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Finish It and It's Free: An Evaluation of College Graduation Subsidies

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Abstract

Despite the rapid increase in the returns to higher education witnessed in the labor market over the past few decades, there has also been a marked increase in the share of individuals who drop out of college or university. Several Canadian provincial governments introduced graduate retention tax credits available to students after their graduation. Credit availability was tied to students successfully completing their education with the aim of increasing the local stock of human capital by discouraging cross-province migration. We analyze the efficacy of the graduate retention tax credits within a difference-in-difference framework using confidential data from both administrative tax records and longitudinal surveys. Graduate retention credits were unable to decrease internal migration but were able to reduce the interest graduates paid on their loans.

Keywords: higher education, education financing, college dropout

JEL Codes: I22, I23, I28

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1 Introduction

Large increases in college and university[1] enrollment over the past several decades has led to increasing drop-out rates (Turner, 2004) and stagnating completion rates (Oreopoulos and Petronijevic, 2013). According to 2012 data from the National Center for Education Statistics, 58% of American students enrolled in a four-year college program graduated in six years, while in Canada, 84% of students enrolled in university graduated in seven years (Magazine, 2014).With drop-out rates being as high as they are, researchers and policymakers are asking what can done to increase college persistence.[2]

Starting in 2005, the Canadian province of New Brunswick began offering tax credits in an effort to encourage recent university graduates to remain in, and thus contribute to, the local economy. Nova Scotia released similar province-specific incentives in 2006, while Manitoba and Saskatchewan implemented their own graduate retention programs (GRPs) in 2007. These GRPs offered tax credits between $\$15,000$ and $\$25,000$ (nominal Canadian dollars) to students who are enrolled in post-secondary education.

This paper examines the tax policies of Canadian graduate retention programs (GRPs) that are aimed at increasing the number of college graduates and retaining them in the provinces where they studied. We measure the impacts of these programs on university enrollment, university drop out, and interprovincial migration decisions using a difference-in-differences empirical design and restricted administrative and survey data. Our analysis using the Longitudinal Administrative Databank (LAD) suggests retention programs did not change enrollment or drop-out decisions for individuals age 18 to 23 in affected provinces. However, these individuals did show decreases in the amount of student loans by about 123.1 (real) dollars annually (relative to a pre-treatment mean of 620 real dollars). These results are robust when we compare the subsample of individuals who were already enrolled in post-secondary education with the sample of those who were yet to enter when the graduate retention program was announced. We further present event studies figures to understand potential dynamics of those affected by graduate retention programs and to give visual evidence of parallel trends prior to their rollout. While no point estimates following the GRPs are statistically significant at the 95% level, university graduates are trending upwards and university dropouts are trending downwards following the GRPs.

Individuals aged 23 to 28 in Atlantic Canada who were affected by the retention programs were 5.3 percentage points (relative to a pre-treatment mean of 57.7%)

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[1]In the United States, both colleges and universities offer programs leading to bachelor's degrees, while typically only universities offer programs leading to master's and doctoral degrees. In Canada, universities offer bachelor's, master's, doctoral, and post-doctoral programs, while colleges offer programs that provide technical training and diplomas or certificates.

[2]See, for example, Bailey and Dynarski (2011), Attewell et al. (2011), Turner (2004) and Denning et al. (2019).

more likely to have graduated university following the program when compared with those who were unaffected. Affected males were 6.9 percentage points more likely to graduate (relative to a pre-treatment mean of 57.0%), while affected females were 4.1 percentage points more likely to graduate (relative to a pre-treatment mean of 58.2%). While we find null effects for changes in migration across the samples of all individuals and of only males, we find females in Atlantic Canada were 4.5 percentage points less likely to move provinces (relative to a pre-treatment mean of 31.1%).

We use the Survey of Labour Income and Dynamics (SLID) to further investigate educational attainment and migration decisions. We find that individuals aged 18 to 23 and affected by the graduate retention program were 4.5 percentage points less likely to drop out of university (relative to a pre-treatment mean of 9.5%), while the subsample of males was 8.3 percentage points less likely to drop out of university (relative to a pre-treatment mean of 11.3%). We found no statistically significant effects among individuals attending college or any post-secondary education program in GRP provinces and among females attending university. All individuals who were affected by GRP programs and who turned 18 after the program rollout were also less likely to drop out of university by 5.8 percentage points (relative to a pre-treatment mean of 9.5%). These results suggest that GRP programs decrease the willingness of individuals to drop out of university. While males in the SLID in Atlantic Canada and aged 23 to 28 who were affected by the programs were 17.7 percentage points more likely to move provinces (relative to a pre-treatment mean of 76.4%), we generally find no effects on educational attainment or migration decisions for females and for both sexes.

The results from both datasets suggest that graduate retention credits were not able to robustly decrease cross-province migration. Using the LAD, we found females may have been less likely to move; however, we could not confirm this using the SLID. Moreover, the use of either the combined sample of males and females or the sample of only males from both datasets suggests null effects or increasing likelihood of migration.

Our analysis emphasizes that, in settings with few treated clusters, traditional methods for cluster-robust inference can over-reject the null hypothesis (MacKinnon and Webb, 2017). Following the recommendation in MacKinnon and Webb (2020), we perform a Monte Carlo given the specific distribution of cluster sizes and treatment for our datasets. On the basis of this, we construct context-specific confidence intervals using both the six-point bootstrap (Webb, 2022) and the effective number of clusters Carter et al. (2017).

The Canadian graduate retention programs are similar to several American state governments that have a merit scholarship program.[3] Both the merit scholarships and the retention credits attempt to raise the average level of educational attainment within a jurisdiction. While both programs tie educational funding to a geographic

[3]Fifteen states now offer some form of merit scholarship, and the effectiveness of these various programs has been studied by Fitzpatrick and Jones (2013).

location, there are three notable differences between merit programs and retention programs. First, merit programs do not restrict where recipients can reside following graduation. Second, merit scholarships offer incentives to *enroll* in college in a specified location, while retention credits offer incentives to *graduate* from college and *reside* in a specified location after graduation. Third, merit scholarships offer financial assistance while the student is enrolled in college, whereas retention credits offer assistance after graduation.[4] While the merit scholarships have received considerable attention, there has been relatively little analysis on graduate retention credits.[5] This paper provides the first analysis of causal outcomes of these programs. The New Brunswick program is evaluated in Bhuyian et al. (2020) in terms of its stated goals. The local stock of human capital is increasingly considered important for developing regional economies. In particular, several researchers have studied the effectiveness of various policies at increasing the local stock.[6] Yet, improving the local stock of higher education graduates is difficult because of the higher likelihood of graduates to migrate within a country (Malamud and Wozniak, 2012; Kennan, 2018). Other research suggests merit scholarships do not increase the retention of college-bound students after graduation (Sjoquist and Winters, 2013). Retention programs were introduced in Canada to discourage internal migration because many graduates move between provinces after they graduate.[7] However, we find migration patterns unchanged as a result of the programs, possibly explaining why three of the four provinces have temporarily or permanently suspended their graduate retention programs.

The remainder of this paper is as follows. Section 2 places the programs in the context of the literature. Section 3 provides an overview of the various graduate retention programs we study. Section 4 describes Canada's Longitudinal Administrative Databank (LAD) and Survey of Labour Income and Dynamics (SLID). Section 5 describes the linear difference-in-differences (DiD) estimation strategy and the relevant treatment and comparison groups. Results are discussed in Section 6, and Section 7 concludes.

2 Context of the Retention Programs

Starting in 2005, several Canadian provinces offered "graduate retention credits" in an effort to discourage recent graduates from moving out of province. The design of these programs offered large tax credits that were conditional on graduation. In

[4] The characteristics of merit scholarships are similar to those of Fulbright scholarships, with the latter being international and for graduate students. Fulbright scholarship recipients must return to their home country for two years, so they also have a place-based component. Similarly, New York State offers the Excelsior Scholarship, which requires students reside in New York State for the same length of time the scholarship was awarded, or pay back the scholarship as a loan.

[5] Essaji and Neill (2010) detail the costs and program features of these credits but not the consequences of these programs.

[6] See for instance, Groen (2011) and Winters (2015).

[7] The Saskatchewan government mentions that there "has been significant leakage of post-secondary graduates outside the province" (Saskatchewan Labour Market Commission, 2009).

general, the programs offered between CA$15,000 and CA$25,000 in tax credits to recent university graduates. The credits refunded between 50% and 97% of the average four-year total tuition in these provinces.

Yet, increasing drop-out rates for students is surprising considering the increased returns to education prior to the 2000s. Deming and Dynarski (2009) find that, between 1972 and 2005, real wages held steady for college graduates, while real wages for high school graduates fell by one third. For men, the bachelor's degree wage premium was 22% in 1972 and had increased to 60% by 2003. And although the returns are heterogeneous, college is often a worthwhile investment for both average and marginal students (Oreopoulos and Petronijevic, 2013).

Students dropping out is worrisome because returns need not increase with every additional year of education. Rather, graduates are rewarded with returns to education associated with "degree effects" or "sheepskin effects" that are greater than for an individual with just as many years of education but who did not graduate (Hungerford and Solon, 1987).[8] More recent literature finds degree effects across the earnings distribution (Oreopoulos and Petronijevic, 2013) and that individuals with only some college earn only slightly more than high school graduates. For Canada, Ferrer and Riddell (2008) estimate bachelor's degree holders have sheepskin effects (in wages) in the order of 20% for women and 16% for men. Additionally, Riddell and Song (2011) find college graduates have better re-employment prospects following job termination. Finally, Jepsen et al. (2014) find both earnings premiums and higher levels of employment for community college graduates. The prevalence of sheepskin effects across a variety of countries and education levels suggests that individuals who drop out possibly do so at significant private cost.[9] For example, Webber (2016) estimates the net present value of a degree for the median student to be between US$85,000 and US$300,000 depending on the student's major.

In addition to the private costs of dropping out, there are also social costs. Schneider and Yin (2012) perform a "back-of-the envelope" calculation and suggest large losses in income tax revenue among dropouts. There is also speculation that many new jobs will require higher levels of education, suggesting diminished employment prospects for dropouts going forward.

There are many reasons why provinces would want to retain university and college graduates. The post-secondary education (PSE) spillovers literature presents evidence that higher levels of education benefit the community at large. When analyzing minimum schooling laws, Acemoglu and Angrist (2001) find evidence that an extra year of education results in small positive external returns. Moretti (2004) uses the presence of a land grant university as an instrumental variable for college

[8] The literature on sheepskin effects is vast and has found, among other things, that there is a larger effect for females and minorities (Belman and Heywood, 1991; Ferrer and Riddell, 2008) and that they exist in several countries (Denny and Harmon, 2001).

[9] However, it is possible that the drop-out decision is welfare improving because simulations in Stinebrickner and Stinebrickner (2014) show that newly enrolled students who perform poorly learn that staying in school is not worthwhile.

attendance to examine the impact of increasing the share of college graduates in a city. He shows that a percentage point increase in the presence of college graduates is associated with increased wages for others, specifically a 1.9% wage increase for high school dropouts and a 1.6% increase for high school graduates. In a similar study, Shapiro (2006) find that a 10% increase in a city's concentration of college graduates was on average followed by a 0.8% increase in employment growth. Aghion et al. (2009) find that investment in four-year college educations has a positive effect on economic growth. Denning et al. (2019) find that increased grant funding is fully recouped in the long run because of the increased income tax payments made by college graduates. Our paper contributes to this literature by exploring whether GRP programs are able to retain recent graduates in hopes of these positive externalities.

