

Blit, Joel; Skuterud, Mikal; Zhang, Ruiwen

## Working Paper

# The potential of Canada's international student strategy: Evidence from the "MIT of the north"

Working Paper Series, No. 74

## Provided in Cooperation with:

Canadian Labour Economics Forum (CLEF), University of Waterloo

*Suggested Citation:* Blit, Joel; Skuterud, Mikal; Zhang, Ruiwen (2024) : The potential of Canada's international student strategy: Evidence from the "MIT of the north", Working Paper Series, No. 74, University of Waterloo, Canadian Labour Economics Forum (CLEF), Waterloo

This Version is available at:

<https://hdl.handle.net/10419/303035>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



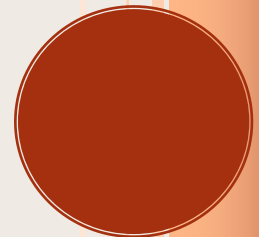
Canadian Labour Economics Forum

*WORKING PAPER SERIES*

**The Potential of Canada's  
International Student Strategy:  
Evidence from the “MIT of the  
North”**

Joel Blit (University of Waterloo)  
Mikal Skuterud (University of Waterloo)  
Ruiwen Zhang (University of Waterloo)

CLEF WP #74



# **The Potential of Canada’s International Education Strategy: Evidence from the “MIT of the North”**

Joel Blit<sup>†</sup>, Mikal Skuterud<sup>\*</sup>, and Ruiwen Zhang<sup>‡</sup>  
Department of Economics  
University of Waterloo

September 2024

---

Professor Skuterud acknowledges financial support from the Social Sciences and Humanities Research Council of Canada (Insight Grant 435-2023-0413). We are also grateful to Allan Starr and Daniela Seskar-Hencic in Institutional Analysis and Planning (IAP) at the University of Waterloo for supporting the data linkage studied in this paper and Immigration, Refugees, and Citizenship Canada (IRCC) for funding it.

<sup>\*</sup>Corresponding author. Professor, Department of Economics, University of Waterloo, skuterud@uwaterloo.ca

<sup>†</sup>Associate Professor, Department of Economics, University of Waterloo, jblit@uwaterloo.ca

<sup>‡</sup>PhD candidate, Department of Economics, University of Waterloo, r54zhang@uwaterloo.ca

## EXECUTIVE SUMMARY

A key objective of Canada's *International Education Strategy* (2014) is to leverage Canada's postsecondary institutions to attract and retain the world's "best and brightest" students to raise the average skill of the Canadian population and boost economic growth. However, evidence suggests that Canada's former international students experience significant labour market integration challenges, and the *Strategy* overlooks these challenges. The earnings disparities of former international students, and Canadian immigrants more generally, are usually interpreted as evidence of skill underutilization owing to employer discrimination against racial and ethnic minorities. Hard evidence of skill underutilization is, however, scant due to a dearth of data providing direct measures of workers' skills.

Our study brings new evidence to bear on the skill underutilization hypothesis by examining a unique linkage of student records from the University of Waterloo, including students' grades, with immigration data from Immigration, Refugees, and Citizenship Canada and T1 income tax returns from the Canada Revenue Agency.

UWaterloo is best known for its academic programs in computer science, mathematics, and engineering, which has earned it the moniker the "MIT of the North." Evidence that UWaterloo's international student graduates struggle in Canadian labour markets relative to their Canadian-born counterparts graduating from the same academic programs with similar academic standing provides a direct test of the skill underutilization hypothesis. The evidence also offers critical lessons on whether policy efforts to realize the full economic potential of international students are best directed at augmenting employer hiring behaviour through DEI initiatives, for example, or at improving the attraction and selection of international talent and promoting skill formation, including language training.

Our main findings are:

1. Roughly 70 percent of UWaterloo's international students transition to Canadian permanent residency (PR), twice the rate of international students at the national level. There is little difference in the transition rates of UWaterloo's students with the highest and lowest academic achievement and little evidence that policy efforts since 2008 to ease foreign students' PR transitions has impacted UWaterloo graduates, unlike at the national level. This suggests these policies have primarily affected the immigration outcomes of lower quality graduates, including community college graduates.
2. Canadian-born students at the 95<sup>th</sup> percentile of the skill distribution leave Canada after graduation at twice the rate of Canadian-born students at the 5<sup>th</sup> percentile. While the best international students are twice as likely to outmigrate as the best Canadian-born graduates, there were five times more Canadian-born graduates of UWaterloo between 2005 and 2021. This implies that Canadian students have contributed more in absolute numbers to "brain drain" in recent years than international students at UWaterloo.
3. The average post-graduation earnings of UWaterloo's international students not only exceed Canadian-born graduates of UWaterloo, but also Canadian-born university graduates nationally. Moreover, the earnings advantage of UWaterloo's international student graduates has increased over time as the economic returns to degrees in technology and engineering, where UWaterloo's foreign students are heavily concentrated, have increased relatively more.

4. Comparing students graduating at the same time from the same academic programs with similar academic standing, we find evidence of disparities in international students' average earnings after graduation. The earnings gaps are largest for East Asian, especially Chinese-born graduates. They are also concentrated among academically weaker students and appear to be entirely explained by deficiencies in English language proficiency. The results provide no evidence consistent with the common belief that immigrants' skills are underutilized in the Canadian economy. In fact, we find that measured skills are more important in determining the labour market earnings of foreign-born than Canadian-born graduates.

Overall, our analysis points to the potential of Canada's *International Student Strategy* to boost economic growth. However, given the extent to which student outcomes vary by program of study and institution, realizing this potential requires prioritizing quality over quantity in foreign student admissions. Unfortunately, the *Strategy* has become preoccupied with growth, especially in the college sector. We recommend redirecting the *Strategy* in two directions. First, IRCC needs to offer international students a single transparent pathway to economic-class immigration that relies exclusively on an enhanced Comprehensive Ranking System to select candidates with the highest expected future Canadian earnings. The success of the CRS in predicting immigrants' future Canadian earnings can be enhanced significantly by adding applicants' fields of study, school identities, and post-graduation Canadian earnings to the set of criteria used. Second, Canada can do more to influence the choices that the world's best and brightest students make themselves about where to study and settle after graduation. Options include using targeted tuition subsidies to attract exceptional prospective foreign students to the country's top university programs in technology and engineering and income tax schemes to incentivize the highest quality graduates to work in Canada after graduation.

## 1. Introduction

While Canada's skilled immigration system has been the envy of the world for decades, a hard and longstanding reality is that Canadian immigrants struggle economically relative to their counterparts in other immigrant-receiving countries (Clarke and Skuterud 2013; Clarke, Ferrer and Skuterud 2019). Beginning in the early 2000s, the Canadian government made efforts to address immigrants' earnings gaps by shifting to "two-step immigration" in which new immigrants are drawn from former international students who have demonstrated Canadian labour market success (Ferrer, Picot and Riddell 2014). The push to grow international student enrolments accelerated in 2014 with the unveiling of the federal government's *International Education Strategy*.<sup>1</sup> For postsecondary institutions facing declining domestic youth populations, the *Strategy* aligned well with their needs. The period from 2014 to 2023 saw the international student share of postsecondary enrolments nearly double (10.6 to 18.2 percent), while evidence up to 2019 suggests immigrant earnings gaps have narrowed after decades of deterioration (Crossman, Hou and Picot 2021; Parliamentary Budget Office 2024).

Despite its strengths, the *International Education Strategy* overlooks persistent labour market integration challenges of former international students in Canada. The challenges have been found to be especially acute among community college graduates where the growth in international student enrolments has been largest (Sweetman and Warman 2014; Hou and Lu 2017; Chen and Skuterud 2018). The dominant interpretation is that immigrants' skills are underutilized in Canadian labour markets due to employer discrimination against immigrants who are disproportionately racial and ethnic minorities.<sup>2</sup> This interpretation is supported by audit studies revealing lower callback rates for Canadian-educated job applicants with Indian, Pakistani, Chinese, and Greek names (Oreopoulos 2011). The "brain waste" interpretation is also supported by evidence of low rates of employment in STEM jobs among immigrants with degrees in STEM fields (Picot and Hou 2018; Blit, Skuterud and Zhang 2020).

