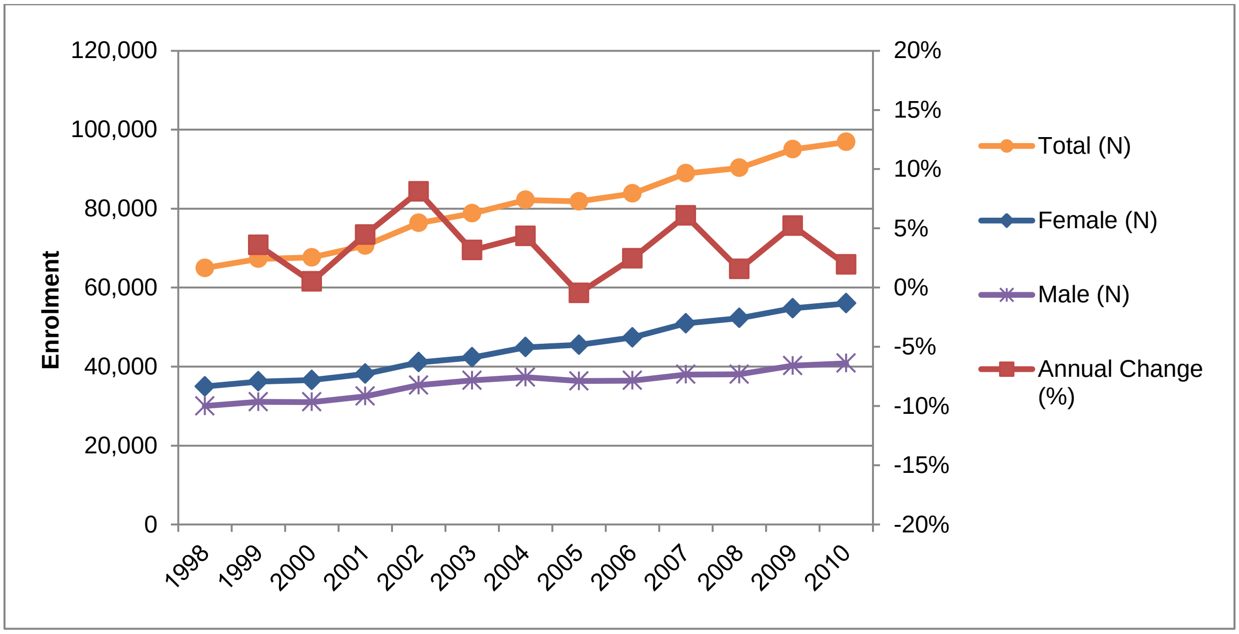
Figure 3.5d: International PhD students by province



3.5.2 Enrolment of Canadian and Permanent Resident Students

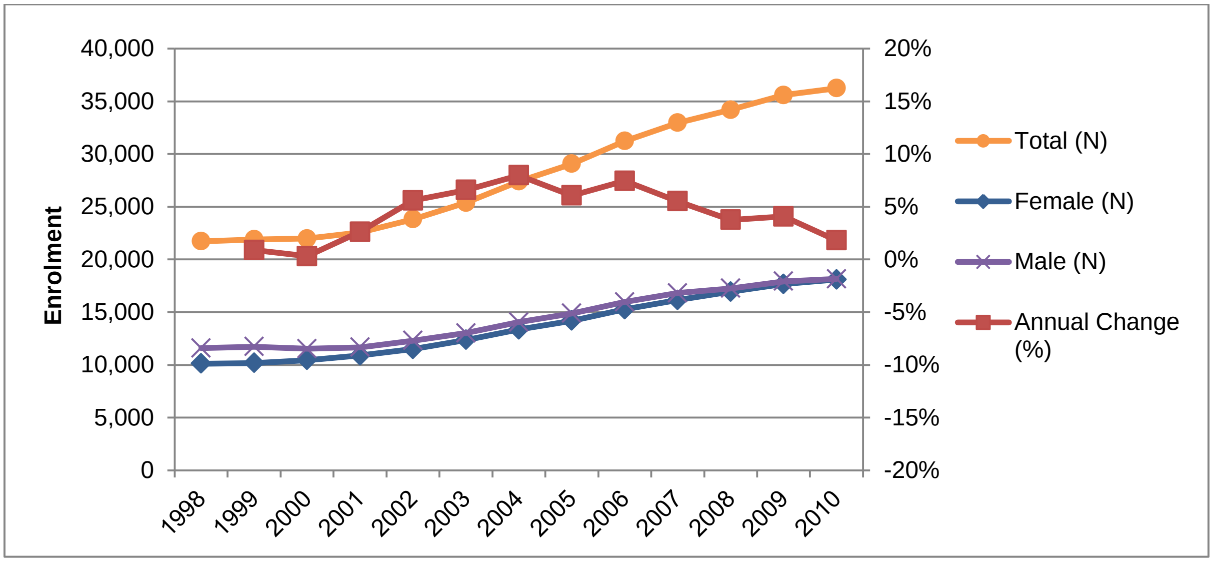
Having seen the changing numbers and percentages of international graduate students, it is interesting to look also at the numbers for only Canadian (and permanent resident) students. Figure 3.5e shows the situation for master's students. The most prominent part of the graph is the annual percentage change in total enrolment, which shows that there was no consistent rate of growth among Canadian students overall, even after 2003 and the CGS awards. In 2005, there was even a small reduction in numbers. Not as prominent visually but still noteworthy is the widening difference between female and male numbers over time, which is greater than that shown in Figure 3.3 earlier. There, the 2010 difference between female and male enrolments is just over 12,000. In Figure 3.5e, the difference is well over 15,000. The inclusion of international student numbers masks the extent of the difference that has developed between male and female Canadian student enrolments.

Figure 3.5e: Canadian and permanent resident master's student enrolment by gender



For PhD students too, the inclusion of international students masks the trend in male-female enrolment difference. As Figure 3.5f shows, for Canadian students, female numbers have almost completely caught up with those for males. The difference in 2010 is only 63 students, which means that the two lines on the graph are superimposed. Even in 2001, the difference was less than 1,000. This contrasts markedly with the statement made in Section 3.4 that the difference has been relatively constant at around 2,800. The growth rate of Canadian PhD numbers is consistently above 5% from 2002 through 2007, but has fallen since then.

Figure 3.5f: Canadian and permanent resident PhD student enrolment by gender



3.5.3 Tri-Council Awards and Greater Increase in Canadian Female Student Numbers

It is natural to seek reasons for the greater increase in female graduate enrolment than in male enrolment. Employment prospects and concomitant future earnings expectations may have something to do with it, but we do not yet have data on those.[18] In one sense, scholarships, and especially the $35,000 CGS awards, may represent immediate earnings (or income) expectations, or at least possibilities. If potential graduate students perceive different probabilities of success in applying for a scholarship, it could affect relative interest in graduate school, although again we have no data that indicate females have a greater expectation of success than men. As discussed in the remainder of this section, in the scholarship competitions at both SSHRC and NSERC women have a higher probability of success than do men, although that is not the case for CIHR scholarship competitions.

For SSHRC scholarship competitions, it is instructive to look at the success rate at three stages of the process. Applicants for a SSHRC doctoral scholarship apply first to their university. The university selects from all of those applicants the set to forward to SSHRC (List A), for which each university's number is limited based on past success in this competition. The university also informs SSHRC of the number of applications not forwarded (List B). A national adjudication of all the A lists then takes place at SSHRC to identify first the CGS doctoral award winners and then the winners of regular SSHRC doctoral scholarships. Table 3.5a shows the success rates for females and males at these steps and also the shares of the prestigious CGS awards for females in comparison with their share of all applicants. For the decisions made within universities (List A as % of Lists A&B in the table below), women had a higher success rate in all eight years for which there are data. The average difference was 3.1%. Under the assumption of equal probabilities of success for

[18] Two very recent studies also focus on the earnings issue as it pertains to university and males dropping out. Dwyer et al. (2013) hypothesize that women see the financial returns to an undergraduate degree as being higher than men do and are therefore more willing to persevere, even in the face of higher debt. DiPrete and Buchmann (2013) also suggest that men perceive less of a return from education than women do and therefore underinvest in education.

males and females, this history of outcomes could be expected to arise less than 1% of the time (noted in the table as the t-test probability). For the decisions made at SSHRC, by their selection panels which also consist of university faculty members, the average advantage for females is 2.6%, although in one year males were actually more successful than females. This pattern of outcomes would arise less than 2% of the time under an assumption of equal probabilities of success. The net result is that females are consistently more successful in the SSHRC doctoral competitions than are males, including in the CGS awards.

Table 3.5a: Success Rates in SSHRC Doctoral Scholarship Competitions for Females and Males[19]

		2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
List A as % of Lists A&B									
	Female	46.0%	41.5%	40.6%	37.0%	36.7%	37.3%	40.3%	40.1%
	Male	44.4%	38.0%	34.2%	37.3%	33.8%	33.9%	37.1%	36.0%
	t-test probability		0.0026						
Awards as % of A list									
	Female	57.3%	55.1%	54.5%	61.3%	61.2%	57.6%	49.1%	58.3%
	Male	55.6%	56.6%	50.7%	57.7%	60.7%	51.9%	46.1%	54.6%
	t-test probability		0.0155						
Female share of CGS vs. share of applicants									
	CGS	64.1%	61.8%	65.5%	62.8%	64.4%	67.5%	62.6%	65.2%
	Applicants (A&B)	60.7%	61.1%	60.8%	59.6%	59.9%	60.2%	59.3%	59.6%
	t-test probability		0.0006						

Table 3.5b shows a related analysis for NSERC graduate scholarship competitions (master's and doctoral level combined). NSERC does not report comparable List B data and has other details on its website for only the last two years. They do, however, report success rates by gender for the combination of CGS and regular postgraduate scholarships. Those are the rates reported in Table 3.5b. As with SSHRC, females were more successful in all but one year. The average difference over the ten years was 2.3 per cent, which is significant (on a t-test) at the 0.1% level.

Table 3.5b: Success Rates in NSERC Scholarship Competitions for Females and Males[20]

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Females	72.1%	61.7%	71.8%	74.0%	63.6%	68.5%	71.0%	72.5%	74.2%	52.90%
Males	68.6%	58.8%	69.7%	70.3%	62.5%	69.1%	69.8%	70.1%	70.0%	50.70%

[19] These numbers have been calculated from numbers of applicants and awards for each year, accessed through http://www.sshrc-crsh.gc.ca/results-resultats/stats-statistiques/index-eng.aspx
[20] The numbers come from Table 52 at http://www.nserc-crsng.gc.ca/NSERC-CRSNG/FactsFigures-TableauxDetailles_eng.asp

Table 3.5c shows a similar analysis for CIHR scholarship competitions. These numbers are for master's (since 2003) and doctoral competitions combined and include two dozen awards each year that do not have a degree level specified. In the dozen years covered in the table, females had higher success rates in six, males in five, and in one they were equal. Over the dozen years, the average of these success rates favours females by only 0.3 per cent. There does not appear to be any trend in these data either, although the most recent four years seem to be moving from greater female success to greater male success.

Table 3.5c: Success Rates in CIHR Scholarship Competitions for Females and Males[21]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Females	53.5%	47.0%	32.0%	32.9%	28.4%	34.5%	41.6%	38.2%	67.3%	39.6%	30.5%	27.4%
Males	45.1%	39.1%	35.3%	31.5%	28.7%	35.7%	41.1%	33.9%	59.6%	41.1%	30.6%	34.6%
Difference	8.4%	7.9%	-3.3%	1.4%	-0.3%	-1.2%	0.4%	4.3%	7.7%	-1.5%	0.0%	-7.2%

In both SSHRC and NSERC competitions, but not in CIHR's, female applicants have higher success rates than male applicants. This alone cannot explain the higher enrolment growth for females, but it may be a contributor.

3.6 Enrolment Changes at the Provincial Level

Given the different funding regimes in different provinces, are there observable differences in graduate enrolment growth rates and do those bear any relationship to the dates of the funding? The first subsection here looks at overall growth rates before and after 2003, the year during which the federal CGS initiative was introduced. The second subsection looks at changes in provincial share of graduate enrolment. The third focuses separately on each of British Columbia, Alberta, Manitoba, and Ontario as the provinces that put major funding into either or both of operating grants and scholarships.

3.6.1 Comparison Across all Provinces

Prince Edward Island had only 18 master's students in 1998, growing at an average annual rate of 39% to 258 by 2009. To have included this in Figure 3.6a would have led to a scale on the graph that made it hard to distinguish differences among the other provinces, hence Prince Edward Island has been omitted from the figure. Of the other nine provinces, six had higher averaged annual growth rates in master's enrolment before 2003 than they did after 2003. If all else had been equal, one would have to say that the federal initiative did not lead to increased master's enrolment. At the PhD level, the picture is completely different (Figure 3.6b). All nine provinces showed increases in the rate of PhD growth after the introduction of the CGS awards (as did Prince Edward Island, not included in the graph).

[21] The numbers come from a special analysis compiled for us by CIHR.

Figure 3.6a: Master's enrolment, averaged annual growth rates by province

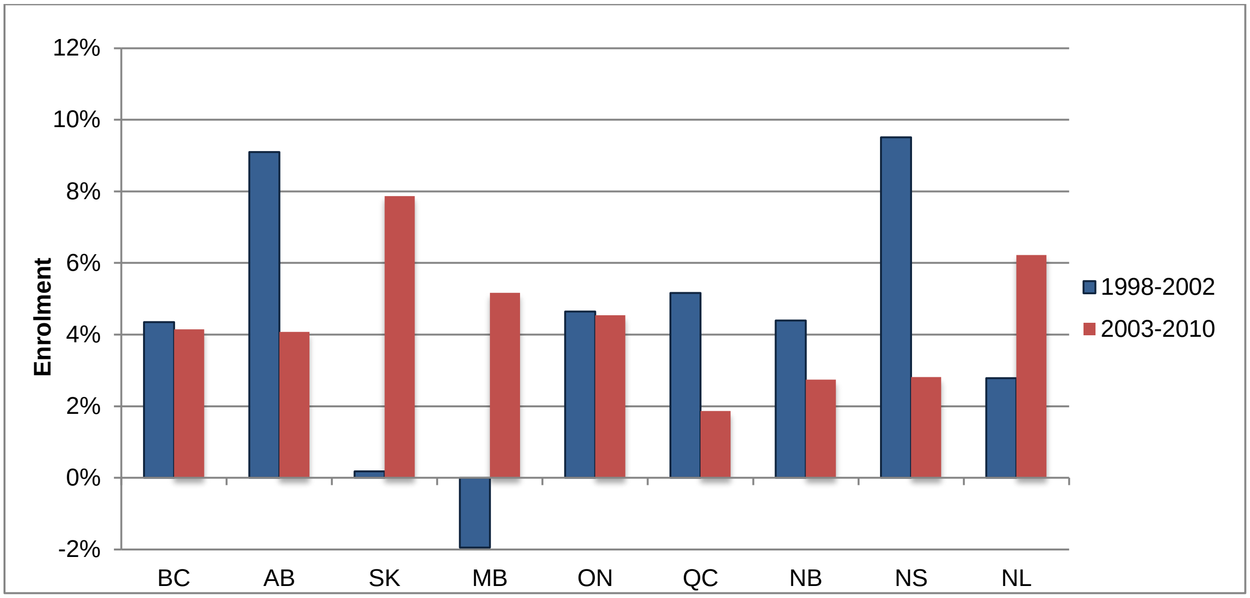
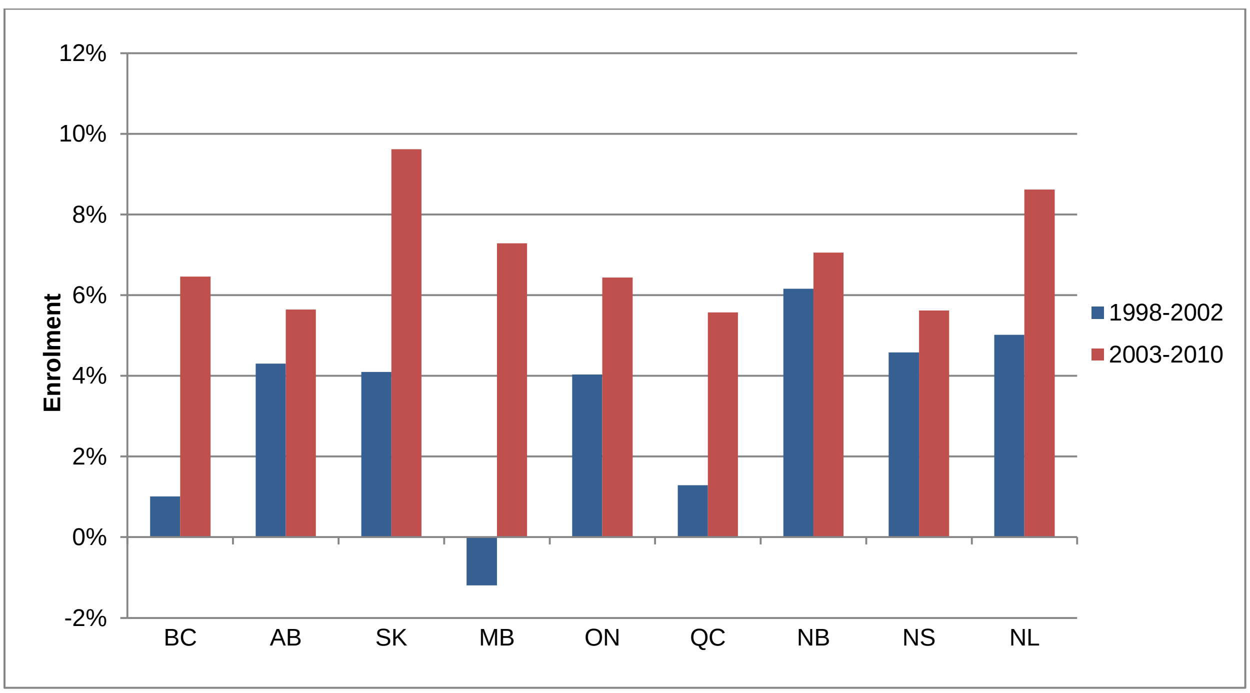


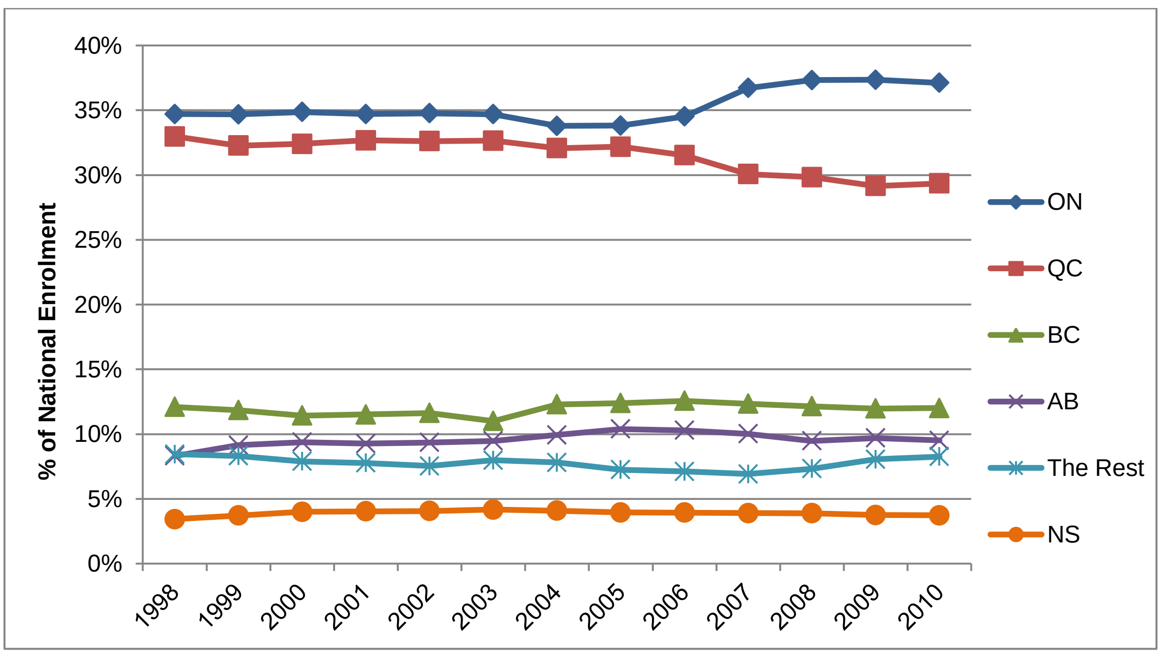
Figure 3.6b: PhD enrolment, averaged annual growth rates by province



3.6.2 Comparison of Provincial Shares of Total Graduate Enrolment

Despite these different pictures for master's and PhD, and the fact that we have kept them separate in the analysis to this point, it is appropriate to look at total graduate enrolment to see how relative provincial shares have changed over time, keeping in mind that the provincial initiatives that did occur were directed toward overall graduate enrolment. Figure 3.6c shows the share of enrolment separately for the five provinces in which total graduate enrolment exceeded 3,000 in 1998. In that year, Manitoba and Saskatchewan were at about 2,500 students, Newfoundland and New Brunswick at about 1,500, and Prince Edward Island at 30; the sum of these five is represented by one line in Figure 3.6c. Their combined share decreased slowly over the period to a low of 6.9% in 2007, after which it began to increase equally slowly. Nova Scotia's share hit a high of 4.2% in 2003 and has declined slightly since. Alberta hit a high of 10.4% in 2005 and has since declined, despite the provincial government's general (as opposed to graduate-specific) growth initiatives in the years since 2005. British Columbia reached a low of 11% in 2003 but then climbed to a high of 12.6% in 2006 and has since dropped by half a per cent, despite the provincial government's graduate growth initiative, but in the face of Ontario's growth. Quebec's share started at 33% but has decreased slowly over the decade to 29.6%, not monotonically but nonetheless steadily. Ontario held steady at 34.7% for five years, but in 2004 suddenly dropped nearly a full percentage point. It managed to hold there in 2005 and then in 2006 started climbing to 37.4% in 2009. In summary, general shares have not changed drastically over the decade, but the changes at the margins seem at least partly related to some of the investment initiatives – or the lack of same in some provinces.

