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Research article

A comparison of postsecondary enrolment trends between domestic and international students by field of study

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Abstract

Recent years have witnessed a small decrease of domestic student enrolments and a growing number of international students in Canadian postsecondary programs. This study examines the relationship of changes in domestic students' postsecondary enrolments with the influx of international students during the 2010s. This study provides one of the first empirical analyses of the relationship in the context of Canada, adding to the literature that had been based mainly on the United States and the United Kingdom. Using enrolment data from the Postsecondary Student Information System, a fixed-effects model was estimated to control for institution-specific characteristics and aggregate time effects. It found positive relationships between changes in domestic and international student enrolments within programs in science, technology, engineering and mathematics (STEM) at universities and in business, humanities, health, arts, social science and education—as well as legal studies, trades, services, natural resources and conservation—(BHASE) at colleges. An influx of 100 international students in STEM fields was associated with 141 additional domestic student enrolments in the same fields at universities. An increase in the enrollment of 100 international students BHASE programs was associated with 99 additional domestic students in these programs at colleges. Although this finding may be partly because of unobserved time-varying factors boosting enrolments of domestic and international students at the same time, it is consistent with the notion of cross-subsidization that high tuition fees paid by international students provide resources to maintain or expand some instructional programs and potentially subsidize domestic student enrolments. There was no evidence of cross-subsidization across programs. A decrease in the domestic young adult population was associated with a decrease in domestic student enrolments in BHASE programs. Trends in domestic and international students' tuition fees and trends of the postsecondary-age population were discussed to contextualize the results.

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Introduction

Postsecondary educational institutions play a key role in building the skill base for the Canadian labour market. However, such a role may become less straightforward with the rapid rise in international student enrolments. From 2010 to 2019, the number of international students enrolled in Canadian public postsecondary educational institutions more than doubled from 142,200 to 388,800, and their share of total postsecondary student enrolments increased from 7% to 18% (Crossman, Choi, & Hou, 2021). This increase varied by instructional program, level of study and province. For instance, the share of international student enrolments increased from 11% to 25% in programs in the science, technology, engineering and mathematics (STEM) fields, from 12% to 21% at the master's degree level, and from 7% to 22% in Ontario (Crossman, Choi, & Hou, 2021).

Unlike domestic students, most international students left Canada after graduation. Among international students who arrived in the 2000s, about 3 in 10 became landed immigrants within 10 years of their arrival (Choi, Crossman, & Hou, 2021). Thus, the majority of international students would not contribute the skills they acquired in Canadian educational institutions to the Canadian labour force. Some studies have found that international students subsidize higher education for domestic students by paying higher tuition fees in postsecondary institutions where tuition fee revenues are a major funding source for operational activities to maintain or expand instructional programs. In the meantime, there are some concerns that international students with strengths in math may push domestic students away from STEM-related programs. If international students reduce the opportunities for domestic students to study in STEM fields and many of them leave Canada after graduation, increased enrolment of international students may weaken the STEM workforce in Canada. However, if international students subsidize higher education for domestic students, increased enrolment of international students may strengthen Canada's skilled workforce. Knowledge about how domestic student enrolment is related to international student enrolment in postsecondary education, particularly in STEM-related programs, would inform the design of policies affecting the growth of the science and engineering workforce and the admittance of international students into the country.

Empirical studies have produced mixed findings, and the direction and strength of the association between domestic and international student enrolments in postsecondary programs seem to depend on instructional programs and levels of study. Some studies suggested a crowding-out effect of international students on domestic enrolments in U.S. graduate and undergraduate programs (Borjas, 2007; Shen, 2016). The crowding-out effect refers to the possibility that a large increase in international students would reduce the enrolment of domestic students if the absorptive capacities of some institutions or programs are not sufficiently expanded (Borjas, 2007). In contrast, other studies found no evidence of crowding-out effects in undergraduate programs (Jackson, 2015; Machin & Murphy, 2017) but found crowd-in effects of international students on domestic student enrolments in graduate programs (Shih, 2017; Machin & Murphy, 2017; Abegaz, Lahiri, & Morshed, 2020). The net higher tuition fees collected from international students would provide resources to maintain or expand some instructional programs and help subsidize the cost for domestic students (Shih, 2017). Universities with a higher share of international graduates had a higher number of graduates relative to comparable universities, suggesting that foreign graduates may have positive spillover effects on overall graduation performance, including domestic students' graduation (Abegaz, Lahiri, & Morshed, 2020).

Previous research on the association between domestic and international student enrolments mostly used data from the United States (Shih, 2017; Borjas, 2007; Jackson, 2015; Shen, 2016; Abegaz, Lahiri, & Morshed, 2020) and the United Kingdom (Machin & Murphy, 2017). It is important to understand the relationship between domestic and international student enrolments in the context of relevant regulations on domestic and international enrolments because the regulations can be different across countries and also across levels of study within the same jurisdiction. For example, a U.K. study found no evidence of

crowding out for domestic enrolments in undergraduate programs where the number of subsidized domestic enrolments was regulated by quotas, but found evidence of crowd-in effects in postgraduate programs where such quotas were not applied (Machin & Murphy, 2017). In Canada, provincial and territorial governments have jurisdiction over postsecondary education, and subsidies from the governments are one of the major sources of funding for publicly funded universities and colleges.[1] The total amount of the subsidies is distributed across institutions according to a funding formula specific to a province or territory (e.g., an enrolment-weighted formula in Quebec, Ontario and Saskatchewan, and yearly adjustments to a historical base in other provinces) (Usher, 2021). While tuition fee structures are regulated at the provincial or territorial level in Canada, there is no regulation on enrolment capacity in a postsecondary institution (Council of Ministers of Education, Canada, n.d.). Since publicly funded Canadian universities have autonomy over their admission standards and program offerings (Council of Ministers of Education, Canada, n.d.), policies on school enrolment may differ across institutions. Although Statistics Canada annually releases national statistics on the enrolments of domestic and international students in publicly funded Canadian universities and colleges, no known studies have examined such associations in the context of Canada using national data.

This study examines whether domestic student enrolments have increased or decreased in programs that have experienced a large growth of international student enrolments in Canadian postsecondary institutions. It uses the administrative data from the Postsecondary Student Information System (PSIS) that cover enrolments in publicly funded postsecondary institutions in Canada. First, descriptive analysis shows the trends in enrolments among domestic and international students from academic year 2010/2011 to 2019/2020. The analysis was further broken down by field of study (STEM vs. BHASE[2]), institution type (university vs. college), level of study (below bachelor's degree, bachelor's degree, master's degree and doctoral degree), and province. Trends in tuition fees among domestic and international students and trends in the population aged 18 to 24—ages of typical postsecondary students—are also presented. Next, to assess the association between domestic and international student enrolments, in addition to simple correlation, a panel fixed-effects regression technique is used to reduce the influence of fixed characteristics of institutions and time effects. The unit of analysis is educational institutions. The outcome variable is the yearly change in the number of domestic student enrolments. The focal independent variable is the yearly change in the number of international student enrolments. Two broad fields of study were examined separately to examine whether changes in domestic enrolments in a field of study were correlated with changes in international enrolments in the field or at the institution level. Subgroup analysis by field of study was also further broken down by institution type and level of study to investigate whether the relationship varied by these program characteristics.

Data and methods

Data from the PSIS were used in this study.[3] The PSIS collects detailed information on student enrolments from public and not-for-profit private postsecondary institutions that are funded by a provincial or territorial government, including enrolment year (in terms of academic year), status of the student in

1. Student enrolments in universities and colleges are also subsidized by the federal government through research grants to institutions, indirect transfers via funds included in the Canada Social Transfer to provincial and territorial governments, and the provision of student loans and tax credits directly to students (Usher, 2021).
2. BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation.
3. This study used the PSIS data that were available at the time of data analysis (June 2022). Since the PSIS is annually updated with historical revisions, the results presented in this report may not exactly match the results from the up-to-date dataset.