The skill underutilization hypothesis is, however, difficult to reconcile with standard economic models of how competitive labour markets work. Skill underutilization means that equally productive workers are paid differently but this implies a profit opportunity for non-discriminating employers, since these employers can produce their output at lower cost and sell at lower prices, enabling them to drive discriminating competitors out of business. Immigrant earnings gaps are a longstanding feature of the Canadian economy. What makes Canadian labour markets exceptionally noncompetitive, and how have the underlying market failures persisted for decades? Audit studies may tell us something about average employer preferences for discrimination in the Canadian economy, but they tell us nothing about equilibrium wage outcomes since immigrants are likely to sort themselves into firms where they are not discriminated against (Heckman 1998).

The empirical evidence on skill underutilization is also problematic. Differences in average earnings of workers with similar levels of schooling is consistent with skill underutilization but might also reflect that an educational attainment is a crude measure of individual human capital. Labour market skills are multidimensional and notoriously difficult to quantify. An individual's human capital includes everything

---

<sup>1</sup> See Government of Canada, "Canada's International Education Strategy: Harnessing Our Knowledge Advantage to Drive Innovation and Prosperity," 2014. In 2019, the government updated the strategy. See "Building on Success: International Education Strategy: 2019-2024."

<sup>2</sup> This interpretation is common in the academic literature (see references of Banerjee, Lamb and Lam 2024), government studies (e.g. Picot and Hou 2019), and private-sector research (e.g. Royal Bank of Canada Economics, "Canada's Growth Challenge: Why the economy is stuck in neutral," June 4, 2024).

that affects their workplace productivity, including cognitive ability, work ethic, career ambition, social skills, and perhaps most important in the immigrant context, language ability. For those of us with first-hand knowledge of the tremendous variation in academic abilities of students enrolled in the same academic programs within a single university, the proposition that an individual's level of schooling fully accounts for their labour market skill is ludicrous.

When immigrants' skills are measured directly, there is in fact little evidence of skill underutilization. Using OECD data measuring adult literacy skills, Ferrer, Green and Riddell (2006) find similar labour market returns to skill for Canadian- and foreign-born workers, contrary to discrimination-based explanations of immigrant earnings gaps. The limitation of their data, however, as shown by Clarke and Skuterud (2016), is that the OECD literacy assessments are intended to capture basic functional literacy, rather than higher level cognitive and language skills. Among Canadian-born workers with a university degree, there is, in fact, no evidence of *any* wage return to literacy test scores in the OECD data. This implies the data are uninformative about variation in wage-determining skills at top end of the skill distribution. But in gauging the potential of the *International Education Strategy* to attract and utilize the skills of the world's "best and brightest," it is clearly skills at the top end that matter.

In this paper we bring new evidence to bear on the skill underutilization hypothesis and the economic potential of Canada's *International Education Strategy* by examining a unique administrative data linkage of bachelor's graduates from the University of Waterloo with their Canadian post-graduation immigration and income tax records. Using data on students' course-level grades, we directly evaluate Canada's success in transitioning top talent to permanent residency, as well as measure the capacity of the Canadian economy to fully utilize and reward their skills. Our findings provide critical insights into the nature of the economic integration challenges of former international students. Moreover, our findings provide critical lessons on whether policy efforts to realize the full economic potential of the *International Education Strategy* are better directed at augmenting employer hiring practices through Employment Equity and DEI initiatives, for example, or at improving the screening and selection of new economic-class immigrants and promoting immigrant skill formation, such as language training.

Our results reveal that UWaterloo's international students transition to Canadian permanent residency at nearly twice the national average and their average labour market earnings after graduation exceed those of Canadian-born bachelor's graduates from UWaterloo and nationally. Moreover, this earnings advantage has increased over time as the returns to degrees in technology and engineering, where foreign students are concentrated, have increased. However, controlling for program of study and grades, we find a gap in the earnings of international students that appears to be largely explained by English language skills. We also find that, relative to Canadian-born graduates, the earnings of foreign-born students are more responsive to their level of skill. Together, these results emphasize the economic potential of an *International Education Strategy* that is directed at the country's top universities who are best able to attract and retain top international talent.

The remainder of the paper is organized as follows. In the following section, we document the evolution of Canada's *International Education Strategy* since its introduction in 2014 including policies aimed at facilitating foreign students' transitions to PR status. We then describe the UWaterloo data and its linkage to immigration and tax data and in Section 4 specify our methodology for measuring student skill and evaluating the utilization of foreign students' skills in Canadian labour markets. We conclude our paper with policy recommendations aimed at better leveraging international students to drive future economic growth.

## 2. Policy Context

As student recruiters know well, immigration policy and foreign student recruitment go hand in glove. For some foreign students, the appeal of a Canadian education is its value to employers in their home countries. However, for a growing number, the lure is the prospect of Canadian immigration. As Canada has increasingly looked to foreign students as a source of new permanent residents, foreign students' willingness to pay for a Canadian postsecondary education increasingly reflects their belief that that education is the ticket to Canadian permanent residency (PR) status.

For Canada's postsecondary institutions facing declining youth populations and provincial regulations on the fees they can charge domestic students, foreign student enrolments offer a solution. But the supply of foreign students is finite and competing on educational quality with universities and colleges in the U.S., U.K., and Australia is difficult and expensive. An easier option for attracting more foreign students and increasing their willingness to pay tuition fee premiums is to lobby governments to offer prospective students a more certain pathway to PR status.

The dramatic growth in Canadian foreign student enrolments since 2005 largely reflects three main policy initiatives which together have provided foreign students with a more predictable and certain pathway to PR status. First, prior to May 2005, students with a job offer could apply for a one-year permit to work in their field of study following graduation. In May 2005, the Post-Graduate Work Permit (PGWP) Program was introduced which allowed students with jobs to renew their permits for an additional year, enabling them to work for two years in Canada in their field of study after they graduated.<sup>3</sup> In April 2008, two important changes were made to the PGWP Program. First, international students could obtain open work permits after graduation with no restriction on the type of employment and no requirement for a job offer. Second, all permits were extended to three years.<sup>4</sup> Both changes made it easier and attractive for post-2008 graduates to remain in Canada after graduation to find a skilled job.

Following on the 2008 reform of the PGWP, in September 2008, the government introduced the Canadian Experience Class (CEC) Program providing former international students with a simplified pathway to PR status. In contrast to the numerous criteria used in the 'points system' of the Federal Skilled Worker Program, the CEC Program enables foreign students who have successfully used their PGWP to obtain one year of Canadian work experience in a skilled occupation to apply for PR status without leaving Canada.

While the PGWP and CEC policies facilitated foreign students' PR transitions, the introduction of the Express Entry System in January 2015 added a layer of complexity. The new system introduced a grading scheme called the Comprehensive Ranking System (CRS) to rank candidates and regularly cream-skim applicants with the highest scores. Within months of its introduction, advocates for international students criticized the system for being unfair as bonus points for candidates with job offers were giving other candidates an advantage in the competition for the PR slots. In response, the government revised the CRS in November 2016 to provide bonus points to candidates with Canadian postsecondary credentials. Making the case, Canada's Immigration Minister, John McCallum, argued: "International students are the best source of immigrants, in the sense that they're educated, they're young, they

---

<sup>3</sup> Source: <https://www.canada.ca/en/news/archive/2006/04/off-campus-work-permit-program-launched.html>. Retrieved on July 10, 2024.