Figure 3.6c: Provincial percentage of national graduate enrolment

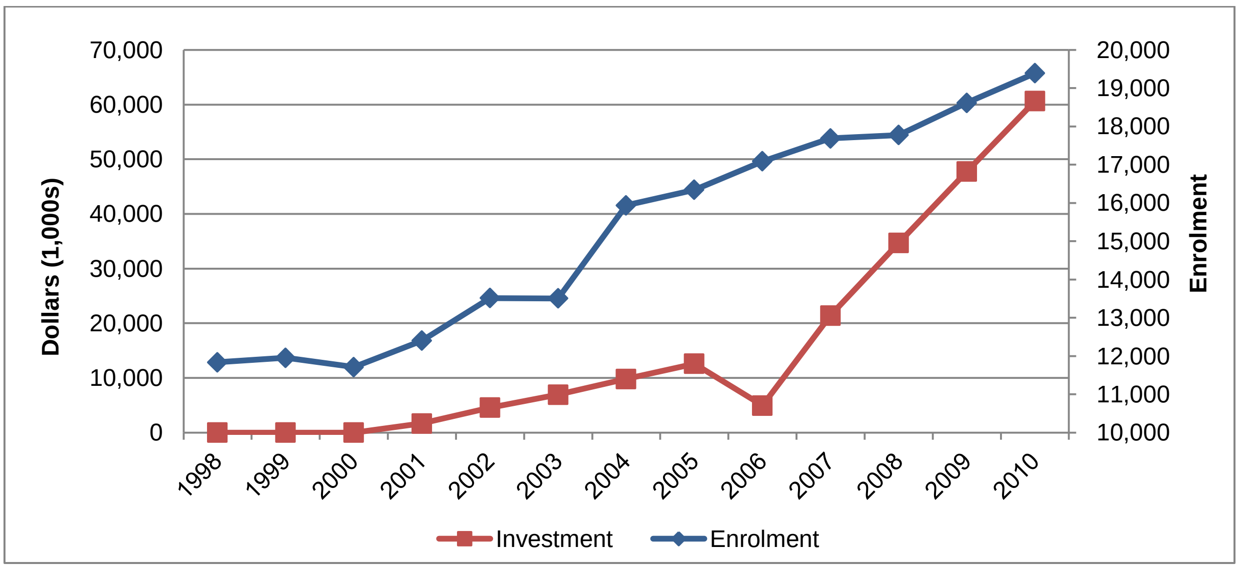


3.6.3 Provincial Growth Relative to Provincial Investments

Seven provinces made investments specifically in graduate enrolment: British Columbia, Manitoba, Ontario, and Newfoundland through both operating and scholarship money; Alberta, Saskatchewan, and Prince Edward Island through scholarship money (although in Alberta there was also non-specific operating funding growth too). Did the timing of growth in these provinces accord with the timing of the investments, either within the same year or within a year or two? The simplest way to look at this is via a separate graph for each province, showing the magnitude and timing of investments and the total enrolment for the province.

The result for British Columbia is shown in Figure 3.6d. Several assumptions had to be made to produce the graph from the data in Tables 2.4 and 2.5. The accuracy of the funding line is certainly open to question, but key elements seem plausible. For example, overall enrolment slipped slightly from 2002 to 2003, despite the Surrey expansion funding and the DTO discipline-specific effort. Enrolment growth slowed somewhat during 2004 and 2005, in the final year of the DTO effort, and during the Health and Nursing expansion. When the DTO program ended in 2007, there was a drop in the level of funding for expansion but overall growth resumed its upward climb. The only surprising result in the figure is in 2008, when growth was less than 100 students despite the continuing major investment started in 2007. This may be an artifact of our use of head count rather than FTE numbers.

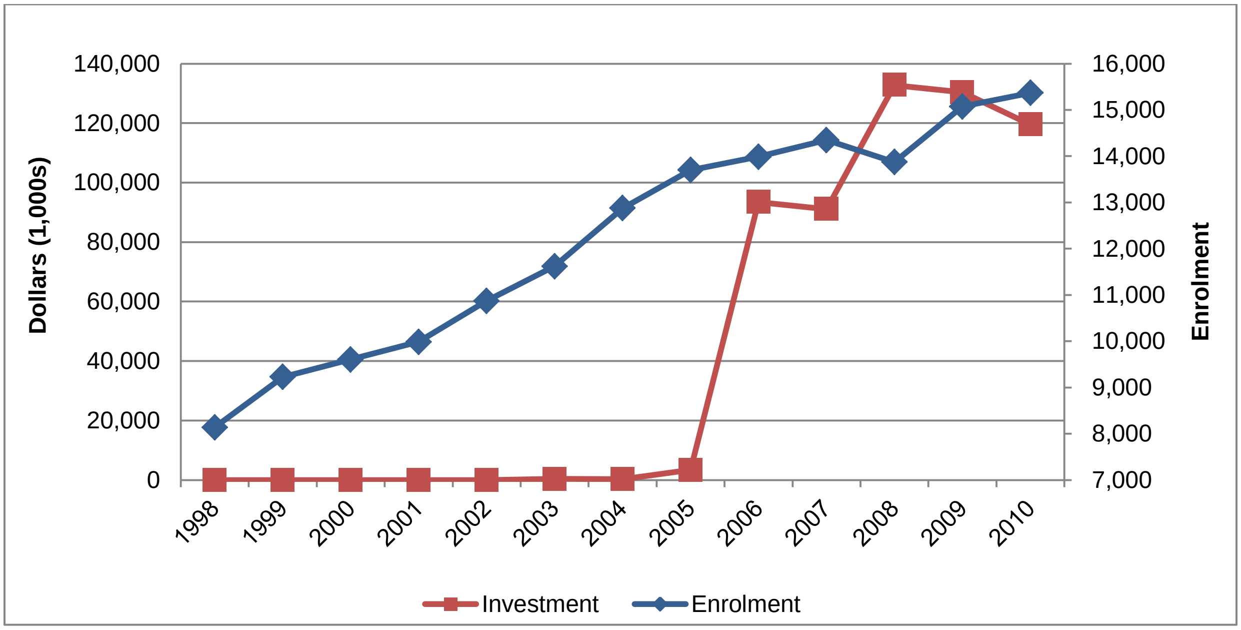
Figure 3.6d: British Columbia total enrolment and total added investment ($1,000s)



For Alberta, Figure 3.6e displays the results of our analysis, which are more problematic than those for British Columbia. The major difficulty is the drop in enrolment from 2007 to 2008, despite the increase in funding made available that year. There is a slight reduction in funding the year before and the year after the enrolment drop, but the decreases are not synchronized as one would expect them to be. The enrolment drop did not occur in full-time graduate enrolment in Alberta (University of Calgary, 2010, pp. 2-4), but may have been in part-time numbers. Furthermore, the investment data may be suspect given the assumptions that had to be made to arrive at those numbers. Nevertheless, the broad trend is clear: graduate enrolment increases were lower in 2006 and 2007 at the same time as the major investments were being made by the province.

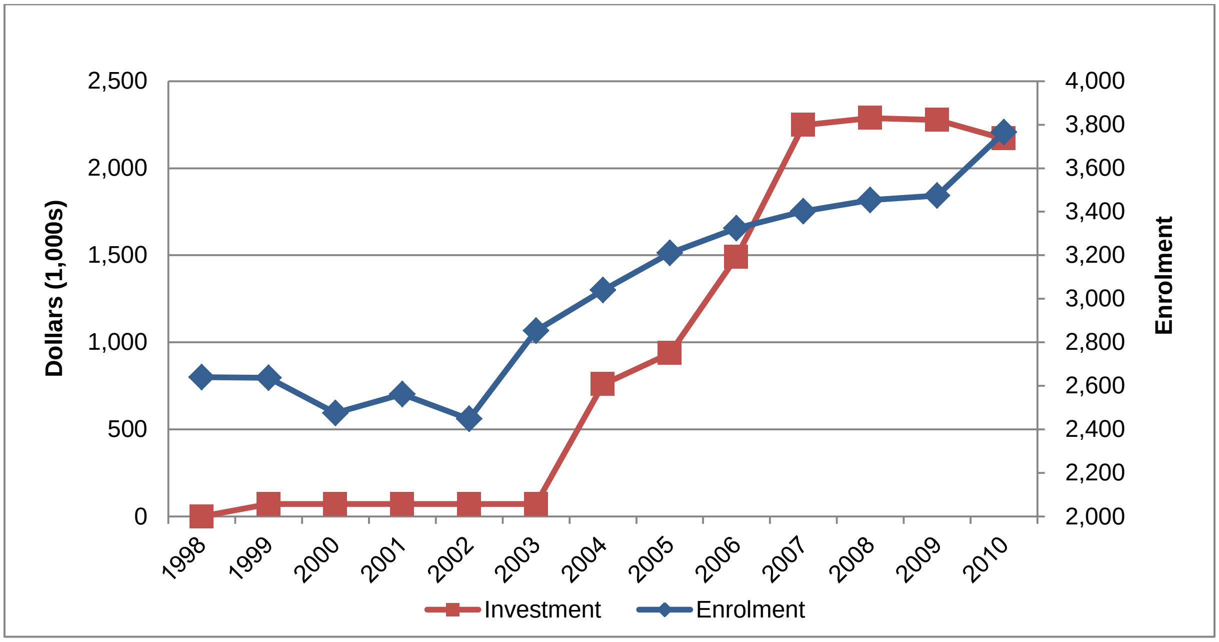
Since the investment targeted enrolment in specific disciplines or sub-disciplines, overall enrolment might have fallen even while those particular areas were increasing.

Figure 3.6e: Alberta total enrolment and total added investment ($1,000s)



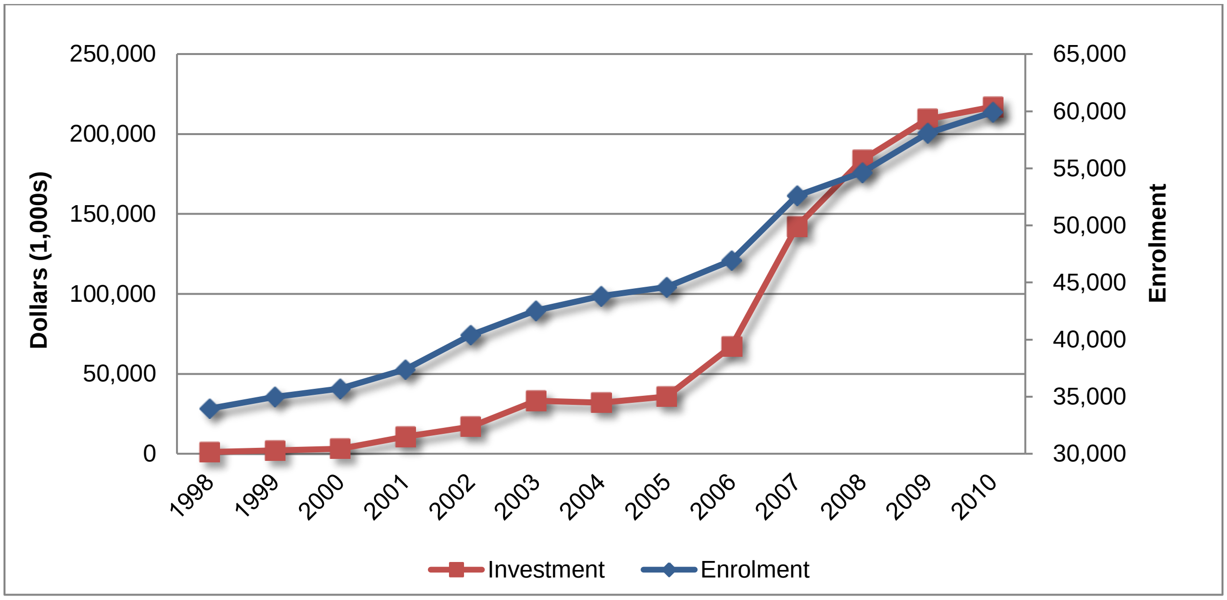
The results for Manitoba (Figure 3.6f) more closely resemble what one would expect: enrolment was drifting slowly lower until 2002 but began to climb at roughly the same time as the provincial investments began, although the first increase in enrolment came a year before the major jump in investment. In recent years both investment and enrolment seem to level off together. While the timing of the change does not coincide exactly with the investment, the overall pattern is closer to expected than was the Alberta pattern.

Figure 3.6f: Manitoba total enrolment and total added investment ($1,000s)



For Ontario, the first item to note is that the growth from 2002 to 2009 in terms of total head count enrolment exceeded the 15,000 target set by the government in 2005, although it was looking for the increase in full-time equivalent (FTE) enrolment. To create Figure 3.6g, it is necessary to make some modifications to the lump sum scholarship investments reported in Table 2.2 ($100M in 2004, $32.5M in 2006, and $10M in 2008). Although the money to create a scholarship endowment was disbursed by the province to the universities, only the annual investment income from that was to be distributed to students. The latter seems more relevant to this analysis than the former. We have assumed in each case a year's lag before there was such income, a conservative 3% payout from the endowment, and for simplicity no growth in the endowment beyond the initial amount over the next five years. With that modification to the numbers in Table 2.2, the picture for Ontario is shown in Figure 3.6g. There is indeed a slight leveling off, or at least decrease, in the growth rate of enrolment from 2003 to 2005, at the same time as the funding is roughly level. When the funding jumps in 2006, enrolment growth also increases, and then even more so for both lines in 2007. There is a reasonable match between investments and growth in both time and magnitude for Ontario.

Figure 3.6g: Ontario total enrolment and total added investment ($1,000s)



For Saskatchewan, Prince Edward Island and Newfoundland, the increased investments are small enough (Saskatchewan and Prince Edward Island) or the numbers too hard to pin down (Newfoundland) that we have not attempted a similar graph.

3.7 Enrolment Changes by University Category

As mentioned in the introduction, an earlier HEQCO report noted that during the Ontario graduate expansion, the smallest universities grew by 7%, mid-sized universities grew by 5%, and the largest three universities grew by only 4% on average (Wiggers, Lennon & Frank, 2011, pp 14-15). To a certain extent, these declining percentages with increasing original size are to be expected and are simply a consequence of the numbers involved. Nevertheless, it is useful to look at comparable data for the national "system" of universities. For the purposes of this analysis, we have identified six categories, four of which are based on the size of the graduate enrolment in 2002. The first category, not size-based, consists of those universities that did not have PhD programs as of 2008, which was the most recent available data year during the bulk of our analysis. There are 25 such universities across Canada. These are labeled "Master's only" and of course appear only in the master's analysis. The other non-size based category consists of the universities within the U15 grouping, a self-identified group of research-intensive institutions. The growth rates discussed below are total growth percentages, not annual average growth rates, from 2002, the year before the major investments began, to 2010, the latest year for which PSIS data are available.

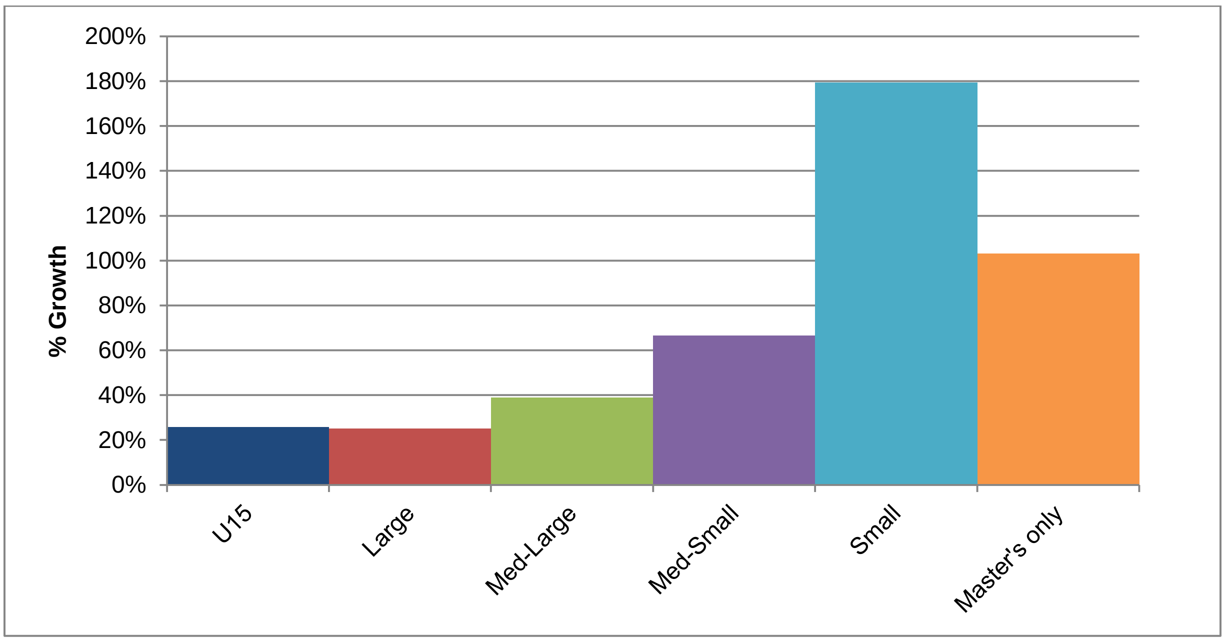
3.7.1 Master's Enrolment Growth by University Size

Within the master's categories, the master's enrolments for the ten universities in the "Large" category ranged from 1,100 to 4,400 in 2002. Master's enrolments in the U15 group ranged from 1,350 to almost 7,000 in 2002; all but the three largest universities were within the same enrolment range as the "Large" category. The "Medium-Large" category encompasses five institutions with 2002 master's enrolments between 750 and

1,000. The "Medium-Small" category covers 17 universities with 2002 enrolments between 150 and 750. The "Small" category contains the five universities that offered PhD programs in 2008 and had fewer than 150 master's students in 2002. The final category includes the 25 master's-only institutions, separated out from the "Small" category to allow us to use these same groups with the PhD data – omitting this last one of course. Only seven of the master's-only universities had 2002 enrolments of more than 50 students, and ten had no master's enrolment in 2002, although they did by 2008.

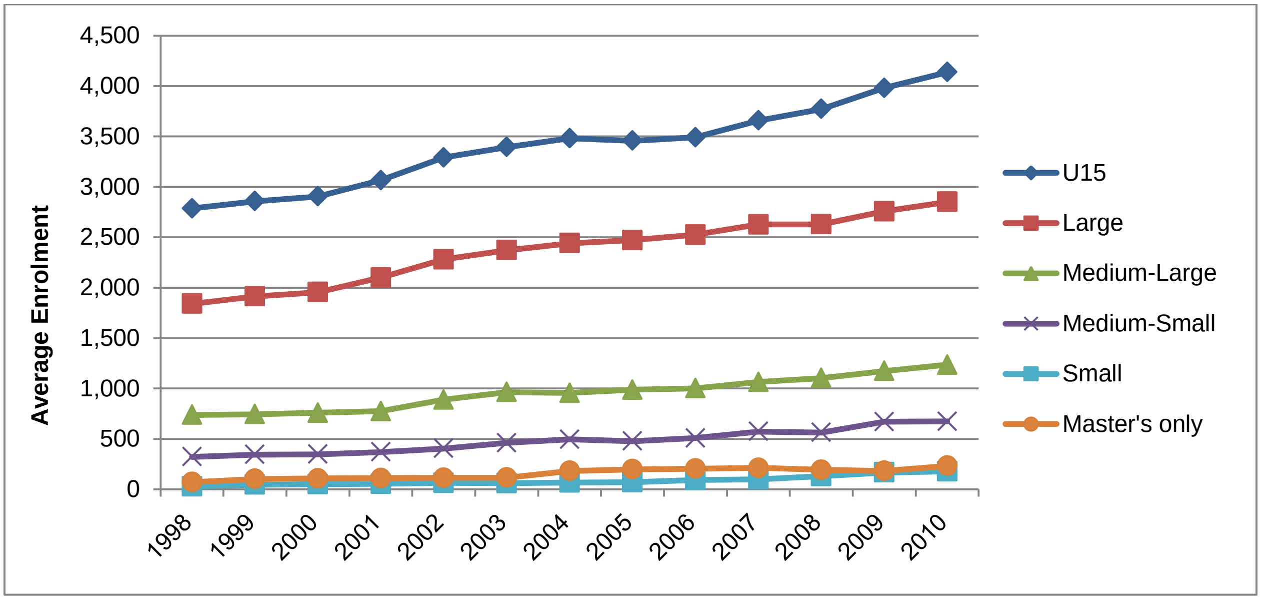
Figure 3.7a shows for the most part the same kind of pattern reported by Wiggers et al. (2011). The anomaly is the "Small" category, which grew by 163%. Over half of the growth in this group came from the University of Ontario Institute of Technology, which went from 0 master's students in 2002 to 315 in 2009. The highest calculable growth rate within the group was the University of Prince Edward Island, which went from 117 master's students to 258. These two cases exemplify what can happen when working with small initial numbers. Similar issues arise within the 25 master's-only institutions. As noted, ten had no master's enrolment in 2002, so they also have undefined growth rates. Five of the 25 had no enrolment in 2010, at least as reported in PSIS. Calculable positive growth rates in this group ranged from 20% to over 500%.

Figure 3.7a: Percentage growth in master's enrolment, 2002-2010, by university category



For these reasons, percentage growth rates are perhaps not the most useful indicator of where growth has occurred. Figure 3.7b shows average enrolments for the universities within each of these same six groups over the decade. Average master's enrolment in the U15 increased by 500 between 1998 and 2002, and by an additional 846 from 2002 to 2010. In the "Large" category, the increase since 2002 was 571. "Medium-Large" had 2002-2010 average growth of 346, "Medium-Small" of 269, "Small" of 114, and master's-only of 118, less than one-seventh the numerical growth of the U15. But although the largest universities (U15 plus "Large") had the largest numerical growth, their share of overall master's enrolment decreased over the 2002-2010 period from 83.3% of the total to 79.5%.