The graduate retention programs are unique because they place no restrictions on pre-college residency or on institutions where one studies, but restrict where one works after graduation. While most education funding for students has been offered with few geographical constraints, there have been a few exceptions. In the US, there are the aforementioned merit scholarships and differential tuition levels for in-state and out-of-state students. Some jurisdictions, including Canadian provinces, have experimented with targeted retention or attraction programs to attract individuals in certain occupations, such as doctors and nurses (e.g. Reamy, 1994; Mullan, 1999). Maryland and New York State have offered scholarships to residents that require an individual to work one year in the state for each year they receive a scholarship (Groen, 2011; Nguyen, 2019). The Excelsior Scholarship in New York State has not been found to increase enrollment (Nguyen, 2019). In 2012, Kansas offered incentives like student debt repayments and income tax waivers to attract individuals to rural Kansas. Unlike the graduate retention programs, in order to be eligible for the incentives, individuals must prove they have resided outside of the state for at least the previous five years.[10] Finally, in 2007, Maine introduced a program generally similar to the retention credits studied here. This program repaid up to US$5,500 per year in student loans for bachelor's degree holders from a Maine college.[11] To our knowledge, the outcomes of either the program in Maine or Kansas have yet to been analyzed.

The credits associated with graduate retention programs are substantial, especially compared with other large scale education financing reforms. Gunnes et al. (2013) investigate an experiment in Norway where students were offered a financial incentive of US$3,000 for graduating "on time." They find that the incentive reduced mean graduation delay by 0.23 semesters per year treated. Similarly, Garibaldi et al. (2012) find that, at Bocconi University, a €1,000 increase in tuition reduced the likelihood of late graduation by 5.2%, with no increase in the drop-out rate. Arendt (2013) finds that a large increase in grants decreased drop-out rates but had no

[10] For more information on the Kansas program, see http://http://www.kansascommerce.com/index.aspx?nid=320.

[11] For more information, see http://www.opportunitymaine.org/opportunity-maine-program/frequently-asked-questions/.

impact on completion rates after controlling for various student and parental characteristics. Dowd (2004) finds that an increased amount of subsidized loans in the first year of college enrollment increased persistence. Recently, Denning (2019) find that additional financial aid accelerates graduation rates for university seniors.

Past literature on financial aid suggests predicting the impact of a reform is difficult considering the importance of administrative details and program knowledge. Deming and Dynarski (2009) show that financial aid is not a homogeneous good and that paperwork matters: programs with high administrative hurdles have smaller benefits. The retention credits are relatively easy to apply for and, in some provinces, can be claimed on provincial tax returns. The salience of these programs, especially among high school students, is an open question. McGuigan et al. (2016) surveyed high school students in London, England, after recent tuition reforms and found that roughly half of the students surveyed were unaware of key features of the reforms.

2.1 A Simple Model of Education Choice

A simple, three-period model of how graduate retention credits could affect individuals' decision-making is presented in Appendix A.[12] Here, we summarize the key dimensions through which retention credits can affect individuals' education decisions.

The most direct impact is through increased consumption following the completion of higher education in a city where an individual has credits, *ceteris paribus*. Accordingly, if wages, taxes, and quality of life are all equal between two cities, residing in the city offering a credit would be preferred by the individual. Moreover, the availability of a credit will increase overall consumption in all periods for those who go to school. Introducing retention credits would plausibly increase educational attainment. This follows from the fact that when a location offers a credit, the credit increases overall three-period consumption for graduates. This increase in lifetime consumption makes obtaining further education relatively more attractive.

Additionally, graduate retention credits may decrease the amount of interest paid on student loans following graduation because it coincides with the time graduates would pay back their loans. Thus, those with student loans may be able to accelerate their debt repayment if they receive a credit. And if there is heterogeneity in the amount of student loans outstanding, those with larger amounts of debt may be more likely to pursue post-secondary education in a location offering a credit.

Finally, the cost of dropping out of school increases if people pursue post-secondary education expecting to receive credits upon graduation. In the absence of a credit, the primary potential costs of dropping out is the forgone higher wages that one might earn after graduating. The presence of a credit increases the cost of dropping out by disqualifying an individual from receiving the credit. One can alternatively think about the credits as a fee/rebate program, wherein payment is made up front and a rebate is offered on graduation. If one expected to receive in the third period

[12] A more rigorous model on a similar and related problem can be found in (Kennan, 2018), which jointly models education, migration, and employment decisions across time and space.

a refund proportional to their first period tuition, then the decision to drop out in period two would retroactively increase the "expected" cost of going to school in period one.

Any influence that a program may have will depend on the age an individual was when the program was announced. We write the model as though the program is in place for all periods. Yet, this is the case only for individuals who reach the end of high school in or after the year a program is announced. There are individuals, however, for which the programs were announced when they had already made the decision to enroll in post-secondary education. For these individuals, the programs may be more likely to affect their migration and graduation decisions because their enrollment decision has already been made.

3 Background of the Graduate Retention Programs

Four Canadian provinces—Saskatchewan, Manitoba, New Brunswick, and Nova Scotia—all implemented graduate retention programs in the mid-2000s.[13] Table 1 overviews the various program attributes and how they differ across provinces.[14] Broadly speaking, the programs are quite similar, with respect to the order of magnitude that each program offers post-secondary graduates. All of the programs are income tax credits, though the characteristics of the credits differ across provinces. Only one of the credits is refundable, though most of the credits do roll over. Specifically, Saskatchewan offered a refundable credit until 2012, which meant that, if individuals earned insufficient income to claim the maximum annual amount, they would receive the difference in the form of a refund.[15] All but Nova Scotia offers a rollover provision, which allows the unused portion of the credit to accrue over time. Individuals would eventually be able to claim the maximum allowable credit.

Saskatchewan and Manitoba do not require a separate application for the graduate retention credits, which can be claimed on income tax returns. Nova Scotia and New Brunswick require separate applications to claim the credits. Three of the four programs determine the maximum credit on the basis of the amount of tuition paid, while Nova Scotia offers a fixed amount to each recent graduate. The proportion of tuition refunded in each province varies, with up to 100% of tuition being refundable in Saskatchewan and 50% being refundable in New Brunswick. The maximum amount of the credits is the same in Saskatchewan and New Brunswick, but in New Brunswick, students would have had to pay CA$40,000 in tuition to receive the maximum credit, compared with only $20,000 in Saskatchewan, because

[13]See Essaji and Neill (2010) for a summary of the various GRP programs.

[14]Quebec also operates a smaller wage subsidy program for people in remote, resource-rich regions who work in the resource industry, with eligibility contingent on holding a degree related to your current occupation. Given the specificity of this program it is ignored in the analysis. For more details about the Quebec program, see http://www.revenuquebec.ca/en/citoyen/credits/credits/credits_reduisant/nouv_diplome/. Additionally, we omit Quebec data from much of our analysis because they cannot be compared across both of our datasets.

[15]In 2012, Saskatchewan allowed the credit to roll over, but ended the refundability provision.

of differing tuition refund percentages. Finally, the total costs of each program are broadly similar in each of the provinces, ranging from CA$24 million to CA$35 million per year as of 2013 (the last year all provinces had the GRP). The governments of Nova Scotia, New Brunswick, and Manitoba have since cancelled their graduate retention programs in 2014, 2015, and 2017, respectively. In early 2014, the government of Nova Scotia eliminated its Graduate Retention Rebate, citing a failure of the programs to retain graduates as the reason for cancelling the programs.[16]

This is perhaps not surprising because results in Section 6 suggest that the various programs did not alter internal migration decisions. While New Brunswick's government reinstated tuition tax credits, they initially removed the program due to its inability to draw individuals to post-secondary education. In 2017, the Manitoba government announced it would phase out its Tuition Fee Income Tax Receipt by 2018.[17] In 2022, only New Brunswick and Saskatchewan offer a GRP in Canada, with Saskatchewan being the only province to continually offer a GRP since its inception.

The graduate retention programs are operationally quite different from the other means of government funding for post-secondary education.[18] The most distinct feature is that they base eligibility on graduation. Another unique feature is that their benefits are provided solely after graduation. Ontario's rebates refund tuition in the year that it was paid. Similarly, the federal and provincial tuition tax credits and education amounts are claimed during the years an individual is enrolled in school.[19] Both of these are non-refundable, so they typically do not ease a student's budget constraint until after graduation, as explained in Neill (2013). Non-refundable tax credits allow an individual to benefit from the credit only to the extent of the taxes owed in that year. When the value of the credits exceeds the taxes owed, the excess credit is either carried forward (a "rollover provision") or it is lost. Students' budget constraints are a current concern in education policy because increased financial aid has been shown to improve college enrollment (Sartarelli, 2011) and achievement (Denning et al., 2019). Retention credits do nothing to ease this constraint while the student is enrolled but rather expand a student's post-graduation budget. Offsetting the less-than-ideal timing of the benefits is the fact that most student loan programs require repayment following graduation and the payouts from the programs coincide

[16] See http://www.novascotia.ca/finance/en/home/taxation/tax101/personalincometax/grr.aspx for more details.

[17] See https://www.cbc.ca/news/canada/manitoba/tuition-tax-credit-eliminated-manitoba-budget-2017-1.4066416.

[18] A recent summary of American tax benefits for college attendance can be found in Dynarski and Scott-Clayton (2016). In a randomized control trial, Bergman et al. (2019) find that emailing students about potential tax breaks does not affect enrollment decisions. Denning et al. (2019) show that when individuals are more likely to receive the maximum of the Federal Pell Grants it increases their community college enrollment and post-secondary educational attainment, amongst other outcomes.

[19] Similar programs in the United States were recently analyzed in Hoxby and Bulman (2016) and not found to increase college enrollment.

with the repayment schedule for student loans.[20]

The rebate schedules of these programs introduces an added complexity to calculating the costs of attending university. For example, a student in Saskatchewan paying average university tuition for four years starting in the fall of 2007 would pay[21] annual (nominal) tuition values $5,015, $5,064, $5,173, and $5,431. Of the total $20,683 paid in tuition, they would be eligible for a $20,000 rebate (or 96.69%), paid out in seven annual installments: $2,000, $2,000, $2,000, $2,000, $4,000, $4,000, $4,000. Moreover, in most cases, individuals need to have a sizeable income to receive the full amount of the credit in the least amount of time. Still, the rollover provisions offered by many provinces mean that the entire value of the credit will eventually be received, but over a longer time horizon. In this way, GRP programs have aspects similar to the UK tuition reforms, where the net present liability of tuition depends on labor market outcomes after leaving school.[22]

Another distinct feature of these programs is that they are place-dependent. This is an unusual characteristic of education funding, but it does align the subsidy with provinces' goals of having a well-educated labor force, rather than a large number of college and university students. While the programs are designed to retain an individual in a province, they are not targeted towards those on the margin of emigrating. As a result, the programs offer generous tuition rebates to all those who were never contemplating leaving the province. However, these rebates are conditional on graduation and thus may influence college graduation and drop-out decisions.

Aside from the retention credits, Canadian provincial and federal governments invest heavily in both post-secondary institutions and their students. Essaji and Neill (2010) summarize the costs and characteristics of the various student funding programs previously in operation in Canada and thoroughly summarize the graduate retention programs. The bulk of public investments into education during this time period are at the federal level, through education tax credits. Concrete examples of small-scale changes include the introduction in 2004 of a $500 (nominal) grant for opening up a registered education savings plan (RESP) and new tax credits for textbooks introduced in 2006. More generous benefits like these may promote increased uptake in education across Canada. Our difference-in-differences strategy takes into account shocks, like these policies, common to all provinces via our birth-year fixed effects and time trends. Moreover, the lack of variation across provinces means that each province should respond similarly to any changes nationally.

Additionally, Essaji and Neill (2010) note several provinces adjusted their approach to funding post-secondary education. For instance, Ontario previously introduced a tuition credit where students are eligible for a 30% rebate of their Ontario

[20] The analysis discussed in Section 6 directly estimates the impact of the credits on interest paid for student loans.

[21] Amounts in Canadian dollars.

[22] In the UK, the full value of tuition is loaned to students while in school and repayment is conditional on post-schooling wages (McGuigan et al., 2016).

college or university tuition.[23] Additionally, proposed tuition increases in Quebec resulted in student strikes in 2011 that lasted for over six months. Further information about the details and costs of government funding for post-secondary education can be found in Neill (2013).

4 Data

This paper uses two datasets, the Longitudinal Administrative Databank (LAD) and the Survey of Labour and Income Dynamics (SLID) from Statistics Canada. We access both datasets through Statistics Canada's Research Data Center program, which allows researchers with approved projects access to otherwise restricted data. While the SLID has a public-use microdata file (PUMF) available to researchers, the LAD does not. Importantly, the SLID's PUMF does not have all the data fields required for this project.