Canada (domestic student or international student), institution type (university or college), field of study (the 2016 Classification of Instructional Programs) and province of study. This dataset has the strength of covering virtually all enrolments in provincially funded postsecondary institutions. However, this data source also has limitations, especially in its exclusion of postsecondary enrolments in privately funded institutions or non-provincially funded public institutions.[4,5,6]

Enrolments during the period of academic years from 2010/2011 to 2019/2020, the most recent year available at the time of study, were analyzed. This study used a fall snapshot of enrolments measured on a single date of the fall semester (between September 30 and December 1) chosen by the institution. Enrolments are defined as program enrolments in this study, unless they are specified as the number of students. For example, a student with a double major is counted toward two program enrolments. Generally, program enrolments are slightly larger than the number of students enrolled at an institution, but results based on the number of students were not very different from results based on program enrolments.

Descriptive analysis was first conducted to provide an overview of enrolment trends of domestic and international students in postsecondary programs from academic year 2010/2011 to 2019/2020. Average yearly growth rates of domestic and international enrolments were presented for two periods: from 2010/2011 to 2015/2016 and from 2015/2016 to 2019/2020. These average growth rates in the two periods showed whether enrolment changes were different in the years after regulations on study permit holders' off-campus work hours were eased on June 1, 2014. Since a postsecondary program application process typically starts in the fall of the year before the intended academic year when students want to begin their studies, academic year 2015/2016 was the first academic year when newly admitted international students' enrolment decisions were affected by the change. Yearly enrolment changes were examined separately for field of study, institution type, level of study and province.

This study distinguishes between domestic students and international students by their immigrant status at the time of enrolment. Domestic students encompass both Canadian citizens (including Indigenous people in Canada) and permanent residents. International students include those with a study permit, those with other visa status or no visa status, and refugees.

For fields of study, two broad groupings were used. The STEM fields of study comprise science, technology, engineering and mathematics. Non-STEM fields of study were named as the BHASE fields of study, which encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation. For each of the STEM and BHASE groupings, yearly changes for two detailed fields of study (engineering and engineering technology, and mathematics and computer and information sciences as the STEM fields; business and administration, and arts and humanities as the BHASE fields) that had a larger number of international student enrolments in 2019/2020 were also presented.

Levels of study were defined based on the United Nations Educational, Scientific and Cultural Organization's International Standard Classification of Education and grouped into postsecondary non-

4. According to Martin and MacLaine (2016), there were 1,300 private career colleges across Canada, which focus on career-oriented vocational training, with over 170,000 students enrolled annually. However, enrolment data from these institutions are unavailable.
5. Some students from Ontario private colleges can be enrolled in the on-campus courses provided in publicly funded colleges through Ontario's public-private college partnerships program. These students may be recorded in the PSIS, but there is no flag variable to identify them.
6. An example of non-provincially funded public institutions is the Royal Military College of Canada, which is mainly funded by the federal government.

tertiary education, short-cycle tertiary education[7], bachelor's or equivalent, master's or equivalent, doctoral or equivalent, and not applicable.

Empirical specification for regression analysis

Two regression models were estimated to examine whether changes in domestic student enrolments were correlated with the influx of international student enrolments in the 2010s. Similar to Shih (2017), the outcome variable is year-on-year changes in domestic student enrolments $(\Delta D_{it} = D_{it} - D_{it-1})$, and the key explanatory variable is the influx of international student enrolments measured as year-on-year changes $(\Delta F_{it} = F_{it} - F_{it-1})$ for institution *i* and year *t* (as the start year of the academic year).

First, a simple correlation between year-on-year changes in domestic and international student enrolments was calculated using a simple ordinary least squares (OLS) regression with the following specification:

$$\Delta D_{it} = \alpha + \delta_1 \Delta F_{it} + \epsilon_{it} \quad (1)$$

Coefficient δ_1 measures the unadjusted correlation between changes in domestic and international enrolment, which falls under the influence of institution-specific characteristics and aggregate time trends. While the above model of first-differencing of enrolments eliminates the influence of the institution's time-invariant characteristics correlated with the level of enrolments, it does not take into account the possible effect of changes in the characteristics of a particular institution. For instance, an institution may change its programs, admission standards and enrolment capacity, all of which may affect the change in the enrolment of both domestic and international students. To examine correlations after accounting for possible changes in institution-specific characteristics and time effects, a fixed-effects model was estimated with the following specification:

$$\Delta D_{ipt} = \alpha + \beta_1 \Delta F_{ipt} + \gamma_t + \gamma_i + \pi_1 \Delta PSagePOP_{pt} + \epsilon_{ipt} \quad (2)$$

Year dummies (γ_t) capture any time trends and aggregate shocks affecting domestic enrolment growth in all institutions nationwide. The institution fixed effects (γ_i) account for unobserved institution characteristics correlated with a growth of domestic student enrolments. In addition, the fixed-effects model controls for changes in the domestic youth population. Variable $\Delta PSagePOP_{pt}$ represents year-on-year change in the Canadian-born and immigrant population (i.e., domestic population) at the typical postsecondary education age (18 to 24) in province *p*. It includes the inflow of immigrants from year *t*-1 to year *t* and emigration but excludes a net flow of temporary residents because international students add to temporary residents. It was included in the model to measure changes in the domestic demand for Canadian postsecondary education.[8]

The coefficient β_1 provides an estimate of the correlation between changes in domestic and international enrolments after adjusting for institution-specific characteristics, aggregate time trends and the domestic

7. Short-cycle tertiary education includes diploma or professional certificate programs in colleges and universities (e.g. early childhood education programs and business diploma programs in colleges) - typically shorter than 4-year bachelor's degree programs.
8. $\Delta PSagePOP_{pt}$ was calculated as $POP_{p,t}^{18-24} - POP_{p,t-1}^{18-24} - \Delta NPR_{p,t}^{18-24}$, where $POP_{p,t}^{18-24}$ is a population estimate at ages 18 to 24 in province *p* in year *t* and $\Delta NPR_{p,t}^{18-24}$ is a net flow of non-permanent residents aged 18 to 24 in province *p* from year *t*-1 to year *t*. Data sources were from Statistics Canada (2022**a**; 2022**b**).

population of youth aged 18 to 24. The fixed-effects model provides a superior estimate to an OLS model because it controls for unobserved heterogeneity across institutions. This estimate still needs to be interpreted with caution because the fixed-effects model is not immune to bias resulting from time-varying unobservable factors and is therefore not sufficient to identify a causal relationship between changes in international and domestic enrolments.

A positive sign in the estimates of the coefficients δ_1 and β_1 indicates that a larger influx of international students was correlated with a larger increase or a smaller decrease in domestic student enrolments. Similarly, negative estimates of the coefficients indicate that a larger influx of international students was correlated with a smaller increase or a larger decrease in domestic student enrolments. The two regression models were first estimated for all fields of study, then estimated separately for the STEM and BHASE fields. Two versions of the subgroup analysis were carried out to determine whether the relationship existed within the boundary of the same fields of study or institution-wide across the fields of the study. Both versions of the subgroup analysis used the outcome variable of the year-on-year changes in domestic student enrolments in study field *s*, ΔD_{ipt}^{s}. However, they differed in terms of their key explanatory variable. The first version used the influx of international students in study field *s*, ΔF_{ipt}^{s}, as a key explanatory variable, and a positive coefficient on ΔF_{ipt}^{s} is interpreted as a positive correlation between domestic and international enrolment growth within the fields of study. This specification assesses whether the correlation between domestic and international enrolment growth (e.g., crowding out or subsidizing) was limited within the fields of study. Meanwhile, the second version used field-specific outcome ΔD_{ipt}^{s} and the institution-wide influx of international students ΔF_{ipt} as a key explanatory variable. This specification assesses whether domestic enrolment growth in a particular field was related to the growth of international enrolments at the institutional level (e.g., international students' tuition fees collected at the institutional level could subsidize the operations in a field of study that does not attract many international students). A positive coefficient on ΔF_{ipt} indicates that domestic enrolment growth in field *s* had a positive correlation with international enrolment growth at the institution level.