Figure 3.7b: Average master's enrolment by university category

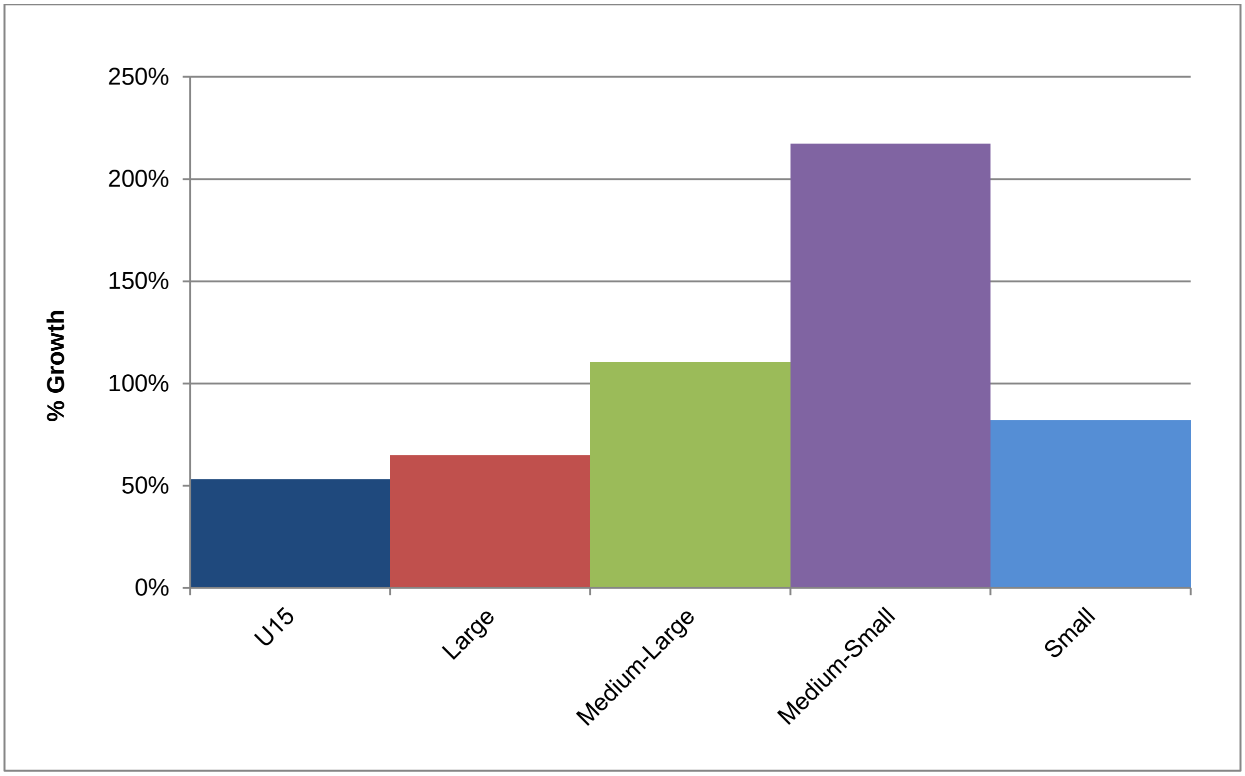


3.7.2 PhD Enrolment Growth by University Size

For the PhD analysis, the universities remain in the same groups as were defined for the master's analysis. PhD enrolments in 2002 for the U15 range from 400 at the low end to five universities with over 2,000 (and the University of Toronto at over 4,500, almost twice as many as the next largest, the Université de Montréal). In the "Large" group, the highest enrolment was only 1,150, with the lowest only 270. Clearly these two groups are not as similar at the PhD level as they were at the master's level. In the "Medium-Large" group, three institutions had enrolments above 150 but only one (at 272) reached the lowest number in the "Large" group. In the "Medium-Small" group, only two exceeded 100 PhD students in 2002 and only four more had over 50. In the "Small" group, only one university exceeded 25 PhD students.

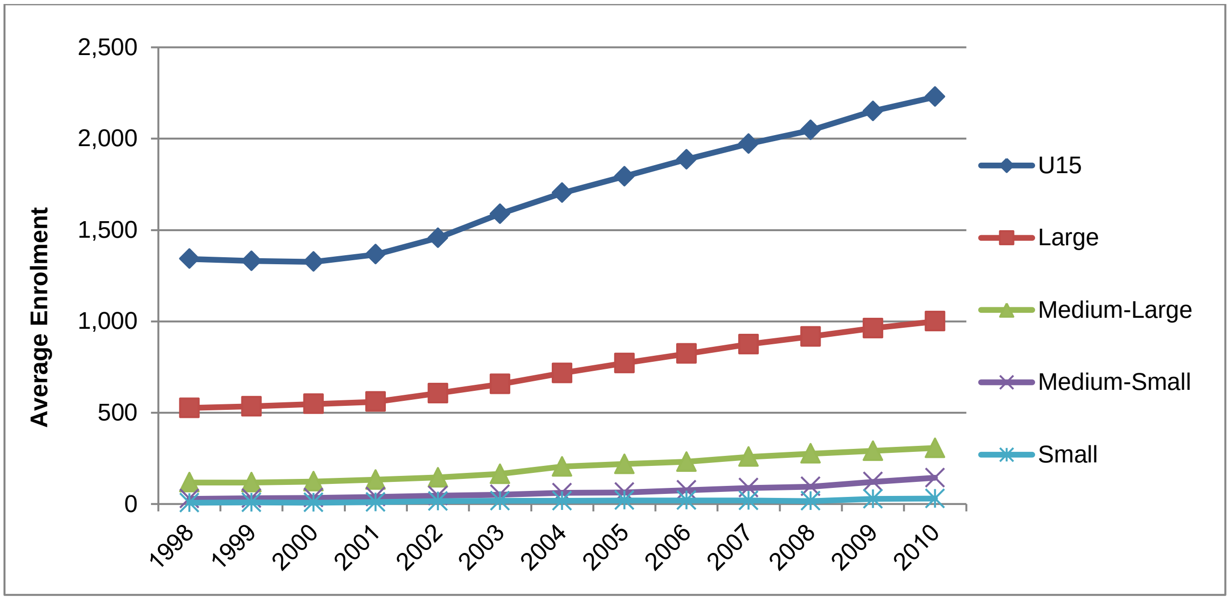
The picture of percentage growth by university size mirrors that in the master's analysis, in that the next-to-last group shows the highest growth rate from 2002 to 2010 at 217% (Figure 3.7c). The "Small" group, which was anomalous in Figure 3.7a, is again an anomaly, this time by showing a lower growth rate than expected (82%). The reason is that two of the five institutions did not grow at all, bringing down the overall result.

Figure 3.7c: Percentage growth in PhD enrolment, 2002-2010, by university category



The graph of average doctoral enrolment over time for these five groups (Figure 3.7d) shows how these percentages translate into enrolment numbers. It also shows a relatively constant slope in both the U15 and "Large" lines, starting in 2002, a year prior to the major federal investment in growth but concurrent with initiatives in British Columbia and Ontario. The share of PhD enrolment attending the U15 plus "Large" universities was 95.8% of the total Canadian PhD enrolment in 1998, dropping only to 94.7% in 2002 just prior to the major expansion efforts and dropping further to 91.5% of the total in 2010. Opinion will perhaps differ on the effectiveness of small PhD programs within small graduate programs, but on the whole PhD enrolment remains concentrated in the largest graduate programs.

Figure 3.7d: Average PhD enrolment by university category



3.8 Changes at the Field of Study Level

The federal government initiatives in 2002 and again in 2007 had a focus on the STEM disciplines, although clearly not to the exclusion of other fields of study. The 2007 initiative was explicit about this, stating (as quoted earlier) that “more individuals with graduate degrees in science and engineering will be needed.” The 2002 initiative was not so explicit but also called for “the highly qualified people required to commercialize and adopt leading-edge innovations,” which certainly implies STEM disciplines. Hence the first part of this section will look at change in enrolments in the STEM fields relative to all others. The second part of the section goes into more detail about individual fields of study. Given earlier issues identified, the analysis will also consider gender and immigration status.

3.8.1 STEM Disciplines

The first issue faced in any analysis of STEM disciplines is simply to define which fields of study should be included in the category. No clear consensus seems to exist. For the purposes of this report, we are restricted by the level of detail obtained from PSIS. Without going into detail of the rationale behind the decision, the following field of study codes have been used throughout this analysis. Full details of the subcategories included can be found on Statistics Canada’s website.[22]

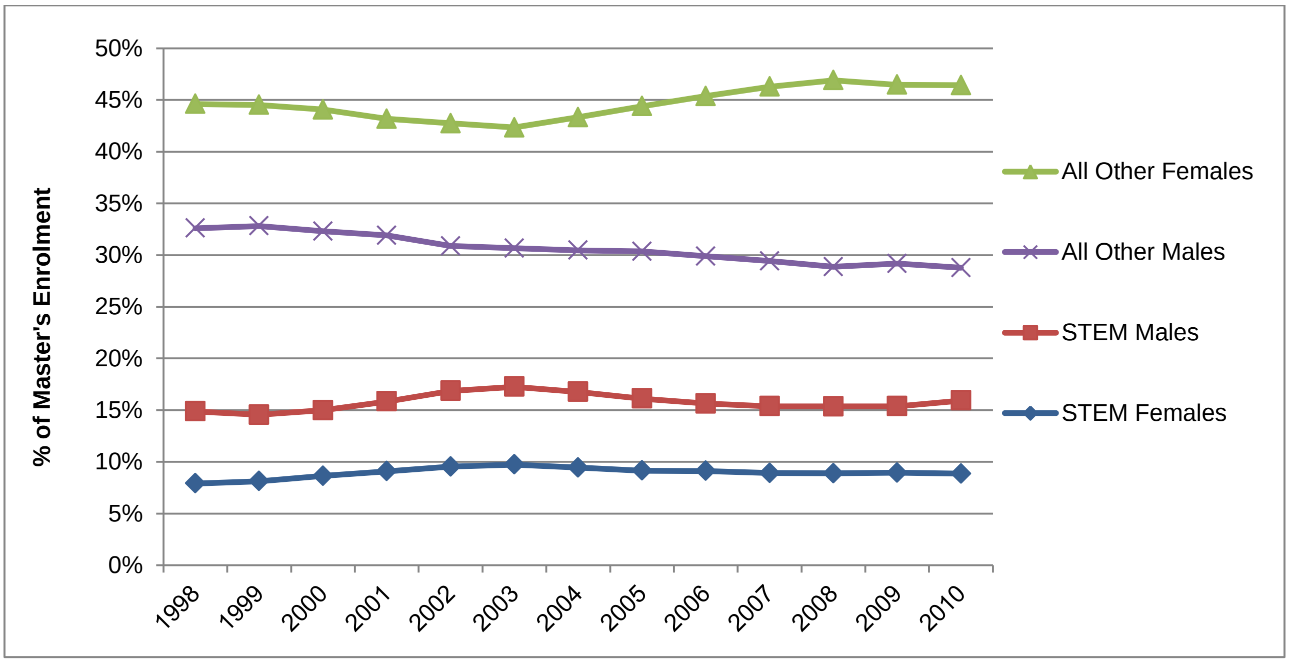
06 Physical and Life Sciences and Technologies
07 Mathematics, Computer and Information Sciences
08 Architecture, Engineering, and Related Technologies – only the Engineering students (subcategory 14) were included from category 08

[22] See http://www.statcan.gc.ca/subjects-sujets/standard-norme/cip-cpe/2000/introduction-eng.htm#a3.

The only contentious part of this decision may be the exclusion of architecture (08-04) from category 08. The other parts of category 08 are subjects not normally offered at the graduate level.

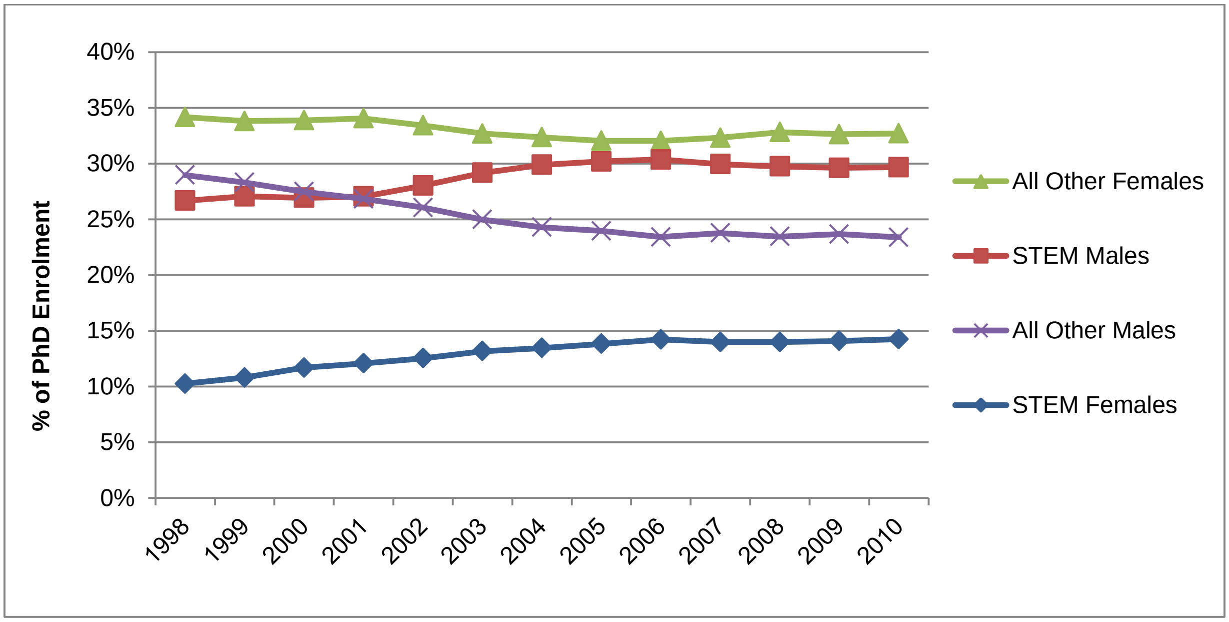
Figure 3.8a reveals that the STEM disciplines did not show much relative growth overall at the master's level during the period. The two lowest lines in that graph represent the percentage of overall master's enrolment in each year that was made up of male or female STEM field enrolment. Although there was some increase in these lines from 2000 to 2003 for both males and females, reaching a maximum of 17.3% and 9.7% respectively of total master's enrolment, this increase had disappeared by 2008. The respective shares were down to 15.4% and 8.9%, not far from where they had started a decade earlier (14.9% and 7.9%). As has been noted before, Figure 3.8a also shows the increasing representation of women in the non-STEM fields. The upper two lines show a decrease from 2000 to 2003, when the lower two show the increase, but after 2003 the percentage of overall enrolment represented by women in non-STEM fields increased while the percentage of men in those fields continued to decrease.

Figure 3.8a: Master's enrolment in STEM fields and all other fields of study combined, as a percentage of total master's enrolment by gender



At the PhD level, the situation is markedly different. Indeed, Figure 3.8b is harder to decipher because of the similar magnitude of three of the lines. The isolated line at the bottom is the percentage of overall PhD enrolment that consists of women in STEM fields. This increased over the period from1998 to 2006 from 10% to 14%, at which percentage it has been almost constant for five years. The comparable percentages for men are represented by the red line, which is third from the top at the start and second at the end, having increased from 26.7% to 29.7% of total PhD enrolment. Male non-STEM enrolment decreased as a percentage of the total throughout the period, ending at only 23.4%, while female non-STEM enrolment remains the largest segment of PhD enrolment at 33%, although this too dropped over the decade. In short, total STEM enrolment at the PhD level has increased from 36.9% to 43.9% of total PhD enrolment, at the same time that total PhD enrolment has itself increased by nearly 21,000 since 1998.

Figure 3.8b: PhD enrolment in STEM fields and in all other fields of study combined, as a percentage of total PhD enrolment by gender



3.8.2 STEM Disciplines and International Students

Given what was found in Section 3.5 about the importance of international enrolments in the relative male and female enrolments, it seems worth investigating the role of international students in this growth in the STEM disciplines. Figures 3.8c and 3.8d provide complementary information regarding master’s enrolment. The first shows that Canadian master’s STEM enrolment hit a peak in 2004 for both males and females and then declined (for two years for males and only one for females). Clearly the NSERC CGS awards were not successful in enticing more Canadians into STEM fields at the master’s level, given that the decrease in enrolments occurred exactly when the CGS awards were being introduced. The second graph (Figure 3.8d) shows that even in the years when Canadian enrolment was increasing, the percentage of total STEM enrolment consisting of Canadian males decreased monotonically, and the percentage that is made up of Canadian females was essentially constant at 30% from 2003 through 2009. The major increase in percentage share has been gained by international males.

Figure 3.8c: Master's enrolment in STEM fields by gender and Canadian or international status

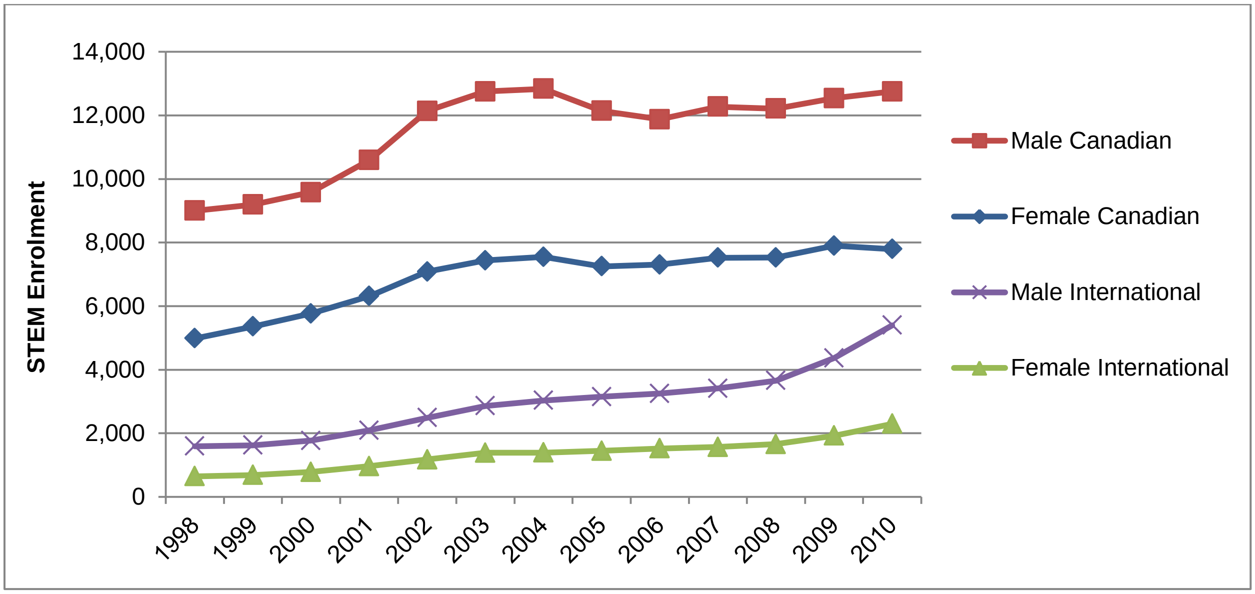
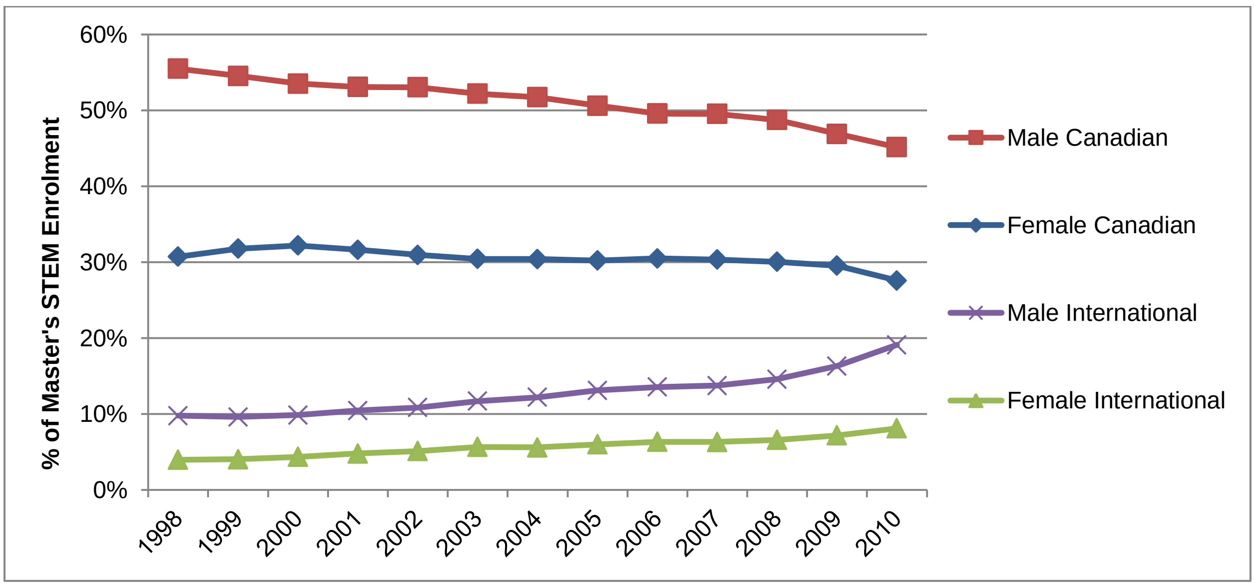


Figure 3.8d: Percentage of master's enrolment in STEM fields by gender and Canadian or international status



At the PhD level, the picture is much more promising with regard to the possible effect of the CGS awards. Both male and female Canadian enrolment increased monotonically over the period since (and before) the implementation of the awards in 2003 (Figure 3.8e). So too did international male and female enrolment. With regard to proportionate share of total STEM enrolment for the four groups, there seem to be three time periods (Figure 3.8f). Prior to 2003, the Canadian male percentage declined sharply, with its loss a consequence of Canadian female (until 2001) and international increases. From 2003 through 2008, the Canadian male share stayed steady at between 48% and 49% of STEM enrolment, while the Canadian female share fluctuated around 24%. International male plus female shares thus likewise stayed relatively steady. For the most recent two years, the Canadian share has decreased while the international student share increased.