With both datasets, we restrict our observations to two samples: an early period and a late period. The early period consists of individuals aged 18 to 23 (inclusive) in all Canadian provinces except Quebec. The purpose of the early period is to better understand post-secondary education decisions like university enrollment, dropping out, and taking out student loans. The late period consists of individuals aged 23 to 28 (inclusive) in the Atlantic Canadian provinces of New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland & Labrador. The late period allows us to evaluate to what extent GRP programs affected migration decisions from graduates. The LAD is restricted to the years 2000 to 2013 because this is the last year all original GRP provinces had their programs intact. The SLID is restricted to the years 2000 to 2011 because 2011 was the last year the survey was conducted.

4.1 Longitudinal Administrative Databank (LAD)

The LAD is administrative and longitudinal tax-filer data on a 20% sample of Canadians.[24] Individuals' age, gender, and province of residence are also recorded in the LAD. The longitudinal nature of the data allows for a nearly perfect measure of migration across years and provinces because individuals in Canada must state their province of residence. The LAD does not explicitly record if someone graduated from university. However, it does contain fields in the tax code allowing researchers to infer university enrollment, which we do here. We detail our strategy to infer education characteristics in Appendix C following methods developed by Morissette

[23] The grant tops out at CA\$1,680 for university tuition and CA\$770 for college tuition, provided the student's parents earn CA\$160,000 or less per year. This grant was eventually replaced by an across-the-board 10% reduction in tuition. See https://osap.gov.on.ca/OSAPPortal/en/PostsecondaryEducation/Tuition/index.htm and https://news.ontario.ca/maesd/en/2019/01/government-for-the-people-to-lower-student-tuition-burden-by-10-per-cent.html for more details.

[24] For more information, see http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=4107.

et al. (2015). Taken together, the LAD can be used to estimate mobility, university enrollment, and educational attainment.

We construct the following variables from the LAD to understand education decisions. *Enrolled in University* is a binary variable for whether an individual was enrolled in university during the current tax year. *Ever Enrolled in University* is a binary variable for whether an individual was ever enrolled in university. *Enrolled in University for* ≥ 2 is a binary variable for whether an individual had been enrolled in university for at least two years, as measured by having been enrolled for 16 full-time equivalent months.[25] *University Graduate* is a binary variable for whether an individual graduated from university, measured by the individual having been enrolled for 24 full-time equivalent months. This is equivalent to three academic years in Canada. *University Dropout* is a binary variable for whether an individual had dropped out of university. The variable is equal to one for individuals who have previously enrolled in university, have not graduated from university, and are not currently enrolled in university. *Student Loan Interest (to date)* measures the cumulative total of student loan interest that an individual has claimed on their tax returns. This variable is analyzed only for those who had enrolled in university. Finally, *Student Loan Interest (to date)* ≥ 0 is the same variable, conditional on claiming a positive amount of interest paid.

Two additional outcomes are constructed: whether an individual moves out of province and whether an individual moves out of Atlantic Canada. *Moved Province* is a binary indicator for whether an individual had moved out of province, which is analyzed only for university enrollees. The variable is set to 1 in the year an individual moves out of province and any subsequent year, and 0 otherwise. *Moved From Atlantic Canada* is similarly defined. It is set to 1 in the year in which an individual moves from the Atlantic Region and any subsequent year, and 0 otherwise.

4.2 Survey of Labour and Income Dynamics (SLID)

A secondary dataset used for analysis is the confidential version of the Survey of Labour and Income Dynamics (SLID), formerly conducted by Statistics Canada. In contrast to the LAD, the SLID directly asks respondents about education outcomes. The SLID surveys roughly $60,000$ individuals each year, with individuals surveyed for six consecutive years.[26] Data are recorded at the individual level.

In general, we construct variables from the SLID to be as similar as possible to those in the LAD. *University Ever* is a binary variable for whether an individual has ever enrolled in university. *University Dropout* is a binary variable for whether an individual has ever dropped out of university. *College Ever* and *College Dropout* are similarly defined for individuals in college. Finally, *Post Sec. Ed. Ever* and *Post Sec. Ed. Dropout* are defined in the same way if the individual had enrolled in (dropped out of) college or university.

[25] See the appendix for details.

[26] Unfortunately, with the SLID being a survey, there is some attrition. Survey weights are used to correct for attrition.

We analyze mobility decisions by constructing a variable called *Same Province as High School*, which is a binary indicator of whether the individual currently lives in the same province as where they attended high school. This variable is set to 1 for individuals in the same province, and 0 otherwise. The variable is also summarized for individuals who had attended university. Finally, we further construct whether individuals were university, college or post-secondary education graduates.

4.3 Summary Statistics

Table 2 summarizes all of the dependent variables we use in our analysis. The top and bottom panels are represented by the LAD and SLID, respectively. The left side of both panels represents the early period and the right panel represents the late period. Each column containing statistics in the table is further split up into GRP versus non-GRP provinces and the timing of the GRP rollout (pre and post).

The top-left quadrant of Table 2 summarizes statistics from the LAD's early period. In general, GRP and non-GRP provinces have similar proportions across all variables when compared across the same time period (pre versus post). Before the GRPs were introduced, GRP provinces had 0.132 enrolled in university, with 0.456 having ever been enrolled in university and 0.756 being enrolled for greater than or equal to two years of full-time university. Also, before the GRPs, non-GRP provinces had 0.128 enrolled in university, with 0.517 having ever been enrolled in university and 0.787 being enrolled for greater than or equal to two years of full-time university. Before the GRPs were introduced, about 0.631 of individuals in GRP provinces ever enrolled in university actually graduated, compared with 0.638 in non-GRP provinces. Also before the GRPs, university drop-out rates were 0.287 and 0.272 in GRP provinces and non-GRP provinces, respectively.

Following the adoption of GRPs, we see similar proportions of statistics between the GRP and non-GRP provinces in the LAD's early period. Specifically, enrollment in university increases by about 1.5 times the pre-GRP period, those ever being enrolled in university decreases by 6.5 percentage points in GRP provinces compared with 9.5 percentage points in non-GRP provinces, and both GRP and non-GRP provinces see declines of about 10 percentage points in those ever enrolled in university for more than two years. Following the GRP programs, university graduates decrease by about 14 percentage points for GRP provinces and by about 15 percentage points for non-GRP provinces. University drop-out rates decrease by 1.3 percentage points for GRP provinces, while drop-out rates increase by 2 percentage point for non-GRP provinces.

While individuals from GRP provinces paid more in interest towards student loans in either period when compared with non-GRP provinces, both GRP and non-GRP provinces see a reduction in payments in student loans in the later years of our sample.[27]

[27] Our summary statistics on student loans in the LAD's early period were rounded to the nearest $10 in accordance with Statistics Canada's output vetting policy.

The bottom-left quadrant of Table 2 summarizes statistics from the SLID's early period. We see that individuals enrolled in university fall in the range of 0.359 to 0.432, depending on province and GRP time period. The proportion of individuals ever enrolling in college is slightly lower than the proportion ever enrolled in university, with values ranging between 0.247 and 0.367. Nearly two thirds of all individuals attend university, college, or both. University drop-out rates for the whole sample are higher in GRP provinces (pre-GRP being 0.095 and post-GRP being 0.047) when compared with non-GRP provinces (pre-GRP being 0.051 and post-GRP being 0.027). Those dropping out of college are slightly higher than for university by 5 to 10 percentage points.

The top-right quadrant of Table 2 summarizes statistics from the LAD's late period. In general, individuals graduate from university more often from GRP provinces compared with non-GRP provinces, with both experiencing increases in the number of university graduates following GRP reforms. While there is less mobility in GRP provinces compared with non-GRP provinces before GRP programs (0.329 versus 0.416), both sets of provinces experience decreases in provincial movers in the late 2000s (non-GRP decline of about 3 percentage points compared with a decline of about 10 percentage points in GRP provinces). These values are slightly different when comparing the mobility of individuals from Atlantic Canada, which is about 5 percentage points, independent of province and time period. Moreover, there is an increasing number of graduates over time (pre versus post). GRP provinces have higher proportions of university graduates (0.512 pre-GRPs and 0.667 post-GRPs) compared with non-GRP provinces (0.478 pre-GRPs and 0.561 post-GRPs).

The bottom-right quadrant of Table 2 summarizes statistics from the SLID's late period. Mobility measures are slightly less than the LAD's late period with estimates falling in the range of 0.222 and 0.320. University graduates fall in the range of 0.496 and 0.542, while college graduates fall in the range of 0.666 and 0.690.

5 Empirical Strategy

We answer our research question using a difference-in-differences research design. Individuals who turned 18 (or 23) in a province offering a retention credit (Manitoba, Saskatchewan, New Brunswick, or Nova Scotia) will be regarded as "treated," while all others are regarded as the "comparison" group. Each group has pre-GRP and post-GRP time periods. Table 1 gives a rough overview of the provinces with GRP programs and their characteristics.

The impacts of the credits on early period outcomes are modelled for each individual i in province s and year t by the following equation:

$$\begin{aligned} Y_{ist} = \delta + \beta_{GRP} \times \mathbf{1}\{\text{GRP Prov at } 18_{ist}\} \times \mathbf{1}\{\text{age GRP announced}_{ist}\} \\ + \tau \text{ TRENDS}_{st} + \pi \text{ PROV}_s + \alpha \text{ AGE}_i + \upsilon \text{ BIRTH YEAR}_i + \epsilon_{ist}. \end{aligned} \tag{1}$$

Our dependent variables (Y_{ist}) are summarized in Table 2 and are often binary variables regarding individuals' university and college enrollment, their drop-out decisions, and their mobility across provinces.[28] In these cases, equation 1 is a linear probability model. We also use a continuous dependent variable measuring the amount of interest paid on student loans.

The coefficient of interest is β_{GRP}, which captures the marginal impact of being in a province with a retention credit (for those who were young enough to be eligible for a credit) on the dependent variable. The variables associated with β_{GRP} are indicator variables, denoted by $\mathbf{1}\{\cdot\}$, for the interaction between living in a province offering a credit and being young when the credit was announced. This variable equals 1 for those who turned 18 in Nova Scotia from 2006 to 2013, in New Brunswick from 2005 to 2013, and in Saskatchewan or Manitoba from 2007 to 2013, and 0 otherwise. Because the dependent variable are often binary, estimates of β_{GRP} are interpreted as percentage point changes. Equation 1 has province dummy variables, birth-year dummy variables, province-specific time trends, and age dummy variables. Aside from age dummies, there are no control variables because the unconditional impact of the programs is of primary concern.

In addition to the model in equation 1, we present two additional models for the early period individuals: (i) event studies and (ii) breaking the individuals into those who were in university when the program was announced and those who were yet to make the enrollment decision.[29] Empirically, these models allow us to investigate potential heterogeneity between these groups of individuals as motivated earlier and in Appendix A. More importantly, the event studies give a visual test for the parallel trends assumption integral for difference-in-differences empirical strategies to yield causal estimates.

Inference with linear difference-in-differences is challenging, with over-rejection problems being known since at least Bertrand et al. (2004) and Donald and Lang (2007). The source of these problems is largely due to serial correlation in the error terms. These problems can be corrected for by clustering standard errors at the level of the policy change and is common amongst applied literatures. While we present these standard errors, the cluster-robust variance estimator is unreliable when there are few clusters (Cameron et al., 2008) or when clusters are unbalanced (MacKinnon and Webb, 2017; Carter et al., 2017).

In order to overcome concerns regarding appropriate inference for unbalanced samples and those with few clusters (nine in the early samples and four in the late sample) in our case, we also present effective number-of-cluster P-values following Carter, Schnepel, and Steigerwald (2017) and the six-point wild cluster bootstrap P-values following Webb (2022). We perform a small Monte Carlo exercise to test how these procedures work in an environment similar to our own. The Monte Carlo

[28] Our university variables from the LAD are imputed following the methods described in Appendix C. As such, these are proxy variables and contain measurement error that would increase the size of the standard errors, all else equal. Measurement error is less of a concern when using the SLID because it directly collects information on education.