<sup>4</sup> Source: <https://www.canada.ca/en/news/archive/2008/04/government-canada-introduces-changes-work-permits-international-students-making-canada-more-attractive-skilled-individuals.html>. Retrieved on July 10, 2024.



speak English or French, they know something of the country, so we should be doing everything we can do to court them."<sup>5</sup>

The impact of these three policy reforms on international student enrolments and transitions to PR status have been dramatic. Foreign student enrolments in Canadian universities increased by 201 percent between the 2005-2006 and 2021-2022 academic years, while enrolments of domestic students increased by only 19 percent. More striking, enrolments of foreign students at community colleges increased by 499 percent, while domestic enrolments increased by only 2 percent. These changes occurred even while foreign students paid ever increasing tuition fee premiums.<sup>6</sup> Foreign students enrolled in bachelor's programs, for example, paid on average 3 times more than domestic students in 2006-2007 but 5 times more in 2021-2022.<sup>7</sup> Perhaps most significant, the percentage of Canada's new PRs who transitioned from a study permit increased from 8 percent in 2006 to 39 percent in 2021. Based on these metrics, the *International Education Strategy* has been a runaway success.

Nonetheless, there is reason for concern. The immigration mandate of the *Strategy* was to leverage the country's postsecondary institutions to attract and retain the world's "best and brightest."<sup>8</sup> Yet, the growth in foreign student enrolments has been largest in Canada's college sector. Between 2005-2006 and 2021-2022, the share of foreign students attending college (versus university) increased from 24 to 39 percent, while for domestic students it dropped from 38 to 35 percent. Part of this shift reflects a deliberate effort to diversify the fields and levels of education drawing on foreign students.<sup>9</sup> Of particular significance is the Student Partners Program (SPP) launched in April 2009 to increase acceptance rates of applicants from India (and later China, Philippines and Vietnam) applying to one of twenty members colleges of the Association of Canadian Community Colleges.<sup>10</sup> The growth has, however, also been concentrated in less research-intensive universities. The percentage of international students enrolled in a U15 institution remained relatively constant at about 40 percent between 2009 and 2015 when it began to decline, reaching 33 percent in 2019. Meanwhile, the share of domestic students enrolled at a U15 school increased over the same period from 28 to 30 percent.<sup>11</sup>

What is the policy rationale for deprioritizing growth in foreign student enrolments in the country's top universities? One factor may be a popular perception that there is an oversupply of university educated workers who increasingly find themselves employed involuntarily in low-wage service sector jobs. If Canadian-born workers with university degrees are forced to work as baristas and Uber drivers, why flood labour markets with more university-educated workers? Corporate Canada argues that labour shortages are most acute in low- and semi- skilled markets, especially in skilled trades and college-level nursing. Another explanation may be that increasing immigration levels through foreign student

---

<sup>5</sup> Donovan, Moira, "John McCallum pledges to make immigration easier for international students," *CBC News*, March 16, 2016.

<sup>6</sup> These data are from the Post-Secondary Information System and published annually in Statcan table 37-10-0018-01. Note that the data exclude private career colleges, which have also seen a surge in foreign student enrolments.

<sup>7</sup> Source: Statistics Canada table 37-10-0045-01. Comparable information on tuition fees at community colleges is not publicly available.

<sup>8</sup> The term "best and brightest" appears three times in the 2014 *International Education Strategy*.

<sup>9</sup> Page 7 of the 2019 *International Education Strategy* lists three key objectives, the second of which is to "diversify the countries from which international students come to Canada, as well as their fields, levels and location of study within Canada."

<sup>10</sup> The program was created as a pilot program but has since evolved into the permanent and bigger Student Direct Stream. For more information on the program, see <https://www.canada.ca/en/news/archive/2010/01/canada-works-welcome-more-indian-students-canadian-colleges.html> (retrieved on August 8, 2024).

<sup>11</sup> The U15 is an association of fifteen Canadian research-intensive universities, which includes UWaterloo.

enrolments at top universities is difficult because the size of their academic programs are largely fixed, and foreign students must compete on academic ability with domestic students for limited slots. In addition, graduates of these programs are more likely to receive foreign job offers after graduation, so they are less likely to settle in Canada after graduation. If the primary objective of the *Strategy* is to scale up the quantity of the foreign student admissions and immigration levels, better to focus on institutions with excess capacity and where lowering academic entry standards is less of a concern.

By January 2024, growth in foreign student enrolments at Canadian colleges had grown to such an extent that the government was compelled to introduce caps on new study permits. Of particular concern has been the absorptive capacity of the communities where foreign student numbers have surged most, especially the impact on housing markets. Imposing a cap, however, forces the government to allocate permit applications across postsecondary institutions. The federal government has opted to download this responsibility to provinces. Ontario has allocated only 15 per cent of its 235,112 visas to universities, with the remainder going to community and private career colleges.<sup>12</sup>

But as the *International Education Strategy* itself argues, the economic potential of the *Strategy* lies in its capacity to attract the world's "best and brightest" to drive innovation and economic growth. The margin on which immigration can raise labour productivity and GDP per capita is not in addressing current labour markets, but in boosting average human capital and this can only be achieved if newcomers have levels of human capital above that of the current population. Immigrants with high human capital are also more likely to generate positive externalities on innovation and productivity, therefore impacting not just the current level of GDP per capita but also future economic growth. A challenge of any immigration policy focused on boosting average human capital is the fact that human capital is fundamentally multi-dimensional, and some dimensions are not easily measured. However, a good proxy for human capital is labour market earnings. An *International Education Strategy* that seeks to boost human capital, productivity and economic growth should thus prioritize students, programs and institutions based on expected future earnings.

One possible caveat to this prescription, is that the economic potential of the *Strategy* is weakened if Canadian labour markets fail to fully utilize the skills of foreign students. This could occur if, for example, former international students face employment barriers arising from discrimination. Whether the skills of Canada's foreign student graduates are in fact underutilized remains an open question. Obtaining an answer requires data that not only identifies the skills of graduates from a top university, but also their post-graduation immigration and labour market outcomes.

### 3. Data

The University of Waterloo is a publicly funded university located in Waterloo, Ontario, Canada. The university is best known for its undergraduate programs in engineering and computer science and its pioneering programs in co-operative education. Its reputation as Canada's most innovative university has earned it the moniker: "The MIT of the North." In a 2013 feature article, the *New York Times* described the consequences of the 2012-2014 downsizing at BlackBerry – a big local employer – as nearly invisible on local unemployment due to the remarkable success of UWaterloo's tech graduates in securing jobs with U.S. tech giants including Google, Apple, Facebook, and Microsoft.<sup>13</sup>

---

<sup>12</sup> See Philip Oreopoulos and Mikal Skuterud, "Once the envy of the world, Canada's immigration system now lies dismantled," *Globe and Mail*, July 8, 2024.

<sup>13</sup> Ian Austen, "Once BlackBerry Focused, a Campus Widens Its View," *New York Times*, February 3, 2013.

Our sample is comprised of all bachelor's degree graduates of UWaterloo between 2005 and 2021. The size of UWaterloo's graduating classes increased steadily from 3,960 in 2005 to 6,730 in 2021, providing us with an overall sample of 86,250 graduates. The student data identify students' year of graduation, program of study, months taken to complete their program, and whether they graduated as a co-op student. In addition, it includes students' final grades (recorded as a percentage score) in all their completed courses, allowing us to construct an objective measure of student skill to relate to their immigration and earnings outcomes. This measure is defined in the following section.

Students were linked to their individual-level immigration records and T1 income tax returns by the Social Data Linkage Environment (SDLE) at Statistics Canada. Since UWaterloo does not collect Social Insurance Numbers (SINs), record linkages relied on students' names, birthdates, and addresses.<sup>14</sup> The percentage of the sample who were linked to at least one source of government administrative data (either immigration or tax) was 98 percent. In comparison, response rates to university alumni surveys, the usual source of information on post-graduation student outcomes, are on average about 40 percent and often lower (Porter and Umbach 2006).