For the regression analysis, standard errors were clustered by institution to take into account serial correlation within an institution. Each institution was weighted by its enrolment size.[9]

Sample

The unit of observation in the regression analysis is an educational institution. If a university or college has more than one campus, each campus was analyzed as a separate institution. The regression sample consists of postsecondary institutions that were consistently observed every academic year from 2010/2011 to 2019/2020. The PSIS used an imputation procedure to infer some information for a small number of institutions that failed to provide microdata of enrolments. The imputed institutions were excluded from the sample. Also, records for offshore campuses of Canadian universities were excluded. The balanced sample excludes institutions that were newly established, closed permanently or imputed

9. The square root of group size is commonly used as a weight in regression models with group-level data to address possible heteroskedasticity correlated with group size. Following Solon, Haider, and Wooldridge (2015), a diagnostic test was performed to check the heteroskedasticity issue. The diagnostic test result showed no evidence of heteroskedasticity in an unweighted institution fixed-effects model. This study presents results based on regression models using enrolment sizes of postsecondary programs as weights. Unweighted models and models weighted by the square root of group size were also estimated. Three sets of results (unweighted, weighted with enrolment sizes and weighted with the square root of enrolment sizes) showed some differences in the statistical significance of coefficients of key variables for some subgroup analysis. However, the signs of the coefficients were the same in all three sets of results. When the main results and unweighted results were different, differences were discussed in a footnote.

for at least one year during the period of interest. As a result, an extensive margin of enrolments through the establishment of new institutions to meet increased demand for Canadian postsecondary education or the closure of existing institutions because of a lack of demand was not examined. Also, postsecondary institutions in the territories were excluded because very few international students were in these regions. The restriction of 10 years of observations (i.e., nine observations of year-on-year changes) excluded a total of 61 institutions, consisting of 32 universities and 29 colleges. Three in five excluded universities and two in five excluded colleges were located in Ontario. The final sample used for the regression analysis includes a total of 236 institutions, with 107 universities and 129 colleges.[10]

For each institution, enrolments of domestic and international students were counted at a single date of the fall semester in each academic year. Enrolments of students with unknown immigrant status in Canada and enrolments in upper secondary programs were not included.

Descriptive results

Trends in postsecondary enrolments of domestic and international students

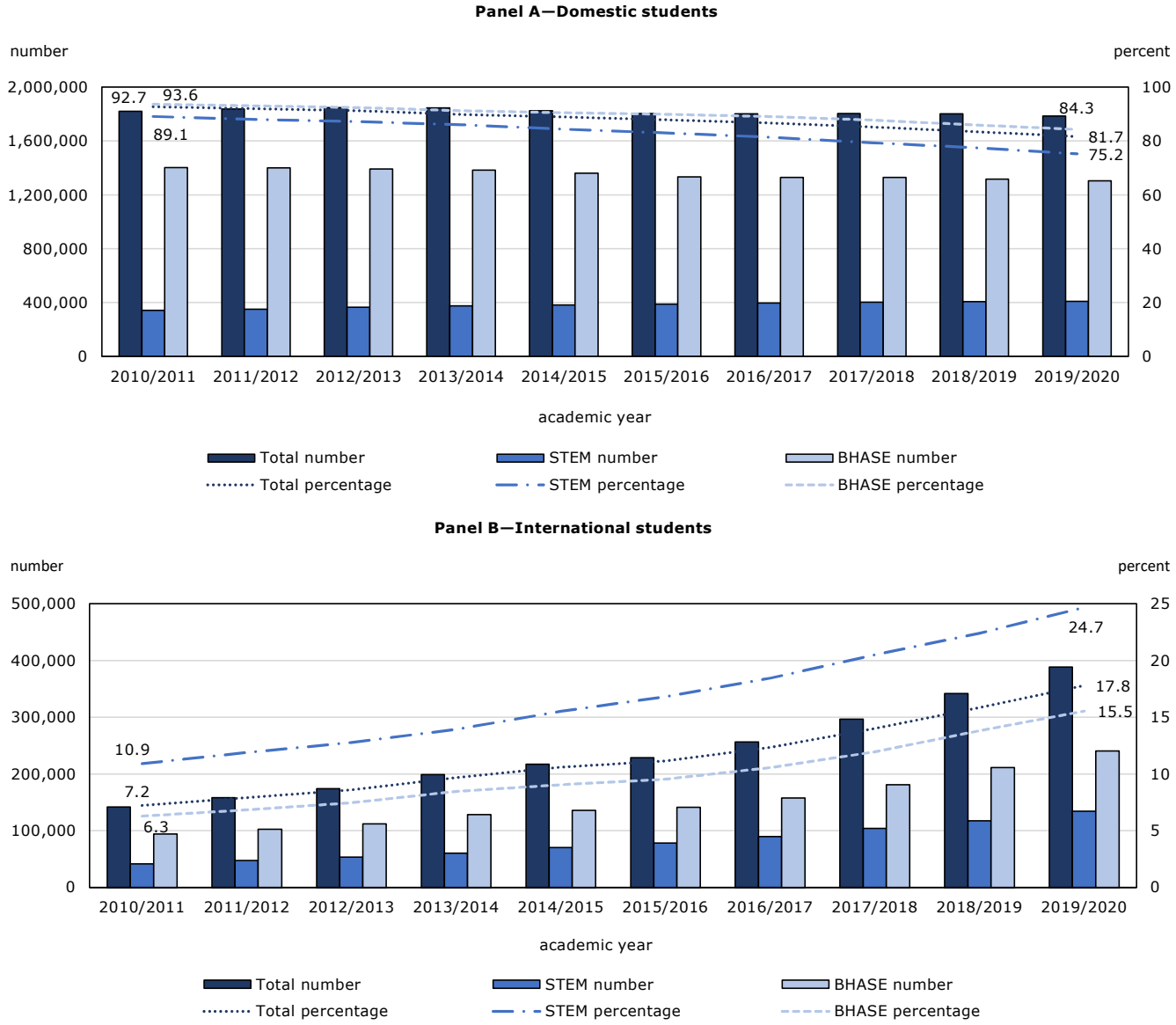
According to official estimates from Statistics Canada, overall, domestic student enrolments increased from 1,821,246 in 2010/2011 to 1,847,490 in 2012/2013 and decreased gradually over the following years to 1,784,181 in 2019/2020 (Panel A of Chart 1). There was a growing trend of domestic enrolments in the STEM fields, increasing from 342,375 in 2010/2011 to 410,256 in 2019/2020. In contrast, the BHASE fields showed a downward trend, decreasing from 1,403,241 in 2010/2011 to 1,305,492 in 2019/2020.

Domestic students accounted for 92.7% of total enrolments in postsecondary programs in 2010/2011, and the percentage steadily decreased to 81.7% in 2019/2020 (Panel A of Chart 1). The percentage of domestic student enrolments decreased in both the STEM and BHASE fields but at a faster pace in the STEM fields than in the BHASE fields. Over the 10-year period, domestic enrolment shares decreased by 13.9 percentage points from 89.1% to 75.2% in the STEM fields and by 9.3 percentage points from 93.6% to 84.3% in the BHASE fields.

Over the same period, the number and percentage of international student enrolments in postsecondary programs steadily rose (Panel B of Chart 1). International student enrolments grew in number from 142,170 in 2010/2011 to 388,782 in 2019/2020 and in percentage from 7.2% to 17.8% of total enrolments. These upward trends were found in both the STEM and BHASE fields. From 2010/2011 to 2019/2020, the number of international student enrolments in the STEM fields more than tripled from 41,943 to 134,664, and the number in the BHASE fields more than doubled from 94,404 to 240,711. International student enrolments as a percentage of total enrolments more than doubled in both fields (from 10.9% to 24.7% in the STEM fields and from 6.3% to 15.5% in the BHASE fields).

10. Quebec has disproportionately more colleges than other provinces, likely because of its provincial education system requiring a diploma from a CEGEP for admission to a university.

Chart 1
Number and percentage of domestic and international student enrolments in postsecondary program



Notes: The STEM fields of study comprise science, technology, engineering and mathematics. The BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation.
Source: Statistics Canada, Table 37-10-0184-01 Postsecondary enrolments, by status of student in Canada, country of citizenship and Classification of Instructional Programs, STEM and BHASE groupings.