[29] This second breakdown is similar to that of Denning et al. (2019), who classify students who are yet to enter university as "first time in college" and all returning students as "returning."

exercise uses the homoskedasticity setup from Cameron et al. (2008) and is outlined in Appendix B. In all cases, the rejection frequency in our simulation when using the CRVE estimator with $t(G-1)$ degrees of freedom is far too large. That is, the effective number of cluster and the six-point bootstrap P-values are (correctly) more conservative. We present all three different types of inference in our analysis. Additionally, in response to number of different models we present, we also show a modified max-t distribution following (Romano and Wolf, 2005). For our application, we discuss results from columns regarding the six-point bootstrap P-values for consistency.

We split our analysis into early and late periods because the impacts of the programs may depend on the age of an individual when introduced. The early period models the impact the programs have on education decisions for individuals aged 18 to 23, as described in equation 1. The late period models the impact of the programs on migration decisions and university outcomes using data on individuals aged 23 to 28. The late period model follows equation 1 but changes variables associated with β_{GRP}. The sample used for analysis is different for the early period and late period analysis, given differing concerns about common support. The early period analysis, which focuses on educational outcomes, uses individuals from all Canadian provinces.[30] The late period analysis, which focuses on migration decisions, will look at the impact of the programs in the Atlantic provinces. The Atlantic provinces offer a useful setting for conventional difference-in-differences analysis of migration. The Atlantic region is comprised of two provinces with retention programs—Nova Scotia and New Brunswick—and two provinces without—Prince Edward Island and Newfoundland & Labrador. There is the additional benefit of interprovincial migration being nearly symmetric within the Atlantic Region.[31]

Accordingly, the assumption of common trends in interprovincial migration is more realistic when restricting the sample to the Atlantic provinces.

6 Results

LAD – Early Period Decisions

Results from the early period LAD regressions can be found in Panel A of Table 3. Our estimates suggest that the announcement of GRPs had no effects on the university enrollment decision, the likelihood that university students attend university for greater than two full-time years, their likelihood to graduate or drop out. These results are robust to the different specifications of standard errors. GRPs are likely to decrease the amount of interest paid on student loans. On the subsample of students who took loans, there was a decrease of (real) CA$123.10 (relative to a pre-treatment mean of CA$620) following the GRP programs.

[30] The majority of Canadians attend university within their own province. Accordingly, we assume that changes in the net cost of attending university in one province are unlikely to affect the decision of someone in another province to attend university.

[31] See Statistics Canada, CANSIM table 051-0019.

In Table 4, we decompose our difference-in-differences variable into those who would have been partially affected by the program. We define a partial exposure variable as anyone older than 18 in a GRP province at the time of announcement. Individuals who turn 18 after the GRP announcement are considered to be in the full exposure group. We do this recognizing that GRP programs are likely to affect students at different places in their education (applying versus already in university) to see if there are differential impacts. Using an F-statistic to test if the coefficients for partial or full exposure are statistically different from one another, we find no difference on the likelihood to enroll in university, the likelihood that university students attend university for greater than two full-time years, or their likelihood to graduate or drop out. While the full sample of individuals who ever enrolled in university shows no statistical significance in their total interest to date, the subsample of those with positive interest is statistically significant. Individuals who are fully exposed to the GRP program pay (real) CA$89.29 less on average compared with those in non-GRP provinces.

Finally, we evaluate the six variables from Panel A of Table 3 in an event study framework in Figure 1 through Figure 3. Each coefficient is an indicator variable for an individual in a year relative to a GRP program announcement, and all confidence intervals are constructed at the 95% level using the six-point wild cluster bootstrap.[32] In all of the figures, the coefficient estimates are statistically indistinguishable from zero, with large confidence intervals using the six-point wild cluster bootstrap. There are some important trends that can still be picked up from the figures. Figure 1a shows increasingly positive coefficient estimates for individuals graduating university following the GRP rollout (albeit statistically insignificant). Individuals are less likely to drop out following the GRP program rollout, with effects becoming larger in magnitude as time progresses. Individuals are no more likely to enroll in university, as indicated by Figure 2a. Individuals appear to be staying in university for greater than 16 months four years following the GRP announcement, as shown in Figure 2b. Finally, the interest paid by individuals on student loans—unconditionally (Figure 3a) or conditional on having student loans (Figure 3b)—does not appear statistically significant following the GRP.

LAD – Late Period Decisions

Panels B through D of Table 3 show the estimates of the late period decisions using the LAD. Panel B shows all individuals, and panels C and D partition all individuals into only males and only females, respectively. In the late period, we focus on the likelihood of individuals to graduate university, their likelihood to move provinces, and their likelihood to move out of Atlantic Canada. In all cases, we interpret results following the six-point bootstrap P-values, which often give the largest confidence

[32]The coefficient estimates tend to be less precise further away from the GRP announcement due to decreasing sample sizes. In 2000, there is only the cohort of 18-year-olds, while in 2005, there are six cohorts (18-year-olds through to 23-year-olds). A similar phenomenon occurs on the tail end of the sample.

intervals. The sample of combined individuals were 5.3 percentage points more likely to graduate in GRP provinces following the rollout of GRPs relative to non-GRP individuals (relative to a pre-treatment mean of 57.7%). When breaking down the sample by sex, effects are found for both sexes but males are more likely to graduate than females (6.9 percentage points compared with 4.1 percentage points). All of these estimates are statistically significant at the 10% level, with P-values less than 0.06 in all cases using the six-point bootstrap. Post-GRPs, females in GRP provinces were 4.5 percentage points less likely to move provinces compared with females in non-GRP provinces (relative to a pre-treatment mean of 31.1%). This effect is not found in males or when using the combined sample of males and females. Finally, using the six-point bootstrap, there is no statistically significant difference for any of the GRP samples to be more likely to move from Atlantic Canada.

SLID – Early Period Decisions

Table 5 shows the the results of the early period analysis using the SLID. Similar to the early period sample for the LAD, we look at the enrollment and drop-out decisions for individuals in GRP provinces following the program rollout compared with non-GRP provinces. Importantly, the SLID contains information about which type of post-secondary education (university or college or both) individuals are enrolled in. Table 5 has three panels for the combined sample of males and females (Panel A), only males (Panel B), and only females (Panel C). Across all samples, we find no effects for enrolling in college, university, or post-secondary in general and no effects for dropping out of college or post-secondary. However, we do see that, following the GRPs, individuals in the combined sample of males and females and the sample of only males were less likely to drop out of university by 4.5 percentage points (relative to a pre-treatment mean of 9.5%) and 8.3 percentage points (relative to a pretreatment mean of 0.113%), respectively.[33]

Table 6 similarly breaks down the SLID sample into individuals partially affected by the GRP and those who would be fully affected by the GRP. The table also breaks down individuals into their sample by sex, yielding three panels for the combined sample, the sample of only males, and the sample of only females. With the exception that fully exposed individuals were more likely to drop out of college compared with non-GRP college-enrolled individuals (3.4 percentage points relative to a pretreatment mean of 0.130), Table 6 yields results similar to those in Table 5.[34]

All individuals who were fully exposed to the GRP programs were 5.8 percentage points less likely to drop out of university relative to non-GRP individuals (relative to a pretreatment mean of 9.5%). All individuals who were partially exposed were no less likely to drop out from university compared with non-GRP individuals.

[33] For consistency, we discuss the six-point bootstrap P-values when interpreting results. While the combined sample is statistically significant across all methods of inference, the male-only sample has the largest P-value, 0.1124, when using the effective number of clusters t-statistic.

[34] We interpret this pointwise estimate with caution because tests for joint significance yield null results when fully exposed are compared with partially exposed *or* when we sum their effects.

However, the full exposure group was more likely than then partial exposure group to stay in university (P-value of 0.024 using an F-statistic with a null supposing coefficients were equal). Moreover, we find that the sum of the partial and full exposure coefficients were statistically different from zero using a F-statistic with a P-value of 0.086. When partitioning our sample to only males, we find the drop-out rate is not statistically significant pointwise. However, there is statistical difference between the full exposure male sample and the partial exposure male sample on our GRP coefficient with a P-value of 0.022. This is unsurprising because the full exposure coefficient value is -0.066 and the partial exposure coefficient estimate is 0.017 (relative to a pretreatment mean of 0.113). A new result in Table 6 is that partially exposed and fully exposed females are less likely to drop out when tested if they are jointly different from zero using an F-test. While pointwise statistically insignificant, the fully exposed females coefficient is larger in magnitude compared with the partially exposed females coefficient. These results suggest that GRP programs decrease the willingness for individuals to drop out of university. Moreover, those who were yet to enroll in university had less willingness to drop out compared with those already enrolled. With the exception of the results already discussed, there are no other pointwise of jointly significant effects.

SLID – Late Period Decisions

Table 7 shows the results using the SLID data on the migration and graduation decisions. We see that males in GRP provinces who ever enrolled in university were 17.7 percentage points more likely to move provinces compared with males not in GRP provinces (relative to a pretreatment mean of 76.4%). While the magnitude and statistical significance are similar for the same model, for the combined males and females sample using the six-point bootstrap, the effective number of clusters P-value is 0.122 and just outside traditional confidence levels. There is a similar disagreement between the six-point bootstrap and the effective number of clusters for the difference-in-differences coefficient when we model university graduation on the combined male and female sample. While those affected by retention credits are 7.8 percentage points more likely to graduate compared with those unaffected by the policy (relative to a pretreatment mean of 54.2%), the effect lies outside traditional confidence levels when using the effective number of clusters critical value. Outside of these models, our difference-in-differences coefficient estimates are not statistically significant when using the unconditional movement across Atlantic Canadian provinces, college graduates, or post-secondary graduates variables as outcomes.

7 Conclusions

Several Canadian provinces introduced generous tax credits to increase the local stock of college and university educated individuals. Although the programs were designed to keep individuals in a province after graduation, they also explicitly encourage graduation, discourage dropping out, and implicitly encourage post-secondary education. We analyze the impacts of these programs on a variety of education and migration decisions with a difference-in-differences empirical strategy using both administrative and survey data. Using the Longitudinal Administrative Databank (LAD), we find that graduate retention credits decreased the amount of interest paid on loans while having no discernible impact on university enrollment for individuals aged 18 to 23. While the same individuals in the LAD were no more likely to graduate or drop out from university using canonical difference-in-differences models, event studies suggest increasing graduation rates and decreasing university drop-out rates within five years of program introduction. Individuals aged 23 to 28 in Atlantic Canada, in the LAD, and affected by the retention credits were more likely to graduate university. Finally, affected females aged 23 to 28 in Atlantic Canada were 4.5 percentage points less likely to migrate from their home province following introduction of the retention credits.

We construct similar estimates and models using the Survey of Labour Income and Dynamics (SLID). Individuals affected by retention credits and aged 18 to 23 were less likely to drop out of university, with the male subsample being 8.3 percentage points less likely to drop out. While males aged 23 to 28 who attended university and were affected by graduate retention credits were more likely to move provinces, we find no migration effects for females or for the combined male and female sample.

Overall, these programs seem to have been successful at encouraging students to finish their degrees, with less success at retaining graduates. Moreover, retention programs did not affect the enrollment decision in post-secondary education.

From a policy perspective, the implications of this analysis are somewhat ambiguous. The credits were introduced to discourage interprovincial migration. While it appears the credits did not change migration patterns, they seem to decrease the size of student loans and may decrease university drop-out rates. If those individuals who did not drop out go on to graduate, then the programs may have met the goal of increasing the average education level in the province. It is possible that the programs are superior to the merit scholarships in that they both offer financial relief for local students and directly encourage individuals to graduate. Past research finds merit programs to be distortionary, with Cohodes and Goodman (2014) finding decreased college completion rates. Sjoquist and Winters (2014) find that merit scholarships decrease the likelihood that a student majored in a science, technology, engineering, and mathematics (STEM) field. Future research should examine whether the retention credits had similar distortionary effects.