Figure 3.8e: PhD enrolment in STEM fields by gender and Canadian or international status

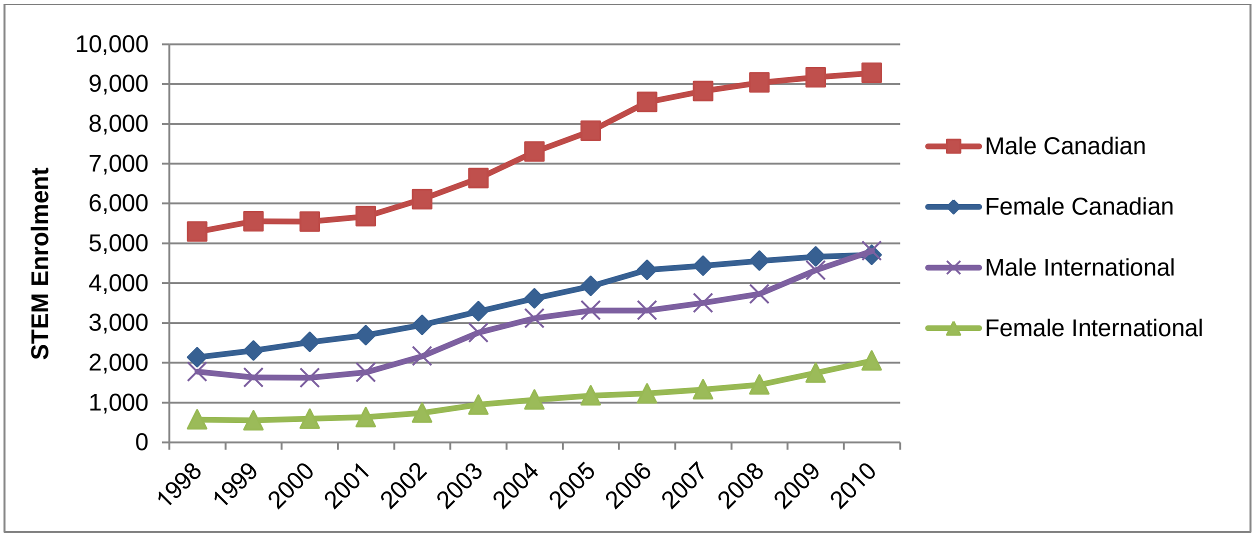
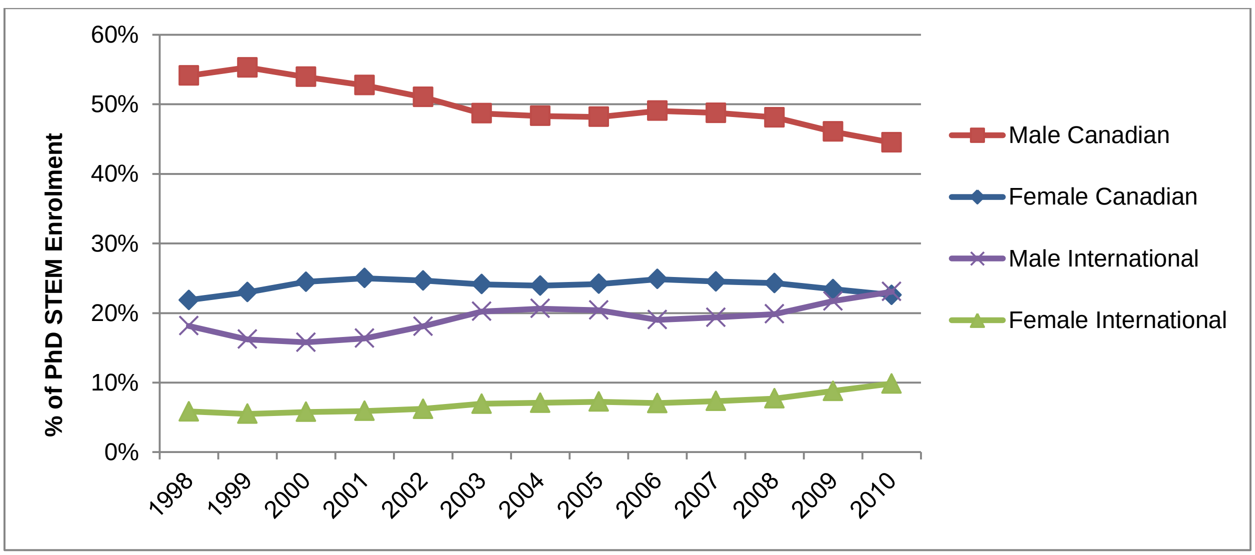


Figure 3.8f: Percentage of PhD enrolment in STEM fields by gender and Canadian or international status

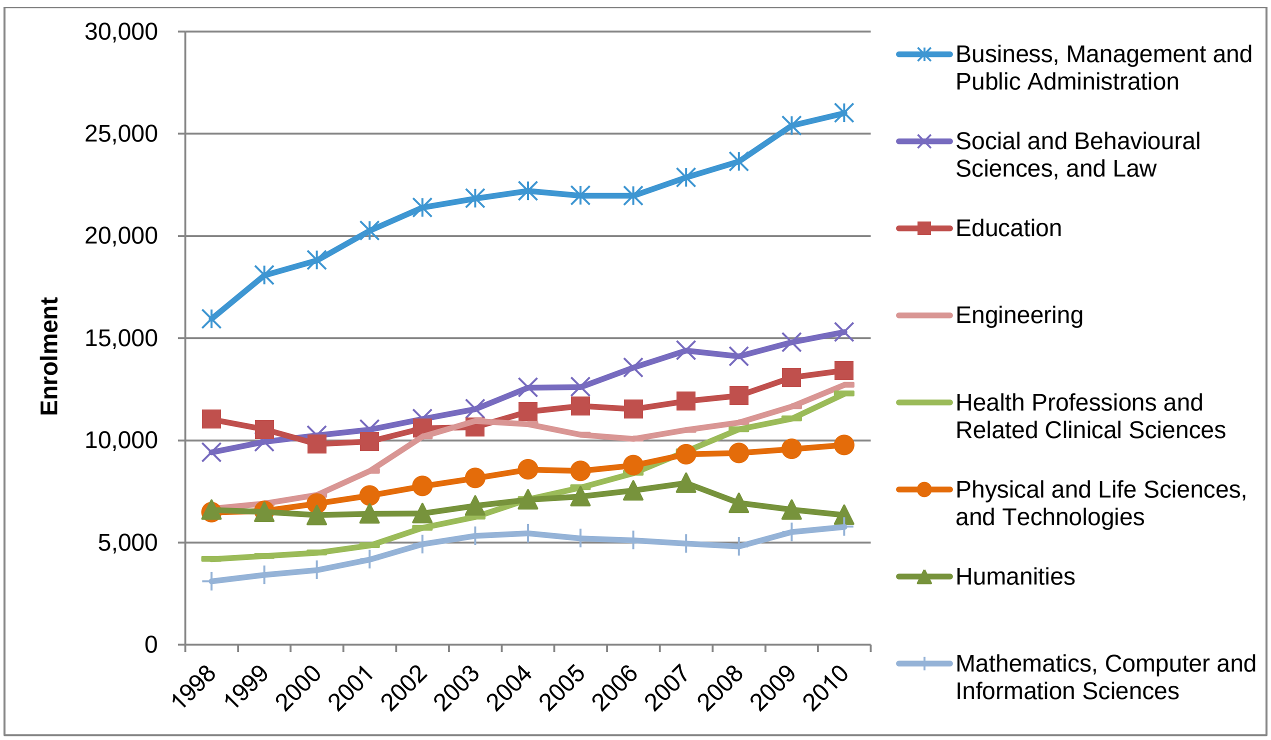


3.8.3 More Detailed Field of Study Breakdown

The PSIS website referred to in Section 3.7.1 identifies twelve primary fields of study that are relevant to graduate education. In addition to splitting out category 08 as described above, we also split category 10, “Health, Parks, Recreation and Fitness,” in order to focus on the health disciplines (which turn out to have increased from 75% to nearly 90% of the larger category 10 over the decade). Given these modifications to the PSIS groupings, the eight fields of study with the largest enrolments have been graphed in each of Figures 3.8g and 3.8h, for master’s and PhD respectively.

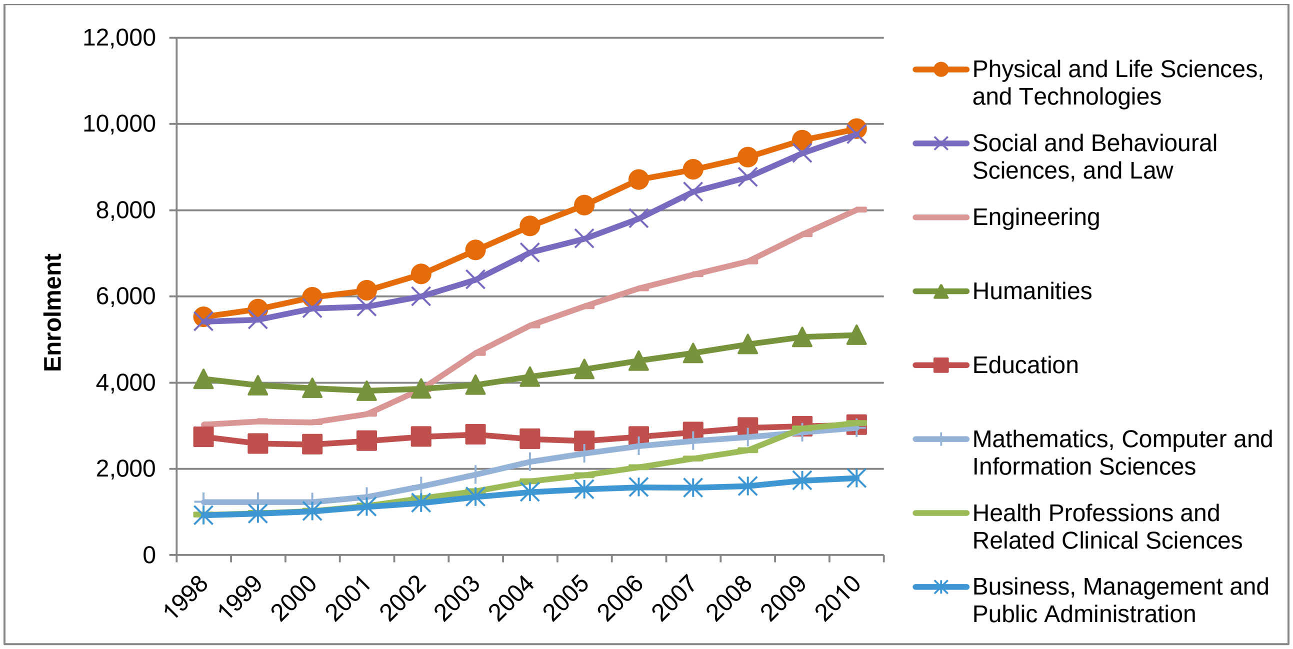
At the master’s level, the first thing that stands out in Figure 3.8g is how much larger the enrolment is in Business, Management, and Public Administration than in any other field of study, and how much it has increased since 1998, by over 10,000 students. However, most of this growth occurred prior to 2003 and after 2006; between 2003 and 2006, it essentially leveled off, and between 2002 and 2010 this field increased by only 4,600 students. The largest increase numerically from 2002 to 2010 was in Health Professions and Related Clinical Sciences (which does not include residency programs), which grew by 6,600 students or 115%. The third largest numerical increase (4,200) was in Social and Behavioural Sciences and Law, although this declined momentarily in 2008. Of the three lines representing the STEM constituents, only that for Physical and Life Sciences shows steady increases (except for 2005). Both Engineering and Mathematics have some years of declining enrolment (from 2003 to 2006 for Engineering, and from 2004 to 2008 for Math) – surprisingly around the time of the major increases in Tri-Council scholarship funding. One would have to conclude that the introduction of the CGS awards was not associated with a boost in NSERC-fields’ master’s enrolments, but was for CIHR and SSHRC fields.

Figure 3.8g: Master’s student enrolment in selected fields of study



The order of these same eight fields of study at the PhD level (Figure 3.8h) is quite different than at the master's level. Business is now the lowest line on the graph (at least for the latter half of the period). Social Sciences are still second highest, but now the Physical and Life Sciences have the highest enrolments. All three of the lines representing STEM constituents show steady increases over the period. At the PhD level, it is Humanities, Education, and even Business that have shown decreases in enrolments. It is at the PhD level, then, that the objectives of the federal initiatives with respect to STEM disciplines seem to have been met and the CGS scholarships seem to have been effective.

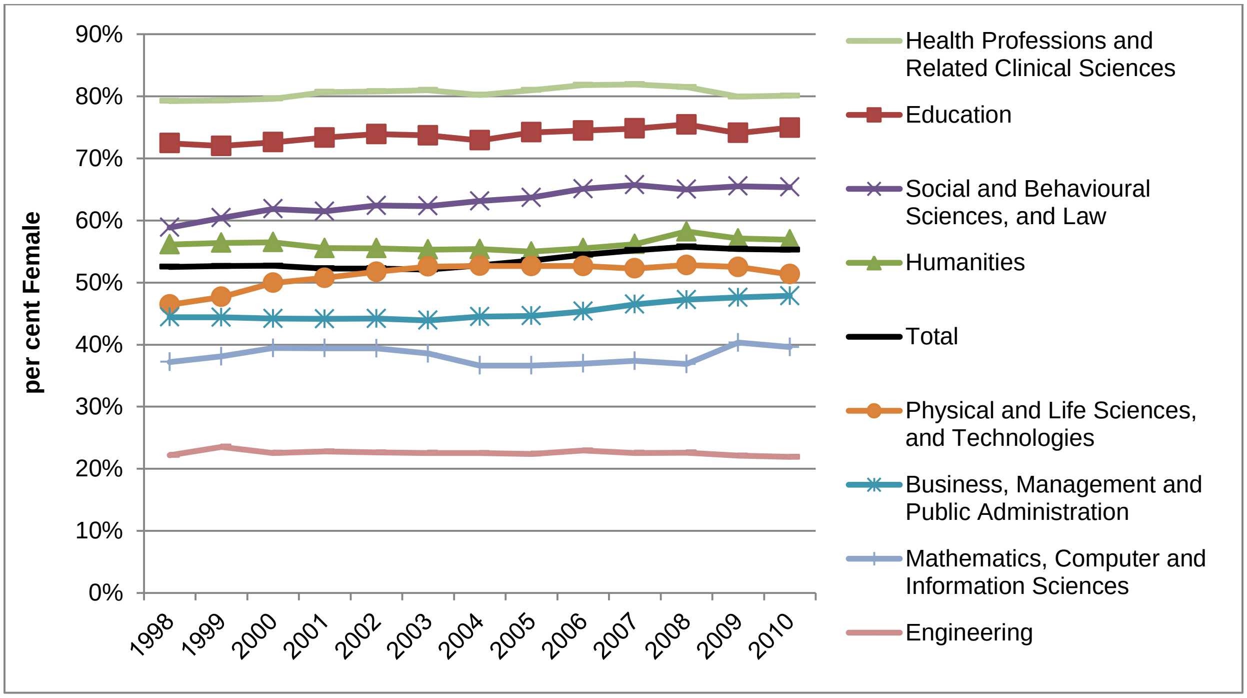
Figure 3.8h: PhD student enrolment in selected fields of study



3.8.4 Gender and Field of study

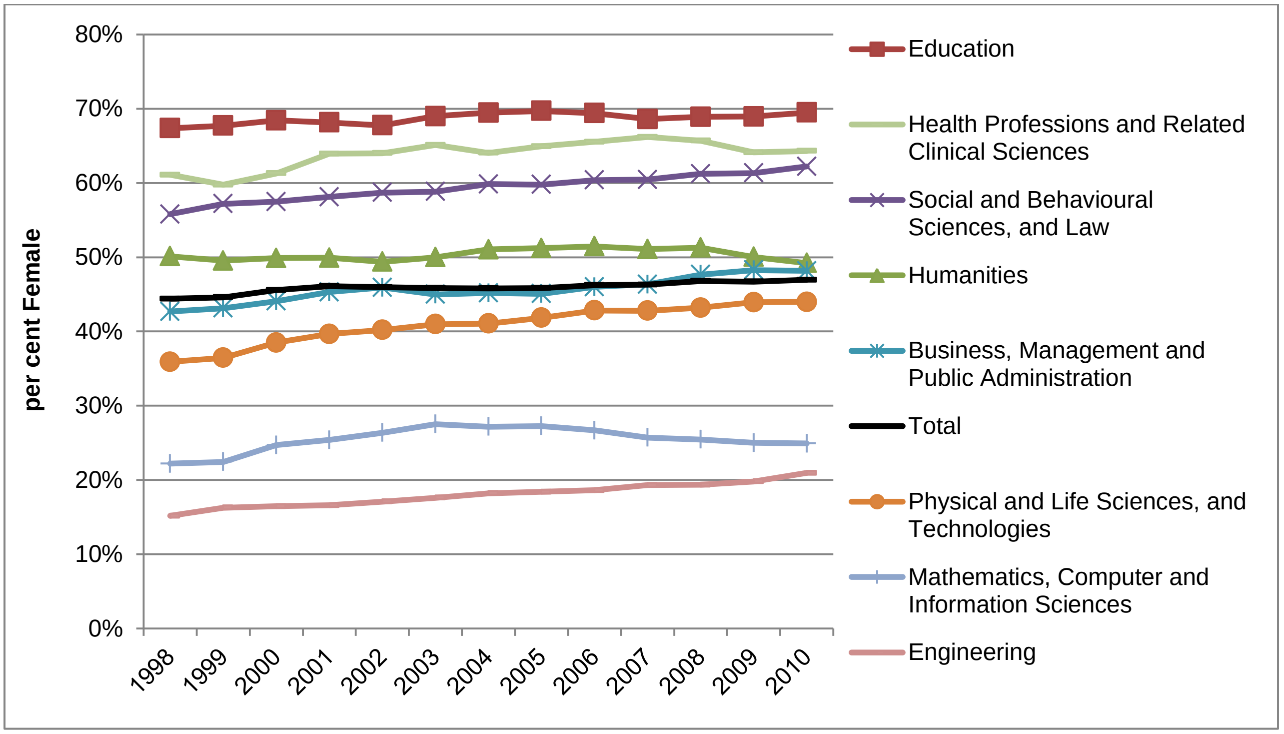
The gender split by field of study and the differential growth rates of those fields may also help to explain the growth in the female percentage of graduate students. Figure 3.8i shows that the female share changed very little by field at the master's level between 2003 and 2010, except in Business, Management and Public Administration (Business) and Social and Behavioural Sciences, and Law (Social Sciences), the only two areas in which the female percentage increased by more than 2%. (There was also a 3.5% increase in Physical and Life Sciences between 1998 and 2003, somewhat surprisingly.) Business and Social Sciences happen to be the two largest fields of study at the master's level. The increase in overall percentage of females at the master's level is due primarily to the increase in female participation in those two fields of study. For most of that period, MBA students (the bulk of the Business category) were not eligible for CGS awards, so it is clear that the awards as such did not have an effect on the increasing female percentage in that field . Although that same argument does not hold for Social Sciences, as we discuss later (Section 5.1.1), the CGS awards constituted such a small fraction of SSHRC-area enrolment that it is hard to see them having a driving effect on this field. In addition, the increasing female percentage in Social Sciences is a continuation of a trend already apparent between 1998 and 2003.

Figure 3.8i: Percentage of enrolment that is female in each field of study, master's only



At the PhD level (Figure 3.8j) the overall female percentage increased by 1.5% from 1998 to 2003, and then by only another 1.1% between 2003 and 2010, thus there is less to "explain" at this degree level. Nevertheless, there are several interesting trends by field of study, including particularly the same three as mentioned for the master's degree. The female percentage in Physical and Life Sciences grew 8.1% between 1998 and 2010, 5.1% in the first five years and 3.0% in the last seven. In Social Sciences the female percentage grew 6.4% over the 12 years, split 3.0% and 3.4% over the two segments. Business grew 5.5%, split 2.3% and 3.2%. Somewhat surprisingly, Engineering showed the third highest increase for female percentage, ahead of Business, with increases of 2.5% and 3.3% in the two time segments for an overall increase of 5.8%, although Engineering started from a lower base. In all four of these fields, the growth after the introduction of the CGS awards seemed simply to be a continuation of the trend in the five years prior to their introduction. It would be difficult to conclude that the CGS awards did anything to cause or encourage the increased female percentages.

Figure 3.8j: Percentage of enrolment that is female in each field of study, PhD only



4. Changes in Degree Completions

While some of the objectives identified by governments for their increased investment in graduate education pertained to enrolment expansion as just discussed, others related to the number of degrees awarded. The federal government spoke to this, although not with specific targets, as did British Columbia (for specific fields), and Alberta, Manitoba, Ontario and Prince Edward Island, at least implicitly. This chapter of the report looks at degree completions primarily using the PSIS data but also in the first section some data provided by the U15 group of universities. While most of the sections mirror those of the previous chapter, the distinction between full-time and part-time enrolment is not carried through in PSIS for degree recipients, so that section does not appear here. After consideration of the U15 data on completion times and rates, this chapter investigates the total number of degrees awarded at each of master's and PhD level between 1998 and 2010, and then looks separately at master's and PhD recipients by gender and by Canadian or international status. The fifth section of the chapter considers degrees awarded by province, separately for master's and PhD. This is followed by sections that consider degrees awarded by university category, using the same categories used for enrolments; and then finally degrees awarded by field of study, again with special consideration of STEM disciplines.

4.1 Completion Times and Percentages from U15 Data

The U15 group includes research-intensive universities which have banded together to, among other things, share information. The group is an expansion of an original group of ten founded in 1991. One of its information-sharing activities pertains to graduate degree completion rates and times to completion. The institutions have been kind enough to share some summary data from that activity with us for this report. Their analysis is based on entering cohorts, which are defined by calendar year. The progress of PhD students is summarized nine years after entry, master's students five (previously nine) years after entry. Because of this time lag, the most recent year for which data were available was the 2001 entering cohort for PhD students and the 2005 entering cohort for master's. The nine (or five) years ended at the end of September 2010. It then took each university as much as a year to compile the data and submit them to the U15, and another six months or so for the U15 to create the data cube and extract the summary. These data will be useful in terms of setting expectations for the relationship between enrolment data and degrees awarded in terms of time lags and expected success rates. Although the U15 data may not be representative of all universities in Canada, these are the only data available that deal with completion rates or times, and these 15 institutions enrolled 75% of the PhD students in Canada in 2001.

4.1.1 Master's Students

The U15 performs completion calculations for research master's students, but not for course-work or professional master's degrees (such as the MBA). A successful outcome for a master's student is considered to be either completion of all degree requirements or promotion to the PhD (an outcome that is most common in the sciences). The original G10 first tracked master's students' completion data after nine years, just as for PhD students, but realized after several cohorts that nine years was too long and changed that to a five-year time horizon. This change of practice explains the break in the middle of the lines in Figures 4.1a and 4.1b. The first five data points reflect the situation nine years after the specified entry year for each cohort. The last five data points reflect the situation five years after entry for the cohort. The three entering cohorts for 1999 through 2001 were not analyzed.

Three things stand out in Figure 4.1a: (1) completion rates vary by broad disciplinary divisions; (2) no division has more than 90% of students completing within the five years for more recent cohorts or the earlier nine years; and most surprising, (3) completion rates are higher when calculated over five years than when they had been calculated over nine years for earlier entering cohorts, which is counterintuitive. However, in all of the broad disciplinary divisions except Physical Sciences and Engineering, the completion rate had been trending upward prior to 1997 and the four-year break in the cohort tracking. The higher completion rates after 2000 probably just reflect a trend that had been underway in the intervening years. Indeed it is possible that the very act of reporting completion rates to the universities may have led to more attention being given to it and thus improvement in it.