Students' immigration records were obtained from the Longitudinal Immigration Database (IMDB) which includes the universe of all non-permanent resident permits (study and work visas) issued by the Immigration Department since 1980 and all landing records since 1952. IMDB data up to the end of 2021 were included in the linkage. These data allow us to distinguish between three types of graduates: (i) students who held a study permit at the time that they first enrolled at the UWaterloo ("international students"); (ii) students who were born outside Canada but whose landing record indicates that they had Canadian PR status when they first enrolled at the UWaterloo ("foreign-born PR students"); and (iii) students with no IMDB linkage ("Canadian-born students"). Note that group (ii) includes both individuals who were Canadian citizens when they first enrolled at UWaterloo and those who were not.

Since foreign students are charged substantially higher tuition fees, the university's administrative data contains a reliable indicator of which students were visa holders in their year of graduation. Statistics Canada failed to find an IMDB match for roughly 10 percent of the graduates identified as international students in the university data.<sup>15</sup> While there is no way to determine the cause of the failed matches, there is some evidence that it is more common among Chinese students whose names are less likely to uniquely identify them. Throughout our analysis we identify these graduates as international students but exclude them from the PR transition analysis in Section 5.1.2.<sup>16</sup>

Graduates' T1s, on the other hand, were obtained from the T1 Family File (T1FF) which includes the universe of all personal income tax returns filed with the Canada Revenue Agency since 1992. T1FF data up to and including the 2020 tax year were included in the linkage. The tax data allow us to identify graduates' annual T4 earnings and self-employment income after graduation. In addition, the presence or absence of a T1 file in consecutive years following graduation allows us to infer which students left Canada and to compare outmigration rates of foreign- and Canadian-born graduates, as well as how outmigration is related to student skill measured using students' academic grades.

---

<sup>14</sup> The linked data file was accessed through the South-Western Ontario Research Data Centre (SWORDC), which is a secure Statistics Canada data lab located on the University of Waterloo. The file contained no personally identifiable information, such as student numbers, names, birthdates, or addresses.

<sup>15</sup> At least one T1 income tax record was, however, found for one-fifth of the international students who were not matched to the IMDB.

<sup>16</sup> We completed a separate analysis gauging the sensitivity of our estimated PR transition rates to alternative assumptions regarding the PR transitions of the international students who were unmatched to the IMDB. All the main findings are robust to this analysis. The results are available on request.

Table 1 reports sample means of student characteristics separately for international, foreign-born PR, and Canadian-born students who comprise 12.7, 26.2, and 61.1 percent of the overall sample, respectively. International students are younger and more male, but the differences are negligible. However, in line with the national trend, their share of graduates increased four-fold over the sample period, from 4.8 percent of the 2005-2007 graduating cohorts to 21.5 percent of the 2020-2021 cohorts. The internationalization of UWaterloo's student body is exceptional when compared to other universities – the foreign student share of bachelor's graduates increased from 5.6 to 13.6 percent over the same period nationally and from 4.4 to 11.7 percent in Ontario.<sup>17</sup> Indeed, a key goal of the university's 2013 Strategic Plan was to "become one of the most internationalized universities in Canada."<sup>18</sup>

The following rows of Table 1 indicate that China is by far the biggest source of UWaterloo's international students, accounting for nearly two-thirds of international students and one-quarter of foreign-born PRs. South Asia (almost entirely India and Pakistan), East Asia (more than one-half from Hong Kong with most of the remaining from South Korea and Taiwan), Southeast Asia (mostly Philippines, Malaysia, and Vietnam), and Africa (roughly one-half from Nigeria, Egypt, and Kenya) account for an additional one-quarter of the international student sample, while East Asia, South Asia, and Europe together account for one-half of foreign-born PR students. International students are much more likely than Canadian-born students to have graduated from programs in mathematics and statistics, computer science, and business and management (55 compared to 19 percent).<sup>19</sup> This is also true of foreign-born PRs, but the differences are much smaller. International students are, however, not more likely to have graduated from a co-op program (36 compared to 49 percent of Canadian-born students and 64 percent of foreign-born PR students).

The last four rows of Table 1 report the linkage rates to the government's immigration and tax data. As noted above, 90 percent of international students were successfully linked to the IMDB, while 86 percent were linked to at least one T1 record, and 50 percent to a T1 in at least one year following graduation. Foreign-born PRs, on the other hand, were, by definition, all linked to immigration data (since a landing record in the IMDB is what identifies them as foreign-born PRs), 99.3 percent were linked to at least one T1 record, and 76 percent to a T1 following graduation. Last, none of Canadian-born students were linked to the immigration data (by definition), 98 percent were linked to at least one T1, and 81 percent to a T1 following graduation. Taken together, 98 percent of the 86,250 graduates in the full sample were linked to at least one source of government administrative data.

The key determinant of whether immigrants serve to boost Canada's GDP per capita is whether their labour market earnings exceed average earnings in the overall population (Doyle, Skuterud and Worswick 2024). To gauge the relative economic impact of UWaterloo's international student graduates who settle in Canada, it is informative to not only compare the earnings of UWaterloo's international student graduates to their Canadian-born counterparts at UWaterloo, but also to graduates of other Canadian universities and colleges. To do this, we use the National Graduates Survey (NGS) which identifies the annual employment income (T4 earnings plus self-employment income) in 2006, 2012, and 2017 of nationally representative samples of college and university graduates from 2005, 2010, and 2015, respectively. Extracting the same graduation cohorts from our data and pooling the samples, we

---

<sup>17</sup> Source: Statistics Canada table 37-10-0020-01.

<sup>18</sup> See "A Distinguished Past – A Distinctive Future," University of Waterloo Strategic Plan 2013.

<sup>19</sup> Note that UWaterloo does not have a Faculty of Business. The prevalence of international students in business and management programs is accounted for by two main programs both offered by the Faculty of Mathematics: Actuarial Science and Mathematical Finance.

can compare labour market outcome of UWaterloo's to college and university students graduating from similar fields of study nationally.<sup>20</sup> Note that since the NGS is a nationally representative survey of graduates of all publicly funded Canadian postsecondary institutions, it likely includes a small number of UWaterloo Bachelor's graduates. While there is no way for us to identify and exclude them, their number should be negligible.

#### 4. Methodology

Our analysis of the data follows the journey of international students from their initial enrolment at UWaterloo to establishing careers in Canada. There are two main parts to the analysis. In the first, we examine the relative migration behaviour of UWaterloo's international students following graduation, and in the second, the relative employment and earnings outcomes of international students who remain in Canada following their graduation.

The migration analysis begins by examining international students' take-up of study and work permits following graduation. Of particular interest is whether the 2008 reform of the PGWPP served to increase the take-up of post-graduate work permits. We then turn our attention to transitions to PR status and compare transition rates across graduation cohorts, countries of origin, fields of study, and student skill, as well as to PR transition rates at the national level. Last, we turn to the tax data, which we use to estimate international students' rates of outmigration from Canada following graduation, which we compare to their Canadian-born and foreign-born PR counterparts at UWaterloo. Previous studies have defined outmigration alternatively as two, three, or four consecutive years of non-filing of a T1 (Dryburgh and Hamel 2004; Berard-Chagnon, Tang and St-Jean 2019; and Aydemir and Robinson 2008, respectively). We define outmigration as three consecutive years of non-filing of a T1 starting in the year after graduation.<sup>21</sup> We conclude the migration analysis by using the presence of a T1 record following a period of outmigration to examine the return migration rates of UWaterloo's graduates, paying particular attention to the relative return migration rates of higher and lower skill students.