The credits are perhaps also a better alternative to in-state tuition because they effectively reduce the net tuition for those who stay in province following graduation. Aghion et al. (2009) argue that investments in educational institutions in states far away from the technology frontier tend to benefit states closer to the frontier because graduates of said institutions tend to migrate toward the frontier. Thus, it is perhaps preferable to offer reduced tuition for those who stay in province as opposed to reducing it for those who attend school in province. Whether this change would be regressive in its incidence is beyond the scope of this paper, although it is encouraging that the credits reduced the amount of student loan interest paid by students. While the programs appear to encourage those enrolled in university to finish their education, the costly nature of these programs makes further experimentation difficult.

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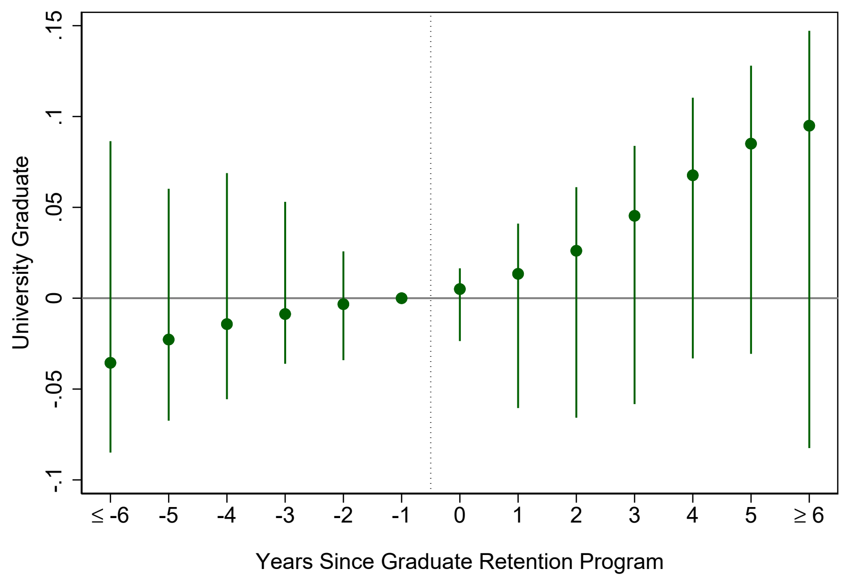
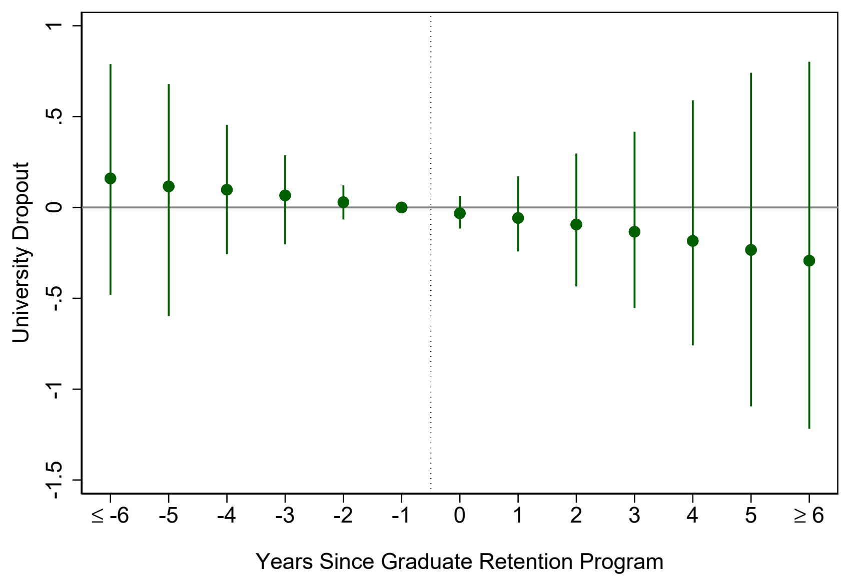
8 Figures

Figure 1: Event Studies of University Graduates and Dropouts During Early Period

(a) University Graduate



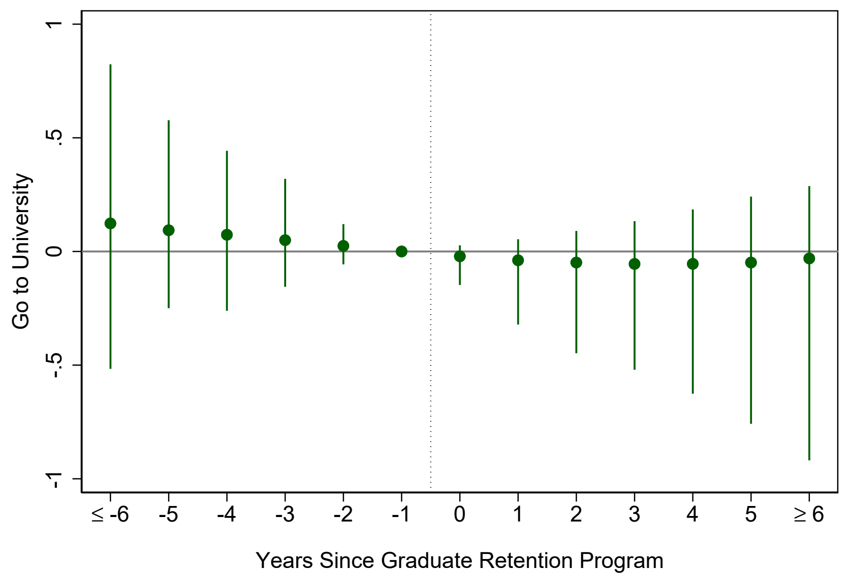
(b) University Dropout



Figures 1a and 1b show event studies for University Graduate and University Dropout from the Longitudinal Administrative Dataset (LAD), respectively, during the early period. Least squares used for all coefficient estimates. Coefficients to be interpreted as percentage points. All confidence intervals estimated using six-point bootstraps. Includes the following control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs. The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). All individuals aged 18 to 23 who turned 18 between 2000 and 2013. Both figures include the sample of individuals who had ever gone to university.

Figure 2: Event Studies of Attending University Decisions

(a) Ever Enrolled in University



(b) Enrolled in University for Two Years or More

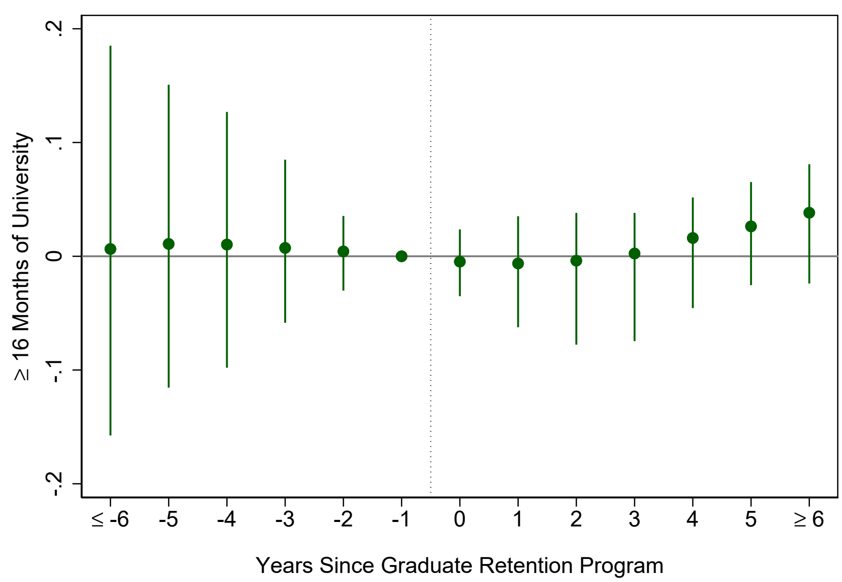
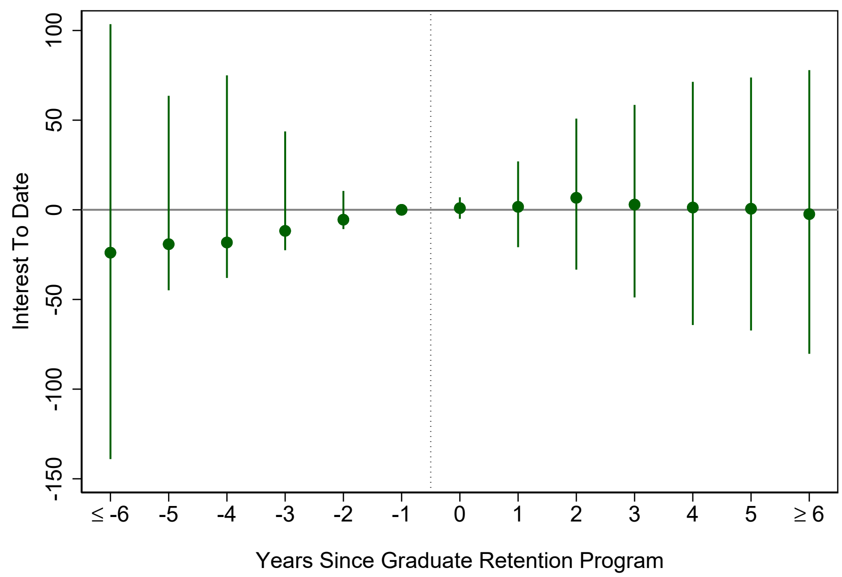


Figure 2a and 2b show event studies for Ever Enrolled in University and those Enrolled in University for Two Years or More from the Longitudinal Administrative Dataset (LAD) during the early period, respectively. Least squares used for all coefficient estimates. Coefficients to be interpreted as percentage points. All confidence intervals estimated using six-point bootstraps. Includes the following control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs. The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). All individuals aged 18 to 23 who turned 18 between 2000 and 2013. Figure 2a includes all individuals, while Figure 2b includes only the individuals who had ever gone to university.

Figure 3: Event Studies of Attending University Decisions

(a) Unconditional Student Loans



(b) Student Loan Conditional on Positive Student Loan

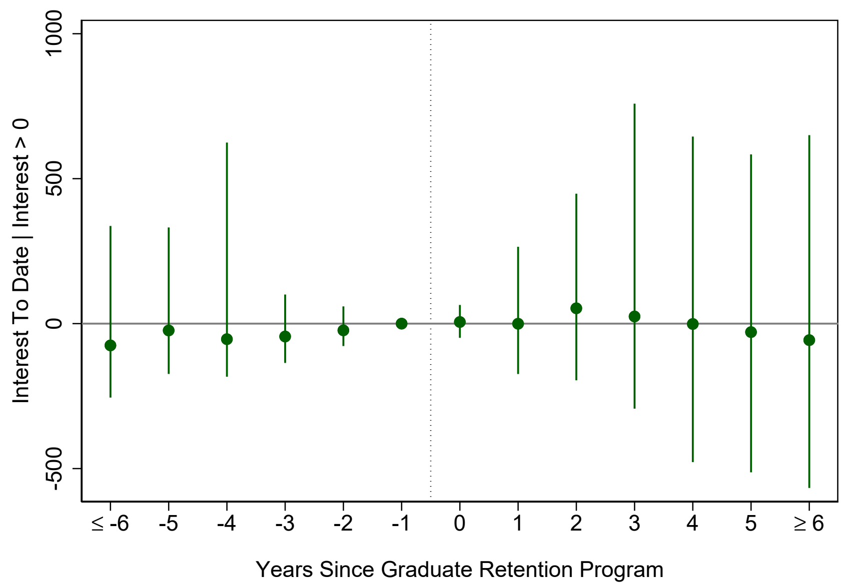


Figure 3b and 3b show event studies for Student Loans and those with positive student loans from the Longitudinal Administrative Dataset (LAD) during the early period, respectively. Least squares used for all coefficient estimates. Coefficients to be interpreted as percentage points. All confidence intervals estimated using six-point bootstraps. Includes the following control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs. The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). All individuals aged 18 to 23 who turned 18 between 2000 and 2013. Both figures include the sample of individuals who had ever gone to university.