In terms of times to completion, Figure 4.1b shows that at the master's level, Humanities and Social Sciences students finish faster, in less than two years and just over two years, respectively, in the most recent data. In the Physical Sciences and Engineering, times to completion currently average between two and 2.5 years, somewhat less than they were for the earliest cohorts.

Figure 4.1a: Master's completion rate by broad disciplinary division, after nine or five years, by year of entering cohort

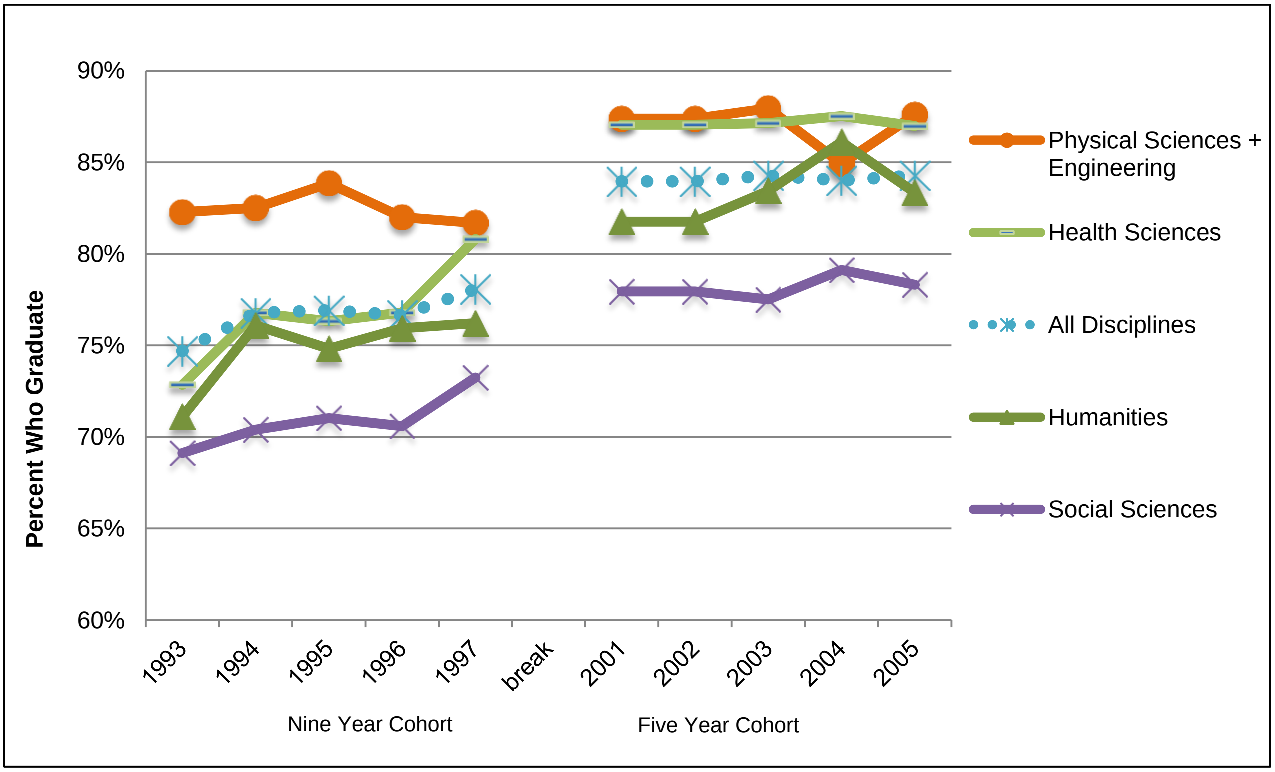
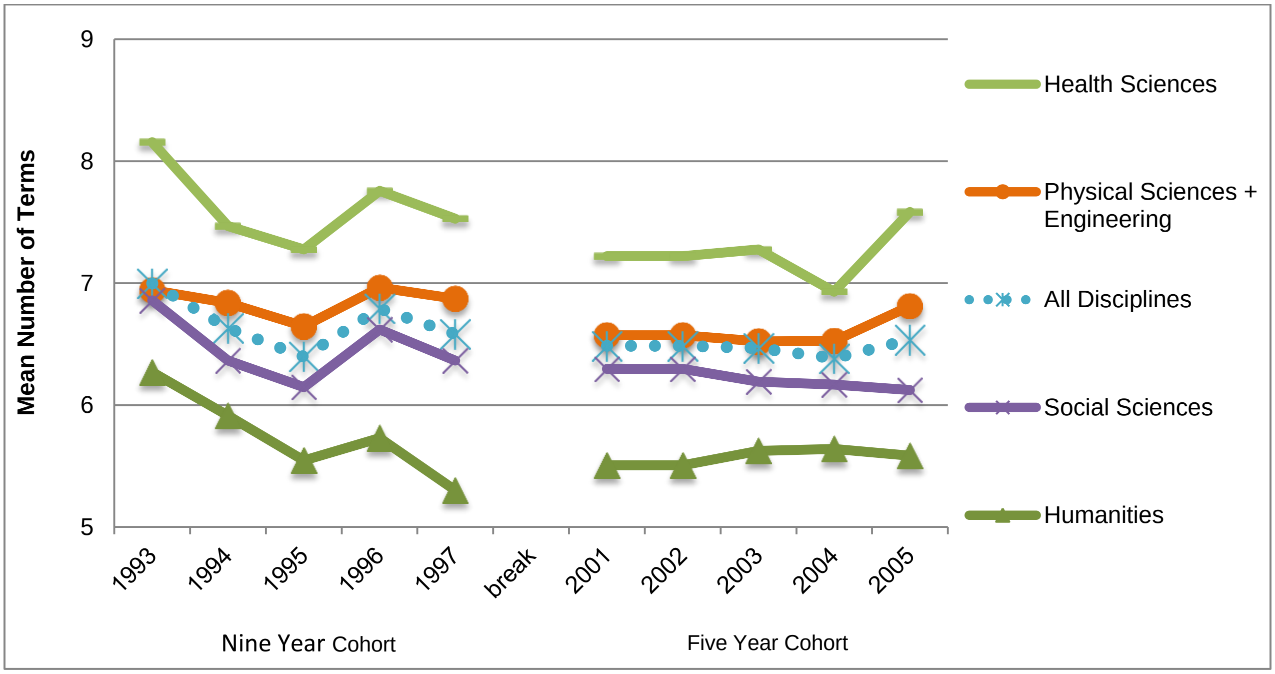


Figure 4.1b: Mean number of terms to master's completion by broad disciplinary division, for those who completed within nine or five years, by year of entering cohort



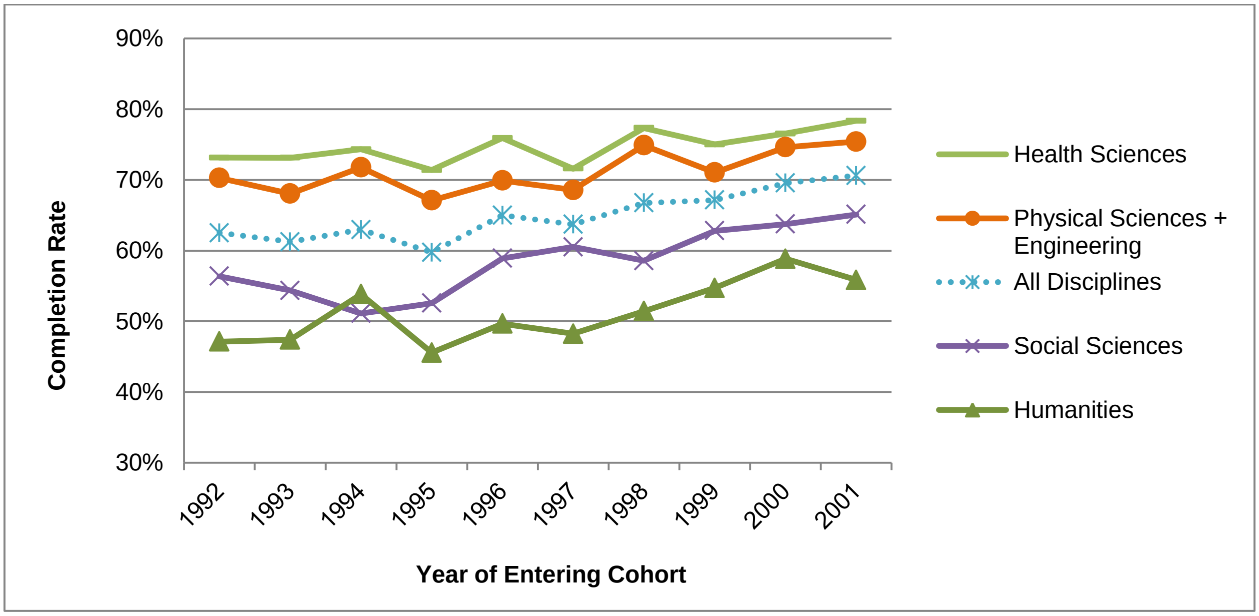
4.1.2 PhD Students

Figure 4.1c shows the percentage of PhD students who have successfully completed their degree within nine years (27 terms) of the date they began the program.[23] Note that the vertical axis in Figure 4.1c is different from that for Figure 4.1a. For PhD students, there were cohorts with completion rates below 50% in some broad disciplinary divisions and years. For master's students, the lowest completion rate is slightly below 70% and the highest is nearly 90%. At the PhD level, the percentage completing has increased noticeably over the decade. The largest increases in completion rate occurred in those areas with the lowest rates: Social Sciences and Humanities. For the 1992 Social Sciences cohort, only 56% completed their degree within nine years of starting it; for the 2001 cohort, 65% completed in nine years – an increase of 9%. For Humanities, the comparable numbers are 47% and 56%, again an increase of 9%. Given the fluctuations of these completion rates over the decade, one can also look at the average rate for the first five years of the decade versus that for the last five years. Doing that, one sees an improvement of 7.5% between the two halves of the data for Social Sciences and 5.1% for Humanities. The comparable average improvement for Science and Engineering is 3.5% and for Health Sciences only 2.2%. Completion rates in all four fields of study have improved over this decade of entering cohorts. Note that failing to complete the degree within nine years does not necessarily indicate "failure". In Humanities and Social Sciences, some are still continuing to work on their

[23] In order to maintain a consistent set of universities throughout the time period shown in Figures 4.1a through 4.1d, only those institutions whose data was available in all periods have been included. In 1992, the group was still only the G10, and not all of those ten provided completion data. Thus although the U15 represented 75% of PhD enrolment in 2001, these data represent probably less than 60% of PhD enrolment in Canada.

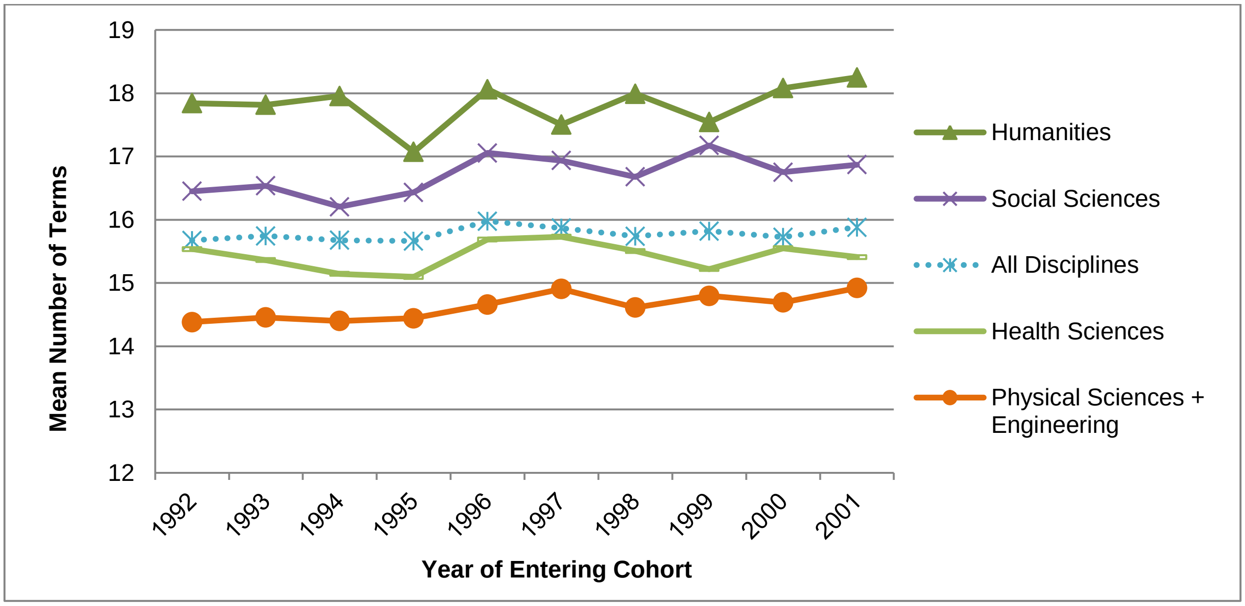
degree even after this period of time. A number of those who do not complete the PhD do so because they obtain permanent jobs that draw on what they have learned in the degree program but do not require the PhD itself. Others, especially in the life sciences, are admitted to medical school, for example.

Figure 4.1c: Doctoral completion rate by broad disciplinary division, after nine years, by year of entering cohort



The times to completion (Figure 4.1d) appear not to have changed noticeably over this same decade of entering cohorts. If one performs the same comparison of averages over the first five years with averages over the second five years, all five categories show an increase – but all are under 0.4 terms, the unit of measure, which is to say an increase of slightly over one and a half months (0.4 x 4 months per term). A regression analysis for the “all disciplines” line shows a positive slope of 0.015 terms/year, or 0.15 terms over the ten years, much lower than the difference of means. On average across all disciplines, the mean time to complete for all those who complete within nine full years of starting the PhD is between 15 and 16 terms, which is to say just over five years. By broad disciplinary division, this average varies from a bit less than five years for Engineering and Science to nearly six years for Humanities. Hence in looking at PhD degree completion data in what follows, one needs to keep in mind that they refer to entering cohorts from roughly five or six years earlier.

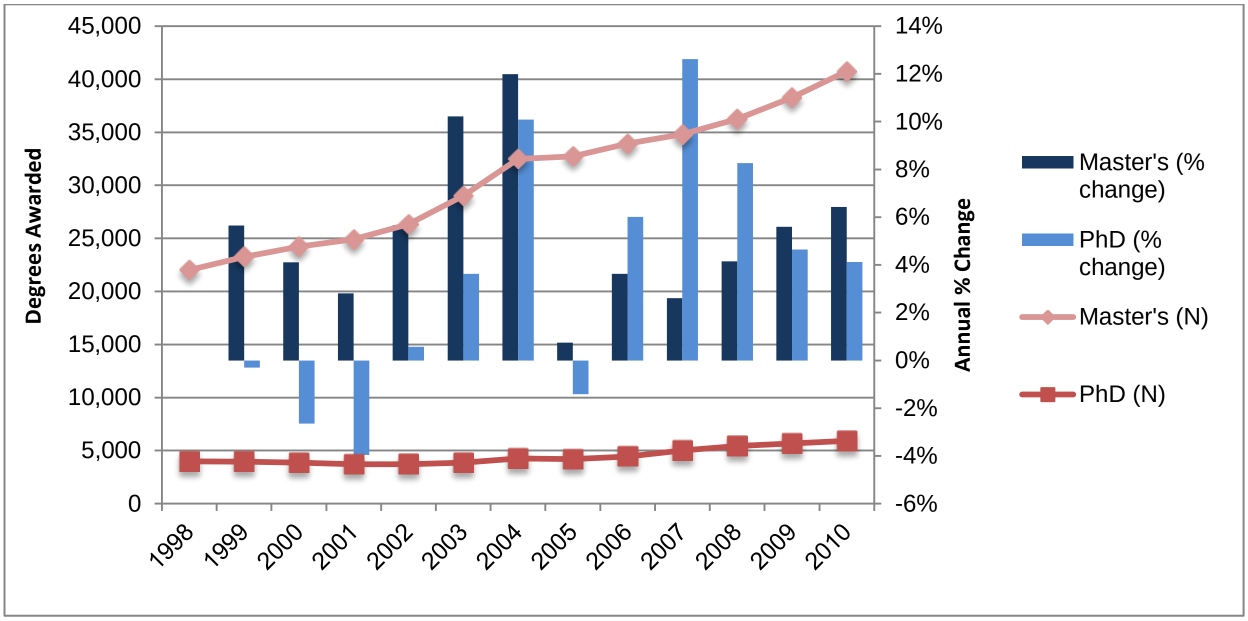
Figure 4.1d: Mean number of terms to PhD completion by broad disciplinary division, for those who completed within nine years, by year of entering cohort



4.2 Total Degrees Awarded

The picture that emerges concerning the number of degrees awarded is somewhat surprising in two respects, which is why two additional lines have been added in Figure 4.2. First, the number of master's degrees awarded was on the increase prior to the implementation of any of the investments discussed in this report. And second, the number of PhDs awarded was declining in the early part of the decade. To provide more detail on those changes, bars have been added to the figure to identify the year-over-year percentage change in each set of numbers.

Figure 4.2: Degrees awarded by year and annual percentage change, for master's and PhD



The master's annual percentage change ranged from 3% to 6% until 2002. Then it was over 10% for 2003 and 2004, but in 2005 it dropped to under 1% for a year before resuming at a 2% to 6% increase. The decreased rate of change in 2005 is curious, because this was after the federal initiatives began, as well as after several provinces had started investing in graduate growth. Granted, there is a two- to three-year lag in master's graduations from date of entry, so one would not expect investments made in 2004 to have an effect until 2006 or 2007, but even then there is not a noticeable increase in the annual percentage change.

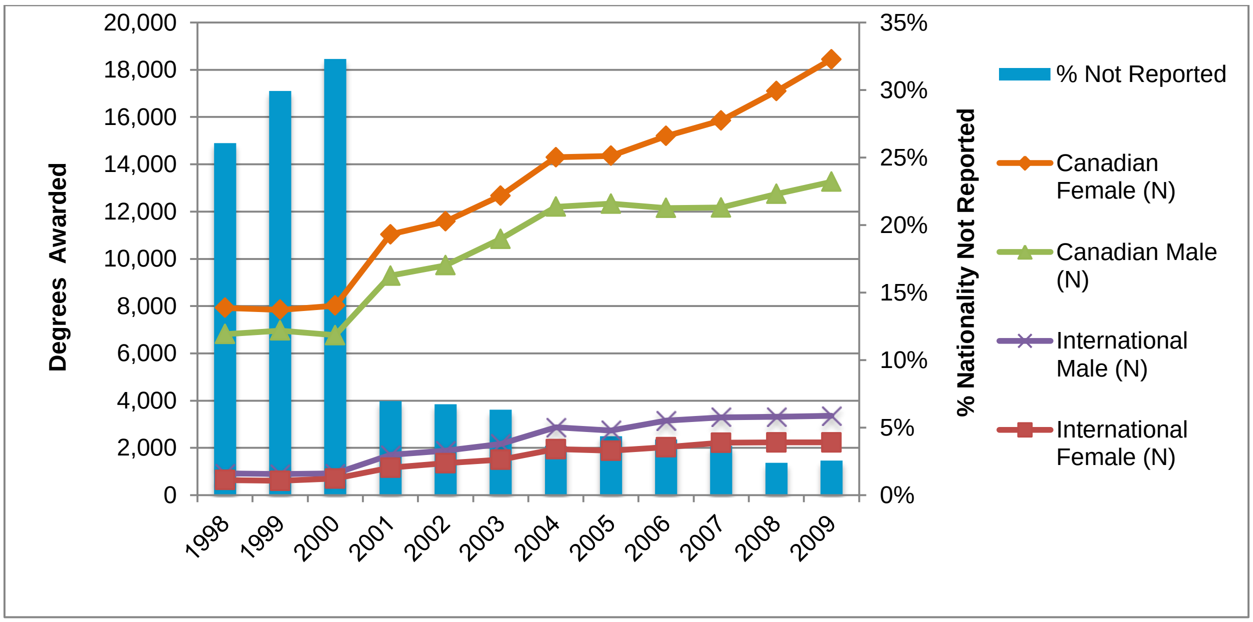
For the PhD, the annual percentage change was negative for three of the first seven years, suggesting that there was indeed a need for some stimulus if more PhD graduates were needed. At the start of the study period, there was one PhD graduate for every 5.5 master's graduates; by the end, the ratio was 1 to 6.75. The largest year-over-year increase in PhD graduates (12.6%) was in 2007. This is unlikely to be a consequence of the CGS program that started in 2003 or 2004, since almost none of those graduating in 2007 would have been eligible for it, having already been one or two years into their program in 2004 and therefore not eligible to apply. The effects that one might expect to see from the CGS program would be in 2008 or 2009, both of which have reasonable increases in the number of PhD degrees awarded, although not as high as in 2007.

4.3 Master's Degrees Awarded by Gender and Canadian or International Status

Because the analysis of enrolments showed important differences by gender, which were also affected by differences between Canadians and international students, those variables will be considered here. There are two problems with distinguishing between Canadian and international students. First, this variable is not recorded in PSIS for a percentage of degree recipients. The bars in Figure 4.3 show the magnitude of this non-reporting: in the first three years, the national status is not available for over a quarter of the degree recipients. For the most recent five years to 2009, the non-reporting affects less than 5% of degree recipients. The pattern is the same for each of males and females considered separately, so only the percentages for the total are shown. For 2004 to 2009, when the non-reporting is below 5%, Canadians represent between 83.6% and 85.3% of master's degree recipients. In the first three years, when the "unknowns" represent over a quarter of the total, Canadians are over 90% of degree recipients for whom national status is known. Hence it would appear that a greater proportion of the "unknowns" are international students, but certainly not all are. If all the unknowns were added to the international student numbers, Canadians would constitute only 61% to 67% of the total, which is clearly too low. Thus the non-reported status affects both Canadians and international students, but slightly more of the latter.

The second problem with the data occurred for 2010. For some reason, the Ontario university data did not contain complete information on citizenship and immigration status. Statistics Canada's procedure for such missing data results in such persons being categorized as "non-Canadian, [visa] status unknown". This led to obvious anomalies in the data, such as there being 873 such students in Ontario when there had been zero in 2009 (and only 24 across the country). For this reason, we have excluded the 2010 data on degrees awarded from this analysis.