Having ascertained the relative migration behaviour of UWaterloo's international students, we turn to the labour market outcomes of those who remain in Canada following graduation. We begin by examining average T4 earnings in the years after graduation for subsequent cohorts of graduates paying particular attention to if and how international students' labour market outcomes have evolved differently. We focus on T4 earnings, and not employment income, because we are primarily interested in barriers to paid employment for immigrants and underutilization of immigrants' skills in labour markets. We then turn to the NGS data to evaluate how the employment income of UWaterloo's graduates in the first 1-2 years after graduation compares to bachelor's and college graduates at the national level. Finally, we restrict attention to graduates with full-time earnings and examine whether the relative earnings of UWaterloo's international students graduating from the same academic

---

<sup>20</sup> To obtain nationally representative estimates from the NGS we need to employ the data's sampling weights. In pooling three NGS cycles with the UWaterloo data, we rebase the NGS sampling weights to have a mean equal to one in every cycle and set the weight equal to 1 for all observations in the UWaterloo comparison sample.

<sup>21</sup> We explored the sensitivity of the results to defining outmigration using alternative durations of non-filing. The outmigration rate in the full sample of all UWaterloo graduates are 15.8, 12.7, 11.4, 10.6, and 9.9 percent using 1, 2, 3, 4, and 5 consecutive years of non-filing, respectively. While the range in rates is not trivial, the differences in rates between student types are not sensitive to definition. For example, international students are leaving Canada at rates that are always between 27.3 and 27.6 percentage points higher than Canadian-born students, regardless of whether we use 2, 3, 4, or 5 consecutive non-filings. Last, using the three-year definition, the outmigration rate of international students is close to the rate implied by their rate of transitioning to PR status.

programs as Canadian-born students with similar academic performance provides any evidence consistent with skill underutilization.

To identify the conditional employment and earnings outcomes of UWaterloo’s international student graduates, we estimate the following linear equation by least squares:

$$\log(earn_{it}) = \beta_0 + \beta_1 is_i + \beta_2 fb_i + \beta_3 ysg_{it} + \beta_4 ysg_{it}^2 + \beta_5 age_{it} + \beta_6 age_{it}^2 + \beta_7 ur_{it} + \beta_8 female_i + \beta_9 coop_i + \beta_{10} skill_i + f_i + c_i + u_{it} \quad (1)$$

where  $earn_{it}$  is the log annual T4 earnings of individual  $i$  in year  $t$ ;  $is_i$  and  $fb_i$  are international and foreign-born PR student indicators, respectively;  $ysg_{it}$  is years since graduation;  $age_{it}$  is the student’s age;  $ur_{it}$  is the provincial unemployment rate where student  $i$  resided in year  $t$ ;  $coop_i$  indicates whether the student graduated from a co-op program;  $skill_i$  is our measure of student skill defined below;  $f_i$  are fixed effects for 77 fields of study,  $c_i$  are fixed effects for the year of graduation; and  $u_{it}$  is a random error term with a conditional mean of zero and that is potentially correlated between observations of the same individual.

A complication in interpreting the estimates of  $\beta_1$  in equation (1) – the parameter of primary interest – is that it will reflect differences in annual hours of work, as well as hourly rates of pay. Of particular concern in our sample are students whose post-graduate T4 earnings are from part-time research and teaching assistantship positions in graduate school (Master’s and Ph.D. programs). Since these are likely also the highest quality students, this will also result in downward bias in the estimated returns to skill ( $\beta_{10}$ ). To address this issue, we try to restrict the sample to full-time workers by excluding observations on  $earn_{it}$  which are less than or equal to 2000 (50 weeks times 40 hours per week) multiplied by the minimum wage rate in the province where the student resides.<sup>22</sup> We impose the same restriction when comparing earnings of UWaterloo’s graduates to earnings of other postsecondary graduates from the NGS in Section 5.4. In addition, we drop observations on  $earn_{it}$  above the 99.9<sup>th</sup> percentile (about \$700,000) to ensure that our estimates are not driven by extreme earnings values.

Our strategy for testing the skill underutilization hypothesis hinges on having a direct measure of student skill. University course grades provide a rich source of information on students’ skills. Evidence shows that grades are an important predictor of students’ starting salaries in labour markets, presumably reflecting overlap in the skills that are evaluated, and perhaps also learned, in universities and those valued in labour markets (Chia and Miller 2008; Jones and Jackson 1990). Of particular interest is the relation between a foreign student’s academic achievement and their probability of making a PR transition. Are students who consistently perform above the 90<sup>th</sup> percentile of their course grade distributions more likely to permanently settle in Canada than students whose grades are consistently below the 10<sup>th</sup> percentile? And has the relation between grades and PR transitions changed over time, as Canada has adjusted its policies to better attract the “best and brightest” foreign students?

A key methodological challenge is how to measure students’ relative academic performance. Most undergraduate programs at UWaterloo require students to complete 40 courses. The simplest approach is to use the unweighted average final grade, reported as a percentage score between 0 and 100, across their 40 courses. This average is usually referred to as the grade point average (GPA). Grade distributions, however, vary tremendously across fields of study. For example, the average grade in STEM courses in our sample is on two percentage points lower than in non-STEM courses, and STEM course grades have a higher variance. Moreover, students choose their academic programs and courses.

---

<sup>22</sup> Without this restriction, the distribution of log annual earnings is bimodal with a lower peak to the left of the global mode. Imposing the restriction removes the lower “hump” entirely.

In an earlier analysis of student grades at an Ontario university, Chen and Skuterud (2020) find that struggling students who tend to fall into the lower half of grade distributions within their courses also tend to self-select into programs, courses, and instructors that are more generous in assigning grades. As a result, differences in average grades between students may reflect their program and course selections, as opposed to their academic abilities or labour market skills. An alternative is to restrict attention to students enrolled in the same courses with the same instructors, but with hundreds of university courses in the data, many students in the data are never enrolled in the same courses making comparisons impossible.

To address these issues, we estimate a two-way fixed effects (TWFE) model that separately identifies student and course-instructor fixed effects. As is well known in the econometrics literature, TWFEs are only identified within “connected sets” of students and course-instructor pairs (Abowd, Creedy and Kramarz 2002), which requires observing students enrolled in classes with mixtures of students from different programs and faculties. Since breadth requirements of academic programs require students to take courses outside their programs and faculties, the university grades data satisfy this requirement and we avoid the “limited mobility bias” that has complicated estimation of worker and firm fixed effects in determining wage outcomes (Abowd, Kramarz and Margolis 1999; Andrews, Gil, Schank and Upward 2008). In this regard, our data and methodology is closest to Rivkin, Hanushek, and Kain (2005) and Rothstein (2010) who estimate a TWFE model of student grades to disentangle the influence of teachers and student ability on the test scores of elementary public-school children in Texas and North Carolina, respectively.

Specifically, we estimate the following TWFE linear model:

$$grade_{ijt} = student_i + class_j + covid_{ft}\gamma + \varepsilon_{ijt} \quad (2)$$

where  $grade_{ijt}$  is the final course grade of student  $i$  enrolled in course-instructor pair  $j$  in term  $t$ ;  $student_i$  are student fixed effects;  $class_j$  are fixed effects for course-instructor pairs (e.g., Psychology 101 with Professor Sandra Smith);  $covid_{ft}$  indicates a course completed during the COVID pandemic (between the Winter 2020 and Fall 2021 terms) which is interacted with faculty  $f$ ; and  $\varepsilon_{ijt}$  is a random error term with expected value zero and constant variance within  $ijt$  cells. The COVID indicators are included to control for the higher average grades received in terms when classes were taught online.<sup>23</sup>

We estimate equation (2) using 3,787,570 student grades in 22,886 course-instructor pairs completed between the fall term of 1992 and 2021. Student fixed effects account for 45.6 percent of the overall variance in grades, while course-instructor pairs can account for 24.0 percent.<sup>24</sup> The estimated student fixed effects capture the fact that some students consistently perform above the average by some margin within their classes, while others consistently perform below the average by some margin. These student fixed effects are what we use as our measure of “student skill.” The student and course-instructor fixed effects have a correlation of -0.27, consistent with lower ability students sorting themselves into courses where grading is more generous. This correlation emphasizes the importance of conditioning on the self-selectivity of students into courses and instructors when inferring student skill from course grades. It is important to note that our measure of student skill captures everything that allows some students to consistently outperform their classmates, including both cognitive and non-

<sup>23</sup> The estimates indicate that average grades were 6.9, 4.2, 3.6, 2.6, 2.4, and 2.1 percentage points higher during COVID terms in the Math, Science, Arts, Health, Environment, and Engineering faculties, respectively.