Tables

Table 1: Graduate Retention Programs Information

	Graduate Retention Program Provinces			
Characteristics	Saskatchewan	Manitoba	Nova Scotia	New Brunswick
Year in Effect	2007	2007	2006	2005
Maximum Amount	\$20,000	\$25,000	\$15,000	\$20,000
Rebate per Year	10%, 20%	\$4,000, 10%	\$2,500	\$4,000
Net Present Value (\$000) @ \$5%	\$16.9	\$14.1	\$13.3	\$12.6
Refundable Credit?	Yes*	No	No	No
Rollover Credit?	No*	Yes	No	Yes
Eligibility Duration (years)	7	10	6	20
Application Required?	No	No	Yes	Yes
Tuition Based?	Yes	Yes	No	Yes
Tuition % Refunded	100%	60%	—	50%
Program Costs	\$35,000,000	\$34,000,000	\$25,000,000	N/A

All dollar values are in nominal Canadian dollars. * indicates the change in 2012 that Saskatchewan announced, where the credit was no longer refundable but would instead roll over from one year to the next. The Net Present Value calculation assumes a 5% discount rate, sufficient earnings to get the maximum credit in all years, and \$22,663 in tuition paid in earning a four-year BA degree from Queen's University in Ontario in 2012.

Table 2: Summary Statistics

	EARLY PERIOD					LATE PERIOD			
	GRP		Not GRP			GRP		Not GRP	
	Pre	Post	Pre	Post		Pre	Post	Pre	Post
Panel 2: ***Longitudinal Administrative Dataset (LAD)***									
Enrolled in University	0.132	0.213	0.128	0.193	Ever Moved	0.329	0.298	0.416	0.310
Ever Enrolled in University	0.456	0.391	0.517	0.422	Moved from Atlantic Canada	0.045	0.053	0.051	0.049
Enrolled in University for $\geq$2 years	0.756	0.657	0.787	0.683	Female	0.512	0.500	0.497	0.499
University Graduate	0.631	0.491	0.638	0.485	University Graduate	0.577	0.667	0.478	0.561
University Dropout	0.287	0.279	0.272	0.292					
Student Loan Interest (to date)	50	20	30	10					
Student Loan Interest (to date) $\mid > 0$	620	460	500	340					
All Observations	340,680	265,355	2,313,630	1,203,525		234,480	132,720	123,090	36,425
Observations if Ever Enrolled in University	155,360	103,800	1,195,845	508,650		124,135	64,235	87,700	24,840
Panel 2: ***Survey of Labour Income and Dynamics (SLID)***									
Ever Enrolled in University	0.432	0.422	0.359	0.404	Same Province	0.778	0.776	0.680	0.702
University Dropout	0.095	0.047	0.051	0.027	Same Province | Ever Enrolled in Post-secondary	0.768	0.766	0.670	0.715
Ever Enrolled in College	0.310	0.247	0.367	0.332	University Graduate	0.542	0.532	0.511	0.496
College Dropout	0.130	0.102	0.148	0.077	College Graduate	0.685	0.680	0.666	0.690
Ever Enrolled in Post-secondary Education	0.660	0.617	0.655	0.674	Post-secondary Education Graduate	0.745	0.733	0.744	0.730
Post-secondary Dropout	0.114	0.070	0.105	0.052					

Panel 1 consists of statistics from the Longitudinal Administrative Dataset (LAD). Panel 2 consists of statistics from Survey of Labour Income and Dynamics (SLID). All summary statistics are weighted according to their respective dataset. Observations are rounded to the nearest five. There are early and late periods across graduate retention program (GRP) provinces. The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). The late period consists of GRP provinces (Nova Scotia, New Brunswick) and non-GRP provinces (PEI, Newfoundland & Labrador) in Atlantic Canada. All individuals who lived in Quebec at the age of 18 are excluded. Each column is labelled according to their specific subsample. The first four columns of statistics, labelled Early Period, are for all individuals aged 18 to 23 who turned 18 between 2000 and 2013. The second four columns of statistics, labelled as Late Period, are for all individuals age 23 to 28 who turned 18 between 2000 and 2013. Panel 2 contains only up to year 2011 for both the early period and the late period because this is the last year of the SLID. All variables are proportions excep the interest rates to date, which are in Canadian dollars, and the numbers of observations, which are counts. In Panel 1, the following variables include all observations for the constructed statistic: Enrolled in University, Ever Enrolled in University. In Panel 1, the following variables include all observations of whoever enrolled in university: Enrolled in University for $\geq$ 2 years, University Graduate, University Dropout, Student Loan Interest (to date), Ever Moved, Moved from Atlantic Canada. Student Loan Interest variables are rounded to the nearest 10 in accordance with Statistics Canada vetting procedure. In Panel 2, the following variables include all observations for the constructed statistic: Ever Enrolled in University, College or Post-secondary Education, Same Province, and Post-secondary Education Graduate. In Panel 1, the following variables include all observations are conditional on attempting their respective level of education: University Dropout, College Dropout, Post-secondary Dropout, Same Province | Ever enrolled in University, University Graduate, College Graduate.

Table 3: Regression Results Using the LAD for Both Early and Late Periods of GRP

			P-values				
Dependent Variable	DiD Coeff.	CRVE t-stat.	CRVE P-value	CRVE $t(G^* - 1)$	6-Point Bootstrap	Rounded Obs.	Dep. Var. Mean (Pre X GRP)
Panel A: Early Period Sample							
Sample of Males and Females							
Ever Enrolled in University	0.0087	0.5069	0.6259	0.6507	0.7169	4,123,190	0.456
Enrolled in University for 2 years	−0.0010	−0.0837	0.9353	0.9391	0.9419	1,963,655	0.756
University Graduate	0.0177	1.648	0.1380	0.2079	0.2372	1,963,655	0.631
University Dropout	−0.0243	−1.488	0.1750	0.2430	0.2762	1,963,655	0.287
Student Loan Interest (to date)	−35.15	−2.802	0.0231	0.0764	0.1244	1,963,655	50
Student Loan Interest (to date) $\mid > 0$	−123.1	−4.190	0.0030	0.0304	0.0426	113,950	620
Panel B: Late Period Sample							
Sample of Males and Females							
University Graduate	0.0530	5.994	0.0093	0.0340	0.0540	247,575	0.577
Moved Province	−0.0417	-3.563	0.0377	0.0821	0.1728	247,575	0.329
Moved from Atlantic	0.0116	2.632	0.0782	0.1325	0.1951	247,575	0.045
Panel C: Sample of Males							
University Graduate	0.0691	5.670	0.0109	0.0375	0.0593	107,545	0.570
Moved Province	−0.0392	−3.304	0.0456	0.0928	0.1900	107,545	0.355
Moved from Atlantic	0.0240	5.775	0.0103	0.0363	0.1034	107,545	0.049
Panel D: Sample of Females							
University Graduate	0.0407	3.995	0.0281	0.0680	0.0471	140,030	0.582
Moved Province	−0.0451	−3.442	.0412	0.0869	0.0574	140,030	0.311
Moved from Atlantic	0.0020	0.4815	0.6631	0.6823	0.7661	140,030	0.043

Each row models a different dependent variable following equation 1, each column is a different statistics. Least squares used for all coefficient estimates. Includes the following control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs. Order of columns: Difference-in-Differences (DiD) coefficient, Cluster-Robust Variance Estimator (CRVE) t-stat, CRVE P-value, effective number of clusters (G^*) P-value, six-point bootstrap P-value, and rounded observations (nearest five). **Panel A (Early Period Sample):** The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). DiD coefficient defined by year when 18 in the provinces that are treated. All individuals aged 18 to 23 who turned 18 between 2000 and 2013. All individuals who lived in Quebec at the age of 18 are excluded. The Ever go to University row includes all individuals. All other rows includes only those who had ever gone to university. The final row further conditions on people with positive interest to date. 5.17 is used as the effective number of clusters (G^*). Max t critical values for the 2.5 percentile and 97.5 percentile using our bootstrap t-statistics are −3.530 and 3.475, respectively.
Panels B, C, and D (Late Period Sample): The late period consists of GRP provinces (Nova Scotia, New Brunswick) and non-GRP provinces (PEI and Newfoundland & Labrador) in Atlantic Canada. DiD coefficient defined by year when 23 in the provinces that are treated. All individuals aged 23 to 30 between 2000 and 2013. All individuals who lived in Newfoundland & Labrador, PEI, Nova Scotia, and New Brunswick at the age of 18 are included. All rows includes only those who had ever gone to university. The top three rows are both sexes. The middle three rows are only males. The final three rows are only females. 2.8 is used as the effective number of clusters (G^*). Max t critical values for the 2.5 percentile and 97.5 percentile using our bootstrap t-statistics are −4.806 and 4.806, respectively.

Table 4: LAD – Regression Results – Early Period, Partial Exposure

	Dependent Variables					
Coefficient	Ever Enrolled in University	$\geq$ 16 Months of University	University Graduate	University Dropout	Interest to Date	Interest to Date $\mid > 0$
Full Exposure	−0.0328	−0.0226	0.0000	−0.0005	−21.20	−89.29
Coefficient P-value	0.1724	0.0876	0.9991	0.9752	0.1531	0.0899
Partial Exposure	−0.0428	−0.0222	−0.0181	0.0244	14.30	25.40
Coefficient P-value	0.0877	0.1129	0.1965	0.0205	0.0464	0.4091
P-value Full Exposure = Partial Exposure	0.6750	0.9756	0.2342	0.2634	0.1188	0.0399
P-value Full Exposure + Partial Exposure = 0	0.0909	0.1079	0.3551	0.0207	0.5158	0.3239
Rounded Observations	4,123,190	1,963,655	1,963,655	1,963,655	1,963,655	113,950
Dep. Var. Mean (Pre X GRP)	0.456	0.756	0.631	0.287	50	620

Each column models a different dependent variable following equation 1; each row contains different statistic. Least squares estimators are used to estimate all coefficients. These samples match those of the previous table. Full Exposure is an indicator variable for individuals who were younger than 18 when the programs were implemented in the eligible provinces. Partial Exposure is an indicator variable for individuals who were older than 18 when the programs were implemented in the eligible provinces. Order of rows: coefficient, six-point bootstrap P-value, coefficient, six-point bootstrap P-value, six-point bootstrap P-value testing equality of the two coefficients, six-point bootstrap P-value testing if the two coefficients sum to zero, rounded observations (nearest five). All individuals aged 18 to 23 who turned 18 between 2000 and 2013. All individuals who lived in Quebec at the age of 18 are excluded. For the Ever Enrolled in University column, it includes all individuals. All other columns includes only those who had ever gone to university. The final row further conditions on people with positive interest to date. Includes the follow control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs.