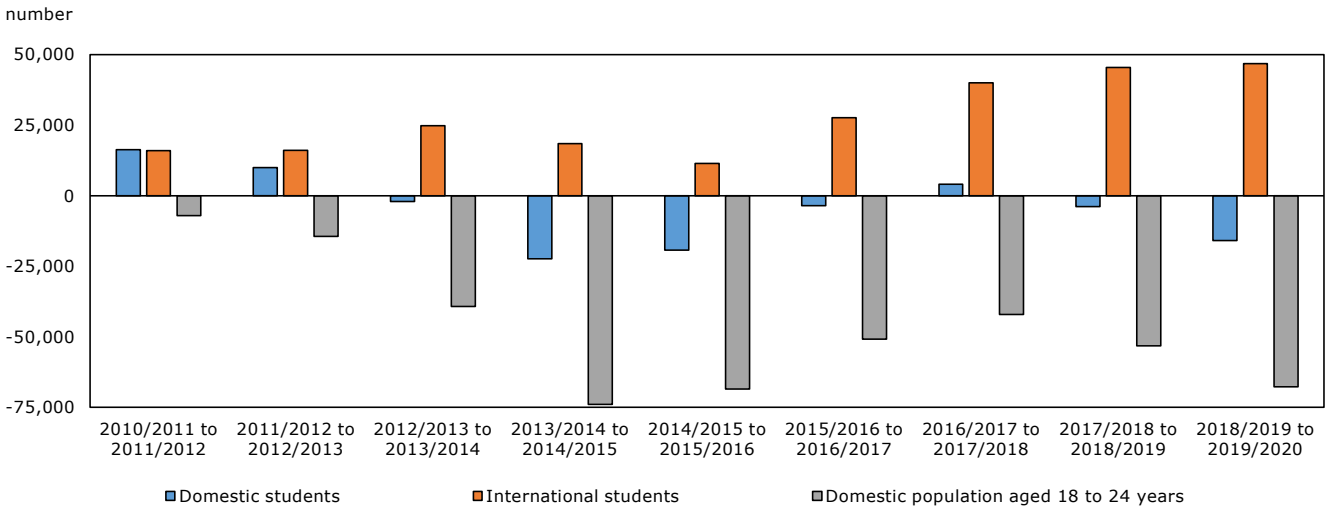
Trends in yearly changes in postsecondary enrolments

Chart 2 shows year-on-year changes in the number of domestic student enrolments, together with year-on-year changes in the domestic population of young adults aged 18 to 24, which represents the age range of typical postsecondary students. The year-on-year changes in the domestic population of postsecondary students do not include the year-on-year changes in temporary residents, which encompass international students, temporary foreign workers and refugees.

As seen in Chart 2, domestic student enrolments grew from 2010/2011 to 2012/2013 but shrank every academic year from 2012/2013 to 2019/2020, except from 2016/2017 to 2017/2018. The size of the yearly decrease was largest in 2013/2014 and became smaller until 2016/2017. However, domestic student enrolments began to shrink again from 2017/2018, and annual decreases have grown in size since then. At the same time, the Canadian (Canadian-born and immigrant) population aged 18 to 24 decreased every year. Overall, the annual decreases in the domestic population at the typical postsecondary education age displayed patterns similar to the year-on-year changes in domestic student enrolments.

Meanwhile, there was an influx of international students to postsecondary institutions every academic year since 2010/2011, with the influx increasing in size since academic year 2015/2016.

Chart 2
Year-on-year changes in domestic and international student enrolments and the population of young adults aged 18 to 24



Sources: Statistics Canada, tables 37-10-0184-01, 17-10-0005-01 and 17-10-0014-01.

Yearly changes in enrolments by selected characteristics

Yearly changes in domestic and international students were examined in two periods—the early 2010s (2010/2011 to 2015/2016) and the late 2010s (2015/2016 to 2019/2020)—to assess whether enrolment changes were different in the years after the easing of limits to study permit holders' off-campus work hours (Table 1). Overall, domestic student enrolments decreased at a similar pace in the two periods, whereas international student enrolments increased at a faster pace in the second half of the 2010s. The average annual growth rate of international student enrolments increased from 10.0% in the early 2010s to 14.2% in the late 2010s.

Yearly changes in enrolments by institution type

When enrolments at universities and colleges were examined separately, on average, a decrease in domestic student enrolments was found for colleges but not for universities (Table 1). Domestic student enrolments in colleges decreased at an average annual growth rate of -0.8% to -0.9% in the 2010s, while those in universities increased at an average rate of 0.1% to 0.2% per year. International student enrolments increased both in universities and colleges. In particular, growth in international student enrolments in colleges accelerated in the late 2010s, with the average annual growth rate increasing from 11.7% in the early 2010s to 26.3% in the late 2010s. Since colleges tend to offer shorter programs than universities, it is possible that an increasing number of international students who intended to receive a Post-Graduation Work Permit and immigrate to Canada chose colleges over universities.

Table 1
Number and yearly changes of domestic and international student enrolments by institution type, field of study and level of study, 2010/2012 to 2019/2020

	Number of enrolments			Average yearly changes	
	2010/2011	2015/2016	2019/2020	2010/2011 to 2015/2016	2015/2016 to 2019/2020
	number			percent	
Total	1,964,640	2,053,737	2,183,973	0.9	1.5
Canadian students	1,821,246	1,803,708	1,784,181	-0.2	-0.3
International students	142,170	228,924	388,782	10.0	14.2
Not reported	1,224	21,105	11,010	76.7	-15.0
By institution type					
University					
Canadian students	1,126,551	1,136,901	1,142,091	0.2	0.1
International students	107,514	168,606	235,419	9.4	8.7
College					
Canadian students	694,695	666,810	642,090	-0.8	-0.9
International students	34,653	60,318	153,360	11.7	26.3
By field of study					
STEM					
Canadian students	342,375	388,821	410,256	2.6	1.4
International students	41,943	78,759	134,664	13.4	14.4
Engineering and engineering technology					
Canadian students	118,968	136,815	135,918	2.8	-0.2
International students	19,650	36,447	55,608	13.2	11.1
Mathematics and computer and information sciences					
Canadian students	48,939	61,488	80,937	4.7	7.1
International students	9,447	19,803	44,427	16.0	22.4
BHASE					
Canadian students	1,403,241	1,333,269	1,305,492	-1.0	-0.5
International students	94,404	141,444	240,711	8.4	14.2
Business and administration					
Canadian students	283,122	277,200	265,593	-0.4	-1.1
International students	38,463	60,945	112,911	9.6	16.7
Arts and humanities					
Canadian students	380,733	302,100	276,873	-4.5	-2.2
International students	23,343	28,104	40,872	3.8	9.8
By level of study					
Postsecondary non-tertiary education					
Canadian students	244,758	235,440	211,053	-0.8	-2.7
International students	5,118	11,241	25,416	17.0	22.6
Short-cycle tertiary education					
Canadian students	312,636	316,818	317,769	0.3	0.1
International students	21,933	41,613	110,367	13.7	27.6
Bachelor's or equivalent					
Canadian students	886,506	906,663	910,575	0.5	0.1
International students	66,120	109,629	160,842	10.6	10.1
Master's or equivalent					
Canadian students	151,530	162,822	170,748	1.4	1.2
International students	20,391	31,611	45,438	9.2	9.5
Doctoral or equivalent					
Canadian students	36,420	35,676	36,012	-0.4	0.2
International students	11,316	16,749	20,871	8.2	5.7
Not applicable, International Standard Classification of Education					
Canadian students	156,690	121,689	111,852	-4.9	-2.1
International students	12,477	14,682	22,749	3.3	11.6

Notes: The STEM fields of study comprise science, technology, engineering and mathematics. The BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation.

Source: Statistics Canada, Table 37-10-0184-01 Postsecondary enrolments, by status of student in Canada, country of citizenship and Classification of Instructional Programs, STEM and BHASE groupings.

Yearly changes in enrolments by field of study

Over the 2010s, the STEM fields attracted increasingly more Canadian and international students (Table 1). The average growth rate of enrolments was much higher for international students than domestic students (13.4% vs. 2.6%, respectively, in the early 2010s). The enrolment trends varied across detailed fields of study within the STEM fields. In the fields of engineering and engineering technology, domestic student enrolments stagnated in the late 2010s and international student enrolments grew at a slower pace in the late 2010s than in the early 2010s. In contrast, enrolments in the fields of mathematics and computer and information sciences expanded throughout the 2010s, and at a faster pace in the late 2010s for both domestic and international students. In particular, the average growth rate of international student enrolments increased from 16.0% in the early 2010s to 22.4% in the late 2010s.