<sup>24</sup> The R-squared from the regression is, however, 0.525, which is less than the sum of 45.6 and 24.0. The difference reflects the collinear variation in the student and course-instructor fixed effects.

cognitive skills such as work ethic, career ambition, and even social skills. Table 1 indicates that the mean standardized student fixed effect of international students is 0.055, which is almost identical to foreign-born PR students (0.070) and slightly higher than Canadian-born students (-0.041). The differences are, however, small and suggest that any differences in the labour market outcomes of international students are unlikely to be explained by their relative skills.

A test of the skill underutilization hypothesis is that  $\beta_{10}$  in equation (1) – the earnings return to skill – is lower for international than Canadian-born students. By interacting our measure of student skill ( $skill_i$ ) with the international student indicator,  $is_i$ , we obtain direct evidence on inefficient utilization of immigrants' skills resulting from discriminatory employer behaviour against immigrants, for example. Ferrer, Green and Riddell (2006) use a similar strategy in their analysis of OECD data measuring the basic literacy skills of Canadian adults and find no evidence of differential returns. In informing Canada's success in attracting the "best and brightest" to boost economic growth, we examine relative returns to university-level grades. Despite the analytical potential of academic grades, we are aware of no existing research to leverage students' grades to provide insights on the link between the skills that are taught in universities and skill utilization in the economy.

## 5. Results

### 5.1. Migration behaviour

#### 5.1.1. Post-graduation study and work permits

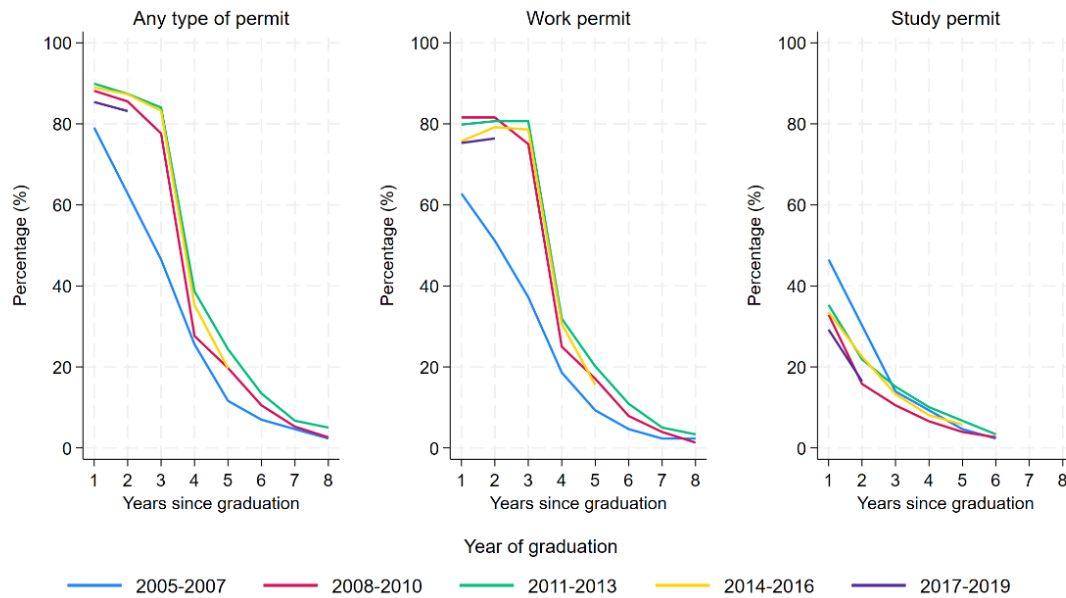
We begin by examining international students' transitions to temporary work and study permits in their years following graduation. To do this, we restrict attention to graduates who were study permit holders in their year of graduation. Figure 1 reports what percentage held any temporary permit (left panel), a work permit (middle panel), or a study permit (right panel) by years since graduation. Since an individual can hold a work and study simultaneously, the percentages in the middle and right panel sum to more than those in the left panel.

The results point to a large uptick in the take-up of work permits after 2007. Whereas 63 percent of 2005-2007 graduates held a work permit in the year after graduation, 82 percent of 2008-2010 did, a 30 percent increase. The increase is consistent with the objectives of the 2008 reforms of the PGWP Program providing all graduates with three-year open work permits. The PGWP reform is also evident in the absence of any decline in work permit holding in the first three years after graduation for the post-2008 cohorts. There is, however, no evidence that the 2015 reform giving bonus points for Canadian education in the CRS has any effect. In fact, the estimates suggest that transitions to post-graduate work permits have, if anything, tended to decline slightly for the most recent graduation cohorts.

The 2008 PGWP reform appears to have also disincentivized foreign students to transition to Canadian graduate programs following graduation. Whereas 46 percent of the 2005-2007 cohorts held a study permit one year after graduation, 33 percent of the 2008-2010 cohorts did, a 28 percent decline. With no requirement for a job offer to obtain a three-year open permit, foreign students may have decided that gaining Canadian work experience provided an easier path to PR status than obtaining additional Canadian education. This appears to have been an unintended consequence of the policy reform which may have adversely impacted the long-run earnings potential of international student graduates.



Figure 1: Percentage of graduates who held a work and/or study permit following graduation, by year of graduation and years since graduation



Note: Sample is restricted to graduates who were study permit holders in their year of graduation. Any type of permit also includes asylum claims.

Overall, the percentage of graduates holding any type of temporary permit in the year after graduation increased from 79 percent prior to the 2008 PGWP reform to 88 percent for the 2008-2010 cohorts, although the rates trended down slightly afterwards. Three years after graduation the effect was, however, much larger – 78 percent of the 2005-2007 cohort versus 47 percent of the 2008-2010 cohort held a permit. With more foreign students spending more years in Canada following graduation, we expect higher proportions to have transitioned to PR status. To evaluate this conjecture, we turn to the data on PR transitions.

### 5.1.2. PR transitions

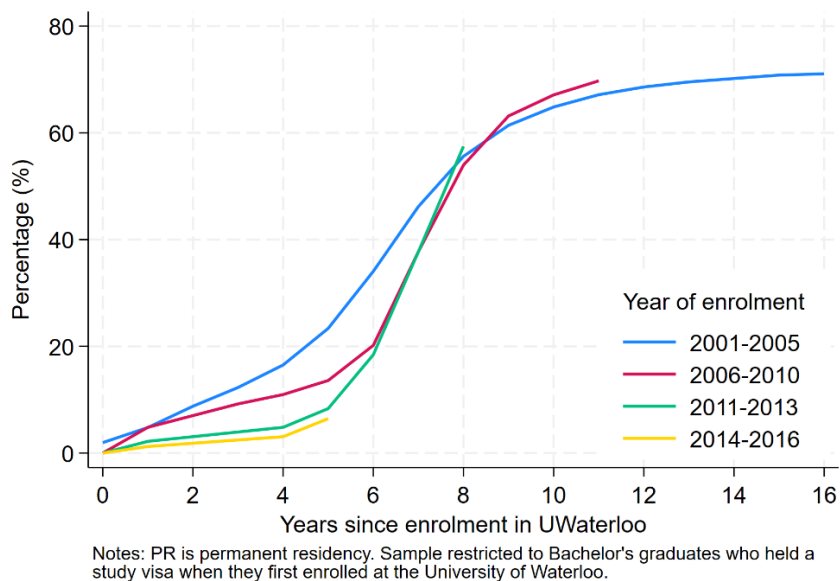
The objective of the 2008 PGWPP reform was to ease the pathway to permanent residency for foreign students by giving them more time to accumulate Canadian work experience in their fields of study. Is there evidence that the policy was successful?