Table 5: SLID – School Enrollment and Dropout Decisions

Dependent Variable	DiD Coeff.	CRVE t-stat.	*P*-values: CRVE *P*-value	*P*-values: CRVE $t(G^* - 1)$	*P*-values: Six-Point Bootstrap	Rounded Obs.	Dep. Var. Mean (Pre X GRP)
Panel A: Sample of Males and Females							
Ever Enrolled in University	−0.0038	−0.1061	0.9181	0.9229	0.9303	34,145	0.432
University Dropout	−0.0448	−3.019	0.0166	0.0650	0.0258	12,050	0.095
Ever Enrolled in College	0.0134	0.6000	0.5651	0.5951	0.5770	33,835	0.310
College Dropout	0.0389	2.462	0.0392	0.1002	0.1571	11,425	0.130
Ever Enrolled in Post-secondary Education	0.0023	0.1049	0.9190	0.9238	0.9261	34,235	0.660
Post-secondary Education Dropout	−0.0020	−0.4529	0.6626	0.6845	0.6001	21,400	0.114
Panel B: Sample of Males							
Ever Enrolled in University	0.0363	1.028	0.3339	0.3870	0.4281	16,895	0.361
University Dropout	−0.0827	−2.324	0.0486	0.1124	0.0232	4,830	0.113
Ever Enrolled in College	−0.0157	−0.3932	0.7044	0.7231	0.7320	16,720	0.314
College Dropout	0.0460	1.499	0.1723	0.2405	0.2205	5,580	0.140
Ever Enrolled in Post-secondary Education	0.0214	0.9651	0.3628	0.4128	0.4147	16,940	0.605
Post-secondary Education Dropout	−0.0164	−0.5464	0.600	0.6266	0.6649	9,550	0.132
Panel B: Sample of Females							
Ever Enrolled in University	−0.0463	−0.9222	0.3834	0.4312	0.4281	17,250	0.502
University Dropout	−0.0207	−0.5625	0.5892	0.6171	0.6177	7,220	0.083
Ever Enrolled in College	0.0354	1.085	0.3097	0.3653	0.3628	17,110	0.301
College Dropout	0.0274	0.6554	0.5306	0.5637	0.6658	5,845	0.119
Ever Enrolled in Post-secondary Education	−0.0217	−0.6138	0.5564	0.5871	0.5914	17,295	0.712
Post-secondary Education Dropout	0.0083	0.3674	0.7229	0.7402	0.7657	11,850	0.100

Each row models a different dependent variable following equation 1, each column is a different statistics. Least squares used for all coefficient estimates. Order of columns: Difference-in-Differences (DiD) coefficient, Cluster-Robust Variance Estimator (CRVE) t-stat, CRVE *P*-value, effective number of clusters (G^*) *P*-value, six-point bootstrap *P*-value, and rounded observations (nearest five). The early period consists of GRP provinces (Nova Scotia, New Brunswick, Saskatchewan, and Manitoba) and non-GRP provinces (all others, excluding Quebec). DiD coefficient defined by year when 18 in the provinces that are treated (GRP). Three panels of six rows vary the sample: all individuals, only males, only females. Within each panel, rows 1, 3, and 5 pertain to all individuals for that panel. Rows 2, 4, and 6 condition on those that went to university ever, college ever, and post-secondary ever, respectively. All individuals aged 18 in all provinces, excluding Quebec, for individuals aged 18 to 23 between 2000 and 2011 and Year at 18 is between 1990 and 2013. Includes the follow control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs. 3.7 is used as the G^* here. Max t critical values for the 2.5 percentile and 97.5 percentile using our bootstrap t-statistics are −3.081 and 3.099, respectively.

Table 6: SLID – School Enrollment and Dropout Decisions, Partial Exposure

	Dependent Variables					
Coefficient	Ever Enrolled in University	University Dropout	Ever Enrolled in College	College Dropout	Ever Enrolled in Post-secondary	Post -secondary Dropout
Panel A: Sample of Males and Females						
Full Exposure	0.0087	−0.0585	0.0225	0.0339	0.0186	−0.0208
Coefficient P-value	0.8891	0.0568	0.4624	0.0251	0.6990	0.2994
Partial Exposure	0.0133	−0.0135	0.0097	−0.0047	0.0174	−0.0186
Coefficient P-value	0.7990	0.5528	0.5182	0.8075	0.5708	0.4021
P-value Full Exposure = Partial Exposure	0.9211	0.0240	0.6026	0.1530	0.9571	0.5420
P-value Full Exposure + Partial Exposure = 0	0.7875	0.0859	0.4116	0.4942	0.6194	0.3363
Rounded Observations	34,145	12,050	33,835	11,425	34,235	21,400
Dep. Var. Mean (Pre X GRP)	0.432	0.095	0.310	0.130	0.660	0.114
Panel B: Sample of Males						
Full Exposure	0.0922	−0.0661	0.0115	0.0316	0.0672	−0.0239
Coefficient P-value	0.1926	0.1698	0.7541	0.3302	0.2653	0.0294
Partial Exposure	0.0594	0.0166	0.0288	−0.0134	0.0488	−0.0074
Coefficient P-value	0.2590	0.7148	0.4575	0.6970	0.3649	0.8195
P-value Full Exposure = Partial Exposure	0.4612	0.0220	0.7141	0.2145	0.4740	0.6543
P-value Full Exposure + Partial Exposure = 0	0.1956	0.5082	0.4483	0.6539	0.3081	0.4073
Rounded Observations	16,895	4,830	16,720	5,580	16,940	9,550
Dep. Var. Mean (Pre X GRP)	0.361	0.113	0.314	0.140	0.605	0.132
Panel B: Sample of Females						
Full Exposure	−0.0766	−0.0560	0.0209	0.0341	−0.0377	−0.0217
Coefficient P-value	0.3378	0.1590	0.6472	0.6564	0.4259	0.5328
Partial Exposure	−0.0321	−0.0346	−0.0154	0.0064	−0.0170	−0.0297
Coefficient P-value	0.4833	0.1354	0.5618	0.7707	0.4968	0.0734
P-value Full Exposure = Partial Exposure	0.4536	0.6067	0.3380	0.6578	0.6160	0.7844
P-value Full Exposure + Partial Exposure = 0	0.3124	0.0966	0.9308	0.6085	0.3584	0.2375
Rounded Observations	17,250	7,220	17,110	5,845	17,295	11,850
Dep. Var. Mean (Pre X GRP)	0.502	0.083	0.301	0.119	0.712	0.100

Each column models a different dependent variable following equation 1; each row contains different statistic. Least squares estimators are used to estimate all coefficients. Three panels vary the sample: all individuals, only males, only females. These samples match those of the previous table (Early Period). Full Exposure is an indicator variable for individuals who were younger than 18 when the programs were implemented in the eligible provinces. Partial Exposure is an indicator variable for individuals who were older than 18 when the programs were implemented in the eligible provinces. Order of rows: coefficient, six-point bootstrap P-value, coefficient, six-point bootstrap P-value, six-point bootstrap P-value testing equality of the two coefficients, six-point bootstrap P-value testing if the two coefficients sum to zero, rounded observations (nearest five). All individuals aged 18 in all provinces, excluding Quebec, for individuals aged 18 to 23 between 2000 and 2011 and Year at 18 is between 1990 and 2013. Includes the follow control variables: Province fixed effects (FEs), year FEs, province-specific trends, age FEs, birth-year FEs.

Table 7: SLID – Migration and Graduation Decisions

Dependent Variable	DiD Coeff.	CRVE t-stat.	*P*-values: CRVE *P*-value	*P*-values: CRVE $t(G^* - 1)$	*P*-values: Six-Point Bootstrap	Rounded Obs.	Dep. Var. Mean (Pre X GRP)
Panel A: Sample of Males and Females							
Same Province	−0.0925	−1.409	0.2535	0.3067	0.3739	8,285	0.778
Same Province | Ever Enrolled in University	−0.1458	−2.782	0.0688	0.1217	0.0569	6,535	0.768
University Graduate	0.0784	2.522	0.0860	0.1414	0.0836	3,640	0.542
College Graduate	0.0522	0.5493	0.6210	0.6432	0.7647	4,280	0.685
Post-secondary Education Graduate	0.0933	3.376	0.0432	0.0896	0.1942	6,535	0.745
Panel B: Sample of Males							
Same Province	−0.0718	−1.058	0.3675	0.4111	0.3201	3,970	0.774
Same Province | Ever Enrolled in University	−0.1766	−3.340	0.0444	0.0912	0.0581	2,935	0.764
University Graduate	0.1366	1.129	0.3411	0.3870	0.4527	1,440	0.501
College Graduate	0.0830	1.302	0.2839	0.3347	0.3291	2,105	0.666
Post-secondary Education Graduate	0.1708	4.000	0.0280	0.0679	0.1500	2,935	0.701
Panel B: Sample of Females							
Same Province	−0.1112	−1.238	0.3037	0.3530	0.6721	4,315	0.783
Same Province | Ever Enrolled in University	−0.1243	−1.729	0.1823	0.2397	0.5120	3,600	0.772
University Graduate	0.0542	1.210	0.3130	0.3614	0.4306	2,200	0.575
College Graduate	0.0112	0.0800	0.9413	0.9442	0.9527	2,170	0.710
Post-secondary Education Graduate	0.01445	0.4578	0.6782	0.6963	0.7504	3,600	0.785

Each row models a different dependent variable following equation 1, each column is a different statistics. Least squares used for all coefficient estimates. Order of columns: Difference-in-Differences (DiD) Coefficient, Cluster-Robust Variance Estimator (CRVE) t-stat, CRVE *P*-value, effective number of clusters (G^*) *P*-value, six-point bootstrap *P*-value, and rounded observations (nearest five). The late period consists of GRP provinces (Nova Scotia, New Brunswick) and non-GRP provinces (PEI and Newfoundland & Labrador) in Atlantic Canada. DiD coefficient defined by year when 23 in the provinces that are treated (GRP). Three panels of five rows vary the sample: all individuals, only males, only females. Rows within each panel correspond to the following subsamples: Row 1 has no further restrictions. Rows 2 and 5 restrict to all who went to post-secondary education (PSE). Row 3 restricts to all who went to university. Row 4 restricts to all who went to college. All individuals living in Atlantic Canada (NFLD, NB, NS, PEI) when they were 18 who were 23 to 30 between 2000 and 2011 and Year at 23 is between 1990 and 2013. 3.7 is used as the effective number of clusters (G^*). Max t critical values for the 2.5 percentile and 97.5 percentile using our bootstrap t-statistics are −3.960 and 4.035, respectively.

A Appendix – Simple Model

Consider a student who is finishing high school. The individual wants to maximize the present value of their utility, which is a function of both their discretionary income ($\tilde{C}$) and their quality of life (QoL). They can do so on two dimensions: their level of education and the city in which they reside. Cities influence quality of life, earnings, and taxes. We imagine the individual solving the following problem:

$$\max_{\substack{educ_{t=1} \in \{hs,c,u\} \\ educ_{t=2} \in \{hs,c,C,u,U\} \\ city \in \{X\}_{t=1}^{3}}} \sum_{t=1}^{3} \beta^{t-1} U(\tilde{C}_t, QoL_t) \qquad \text{subject to}$$

$$QoL_i = f(city_i)$$

$$\tilde{C}_1 = Y_1(educ_1, city_1) + SL_1(educ_1) - taxes(city_1) - rent(city_1) - tuition(educ_1)$$

$$\tilde{C}_2 = Y_2(educ_2, city_2) + SL_2(educ_2) - (1+r)SL_1(educ_1|educ_2) - taxes(city_2) - rent(city_2) - tuition(educ_2)$$

$$\tilde{C}_3 = Y_3(educ_2, city_3) - (1+r)SL_2(educ_2) - taxes(city_3, educ_2) - rent(city_3)$$

An individual maximizes the present value of their utility across three periods: two periods in which they can possibly further their education and the final period. Utility in the second and third periods is discounted by an exogenously given discount factor, β.

We assume the individual make the following educational choices. In the first period, they choose no further education and remain a high school graduate (hs), to attend a community college (c), or to attend university (u). Additionally, they choose the city in which they work or attend school from the set of cities (X). In the second period, they choose to either remain in school or drop out of school. If they choose not to continue education in the first period, they remain at a high school education (hs). If they attend college in the first period, they can either enter the workforce with some college (c) or finish their program and graduate (C). Similarly, if they attended university in the first period, they can either enter the workforce with some university (u) or finish their program and graduate (U).

In the first two periods, the educational decision will affect consumption in several ways. Obtaining additional education requires a good deal of time and, as such, will negatively impact earnings (Y) in the first period. Additional education has a direct tuition cost, which must be paid in the current period. Student loans (SL) are available to help pay tuition and provide additional consumption in the first two periods if additional education is chosen, but they must be repaid with interest (r) in the third period. The individual is free to relocate to a new city after entering the workforce. Education is assumed to increase earnings in the third period. The graduate retention programs introduce an education argument to the tax function in the third period because the individual will face lower taxes in certain cities, given earnings, than a similar person with a lower level of education on account of receiving a graduate retention tax credit. Rent is included in the model to reflect the fact that there are some non-traded goods that people must consume, the price of which is determined by the city of residence.