Figure 4.3: Master's degrees awarded to Canadian and international students by gender

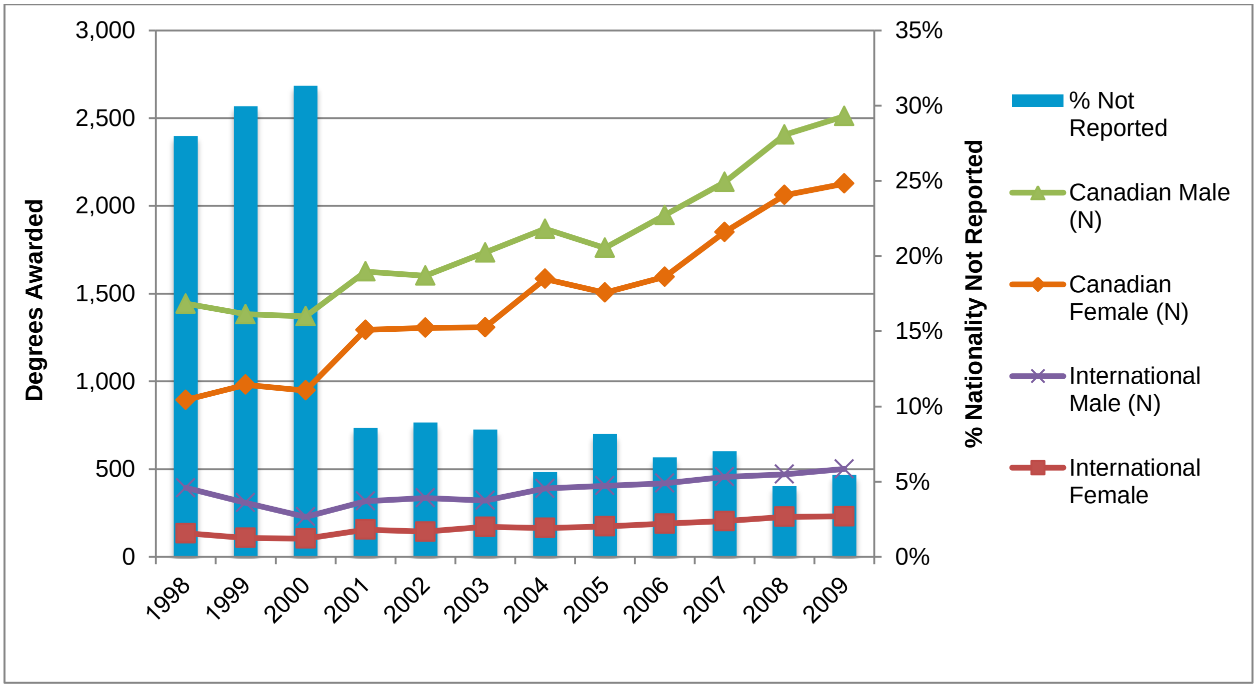


The lines in Figure 4.3 represent the remaining percentage of degree recipients for whom gender and national status are known. These lines show the number of Canadian females receiving a master's degree more than doubling over the period while the number for Canadian males does not double. The difference between the two started at just over 1,000; by 2009 females were earning over 5,000 more master's degrees than were males. Again, take note of the time lag: degrees granted in any year will be largely a function of admission decisions made two or three years earlier (and any difference in completion rates, about which we have no information). For international students, more males than females earned master's degrees each year. For the first three years, the difference was less than 300, but by 2006 the difference exceeded 1,000. Hence the trend among international students runs opposite to the trend among Canadian students; it has been useful to separate the two.

4.4 PhD Degrees Awarded by Gender and National Status

The percentage of non-reported national status is similar for the PhD degree (Figure 4.4), except that the most recent six years are consistently under 8% rather than under 5%. During those six years, the percentage of degrees earned by Canadians varies from 84.8% to 86.5%. In 1998 (28% not reported), the Canadian percentage was 81.6%; in 2000 (30% not reported), the Canadian percentage was 87.4%. (1999 was 85.1%, in the “normal” range.) These numbers suggest that any bias toward non-report of international students is minimal.

Figure 4.4: PhD degrees awarded to Canadian and international students by gender



The picture for PhD degrees awarded by gender and national status is similar to that for master’s degrees with one major difference (Figure 4.4). Canadian male recipients outnumbered Canadian female recipients for the PhD throughout the period, although the difference declined from 550 in 1998 to 250 in 2005; it has increased again since then to 380. Strangely, the number of recipients in both of these groups declined in 2005, although the numbers for international students increased that year. The difference between male and female international student PhD recipient numbers is similar at both ends of the period (about 250), but dropped to half of that in 2000. The international pattern would not have distorted the overall pattern in the case of PhD degrees awarded.

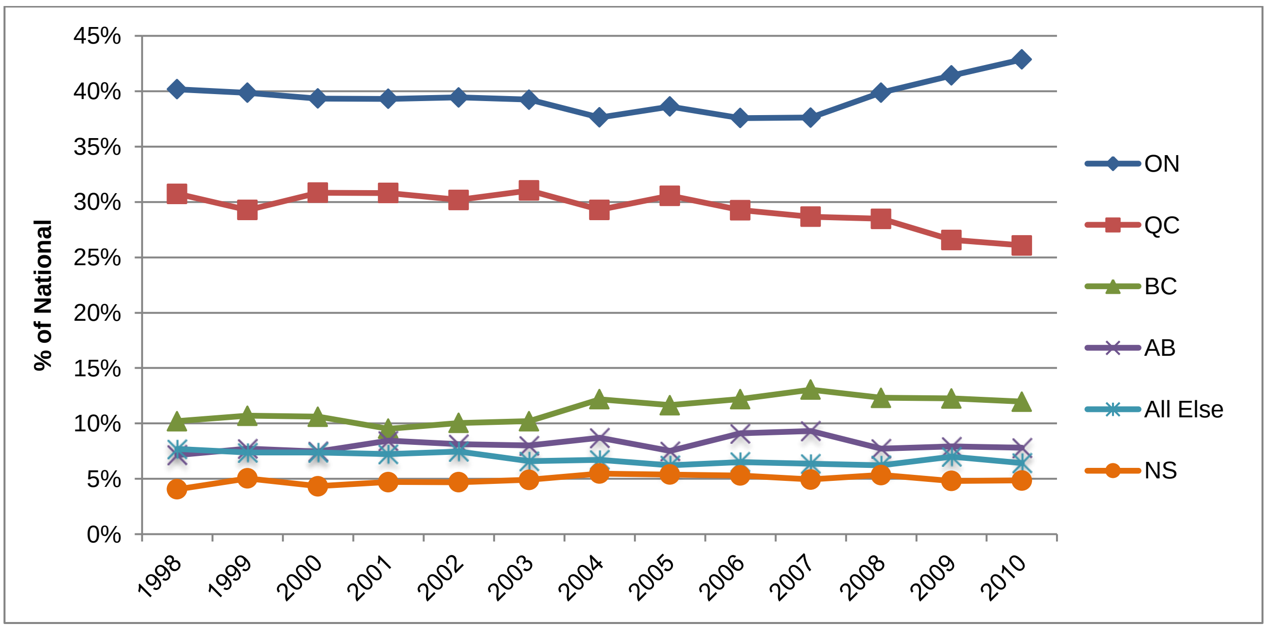
4.5 Degrees Awarded by Province

The issue at the provincial level is whether the differences among the provinces in the provision of funding for enrolment growth had any effect on the provincial distribution of degrees awarded. Section 3.6 found that there was an effect on the distribution of enrolments. Given the time lag from initial enrolment to degree completion and the starting dates for provincial funding initiatives, one might expect to see an effect for master's degrees but little or no effect for PhDs.

4.5.1 Master's Degrees

Figure 4.5a shows that there is indeed an effect for master's degrees awarded. Consider first the provinces whose shares increased. Ontario has the largest share throughout the decade, but its share was declining for the first half of the period, and after a one-year jump in 2005 continued to decline until a three-year increase that started in 2008. The 2005 jump could be related to investments in ATOP or GAE in 2002 and 2003; certainly the increases from 2008 through 2010 are a consequence of the RH investments. British Columbia's share was approximately 10% through 2003, then it jumped to 12% in 2004, where it has stayed except for in 2007 when it hit 13%. 2004 is two years after the DTO and Surrey expansion investments began, but 2007 does not lag any expansion initiative appropriately. Alberta's share was around 8% until 2006 and 2007, when it exceeded 9%, but since then it has fallen back to around the 8% level again. These numbers do not correlate well with investments, as those began in 2006 and one might expect them to lead to increases in degrees awarded in 2008 or 2009. Nova Scotia also has an increasing share, going from 4.1% in 1998 to 5.1% in 1999, and then staying close to 5% most years, dropping only to 4.8% in 2009 and 2010.

Figure 4.5a: Percentage share of master's degrees awarded nationally by province

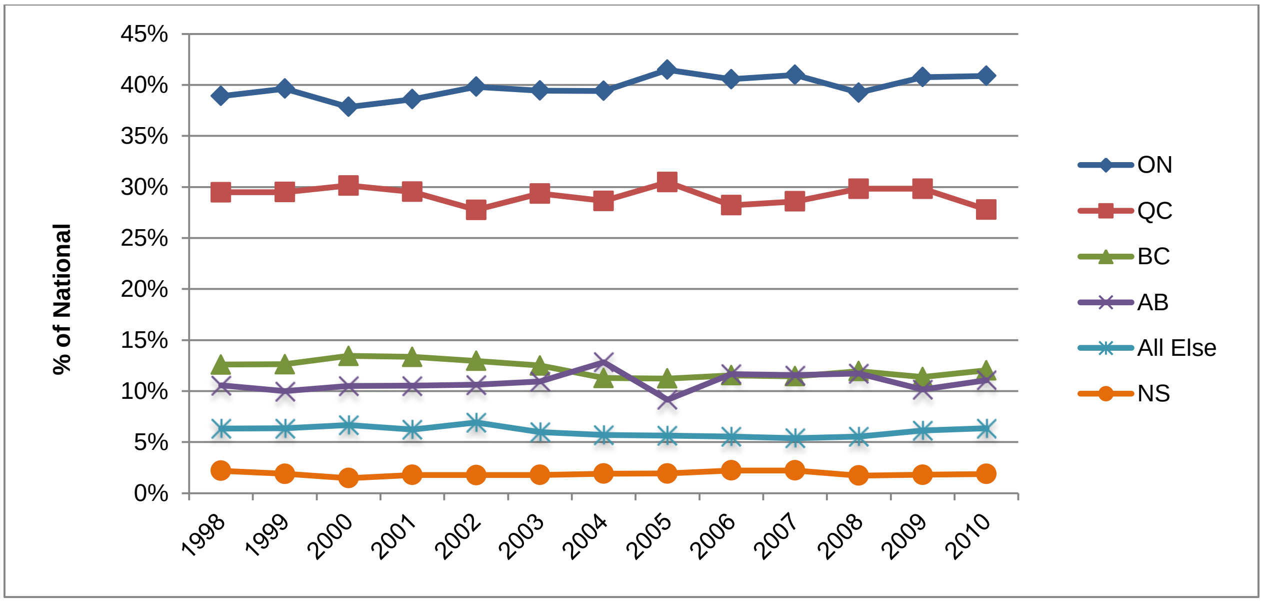


The major losses in share occurred in Quebec and the remaining provinces combined (Saskatchewan, Manitoba, New Brunswick, Prince Edward Island, Newfoundland). Quebec's share stayed between 29% and 31% during 1998 to 2006, and then dropped below 29% in 2007 and below 27% in 2009 and 2010. The five remaining provinces had about 7.5% until 2003, at which point they dropped to around 6.5% until 2009 when they jumped up again above 7%, but only for one year. In essence, these provinces' losses in national share are a consequence of the gains made in provinces where investment took place.

4.5.2 PhD Degrees

At the PhD level, there has not been as much change in shares across the provinces (Figure 4.5b) as there was at the master's level. The only province that does not stay relatively flat is British Columbia, which hit a high of 13.4% in 2000 and has since dropped to 11.3%. Surprisingly, given that there had not been investments five years earlier, Ontario hit a peak of 41.5% in 2005 and has since dropped to 41%. One would not expect to see an effect on degrees granted of increased PhD enrolment share until perhaps 2011 or 2012 – years for which data will likely not be available until 2014.

Figure 4.5b: Percentage share of PhD degrees awarded nationally by province



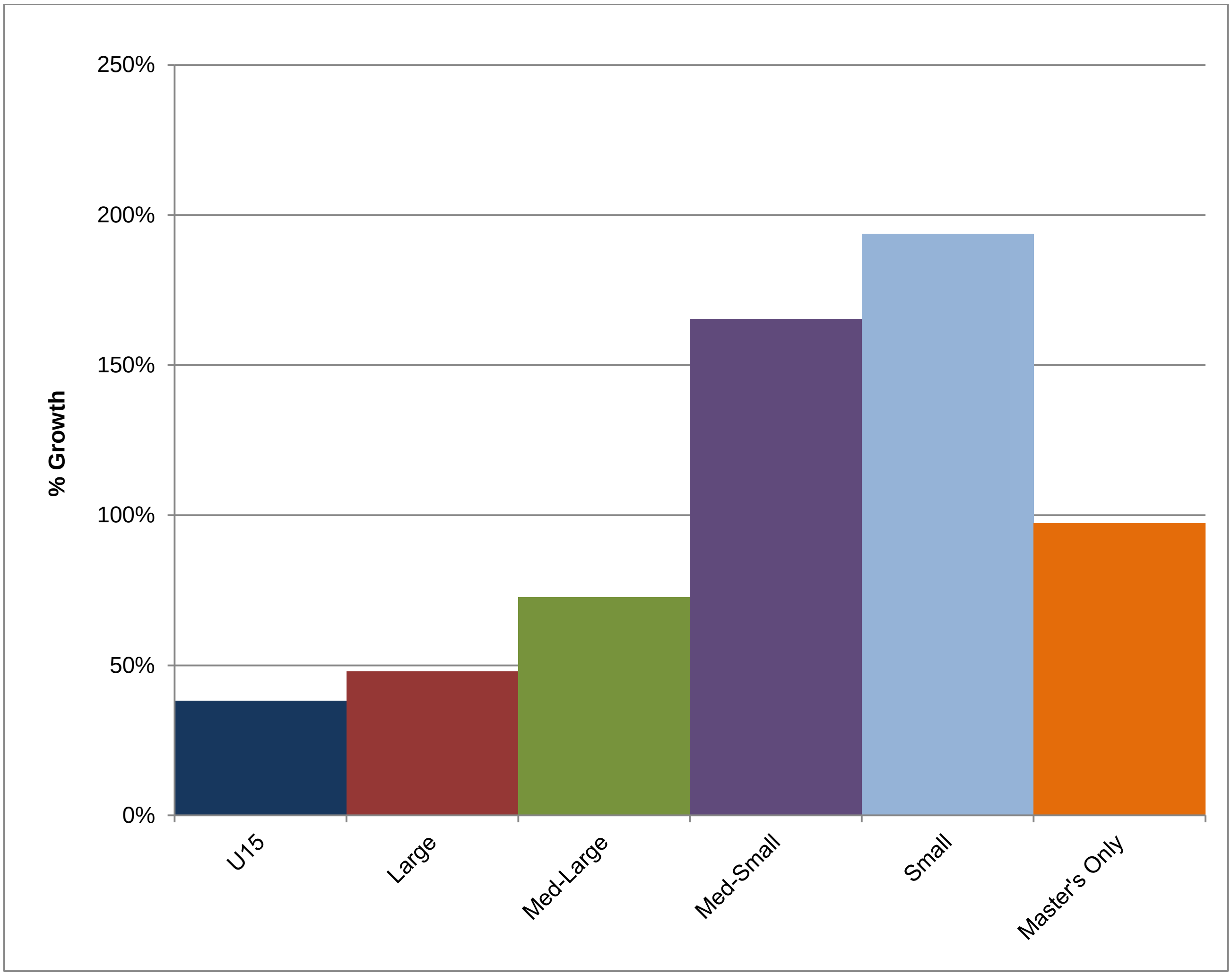
4.6 Degrees Awarded by University Category

The categories used for this analysis are the same as were used and described in Section 3.7. That is, the size-based categories have been defined on the basis of institutional master's head count enrolments in 2002, not on the basis of the number of degrees awarded annually. The item of interest here is similar to that in Section 3.7: in which categories of universities has the growth in number of degrees awarded occurred?

4.6.1 Master's Degrees

As in Section 3.7, we can approach the question by considering either proportional growth or absolute growth. Figure 4.6a shows a similar pattern to that discussed regarding Figure 3.7a: the largest percentage growth occurred in the smallest universities, although not as disproportionately as in Figure 3.7a, because all of the larger size categories also increased their number of graduates by a greater percentage than they did their enrolments – which in itself is curious. For example, U15 master's enrolments grew by 21% between 2002 (average U15 master's enrolment 3,291) and 2009 (3,981), but the number of master's degrees granted grew by 29% (from 1,087 to 1,404). The differences are even greater for the four size-based categories. There are three possible explanations for this result: (1) the proportion of students completing increased; (2) the time to degree decreased; or (3) if both of these held constant, then the rate of change of enrolments over the years in question led to the result, since we are looking at only two years, 2002 and 2009, in this graph. The exception to this pattern is the master's-only institutions, which had a lower percentage increase in degrees granted (53.4%) than in enrolments (58.2%).[24]

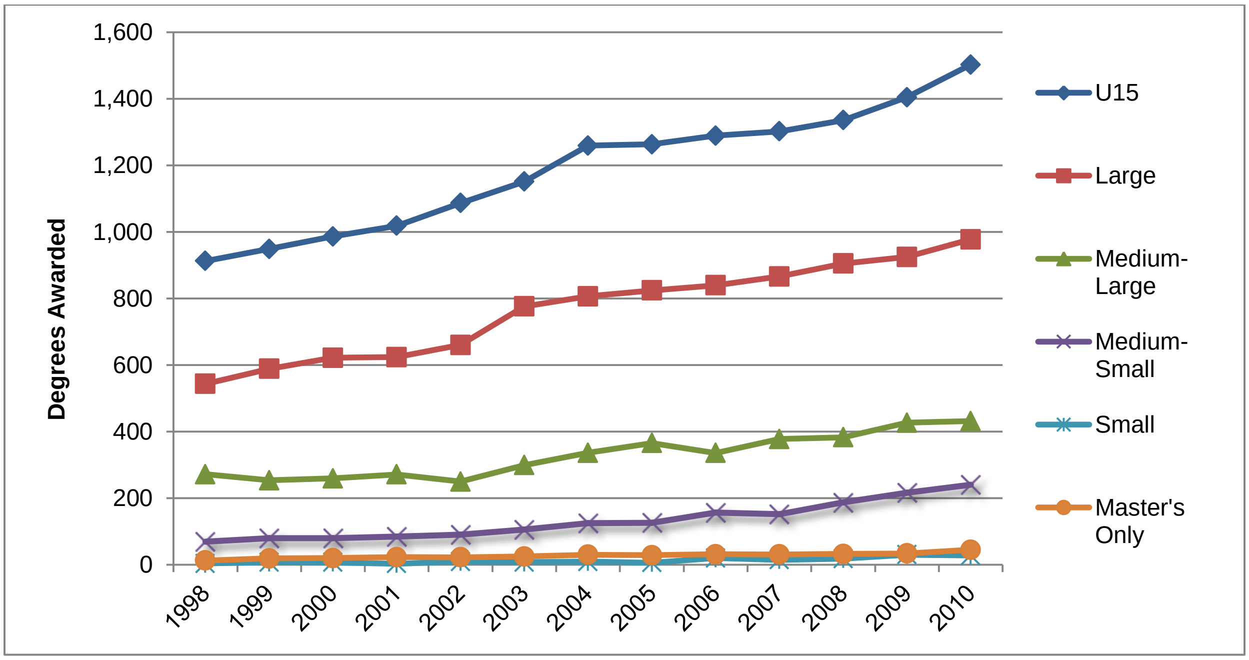
Figure 4.6a: Percentage growth in master's degrees awarded, 2002-2010, by university category



[24] Figure 4.6a omits the data for Royal Roads University. If it were included, the percentage increase for the master's-only institutions would be 251%. The reason for omitting it is that the master's degrees awarded for Royal Roads in the PSIS file go from 0 master's graduates in 2003 to 894 in 2004. However, there were only 735 graduate students registered in each of the previous four years (according to PSIS). This enrolment makes the 894 seem implausible. In some subsequent years, the number of graduates is about half of the head count enrolment, so could be plausible, but given doubts about this one year, we excluded RRU from this graph.

The number of degrees awarded per year by university category gives the impression that the higher on the graph a line starts, the greater its slope (Figure 4.6b). Calculation of the slopes confirms this impression: in order from top to bottom, the least-squares fitted slopes to the lines (in additional degrees per year, essentially) are 46, 36, 15, 12, 2, and 2.[25] Hence even though the percentage increase from 2002 to 2009 was greatest for the smaller institutions, the rate of increase, in additional degrees awarded per year, was greatest for the largest institutions. This is, in our opinion, more important in terms of the outcome of the investments than is the percentage increase. The largest universities (those with 2002 master's enrolments above 1000) produced the bulk of the increase in master's degrees.