In the BHASE fields, domestic student enrolments decreased continuously at a slow pace, but international student enrolments grew steadily. The average annual growth rate of international students in the BHASE fields increased from 8.4% in the early 2010s to 14.2% in the late 2010s, which was almost the same rate as in the STEM fields (14.4%). Trends in the annual growth rates were similar in the two largest sub-fields in the BHASE fields—business and administration, and arts and humanities. In terms of changes in the number of enrolments, the increase in international student enrolments exceeded the decrease in domestic students in the fields of business and administration, and total enrolments expanded. Meanwhile, in the fields of arts and humanities, the decrease in domestic student enrolments outnumbered the increase in international students, leading to a decrease in total enrolments in those fields.

Yearly changes in enrolments by level of study

When changes in enrolments were examined by level of study, domestic student enrolments did not shrink in short-cycle tertiary education and bachelor's and master's degree programs in the 2010s (Table 1). In particular, master's degree programs admitted a growing number of domestic students, and domestic enrolments in these programs increased by 12.7% from 2010/2011 to 2019/2020. Domestic student enrolments in short-cycle tertiary education (1.6%, or 5,133 in number) and bachelor's degree programs (2.7%, or 24,069 in number) also had small increases over the nine years. Meanwhile, doctoral programs lost a small number of domestic enrolments in the early 2010s but kept their enrolment size relatively stable at around 36,600. Most decreases in domestic enrolments came from postsecondary non-tertiary education programs (-13.8%, or 33,705 in number) and some postsecondary programs that were not classified as the other five levels of study (-28.6%, or 44,838 in number).

In the early 2010s, postsecondary non-tertiary education had the fastest growth in international student enrolments, followed by short-cycle tertiary education. These two levels of study experienced a further large increase in the late 2010s. In particular, the average annual growth rate in short-cycle tertiary education programs increased from 13.7% in the early 2010s to 27.6% in the late 2010s, leading to a nearly fivefold increase in the number of international student enrolments from 21,933 to 110,367 during the 2010s. The average annual growth rates of international student enrolments in bachelor's and master's programs were significant and remained similar in the first and second halves of the 2010s. International student enrolments in bachelor's programs increased by about 10% per year on average (from 66,120 in 2010/2011 to 160,842 in 2019/2020), while their enrolments in master's programs increased by about 9% per year on average (from 151,530 to 170,748).

Yearly changes in enrolments by province

Different patterns of changes in domestic and international students were found across the provinces (Table 2). In the early 2010s, domestic student enrolments decreased in most provinces, except for

Quebec and Saskatchewan. The slowest decrease was found in Ontario, with -0.2% of the average annual growth rate, and the fastest contraction was in New Brunswick (-3.8%). Compared with the early 2010s, in the late 2010s, Quebec and Saskatchewan experienced a decrease in domestic student enrolments, and Newfoundland and Labrador showed a faster decline. While domestic student enrolments in many provinces decreased steadily in the late 2010s, those in Prince Edward Island and Alberta increased.

Most provinces experienced an increase in international student enrolments in the early 2010s, except for New Brunswick. Manitoba had the fastest growth in international student enrolments, with an average annual growth rate of 16.8%. International student enrolments in Nova Scotia, Quebec and Alberta increased at a growth rate slightly slower than the national average (10.0%). In the late 2010s, the growth of international student enrolments accelerated considerably in Prince Edward Island, Nova Scotia and Ontario. In particular, international student enrolments in Ontario doubled from 96,492 in 2015/2016 to 192,906 in 2019/2020, with an average annual growth rate of 18.9%, well above the average growth rates in the other provinces, except for Prince Edward Island (24.7%). The growth of international student enrolments in Alberta and British Columbia increased in pace slightly in the late 2010s, but it slowed down in Manitoba and Saskatchewan.

Table 2
Number and yearly changes of domestic and international student enrolments by province, 2010/2012 to 2019/2020

	Number of enrolments			Average yearly changes	
	2010/2011	2015/2016	2019/2020	2010/2011 to 2015/2016	2015/2016 to 2019/2020
	number			percent	
Total	1,964,640	2,053,737	2,183,973	0.9	1.5
Canadian students	1,821,246	1,803,708	1,784,181	-0.2	-0.3
International students	142,170	228,924	388,782	10.0	14.2
By province					
Newfoundland and Labrador					
Canadian students	27,099	24,573	21,507	-1.9	-3.3
International students	1,401	2,406	3,741	11.4	11.7
Prince Edward Island					
Canadian students	5,643	5,529	6,498	-0.4	4.1
International students	483	831	2,007	11.5	24.7
Nova Scotia					
Canadian students	49,443	46,431	44,094	-1.2	-1.3
International students	5,082	7,662	12,939	8.6	14.0
New Brunswick					
Canadian students	29,403	24,174	23,505	-3.8	-0.7
International students	3,528	3,342	4,404	-1.1	7.1
Quebec					
Canadian students	471,531	489,999	470,040	0.8	-1.0
International students	29,460	43,107	59,700	7.9	8.5
Ontario					
Canadian students	713,682	706,866	705,303	-0.2	-0.1
International students	56,058	96,492	192,906	11.5	18.9
Manitoba					
Canadian students	58,551	55,332	54,171	-1.1	-0.5
International students	3,450	7,509	10,617	16.8	9.0
Saskatchewan					
Canadian students	48,540	51,054	48,747	1.0	-1.1
International students	2,910	5,037	6,909	11.6	8.2
Alberta					
Canadian students	174,870	167,946	179,178	-0.8	1.6
International students	12,210	17,478	24,636	7.4	9.0
British Columbia					
Canadian students	241,305	228,351	226,488	-1.1	-0.2
International students	27,582	45,054	70,917	10.3	12.0

Source: Statistics Canada, Table 37-10-0184-01 Postsecondary enrolments, by status of student in Canada, country of citizenship and Classification of Instructional Programs, STEM and BHASE groupings.

Regression results

In this section, regression models were estimated to examine the relationship between changes in domestic student enrolments and the influx of international students in postsecondary programs. Motivated by the variations in changes in domestic and international student enrolments across fields of study, subgroup analyses were carried out for the STEM and BHASE fields.

Baseline results

Regression results from a simple OLS model with the specification in Equation (1) and a fixed-effects model with the specification in Equation (2) are reported in Table 3. In the simple OLS model, the coefficient on year-on-year change in international students was positive but not statistically different from zero. When institution fixed effects, time fixed effects and changes in the domestic youth population were considered in the model, the coefficient increased but was still not statistically significant. Both models suggested no statistically significant relationship between changes in domestic and international student enrolments during the period from 2010/2011 to 2019/2020. According to the fixed-effects model, changes in the population of postsecondary education age had a positive relationship with changes in domestic student enrolment.

Subgroup analysis by field of study: STEM and BHASE

In this section, the relationship between changes in domestic student enrolments and the influx of international students was examined separately for the STEM and BHASE fields. Furthermore, analyses were carried out to disentangle whether the relationship existed within the same fields of study or institution-wide across the fields of study. Results are presented in Table 4.

When growth in both domestic and international enrolments was measured by field of study, the OLS results indicated a positive correlation between the growth in domestic and international student enrolments in the STEM fields. When institution-specific characteristics, time fixed effects and changes in the young adult population were considered, the correlation remained statistically significant.[11] Changes in the young adult population did not have a relationship with domestic enrolment growth in the STEM fields. For the BHASE fields, results after adjusting for institution and time fixed effects showed that changes in domestic enrolments in the BHASE fields were positively correlated with the influx of international students in the fields and changes in the typical postsecondary-age population.

The relationship between domestic enrolment changes in specific fields of study and changes in total international enrolments at the institution level was not statistically significant for STEM or BHASE fields. This result is not consistent with the notion of cross-subsidization across programs.

11. Unweighted results showed a positive coefficient on year-on-year change in international students, but it was not statistically significant. This difference between weighted and unweighted results may suggest that larger institutions had a positive relationship while smaller institutions had no or a weak relationship between the domestic and international enrolments within the STEM fields.