Figure 2 plots the cumulative PR transition rate of graduates who were study permit holders when they initially enrolled at UWaterloo. The results suggest that the PR transition rates of UWaterloo’s international students have changed little over time. However, there does appear to be a change in the timing of PR transitions. PR transitions have over time become increasingly rare during students’ programs of study. Five years after enrolment, 22 percent of the 2001-2005 entry cohorts had transitioned to PR status, but only 6 percent of the 2014-2016 cohorts had.

What explains this change? Prior to 2008 it was possible for applicants to earn the necessary and sufficient 67 points under the Federal Skilled Worker Program’s points grid without any Canadian work experience. However, reforms since 2008, such as the introduction of the Canadian Experience Class Program, have prioritized candidates with Canadian work experience. Consequently, more recent cohorts are more likely to obtain PR status after graduation which is evident in the steep increase in their profiles in Figure 2 from 5 to 8 years after enrolment (note that 61 percent of UWaterloo

bachelor’s students graduate in 48-60 months). However, 8 years after enrolment the cumulative PR transition rates of the 2001-2005, 2006-2010, and 2011-2013 cohorts are virtually identical (about 55 percent). Looking beyond 8 years, there is some indication of higher PR transition rates, but the differences appear small relative to the increase in graduates transitioning to holding work permits following graduation.

Figure 2: Cumulative transition rate to permanent residency status, by year of enrolment and years since enrolment

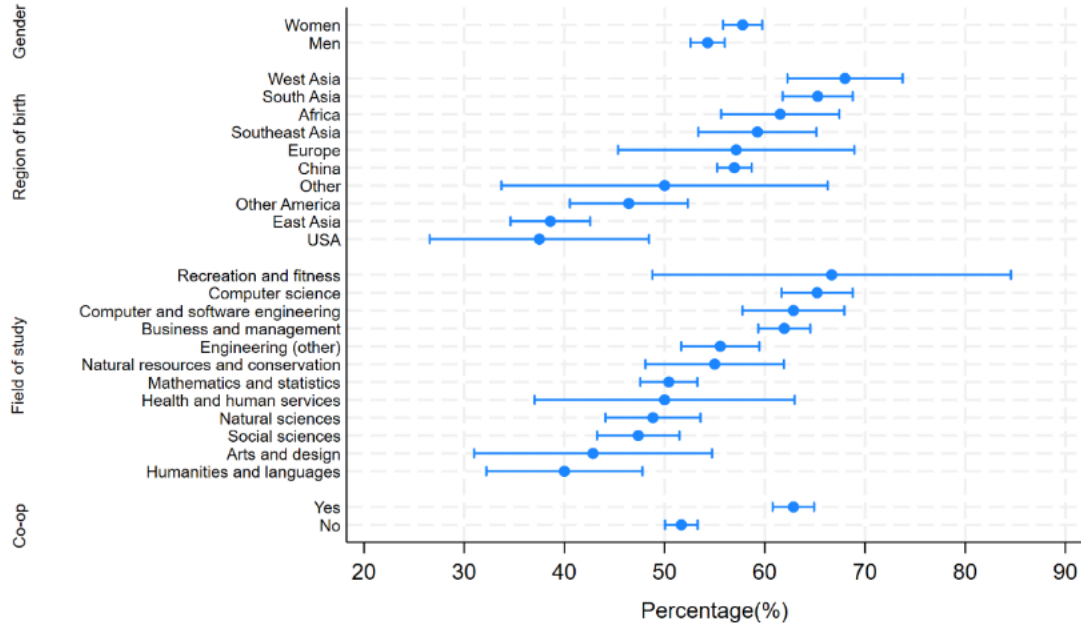


While there is little indication that PR transition rates of UWaterloo’s graduates have increased over time, this is not the case in the national level estimates. In updated estimates of those reported in Choi, Crossman and Hou (2021), the authors find the PR transition rate of international students 10 years after obtaining their first study permit increased from 31 to 40 percent between the 2001-2004 and 2010-2014 cohorts. This suggests that policies intended to ease foreign students’ PR transitions have impacted graduates at the national level, but not at UWaterloo. An explanation is reforms may have primarily benefitted graduates from lower quality institutions and had little impact on graduates from the country’s top universities because graduates of the latter did not face barriers to PR transitions prior to the reforms. Figure 2 indicates that UWaterloo PR transition rates have consistently peaked at about 70 percent, roughly twice the national rate. The 30 percent of UWaterloo graduates who did not transition, and never have, are likely not constrained by immigration barriers but are choosing better opportunities in their home countries or elsewhere. Easing of PR transitions has no impact on these graduates. This suggests that reforms intended to ease foreign students’ transitions to PR status are on the margin affecting the settlement behaviour of lower quality students.

In Figure 3, we compare 8-year cumulative PR transition rates between different types of students. Female graduates appear to settle in Canada at a higher rate than male graduates, but the difference is small (58 versus 54 percent). PR transition rates are highest among students from West Asia, South Asia, Africa, and Southeast Asia and lowest among students from East Asia and the USA. Comparing fields of study, PR transitions are highest in computer science, computer and software engineering, and business and management, and are lowest in humanities and languages and arts and design. There is little difference between the remaining fields. The biggest difference is for co-op students, 63 percent of whom have transitioned to PR status 8 years after enrolment, compared to 52 percent of students who

were not enrolled in a co-op program. While it is possible that this is a beneficial effect of co-op education, it is also possible that students who seek Canadian PR status are more likely to choose co-op programs.

Figure 3: Cumulative transition rates to PR status 8 years after enrolment, by student characteristics

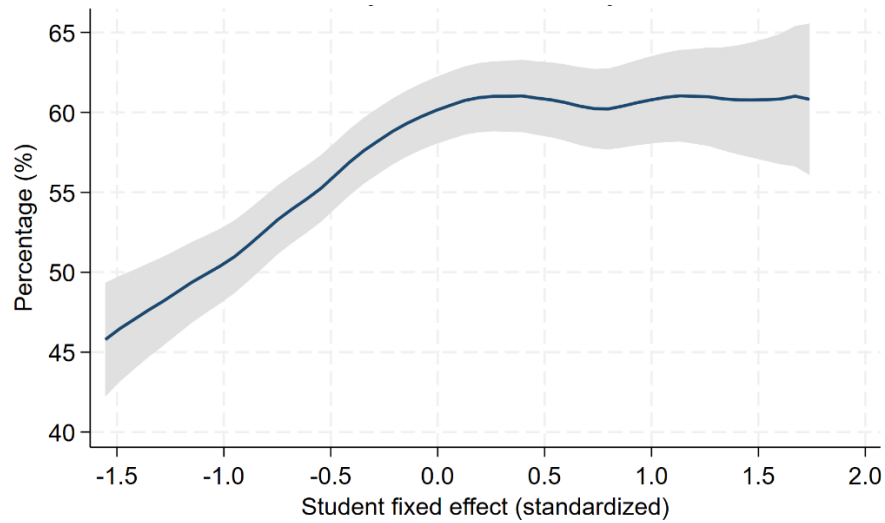


Note: Transition rates to PR status of international students 8 years after entry into UWaterloo. Sample restricted to graduates who were study permit holders at the time of graduation and who enrolled in the 2001-2013 period. 95% confidence intervals shown.