Figure 4.6b: Average number of master's degrees awarded by university category



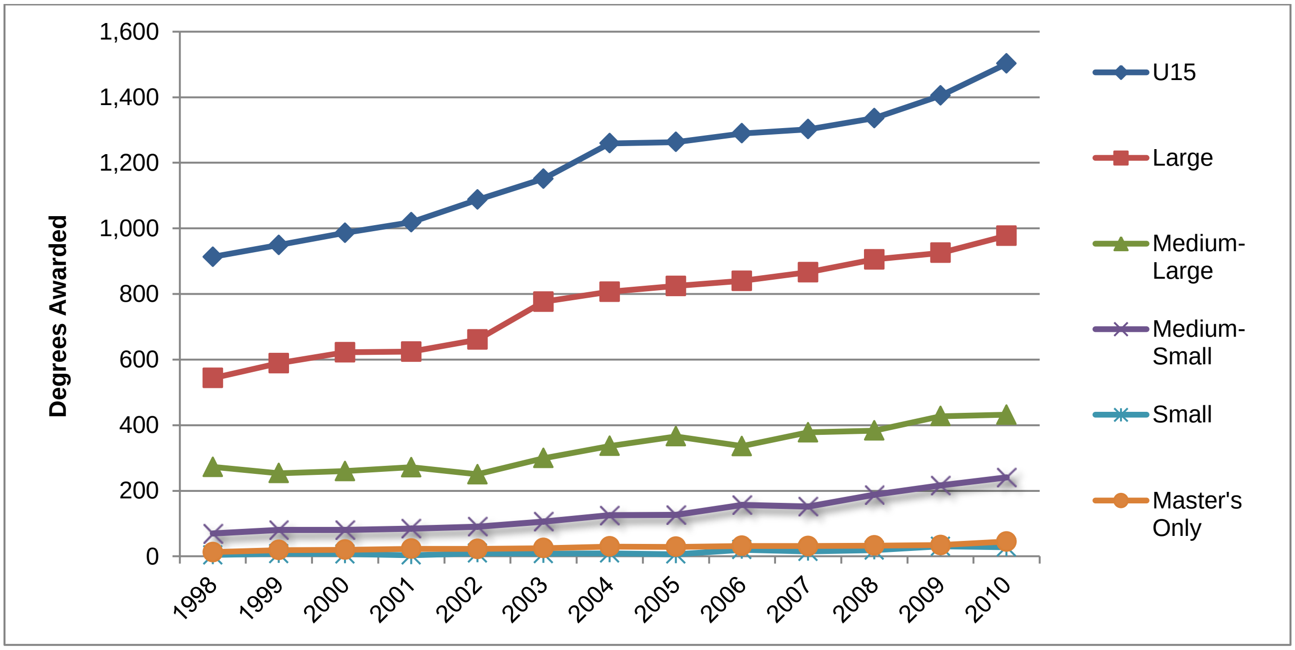
4.6.2 PhD Degrees

Given the contrast between percentage growth and numerical growth just noted, we will omit the percentage growth graph for PhD degrees awarded and focus on the numerical change over time (Figure 4.6c), which looks quite unlike both Figure 4.6b and the growth in PhD enrolment (Figure 3.7d). Whereas PhD enrolment growth was flat for all categories for the first four years in Figure 3.7d, Figure 4.6c shows a noticeable decrease in PhDs awarded by the U15 over the first four years, and decreases for half that time period in both the "Large" and "Medium-Large" categories. Any trend is difficult to discern for the two smallest categories, not just in the figure but also in the raw numbers, as they are in the low single digits in all but the last two years. Two categories saw an increase in PhDs awarded starting in 2003; in the "Large" category this did not start consistently until 2005. Looking only at the slopes of the top three lines since 2003, the increase in PhDs awarded per year has been respectively 14, 7, and 3. Considering the trend lines prior to 2003, it would

[25] Again, Royal Roads has been omitted. If it were included, the slope for the master's-only line would be 6.6 instead of 2.

appear that some intervention was necessary if the nation still needed PhD-level knowledge. The curious thing is that the turn-around in degrees awarded happened essentially in the same year as the federal investment began.

Figure 4.6c: Average number of PhDs awarded by university category



4.7 Changes in Degrees Awarded by Field of Study

4.7.1 STEM Disciplines Compared with all Others

The definition of what constitutes STEM disciplines for this report was described in Section 3.8.1 above. The difference between the relative position of STEM disciplines among master's degrees awarded (Figure 4.7a) and among PhD degrees (Figure 4.7b) is striking. At the master's level, STEM degrees constituted only 22% of all degrees at both the start and end of the period (14% male, 8% female in 2010, as per cent of all master's degrees granted). At the PhD level, STEM degrees constituted nearly half of the total PhD degrees granted: between 44% and 48% from 1998 through 2006, and then over 50% in the four most recent years for which there is data (35% male and 17% female in 2008 and 2010).

Figure 4.7a: Percentage of total master's degrees awarded in STEM and all other fields by gender

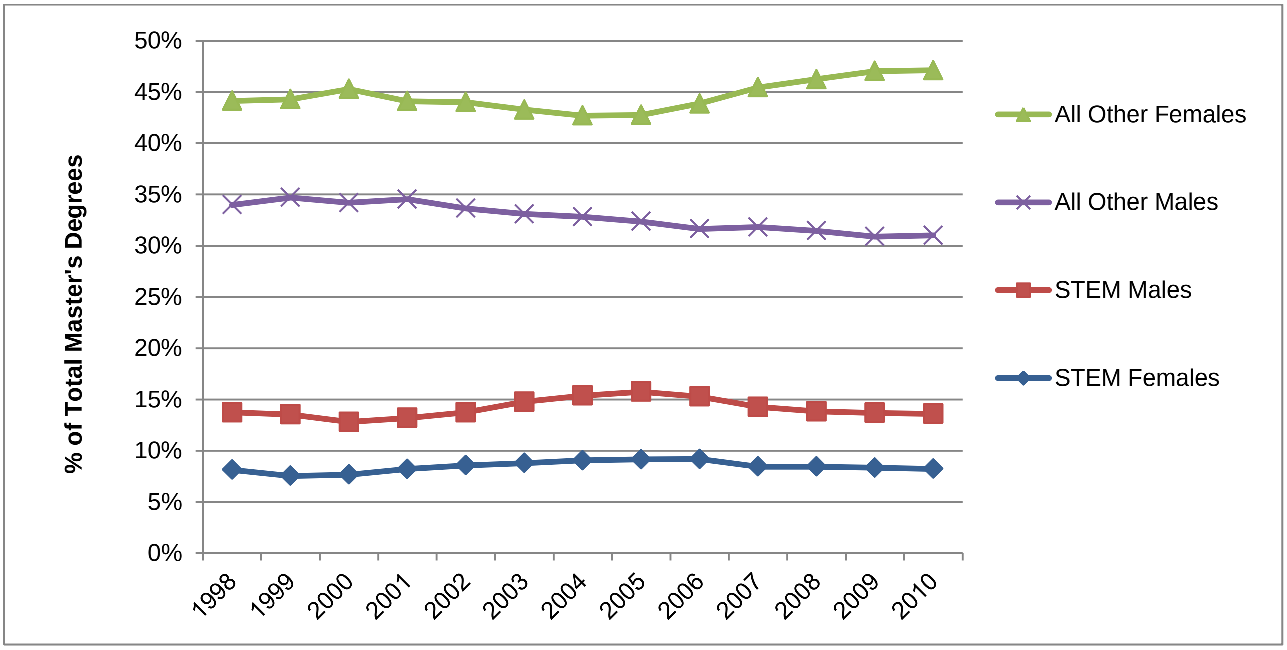
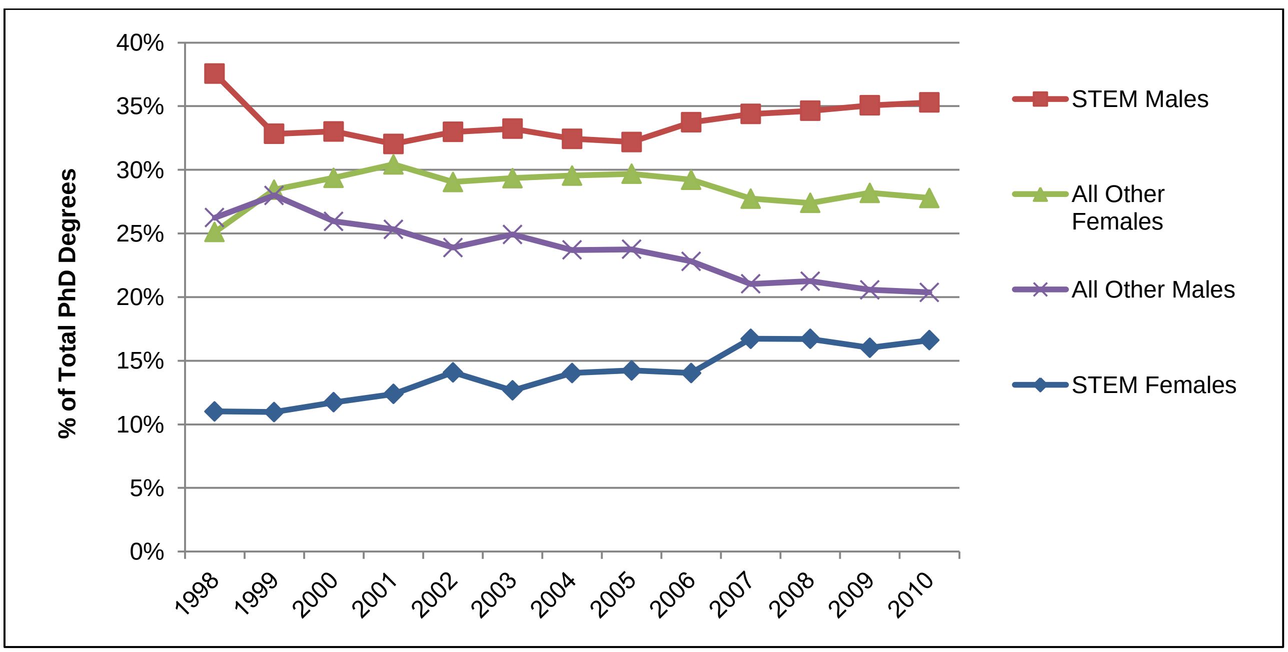


Figure 4.7b: Percentage of total PhD degrees awarded in STEM and all other fields by gender



At the master's level, the percentage of degrees received by males in non-STEM fields declined steadily from 2001 through 2006, and then held relatively steady at 31% or 32%. The percentage earned by females showed a decline from 2000 through 2005, which was the inverse of gains in STEM males and females during the same period. Since 2005, however, both male and female STEM degrees have declined as a percentage of the total, which has been offset entirely by females earning degrees in non-STEM fields.
At the PhD level, 2005 to 2007 saw increases in both female and male STEM degrees as a share of the total, and a concomitant decrease in non-STEM share for both females and males. This STEM increase seems a year or two early to have been influenced by the new CGS awards, which were first offered in 2003 and 2004, especially given the average time to degree of five years discussed earlier. The increase is consistent with increases in the US, where STEM PhDs are an even higher percentage of the whole and increased from 66% a decade ago to 74% of PhDs in 2011 (National Science Foundation, 2012, p. 4).

4.7.2 International and STEM

In looking at STEM enrolments in Section 3.8, we found that international male students comprised an increasing share of the total STEM enrolments, and that Canadian (female and male) enrolments decreased in 2005. It makes sense, then, to investigate Canadian and international student differences in degrees awarded. In all of the next four graphs, there is a significant visual effect in the first three years due to the number of degree recipients for whom national status is not known.

At the master's level, the first thing to note is that for both female and male Canadians, there is a drop in the number of degrees awarded in 2007, two years after the drop in enrolment just mentioned (Figure 4.7c). Degrees awarded to international students keep increasing. As a consequence, one would expect that starting in 2007 the Canadian share would decrease, but in fact the share begins to decrease two years earlier, in 2005 (Figure 4.7d), which is the year when degrees awarded to Canadians level off but international degrees keep on rising. The slight increase in Canadian shares in 2008 seems due primarily to a reduction that year in the share of unknowns.

Figure 4.7c: Master's degrees awarded in STEM fields by gender and Canadian or international status

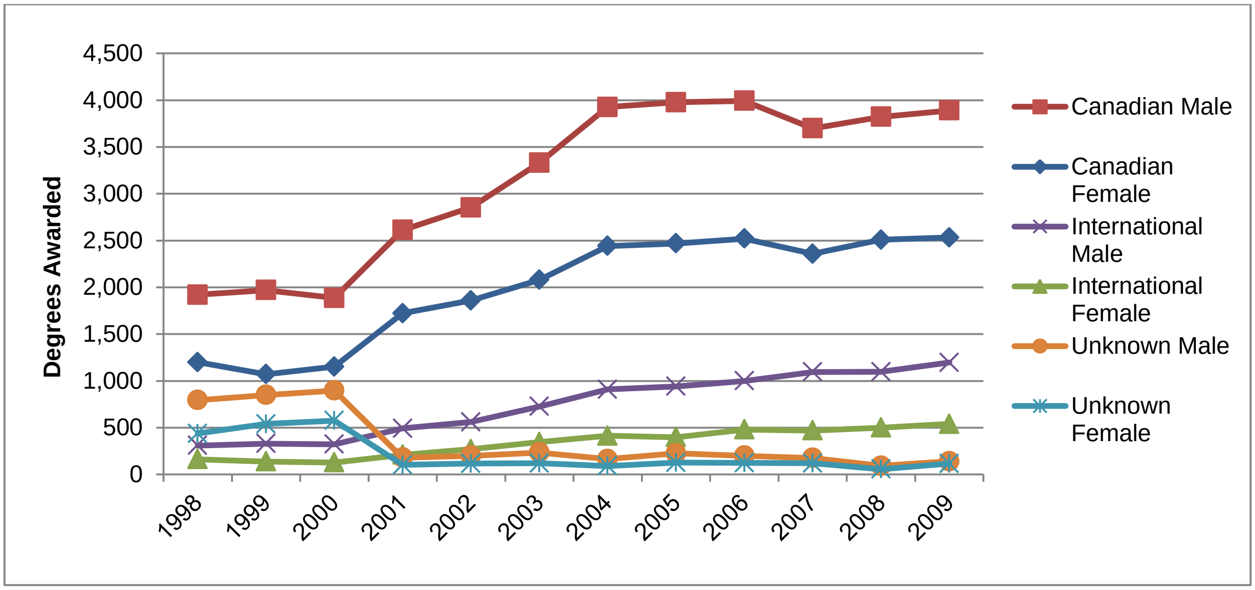
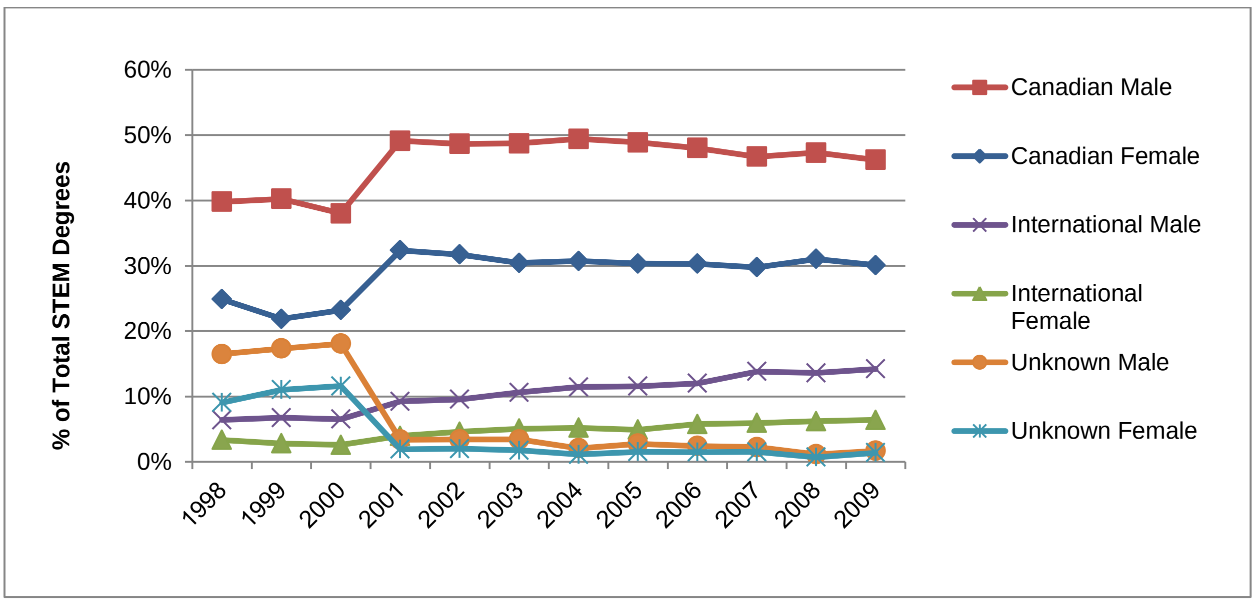


Figure 4.7d: Percentage of master's degrees awarded in STEM fields by gender and Canadian or international status



At the PhD level, degrees awarded to Canadians showed steady increases with the exception of one year, 2003 for females and 2005 for males (Figure 4.7e). The numbers for international males increased steadily through the decade, but their proportion hit a high point in 2005 and has since declined slightly (Figure 4.7f).

International female numbers of degrees earned have been variable, with declines in 2002, 2005, 2006, and 2008. As a result, their share has also been variable. The main point is that Canadian males have in general held steady their share of STEM PhD degrees, and Canadian females have increased their share. STEM degree earners are not simply an enclave of international students.

Figure 4.7e: PhD degrees awarded in STEM fields by gender and Canadian or international status

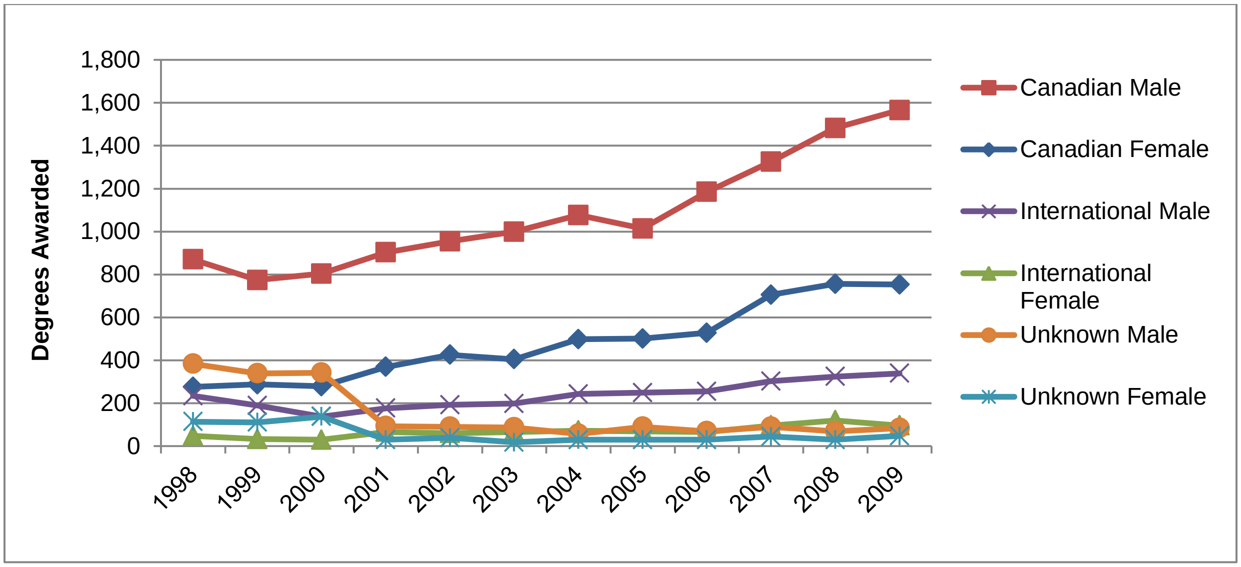
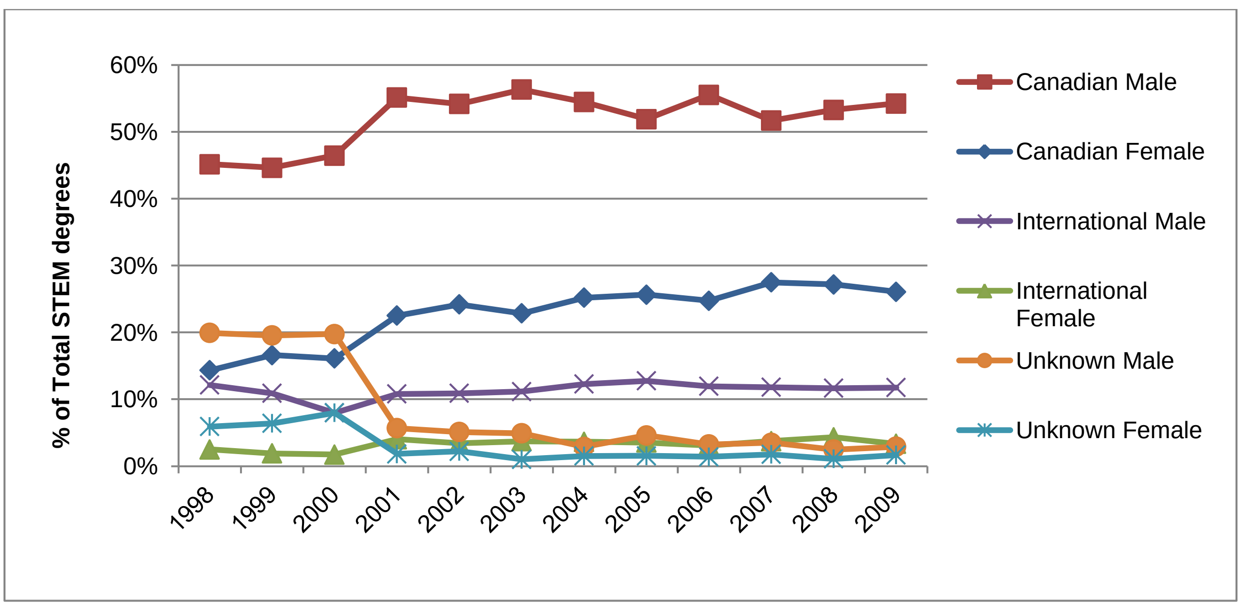


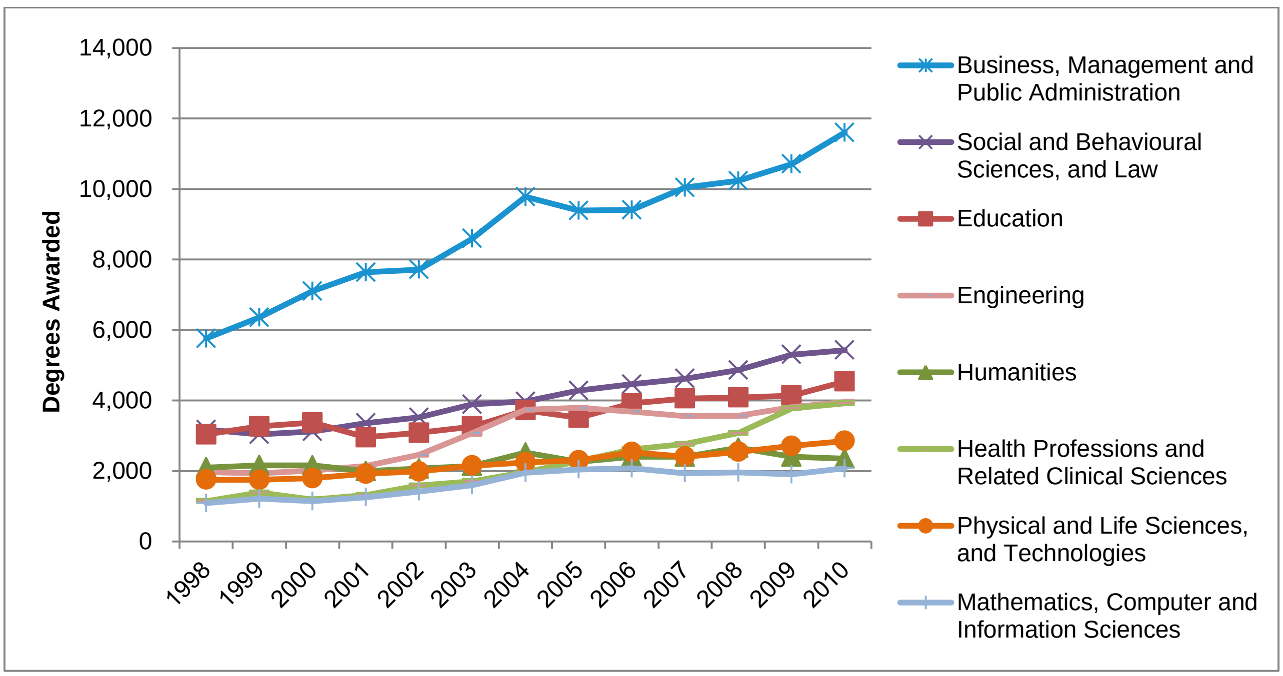
Figure 4.7f: Percentage of PhD degrees awarded in STEM fields by gender and Canadian or international status