Reflecting on the impact of the graduate retention programs through the lens of this model reveals several dimensions in which the programs might have an impact. The most direct impact is that consumption in the third period is higher in a city where an individual is eligible for a credit, with all else being equal. Accordingly, if wages, taxes, and quality of life are all equal between two cities (a city that offers a credit and a city that does not), we expect individual to choose to reside in the city with the credit. Moreover, the availability of a credit will increase overall consumption in the three periods for those who go to school. Therefore, we expect the introduction of a retention credit to increase educational attainment. This follows from the fact that, when a location offers a credit, the credit increases lifetime consumption for graduates. This increase in consumption makes obtaining further education relatively more attractive. A third possible impact may occur because the decrease in taxes from a credit coincides with student loan repayments. If there is heterogeneity in the amount of student loans outstanding, then it is probable that those with larger amounts of debt would be more likely to locate in a city offering a credit. Similarly, those with student loans may be able to accelerate their debt repayment if they receive a credit.

The graduate retention programs have one additional channel of influence. For individuals already enrolled in school, the expectation of receiving credits upon graduation increases the costs of dropping out of school. In the absence of a credit, the potential costs of dropping out is the forgone higher wages that one might earn after graduating. The presence of a credit increases the cost of dropping out by disqualifying an individual from receiving the credit. One can alternatively think about the credits as a fee/rebate program, wherein payment is made up front and a rebate is offered on graduation. If one expected to receive in the third period a refund proportional to their first period tuition, then the decision to drop out in period two would retroactively increase the "expected" cost of going to school in period one.

Any influence that a program may have will depend on the age of an individual when the program was announced. The model is written as though the program is in place in period zero. This will be the case for individuals who reach the end of high school in or after the year a program is announced. However, for some individuals, the programs were announced when they were in period one or period two. For these individuals, the enrollment decision will have already been made, thus the programs are more likely to affect the migration and graduation decisions. The empirical analysis will account for these differences. The model above is framed in terms of an individual's decision, which matches well with the microlevel data used for analysis.

B Appendix – Inference Strategy

Cameron et al. (2008) (CGM) propose a wild cluster bootstrap to deal with the small cluster problem in difference-in-differences models and that they claim works with as few as five clusters. However, Webb (2022) shows the two-point wild cluster bootstrap is unreliable with few clusters.[35] With few clusters, the CGM procedure calculates a point estimate for the P-value although the P-value is actually interval-identified. Webb (2022) proposes the following six-point distribution for use with few clusters:

$$v_g = -\sqrt{\frac{3}{2}}, -\sqrt{\frac{2}{2}}, -\sqrt{\frac{1}{2}}, \sqrt{\frac{1}{2}}, \sqrt{\frac{2}{2}}, \sqrt{\frac{3}{2}} \qquad w.p. \qquad \frac{1}{6}.$$

To deal with unbalanced clusters, MacKinnon and Webb (2017) show that the wild cluster bootstrap works well. However, the simulations in that paper have a comparatively large number of clusters. Additionally, the simulations in Webb (2022) involve only balanced clusters. This leaves open the question of whether the six-point distribution works well with few clusters.

MacKinnon and Webb (2017) also compare the wild cluster bootstrap to the CRVE procedure assuming the t-statistics follow a $t(G^* - 1)$ distribution. With a larger number of clusters in that paper, this CRVE inference procedure understates the P-values relative to the wild cluster bootstrap, yet it remains to be tested how it performs with a relatively small number of clusters. To test this, we compare the usual CRVE assuming the t-statistics follow a $t(G-1)$ with the CRVE assuming a $t(G^* - 1)$ distribution, where G^* is the effective number of clusters when testing the treatment model calculated using the `clusteff` Stata package described in Lee and Steigerwald (2018), based on the procedure in Carter et al. (2017).

We perform a small Monte Carlo exercise to test whether all these procedures work well with few clusters. The Monte Carlo exercise uses the homoskedasticity setup from Cameron et al. (2008). Across 25,000 replications, data are generated by the following equation:

$$y_{ig} = x_{ig} + x_g + \epsilon_{ig} + \epsilon_g,$$

where $x_{ig}, x_g, \epsilon_{ig}, \epsilon_g$ are all drawn from a $N(0,1)$ distribution. This setup imposes within-cluster correlation in both the x-variable $(x_{ig} + x_g)$ and in ϵ $(\epsilon_{ig} + \epsilon_g)$. Two cases are considered, one to match the data in the early decision analysis and one to match the late decision analysis. In both cases, there are 1,000 observations per replication. In the early decision analysis, the data are divided among nine or 10 clusters, proportional to the populations of Canadian provinces. In the late decision analysis, the observations are distributed proportionally to the populations of the four Atlantic provinces. The clusters that are defined as treated, thus, have proportional size to treated provinces in the late decision and early decision analysis.

Within each replication the following regression is estimated:

$$y_{ig} = c + +\beta_T Treat_{ig} + \beta_x x_{ig} + \mu_{ig},$$

where $Treat_{ig}$ is a binary indicator variable of treatment status. The null hypothesis $\beta_T = 0$ is tested using the CRVE procedure assuming the t-statistic follows a $t(G-1)$ and $t(G^* - 1)$ distribution. We test this procedure for nine or 10 clusters matching the LAD early decision and SLID early decision analysis and four clusters to match the late decision analysis. The nine- and 10-cluster designs each have four treated clusters, whereas the four-cluster design has two treated clusters.

[35] Simplifying, the CGM procedure generates bootstrap samples by transforming residuals, from a restricted regression, by a variable v_g, drawn from a bootstrap weight distribution. The same v_g is applied to all observations within a cluster. CGM recommend using the Rademacher distribution in which $v_g = \pm 1$ with probability 0.5.

G^* here is estimated using the same Monte Carlo setup, where, in each replication, it is estimated using the `clusteff` Stata program described in Lee and Steigerwald (2018). We use the average of all the replications, which are estimated to be 5.17, 3.7, and 2.8 for the 10-, nine-, and four-cluster regressions, respectively. In all cases, we report the 1%, 5%, and 10% rejection frequencies for each procedure. These results are reported in Table B1.

Results comparing the two distributions when using the CRVE are in the first panel of Table B1. In all cases, as before the rejection frequency, when assuming the $t(G-1)$, distribution is far too large. On the other hand, when assuming the $t(G^*-1)$ procedure, the rejection frequencies are much lower. For the 10-cluster design, there is slight over-rejection at all three levels. For the nine-cluster design, there is slight under-rejection at the 1% and 5% levels and over-rejection at the 10% level; however, these frequencies are quite close to the size of the test. Both these designs, however, have much more reasonable results than the standard CRVE procedure assuming the $t(G-1)$ distribution. In the four-cluster design, there is still over-rejection at the 5% and 10% levels when assuming the $t(G^*-1)$ distribution; however, the over-rejection is much less severe than the standard distribution.

The results from the six-point bootstrap are in the second panel of Table B1. In all cases, it under-rejects severely at the 1% level. It performs worse than the $t(G^*-1)$ CRVE in the nine-cluster design, with over-rejection at the 5% and 10% levels. In the four-cluster design, however, it works much better at the 5% levels. Like the CRVE, the six-point bootstrap still over-rejects severely at the 10% level. In the 10-cluster design, it works only slightly better than the CRVE at the 5% and 10% levels.

The results from this Monte Carlo suggest that careful attention must be paid to inference. In the early decision analysis, when using data from all 10 provinces, the CRVE assuming a $t(G^*-1)$ distribution will generally result in a well-sized test. However, in the late decision analysis, when using data from only the four Atlantic provinces, inference will be more difficult. In this case, the cluster-robust P-values will be quite significantly understated, while the wild cluster bootstrap P-values will be correctly sized at the 5% level but over-rejecting at the 10% level.

The CRVE, assuming the $t(G^*-1)$ distribution, gives the most reasonable results. In the nine-cluster case, this test is remarkably well sized. The 10-cluster design results in the P-values being slightly understated along with the P-values being understated at the 5% and 10% levels for the four-cluster design. For the four-cluster design, the six-point bootstrap gives a well-sized test at the 5% level, while the CRVE gives a well-sized test at the 1% level. Thus, unless otherwise stated, we report $t(G^*-1)$ and six-point bootstrap P-values.

Table B1: Treatment Model Monte Carlo Results

	10 Clusters		9 Clusters		4 Clusters	
CRVE						
	t(G-1)	t(G*-1)	t(G-1)	t(G*-1)	t(G-1)	t(G*-1)
1% rej. freq.	3.804%	1.200%	6.024%	0.568%	8.224%	1.000%
5% rej. freq.	11.464%	6.784%	15.468%	4.752%	22.924%	8.104%
10% rej. freq.	19.096%	13.668%	23.724%	11.308%	33.612%	18.536%
6 pt. Boot						
1% rej. freq.	0.180%		0.644%		0.176%	
5% rej. freq.	5.504%		7.924%		4.900%	
10% rej. freq.	11.868%		14.836%		17.732%	

Notes: Results from 25,000 Monte Carlo simulations. Average G^* for the 10-, nine-, and four-cluster designs across all replications were 5.17, 3.7, and 2.8 respectively.

C Appendix – Data Management

The procedure used by Morissette et al. (2015) (MCL, henceforth) to estimate university enrollment is described in detail in the appendix of their paper. This procedure borrows heavily from theirs.[36] Since 1999, the tax code has the following three variables that allow for inference of university enrollment rates:

- tuition fees for self
- educational deduction for full-time students
- educational deduction for part-time students

MCL use these variables to construct enrollment rates. Our procedure is as follows:

1. The total education deduction for full time students is divided by the maximum amount allowed per month by the Canada Revenue Agency.[37] This gives the total number of months the individual was enrolled full-time in college or university that year.
2. A similar calculation is performed for the part-time months.
3. An estimate of the months of full-time equivalent enrollment is derived. Full-time months are counted as 1.0 months and part-time months are counted as 0.6 months.
4. The amount claimed in tuition is divided by the number of months estimated in step 3. This yields estimated tuition per month.[38]
5. The monthly average tuition amount is multiplied by 8, to compute a full-time-equivalent annual amount.
6. The annual amount from step 5 is compared with 0.8 to two times the annual provincial average undergraduate tuition amount.[39] If the annual amount is within the interval, then the variable "university enrolled" is set equal to 1, and 0 otherwise.[40]

Building on the MCL procedure, we take advantage of the panel nature of the dataset to construct additional variables. We add the months variable from step 3 over all the years in the dataset to estimate the total months spent in university. We then compare this variable to a number of key thresholds. For "persistence," we estimate whether the individual completed two or more years of university by calculating whether the total number of months exceeded 16.

Similarly, we estimate whether someone graduated from university by comparing the total months variable to 24. University programs are typically 32 months in length in most of Canada,

[36] We are grateful to René Morissette for providing us with SAS code to implement the procedure.

[37] The maximum amounts come from either Morissette et al. (2015) or Neill (2013).

[38] To correctly estimate the average tuition, the amount reported is converted into a full-time-equivalent tuition amount.

[39] The values used are two-year averages, owing to the overlap of the school year and the tax year. The tuition values used from 1977 to 2011 come from these sources: 1977 to 2000: Johnson and Rahman (2005) (we thank David R. Johnson for providing us with these values); 2001 to 2008: MCL; 2009 to 2011: Statistics Canada Table B. 2.9 (http://www.statcan.gc.ca/pub/81-582-x/2014001/tbl/tblb2.9-eng.htm).

[40] Unfortunately for the purposes of this study, the tax system does not differentiate between college and university enrollment. The MCL procedure uses the fact that university tuition is much more costly than college tuition to infer university attendance. In 2013, average undergraduate university tuition in Canada was CA$5,772 (see Statistics Canada Table B, referenced in footnote 39), while average college tuition in Ontario was CA$1,900 (http://www.tcu.gov.on.ca/pepg/audiences/colleges/costs_coll.html#tuition).

but programs in Quebec and non-honours undergraduate programs elsewhere in Canada can be 24 months in length.[41]

Finally, university drop out is set equal to 1 if an individual: (i) was not already a university graduate, (ii) had previously been enrolled in university, and (iii) was not currently enrolled in university.

[41] The majority of drop outs occur early in university careers. Stinebrickner and Stinebrickner (2014) report that of those who dropped out—of one particular college—40% dropped out in year 1, 34.4% in year 2, and 25.1% in year 3.

Declaration of Interest

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