Table 3
Regression analysis: Simple ordinary least squares model and fixed-effects model

Outcome: Year-on-year change in domestic enrolment	Simple OLS model	Fixed-effects model
Year-on-year change in international enrolment		
Coefficient	0.454	0.830
Standard error	(0.419)	(0.517)
Changes in population aged 18 to 24 in study province		
Coefficient	…	0.024 **
Standard error	…	(0.007)
Year (reference year: 2011)		
2012		
Coefficient	…	120.415
Standard error	…	(79.560)
2013		
Coefficient	…	59.113
Standard error	…	(88.052)
2014		
Coefficient	…	-215.729
Standard error	…	(156.543)
2015		
Coefficient	…	241.067
Standard error	…	(146.261)
2016		
Coefficient	…	263.050 *
Standard error	…	(132.829)
2017		
Coefficient	…	298.629
Standard error	…	(199.581)
2018		
Coefficient	…	-14.682
Standard error	…	(168.362)
2019		
Coefficient	…	-172.766
Standard error	…	(167.103)
Institution fixed effects	No	Yes
Number of observations	2,124	2,124
R-squared	0.051	0.173
F-test	1.177	3.561
Number of institutions	236	236

… not applicable
* significantly different from reference category ($p < 0.05$)
** significantly different from reference category ($p < 0.01$)

Notes: OLS = ordinary least squares. Both models included a constant term. The OLS model was weighted with total enrolment at each year. The fixed-effects model was weighted with the total enrolment size in 2019. Standard errors in parentheses were clustered by institution.
Source: Statistics Canada, Postsecondary Student Information System.

Table 4
Subgroup analysis by field of study

	1) Both domestic and international enrolment by field of study				2) Domestic enrolment by field of study on total international enrolment			
	STEM		BHASE		STEM		BHASE	
Outcome: Year-on-year change in domestic enrolment	Simple OLS model	Fixed-effects model	Simple OLS model	Fixed-effects model	Simple OLS model	Fixed-effects model	Simple OLS model	Fixed-effects model
Year-on-year change in international enrolment								
Coefficient	0.776 *	1.217 *	0.438	0.964 **	0.314	0.340	0.136	0.467
Standard error	(0.353)	(0.590)	(0.276)	(0.366)	(0.178)	(0.245)	(0.255)	(0.292)
Changes in population aged 18 to 24 in study province								
Coefficient	…	0.005	…	0.015 *	…	0.005	…	0.015 *
Standard error	…	(0.003)	…	(0.007)	…	(0.003)	…	(0.007)
Year (reference year: 2011)								
2012								
Coefficient	…	112.059	…	148.050	…	113.223	…	167.109
Standard error	…	(72.725)	…	(193.423)	…	(76.197)	…	(211.303)
2013								
Coefficient	…	18.958	…	199.428	…	31.543	…	215.762
Standard error	…	(49.822)	…	(178.547)	…	(51.806)	…	(200.009)
2014								
Coefficient	…	-49.663	…	-63.417	…	6.174	…	-69.745
Standard error	…	(73.267)	…	(242.475)	…	(57.434)	…	(263.971)
2015								
Coefficient	…	68.234	…	144.312	…	142.430	…	143.664
Standard error	…	(70.577)	…	(113.915)	…	(97.913)	…	(118.855)
2016								
Coefficient	…	44.133	…	307.274 *	…	99.056	…	331.693 *
Standard error	…	(68.105)	…	(131.626)	…	(80.466)	…	(156.062)
2017								
Coefficient	…	62.608	…	243.600	…	137.586	…	259.284
Standard error	…	(96.284)	…	(190.610)	…	(136.835)	…	(231.637)
2018								
Coefficient	…	-67.127	…	62.475	…	-43.464	…	141.101
Standard error	…	(75.838)	…	(122.902)	…	(75.910)	…	(159.411)
2019								
Coefficient	…	-137.662	…	41.067	…	-74.816	…	84.033
Standard error	…	(77.170)	…	(151.844)	…	(77.305)	…	(220.705)
Constant								
Coefficient	9.469	-24.893	-156.983 **	-232.278	38.032	35.106	-124.535	-226.092
Standard error	(61.476)	(107.864)	(56.917)	(195.013)	(62.364)	(106.090)	(67.329)	(178.809)
Institution fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Number of observations	1,719	1,719	2,124	2,124	1,719	1,719	2,124	2,124
R-squared	0.225	0.291	0.022	0.103	0.167	0.174	0.005	0.065
F-test	4.832	2.230	2.513	4.373	3.106	3.317	0.282	4.204
Number of institutions	191	191	236	236	191	191	236	236

… not applicable

* significantly different from reference category ($p < 0.05$)

** significantly different from reference category ($p < 0.01$)

Notes: OLS = ordinary least squares. The STEM fields of study comprise science, technology, engineering and mathematics. The BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation. Both models included a constant term. The OLS model was weighted with the total enrolment size in the subgroup at each year. The fixed-effects model was weighted with the total enrolment size in the subgroup in 2019. Standard errors in parentheses were clustered by institution.

Source: Statistics Canada, Postsecondary Student Information System.

Subgroup analysis by field of study and institution type

Table 1 shows that domestic student enrolments in colleges but not in universities decreased in the 2010s, whereas international student enrolments in both universities and colleges increased but at a much faster pace in colleges. The two versions of subgroup analysis were carried out separately by institution type to examine whether the relationship between domestic and international enrolment growth was different for universities and colleges (Table 5).

When the relationship within the STEM fields was examined separately for universities and colleges, a positive relationship between domestic and international enrolment growth was found only for universities.[12] Also, changes in domestic enrolments in STEM programs at universities had a positive relationship with changes in the postsecondary-age population of Canadians and immigrants.

For enrolments in BHASE programs, a positive relationship between domestic and international enrolment growth within the fields was found only for colleges.[13] A strong positive correlation between changes in domestic enrolments in BHASE programs and changes in the postsecondary-age population was found only for universities.

Table 5
Subgroup analysis by field of study and institution type

	1) Both domestic and international enrolment by field of study			2) Domestic enrolment by field of study on total international enrolment		
	All	University	College	All	University	College
A. STEM						
Year-on-year change in international enrolment						
Coefficient	1.217 *	1.405 *	0.222	0.340	0.545	0.016
Standard error	(0.590)	(0.626)	(0.132)	(0.245)	(0.317)	(0.022)
Changes in population aged 18 to 24 in study province						
Coefficient	0.005	0.007*	0.002	0.005	0.008	0.003
Standard error	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)
Number of institutions	191	84	107	191	84	107
B. BHASE						
Year-on-year change in international enrolment	0.964 **	1.067	0.986 *	0.467	0.816	0.173
Coefficient	(0.366)	(0.609)	(0.482)	(0.292)	(0.469)	(0.105)
Standard error						
Changes in population aged 18 to 24 in study province						
Coefficient	0.015 *	0.025 **	-0.005	0.015 *	0.025 **	0.004
Standard error	(0.007)	(0.007)	(0.016)	(0.007)	(0.006)	(0.011)
Number of institutions	236	107	129	236	107	129

* significantly different from reference category ($p < 0.05$)
** significantly different from reference category ($p < 0.01$)

Notes: The STEM fields of study comprise science, technology, engineering and mathematics. The BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation. Fixed-effect models included a constant term and year dummies and were weighted with total enrolments in the subgroup in 2019. Standard errors in parentheses were clustered by institution.
Source: Statistics Canada, Postsecondary Student Information System.

Subgroup analysis by field of study and level of study

Table 6 shows results from examining the relationship between changes in domestic and international students in the same fields and levels of study. For the STEM fields, a positive relationship between

12. This relationship for universities was not statistically significant in the unweighted results. This difference between weighted and unweighted results may suggest that a positive relationship was concentrated among larger STEM programs at universities.
13. Unweighted results showed a statistically significant relationship between domestic enrolment changes in BHASE programs and changes in total international enrolments at the institution level at colleges. This difference between weighted and unweighted results may suggest that a positive relationship was concentrated among smaller BHASE college programs.

domestic and international enrolments in bachelor's degree or equivalent programs was found.[14] In graduate STEM programs, the corresponding coefficient was not statistically significant.