4.7.3 Field of Study Detail

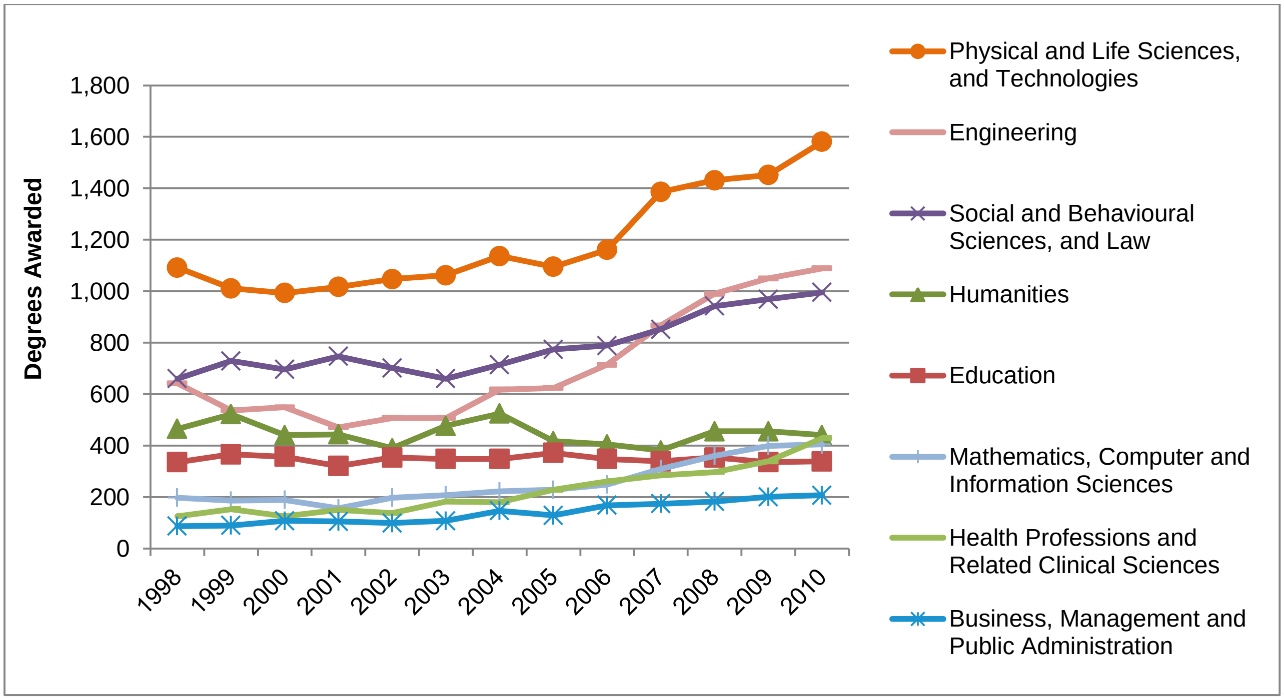
As in Section 3.8.3, the eight fields of study with the largest enrolments have been graphed here in terms of degrees awarded. Master's degrees appear in Figure 4.7g. Not surprisingly, Business master's degrees top the chart. Somewhat surprisingly though, the number of such degrees awarded peaks in 2004 and then drops, not reaching the level of the peak again until 2007. The curious thing about this decline is that it does not follow a similar decline in Business enrolments: those had a small decline after 2004 (Figure 3.8g), but one would expect a two-year lag to any drop in degrees awarded. There is such a time lag in the Engineering degrees awarded, which decline slightly after a peak in 2005; enrolments had similarly peaked in 2003 (Figure 3.8g). A similar lagged pattern happens for Mathematics, with enrolment peaking in 2004 and degrees granted in 2006 (albeit a gentle peak). Physical and Life Sciences have a dip in degrees awarded that does not correspond to a decline in enrolment (like Business, but not as severe). Health and Clinical Sciences, and Social and Behavioural Sciences both displayed a steady climb in master's degrees awarded. That, together with the declines around 2006 for degrees in Engineering, Math, and Physical Sciences, helps to explain the reduction in STEM share at that same time that was shown in Figure 4.7a. This result, again, raises questions about the effectiveness of the CGS master's program following its inception in 2003 and growth in 2004 and 2005.

Figure 4.7g: Master's degrees awarded in selected fields of study



The picture of PhD degrees granted (Figure 4.7h) is consistent with the picture of PhD enrolments by field of study (Figure 3.8h) in that Physical and Life Sciences and Social and Behavioural Sciences top the chart, but the patterns in degrees granted are very different in both from the enrolment pattern. Enrolments climbed steadily for the decade. The number of degrees granted stagnated in both until 2004, which started the steady increase in Social Sciences, or 2006 when consistent increases started in Physical Sciences. The big jump in Physical Science degrees was in 2007, four years after the initiation of the CGS awards. Although average time to degree in this area is a bit less than five years, it is reasonable to think that the higher funding may have led to faster completion and therefore that this jump is indicative of the success of the NSERC CGS doctoral awards. It is hard to reach a similar conclusion for the SSHRC or CIHR doctoral awards, in that the curves for these fields do not share a sharp increase four or five years after the start of the CGS. Of course, CGS-supported students were a smaller share of enrolments in these fields than in Physical Sciences. The climb in Engineering degrees granted starts a little early (2004) to have been affected by the CGS awards, but the steeper increase in 2007 might well have been affected.

Figure 4.7h: PhD degrees awarded in selected fields of study



5. Were Intentions Achieved?

Chapter 2 ended by listing (in Table 2.4) the explicitly stated government intentions for their investments in graduate education. As discussed there, most of the objectives are not easily measured (e.g., improving the competitiveness of a province, or developing the most skilled and talented labour force in the world). Those that can be measured are summarized here in Table 5.1. Perhaps not surprisingly, the governments that invested the largest amounts in graduate education identified some measurable objectives. Each will be considered in the order listed in the table. In addition, a few key findings related to other consequences are summarized.

Table 5.1: Measureable Government Objectives

Federal	- through to 2010 increase the admission of master's and PhD students at Canadian universities by an average of 5 per cent per year - increase the number of students obtaining graduate and post- graduate degrees - double the number of master's and doctoral fellowships and scholarships awarded by the federal granting councils - more individuals with graduate degrees in science and engineering
British Columbia	- expanding the number of graduates who will support the following key sectors of the province's economy: Life Sciences (health and biotechnology); Technology (information and communication, new media and wireless); Clean Technology (alternative energy and sustainable technologies); and Natural Resources (forestry, agriculture, fishing, mining, oil and gas).
Ontario	- address shortages in specialized skills in the high-tech sector (ATOP) - expand graduate education by 15,000 spaces (Reaching Higher)

5.1 Federal Objectives

5.1.1 Increase Number of Admissions

The federal government identified four measurable objectives. The first in the list was stated in 2002: "through to 2010 increase the admission of Master's and PhD students at Canadian universities by an average of 5 percent per year." The data we have considered above were total enrolment data, not admissions data, but for enrolment to grow over time admissions must exceed departures, and thus must also grow over time.

- In terms of total enrolment (Canadian/PR and international students), the target was met for PhD students but not for master's.
    - PhD numbers grew by more than 5% in all but two years, and the average annual growth over the period 2002-2010 was 6.1%.
    - At the master's level, annual growth exceeded 5% in only two years; the average of annual growth rates was 3.5%.
- Looking at Canadian and permanent resident enrolment only, the results are similar.
    - PhD enrolment growth exceeded 5% for 2003 through 2007 but fell below the target in 2008 through 2010; the average of annual growth rates was 5.4%.
    - Master's enrolment growth was variable but exceeded 5% in only one year and was in fact negative in one year; the average of annual growth rates was 3.0%.

The question to ask, though, is whether the federal investments in graduate scholarships caused the increase in enrolment or whether the increase occurred for other reasons. This is an impossible question to answer with certainty, but a few facts might help make reasonable inferences. The first is that master's enrolment grew at a faster rate prior to 2003 than it did after the introduction of the CGS: 5% on average from 1998 to 2002, and 3.5% on average from 2003 to 2010. The second is that at the master's level, only a small percentage of students receive Tri-Council awards. Prior to the introduction of the CGS awards in 2003, CIHR and SSHRC essentially made no direct awards to master's students. NSERC did make awards to master's students but it did not differentiate between the awards given to master's and doctoral students (as shown in Figure 2.2a above). Once such awards began to be made, or differentiated, SSHRC awards went to between 2% and 2.5% of all (head count) master's enrolment in SSHRC disciplines. For NSERC, between 8% and

10% of STEM master's enrolment received an NSERC award. It seems unlikely that these awards were a key driver in enrolment increases.

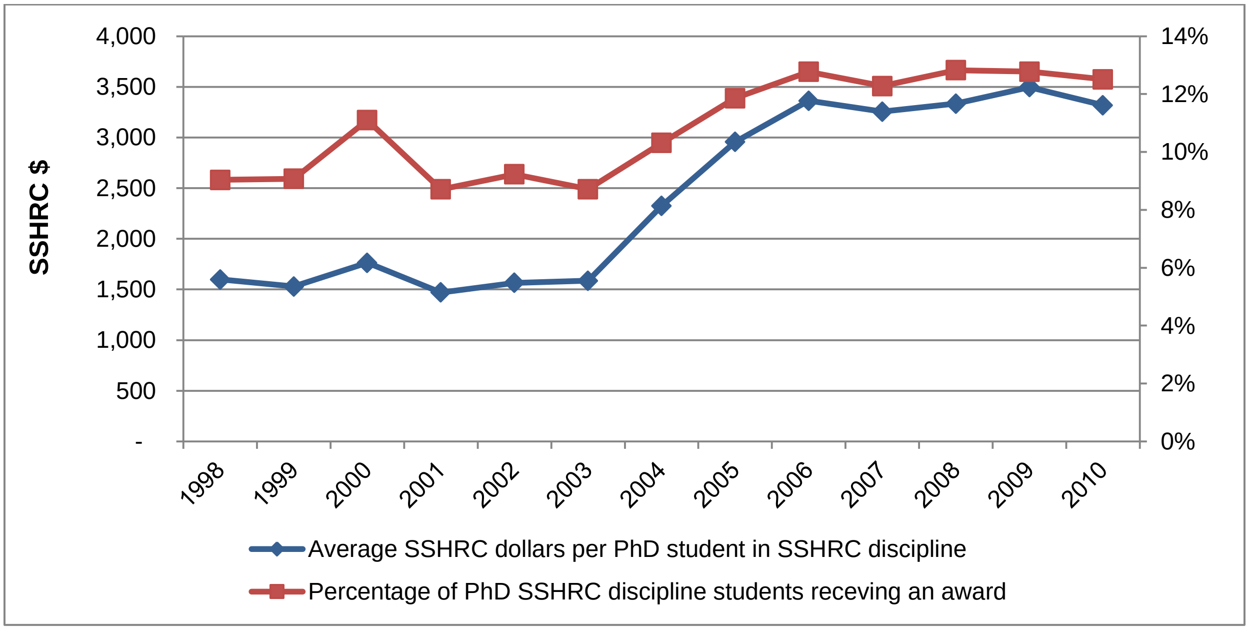
At the PhD level, the first fact works in the opposite direction: the average annual rate of increase in enrolment was higher between 2003 and 2010 (6.1%) than it was between 1998 and 2002 (2.7%). In addition, higher percentages of PhD students received Tri-Council awards than at the master's level: at NSERC these percentages were 50% higher 2006 to 2009 (approximately 14% of STEM PhD enrolment); at SSHRC it was around 12% of PhD students in SSHRC disciplines in the same time period, five times higher than at the master's level. Perhaps these are high enough percentages to have a driving effect on enrolment at the PhD level.

But do these represent increases in the percentages of students receiving awards? Was this just a continuation of the council's previous practice at the PhD level or an improvement? Unfortunately, it is only for SSHRC that we can look at this question, because NSERC awards were not sufficiently distinguished as to level prior to 2005, and CIHR prior to 2003.[26] The average dollars available per SSHRC-discipline PhD student increased from about $1,500 prior to 2003 to around $3,300 after 2006 (Figure 5.1).[27] Thus the increase in funding more than kept pace with the increase in enrolment – and may to some extent have led it. Similarly, the percentage of SSHRC-discipline PhD students receiving a SSHRC award climbed from about 9% to over 12%. However, the consequence of more than doubling the dollars per student but increasing the percentage of students with an award by only one-third means that the average dollars per award holder went up from $16,900 in the five years ending in 2002 to $26,500 in the five years ending in 2010, an increase of nearly 60%. Again taking the averages over those two five-year periods, the total amount of dollars available increased by almost 200%, the number of award recipients increased by 90%, and the average value of the award increased by 60%. Greater numbers of recipients and a higher proportion of the enrolment received more money than before the introduction of the CGS awards. Certainly something led to a turnaround in PhD enrolment after 2001. These kinds of consequences may well have contributed.

[26] While it is possible to calculate the increase in the average dollar value of awards or in the number of awards, or the percentage of students holding them for NSERC and CIHR, the fact that we cannot distinguish between master's and PhD for the early years makes the calculation fruitless.

[27] For purposes of Figure 5.1, the SSHRC disciplines have been defined to include all of the PSIS fields of study except those defined as STEM earlier (Section 3.8.1) and the health-related categories labeled Health Professions and Related Clinical Sciences, and Dental, Medical and Veterinary Residency Programs.

Figure 5.1: SSHRC PhD scholarships: Average dollars per SSHRC-discipline enrolment, and percentage of SSHRC-discipline PhD enrolment receiving an award



5.1.2 Increase Number of Degrees Awarded

The second federal objective was to increase the number of students obtaining graduate and post-graduate degrees. Clearly this was achieved. Although the distinction between graduate and post-graduate degrees is not obvious, the numbers of master's and PhD degrees awarded both increased. Master's degrees increased every year from 2002 to 2010 at an average annual rate of 5.7%. The number of PhDs awarded increased in all but one year at an annual average rate of 6.0%.

Again, it is reasonable to ask whether this was a consequence of the federal awards or of other factors. Given the low percentage of master's students holding federal awards, it seems unlikely that the awards caused the increase in master's degrees. The more likely proximate cause was the increase in completion rates shown in the U15 data in Figure 4.1c. What caused that increase is the more difficult question to answer, but it seems unlikely to be due to 3% or 4% of students holding Tri-Council scholarships. At the PhD level, there was a similar increase in completion rates, although it was not quite so dramatic. Given an average time to completion for the PhD of just over five years (Figure 4.1b), only three cohorts of entering students for whom CGSs were available (2003-2005) would have had adequate time to complete their degrees. The Tri-Council awards cannot explain all of the increase in degrees awarded.

5.1.3 Double the Number of Scholarships

The third federal objective was to double the number of master's and doctoral fellowships and scholarships awarded by the federal granting councils. Not all three councils achieved this. At NSERC, it is not possible to differentiate between master's and doctoral awards prior to 2003, but the total number of awards to the two levels increased from 3,500 in 2002 to only 5,400 in 2009 (the high point). At SSHRC there was only one master's award given in 2002, so doubling was easy; in 2009 there were 1,500 master's awards. At the doctoral level, the change was from 1,467 in 2002 to 2,947 in 2010, just barely a doubling. CIHR was similar to SSHRC, with no master's awards prior to the introduction of the CGS, and 570 in 2009 (also the high point). Direct doctoral awards increased from 917 in 2002 to 1,350 in 2010. Thus doubling occurred in doctoral awards in only one council. To speak of doubling from a master's base of zero or one is not meaningful.

5.1.4 More STEM Degrees

The final easily measured federal objective was to produce more individuals with graduate degrees in science and engineering, stated in 2007. Taken literally, this has occurred. STEM master's degrees awarded went from 5,900 in 2002 to 8,900 in 2010, and PhDs from 1,750 to 3,060. The STEM master's degrees awarded stayed fairly steady near 22% of all master's degrees; at the PhD level, STEM degrees grew to be 52% of the total in 2010 up from 47% in 2002. Clearly the federal investment was more successful at the PhD level than at the master's level.

5.2 British Columbia Objectives

A measurable objective mentioned in British Columbia's material was to expand the number of graduates in four key sectors. Although we analyzed degrees awarded by province and by field of study, we did not do a cross-analysis of both at once. While it would be possible to do that to assess this objective, unfortunately, the level of detail specified in British Columbia's statement is more detailed than the PSIS data we requested (i.e., biotechnology, new media and wireless, alternative energy and sustainable technologies, forestry, agriculture, fishing, mining, oil and gas). As a result, we do not have specific information to assess this objective.

5.3 Ontario Objectives

Ontario had two separate objectives for two distinct investment programs. The first was during the Access to Opportunities Program (ATOP), which ran from 1998 to 2005 and sought to address shortages in specialized skills in the high-tech sector. This was defined narrowly to include computer science and engineering, which as noted for British Columbia is a more detailed level of analysis than the PSIS data we obtained, so we are unable to assess this.

However, the second objective is measurable: to expand graduate education by 15,000 spaces through the Reaching Higher investment. This objective was addressed in Section 3.6, where we noted that in terms of head count enrolment, Ontario graduate student growth exceeded the target by 2009, rising from 40,400 in 2002 to 55,950 in 2009. We have not attempted to calculate FTEs, which are probably the basis for Ontario's view that they have not yet reached the target and will need one additional year. Sixty per cent of this growth occurred at the master's level (from 28,764 to 37,950 by 2009 compared with PhD growth from 11,625 to 17,997).

5.4 Other Considerations

Several other consequences of interest were identified during the detailed analyses. The main ones are listed here in the order of their occurrence in the paper.

- Since 2003, the rate of growth in PhD enrolment has always exceeded the rate of growth in master's enrolment.

- Part-time graduate enrolment has declined: from 37% of master's students in 1998 to 29% in 2010; from 10.5% to 5.0% for PhD. At the master's level, the decline is all in male numbers; female numbers have continued to increase.
- Women are increasing their share of graduate school enrolment. At the master's level, the female percentage of head count enrolment rose from 52.5% in 1998 to 55.3% in 2010, with the increase occurring after 2003. At the PhD level, female enrolments have risen from 44.4% to 46.9%, with all of the increase occurring after 2004. (There had been a small decrease in percentage from 2001 to 2004).
- International student numbers increased at a faster rate than Canadian numbers, such that international students made up 15% of total enrolment by 2010, up from 8.9% in 1998.
- Canadian males have not participated in the graduate expansion to the same extent as have Canadian females. When international students are omitted from the male/female percentage calculations, the female master's percentages become 53.8% in 1998 (up from 52.6% including international) and 57.8% in 2010 (instead of 55.6%). At the PhD level, the corresponding percentages become 46.6% (44.4%) and 49.9% (46.8%).
- There has been a clear and consistent advantage for women in SSHRC and NSERC scholarship competitions. At SSHRC this occurs both at the university level and at the national adjudications. It was not possible to differentiate the two for NSERC. There has not been a comparable advantage in CIHR scholarship competitions.
- Surprisingly, provincial rates of growth in master's enrolment were higher after 2003 in only Saskatchewan, Manitoba, and Newfoundland; in all other provinces, annual averaged growth rates were higher prior to 2003. For the PhD however, growth rates were higher after 2003 in all provinces.
- The share of national graduate enrolment registered in each province has been relatively steady throughout the decade, except that since 2006 Ontario's share has grown and Quebec's had decreased.
- In those provinces that explicitly funded graduate growth, provincial growth occurred in line with the funding for the most part.
- Although percentage growth rates were highest in the universities with lowest initial enrolment (on average), nevertheless the bulk of the graduate expansion took place in the U15 and other largest universities.
- STEM disciplines did not dominate the growth at the master's level, where they have constituted nearly 25% of the total for the past five years, although they were 27% in 2003. STEM disciplines do dominate at the PhD level, where they are now nearly 44% of enrolment (and 52% of 2010 PhDs awarded).
- Enrolment by fields of study is quite different between master's and PhD, with Business dominating the former and Physical and Life Sciences the latter.
- U15 data show that PhD completion rates have been improving over the decade in all four broad disciplinary divisions, with the overall average going from 62% to 71% completing within nine years. Times to completion have gone up marginally, but are still between five and 5-1/3 years on average over all disciplines.
- Master's degrees awarded rose throughout the decade, but in the early 2000s the number of PhDs awarded declined for several years just before the initiation of the CGS awards.
- As with enrolments, so with degrees: the proportion of master's degrees being earned by Canadian women is increasing while the share earned by Canadian men is decreasing. Females earned 58.1% of master's degrees awarded to Canadians in 2009. At the PhD level, they earned 45.9% of degrees awarded to Canadians.

Overall, only a few of these outcomes are surprising. Provinces that invested in graduate expansion were for the most part successful in accomplishing it, and in some cases expanded their share of overall graduate enrolment. The CGS awards seem to have been successful at the PhD level in accomplishing goals, but not at the master's level. Canadian males have not participated in the graduate expansion to the same extent as other groups; both Canadian female and international student percentages of graduate enrolment increased relative to Canadian men.

But all of these consequences pertain simply to the issues that can be addressed by looking into numbers for enrolment and degrees granted. Despite our efforts at data collection, with the cooperation of various agencies and governments, and our detailed analysis, we can identify with certainty only a very limited set of outcomes that these significant investments achieved. In some cases it was difficult to identify what exactly they were intended to achieve. These important considerations could not be addressed: employment outcomes, completion rates and times, changes in the nature of graduate education such as the introduction of transferable skills (and the consequence of such changes for employment outcomes). It is important for the future to develop better data on such matters, in order to have a better understanding of the contribution of graduate education to the country – and of the effect that increased investment has on graduate education and graduate degree recipients. We would recommend that policy statements be clear and that government investment be linked with a commitment to collect the data necessary to measure results.

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