For the BHASE fields, changes in domestic student enrolments in postsecondary non-tertiary or short-cycle tertiary programs were positively correlated with changes in international student enrolments in the programs as well as at the intuitional level. The corresponding coefficient in undergraduate BHASE programs was similar to its counterpart for the STEM fields, but not statistically significant. Changes in domestic enrolments in graduate BHASE programs had a positive and statistically significant relationship with institution-wide changes in total international enrolments but not with changes in international enrolments in the same fields.[15]

Changes in the postsecondary-age population were positively correlated with domestic enrolments in graduate-level STEM programs. The relationship was strongest in undergraduate BHASE programs.

Table 6
Subgroup analysis by field and level of study

	1) Both domestic and international enrolment by field of study			2) Domestic enrolment by field of study on total international enrolment		
	Postsecondary non-tertiary or short-cycle tertiary	Bachelor's degree or equivalent	Graduate degree or equivalent	Postsecondary non-tertiary or short-cycle tertiary	Bachelor's degree or equivalent	Graduate degree or equivalent
A. STEM						
Year-on-year change in international enrolment						
Coefficient	0.239	1.601 *	0.042	0.004	0.518	0.014
Standard error	(0.164)	(0.730)	(0.099)	(0.023)	(0.294)	(0.017)
Changes in population aged 18 to 24 in study province						
Coefficient	0.004	0.006 *	0.003 *	0.005 *	0.007	0.003 *
Standard error	(0.002)	(0.003)	(0.001)	(0.002)	(0.004)	(0.001)
Number of institutions	113	100	62	113	100	62
B. BHASE						
Year-on-year change in international enrolment						
Coefficient	0.589 *	1.389	0.204	0.307 **	0.575	0.155 *
Standard error	(0.280)	(0.721)	(0.416)	(0.112)	(0.374)	(0.076)
Changes in population aged 18 to 24 in study province						
Coefficient	0.011	0.022 **	0.001	0.010	0.022 **	0.001
Standard error	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.005)
Number of institutions	150	138	82	150	138	82

* significantly different from reference category ($p < 0.05$)

** significantly different from reference category ($p < 0.01$)

Notes: The STEM fields of study comprise science, technology, engineering and mathematics. The BHASE fields of study encompass business, humanities, health, arts, social science and education, as well as legal studies, trades, services, natural resources and conservation. Fixed-effect models included a constant term and year dummies and were weighted with total enrolments in the subgroup in 2019. Standard errors in parentheses were clustered by institution.

Source: Statistics Canada, Postsecondary Student Information System.

14. This relationship was not statistically significant in the unweighted results. This difference between the weighted and unweighted results may suggest that a positive relationship was concentrated among bachelor-level STEM programs with larger enrolment sizes.
15. Unweighted results did not show a statistically significant relationship in both versions of the subgroup analysis for graduate BHASE programs. This difference between weighted and unweighted results may suggest that a positive relationship was concentrated among larger graduate BHASE programs.

Discussion

The regression analysis did not find a statistically significant institution-wide relationship between changes in domestic and international students. However, when institution-specific characteristics and time effects were accounted for, changes in domestic enrolments in STEM programs at universities and bachelor's degree STEM programs had a positive relationship with the influx of international students in the programs, but not at the institutional level across fields of study. Results were similar for changes in domestic enrolments in BHASE programs at colleges. For postsecondary non-tertiary or short-cycle tertiary programs in the BHASE fields, there was also a positive relationship between changes in domestic enrolments in this specific group and the institutional-level influx of international students. These results are different from those of Machin and Murphy (2017), which found no relationship in undergraduate programs in the United Kingdom where the number of subsidized domestic enrolments was regulated by quotas. Previous U.S. and U.K. studies also found crowd-in effects in graduate programs (Shih, 2017; Abegaz, Lahiri, & Morshed, 2020; Machin & Murphy, 2017). This study found differential results between the STEM and BHASE fields in Canadian graduate programs, finding a statistically significant and positive relationship in the BHASE fields but not in the STEM fields.

On the one hand, these positive relationships between changes in domestic and international enrolments may reflect a positive bias caused by some unobserved time-varying factors leading to changes in domestic and international enrolments at the same time. On the other hand, the findings from the regression analysis are consistent with the notion of cross-subsidization. Higher tuition fees collected from international students can provide resources to maintain or expand some instructional programs and potentially help subsidize the cost for domestic students (Shih, 2017). The cross-subsidization interpretation is also consistent with differences and changes in tuition for domestic and international students.

Table 7 shows the average tuition fees of full-time domestic and international students in undergraduate and graduate programs at publicly funded degree-granting institutions (universities and colleges) in academic year 2020/2021.[16] Overall, the average tuition fees for international students were higher than those for domestic students, with much larger differences in undergraduate programs than in graduate programs. The international-to-Canadian tuition fee ratio was 4.9 for undergraduate programs. The ratio was lower in the (undergraduate) specialty programs where domestic tuition fees were also high, such as in the fields of law, dentistry, medicine and pharmacy. However, the ratio in undergraduate STEM programs varied between 4.4 in engineering fields and 5.6 in the fields of physical and life sciences and technologies. Similarly, the ratio in undergraduate BHASE programs varied between 4.5 in the fields of business, management and public administration and 5.4 in the fields of social and behavioural sciences, and legal studies.

In the 2010s, tuition fees increased at a faster rate than the overall average prices of consumer goods and services measured by the annual Consumer Price Index (CPI). During the period from academic year 2010/2011 to 2020/2021, international students' tuition fees, especially for undergraduate programs, grew at a much faster pace than the fees for their domestic student counterparts. The average tuition fees of undergraduate Canadian students increased by 27.8% from $5,146 in 2010/2011 to $6,580 in 2020/2021 (Statistics Canada, 2022**c**), greater than the 17.6% increase of the CPI. During the 10 years, the average tuition fees for undergraduate international students grew by 90.2 percentage points from $16,842 to $32,039, and the growth in their fees did not slow down during the pandemic (Statistics Canada, 2022**d**). Over this same period, because of fast-growing average tuition fees and enrolments of international students, tuition fees from international students contributed more significantly to total tuition

16. The tuition fees do not include other compulsory fees (e.g., fees for athletic facilities or student associations) or living accommodation costs.

revenues of Canadian universities to make up for the reduction of provincial funding in universities' budgets for their operational activities (Statistics Canada, 2022**e**).

Table 7
Average undergraduate and graduate tuition fees of domestic and international students by field of study, academic year 2020/2021

	Undergraduate			Graduate		
Field of study	Canadian students (a)	International students (b)	International-to-Canadian tuition fee ratio (b/a)	Canadian students (c)	International students (d)	International-to-Canadian tuition fee ratio (c/d)
	dollars		times	dollars		times
Total, field of study	6,580	32,039	4.9	7,361	19,429	2.6
Education	4,801	22,842	4.8	6,523	17,135	2.6
Visual and performing arts, and communications technologies	5,843	27,431	4.7	5,506	15,619	2.8
Humanities	5,635	29,845	5.3	4,678	14,217	3.0
Social and behavioural sciences, and legal studies	5,639	30,320	5.4	6,008	16,040	2.7
Law	12,727	37,015	2.9	6,087	18,208	3.0
Business, management and public administration	6,864	31,095	4.5	14,052	26,472	1.9
Executive MBA	...	...	...	51,005	63,005	1.2
Regular MBA	...	...	...	29,065	39,674	1.4
Physical and life sciences and technologies	6,149	34,465	5.6	6,740	16,030	2.4
Mathematics, computer and information sciences	6,861	35,182	5.1	8,562	18,406	2.1
Engineering	8,067	35,527	4.4	7,037	21,717	3.1
Architecture	6,462	30,995	4.8	6,349	25,011	3.9
Agriculture, natural resources and conservation	5,693	28,661	5.0	5,896	14,886	2.5
Dentistry	22,408	56,244	2.5	12,995	25,120	1.9
Medicine	14,321	44,648	3.1	..	..	..
Nursing	5,685	23,105	4.1	6,532	16,192	2.5
Pharmacy	11,154	39,855	3.6	4,171	13,396	3.2
Veterinary medicine	14,162	65,652	4.6	3,948	9,163	2.3
Optometry	10,687	..	..	4,508	14,436	3.2
Other health, parks, recreation and fitness	5,993	24,973	4.2	8,570	19,620	2.3
Personal, protective and transportation services	5,777	26,861	4.6	4,500	12,550	2.8

.. not available for a specific reference period

... not applicable

Notes: Data were collected from publicly funded degree-granting institutions (universities and colleges). Degrees in scope include bachelor's degrees, applied (bachelor's) degrees, applied master's degrees, master's degrees, and doctoral degrees. The data do not include associate degrees, diplomas and certificates.

Sources: Statistics Canada, Tuition and Living Accommodation Costs Survey; and tables 37-10-0003-01, 37-10-0004-01, 37-10-0005-01 and 37-10-0006-01.

Caution must be exercised in interpreting the results of this study. First, these results may be specific to the period of interest in this study and thereby related to some of the demographic changes that occurred during the 2010s. For example, the population of young adults aged 18 to 24 declined from 462,009 in 2008 to 410,851 in 2021 (Statistics Canada, 2022**a**). This demographic change stemmed largely from decreases in the number of births throughout the 1990s and the early 2000s (Statistics Canada, 2022**f**). Declines in the domestic young adult population lowered domestic demand for postsecondary programs and left vacant room for international students. Also, the decrease in domestic student enrolments may be related to the reduction of provincial funding in departmental budgets, since domestic student enrolments are subsidized by provincial funding. Because of the demographic change, postsecondary

institutions may have needed to expand their international student enrolments and been able to do so without scaling domestic enrolments down.[17]

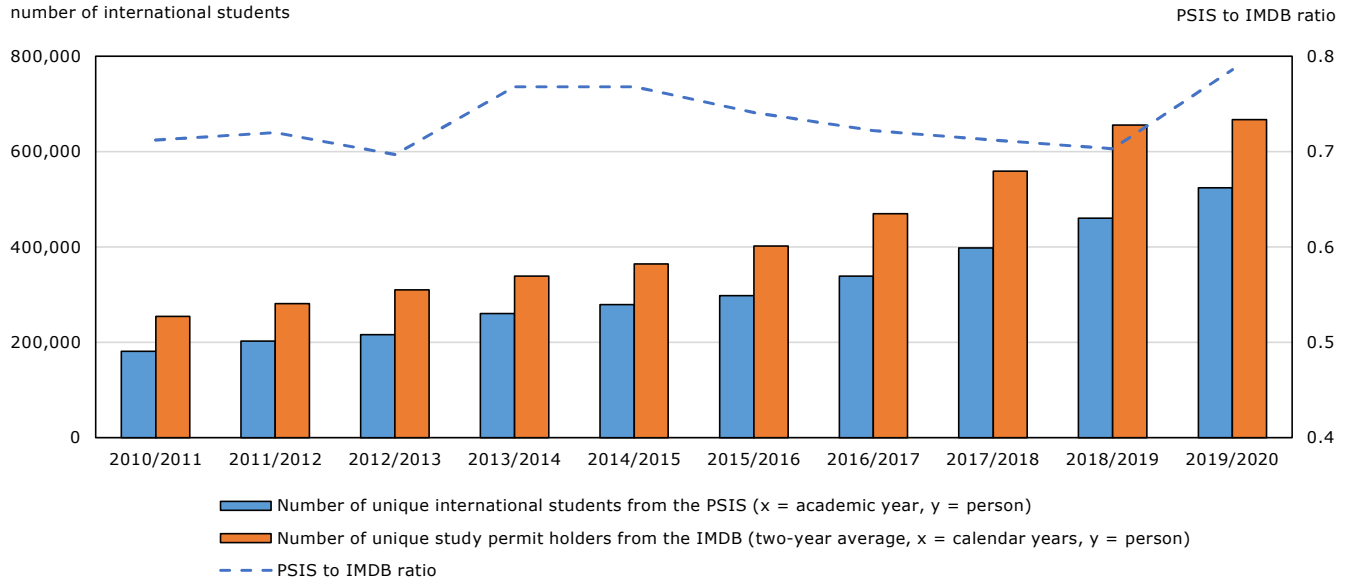
However, demographic trends are projected to be the opposite in the next 10 years. The population of young adults aged 18 to 24 began to increase from its trough in 2021 and is projected to experience rapid growth until 2026, exceeding the level in 2008 (the most recent peak), and then continue to grow at a slower pace until 2034 (Statistics Canada, 2022**g**).[18] This demographic change will lead to increased domestic demand for postsecondary education in the next decade if the tendency for Canadian young adults to participate in postsecondary education in Canada remains similar. Consequently, there may be a shift in the underlying relationship between changes in enrolments of domestic and international students in the next decade.

Furthermore, findings from this study are limited to publicly funded institutions because of the coverage of the PSIS. The PSIS does not cover private postsecondary institutions such as private academic and vocational colleges. Therefore, findings cannot be generalized to the entire postsecondary education system in Canada. Since enrolment data from private postsecondary institutions are not available, the number of study permit holders from the Longitudinal Immigration Database (IMDB) can provide a crude estimate of postsecondary enrolments in the institutions outside the scope of the PSIS. Because international students are generally required to receive study permits to enrol for postsecondary programs in Canada, the number of postsecondary study permit holders covers postsecondary enrolments in both public and private institutions.

As shown in Chart 3, the number of enrolled international students in the PSIS and the number of total valid study permit holders at the postsecondary level grew in tandem over the 2010s.[19] However, the number of international students in the PSIS was about 70% to 79% that of postsecondary study permit holders in the IMDB. Note that the number of postsecondary study permit holders from the IMDB could overestimate the actual number of international students who were studying in Canada. Differences in the number of international students between the IMDB and the PSIS at least partly reflect enrolments in private institutions, which were out of scope for the PSIS. The gaps may also be accounted for by some international students who received a study permit but did not come to Canada or those who left Canada or made a transition to the labour market before their study permit expired.

17. However, some postsecondary institutions that rapidly expanded their international student enrolments might have gone beyond their absorptive capacity. For instance, CBC News reported that some classes for the business management program at Cape Breton University (a university in which the majority of students registered in the 2022 fall semester were international students) were held in movie theatres, instead of a campus building (Latimer, 2022).
18. This population growth projection is based on a medium-growth scenario.
19. In this chart, all international students who were registered in a PSIS program during an academic year were counted, including international students enrolled in short-cycle programs not captured on the PSIS fall snapshot date.

Chart 3
Trends in the number of international students from the Postsecondary Student Information System and the number of study permit holders from the Longitudinal Immigration Database



Notes: PSIS = Postsecondary Student Information System; IMDB = Longitudinal Immigration Database.
Sources: Statistics Canada, Postsecondary Student Information System and Longitudinal Immigration Database.

Conclusions

Recent years have witnessed a small decrease of domestic student enrolments and a growing number of international students in Canadian postsecondary programs. This study examined the relationship between changes in domestic student postsecondary enrolments and the influx of international students during the 2010s. Positive relationships between changes in domestic and international student enrolments in STEM programs at universities and BHASE programs at colleges were found when institution-specific characteristics, aggregate time effects and demographic changes were considered. Also, domestic enrolments in non-degree postsecondary BHASE programs were positively correlated with the influx of international students, not only within the BHASE programs but also at the institutional level. Although this finding may be partly because of common shocks boosting enrolments of both domestic and international students at the same time, it is consistent with the notion that international students who pay three to five times higher tuition fees may subsidize domestic students in some postsecondary programs. Also, changes in domestic student enrolments in some postsecondary programs (such as BHASE programs at universities and bachelor's degree BHASE programs) had a positive relationship with demographic changes in the domestic population of youth aged 18 to 24.

This study had some limitations. The scope of this study was limited to publicly funded postsecondary institutions because of data limitations, which excluded the non-trivial enrolments in private colleges, many of which strongly rely on international students, particularly in recent years. Moreover, as discussed earlier, findings from this study may be specific to the 2010s, when there were decreases in the domestic youth population of postsecondary education age. Because this trend has turned and is predicted to head in the opposite direction in the next decade, the relationship between domestic and international student enrolments should be revisited in the future. Also, the fixed-effects models used in this study may not be sufficient for the results to be interpreted as causal relationships. Despite these limitations, this study provided one of the first empirical analyses of the relationship between domestic and international student enrolments in the context of Canada, adding to the literature that had been based mainly on the United States and the United Kingdom.

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