We complete our analysis of PR transitions by estimating a non-parametric regression of the incidence of having transitioned to PR status 8 years after enrolment on our measure of student skill. The results, plotted in Figure 4, reveal lower PR transition rates for students who consistently underperform in their courses, but no difference between average students and those at the top end of the skill distribution. Once again, the results suggest that Canada’s immigrant selection system serves primarily to screen out candidates at the bottom end of the skill distribution but is ineffective in prioritizing the highest quality candidates. In fact, even the difference at the bottom end of the skill distribution is small – the PR transition rate for students one standard deviation below average skill is only 10 percentage points lower than the average.

It is, of course, possible that the overall flatness of the profile in Figure 4 reflects the superior job opportunities outside Canada of candidates at the upper end of the skill distribution, and in turn weaker preferences for Canadian PR status among the best students. While policy levers to screen out candidates at the bottom end are readily available, it is less clear how governments can increase the preferences of top graduates to settle in Canada. Nonetheless, it is possible that selection at the top has improved over time if, for example, Canadian employers are learning how to better attract and retain talent. To examine whether this is true, we estimate a linear probability model predicting the incidence of a PR transition 8 years after enrolment on student skill, a full set of graduation year fixed effects, and the interaction of student skill and linear trend in graduation year. While the estimated coefficient on the interaction term is positive, it is small (0.022) and statistically insignificant suggesting little or no change in the selection of top graduates over time.

Figure 4: Cumulative transition rate to PR status 8 years after enrolment, by student skill

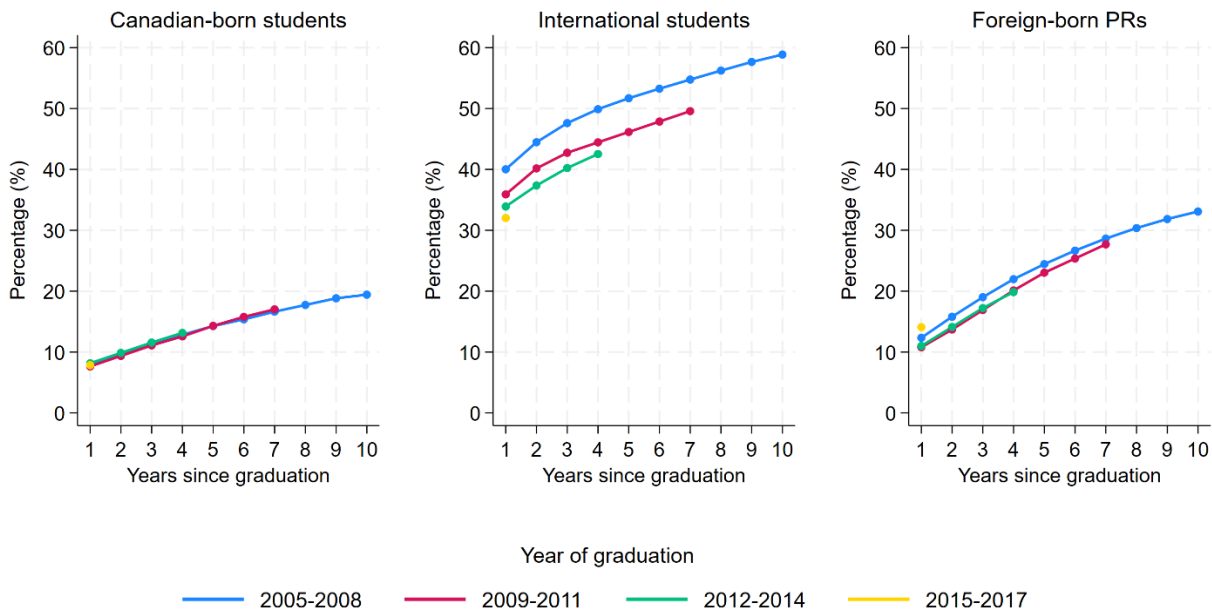


Note: Cumulative PR transition of international students eight years after entry. Sample restricted to international students who entered in the 2001-2016 period. Estimated between 5th and 95th percentiles of student quality distribution. Grey area is 95% confidence interval.

### 5.1.3. Outmigration

The estimates of outmigration plotted in Figure 5 define outmigration as the absence of a T1 income tax return in three consecutive years after graduation. Outmigration in the first year after graduation means, for example, that the individual did not file a T1 in the first, second, and third years after graduation, whereas outmigration two years after graduation means no T1 was filed two, three, and four years after graduation.

Figure 5: Cumulative outmigration rates following graduation, by year of graduation and years since graduation

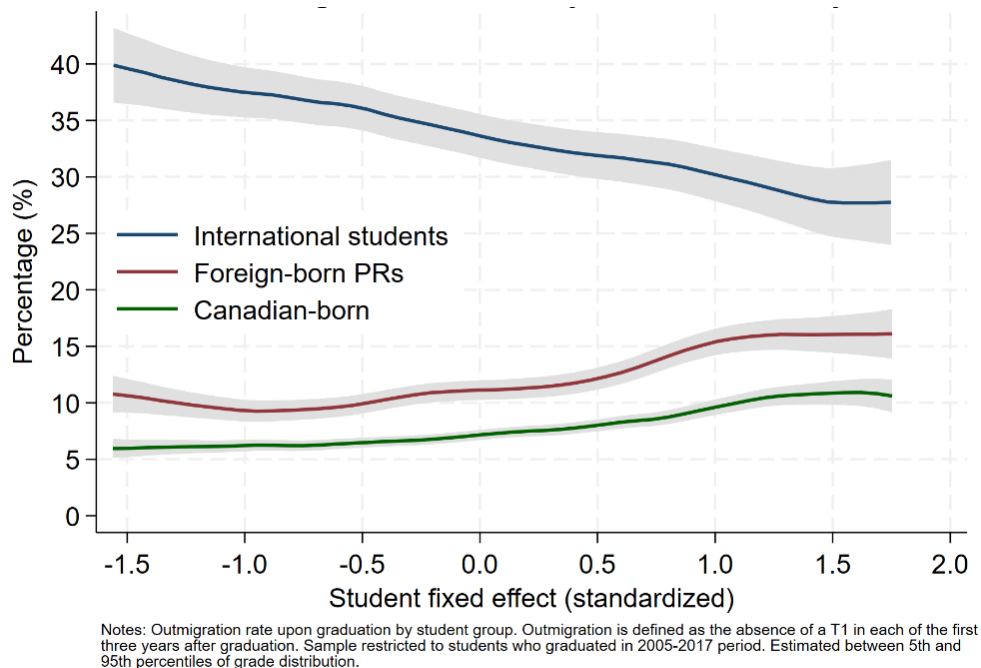


Notes: Outmigration is defined as three consecutive years of not filing a T1. Outmigration one year after graduation means no T1 was filed in the first three years after graduation, for example. 2005-2008 cohort for international students is a fitted quartic due to insufficient sample size.

The middle panel of Figure 5 reveals an unambiguous decline in the outmigration rates of international students, most notably between the 2005-2008 and the subsequent graduation cohorts. This is consistent with the increased take-up of post-graduate work permits after graduation that was identified in Figure 1. Again, it appears that three-year open work permits incentivized more foreign students to remain in Canada following graduation. The rates of outmigration in the first three years after graduation suggest that 60-70 percent of foreign students remain in Canada after graduation. This aligns well with the finding in Figure 2 that roughly 70 percent of graduates eventually transition to PR status. Beyond three years after graduation, the estimates suggest up to one-half of more recent graduates will leave Canada, implying that some graduates who obtain Canadian PR status do not remain in Canada. Moreover, given that PR transition rates have not increased over time, the results suggest that the outmigration rates of graduates who transition to PR status has increased over time.

The more striking feature of Figure 5 is the stability over time in the outmigration rates of foreign-born PR and Canadian-born students. The similarity of the profiles in the Canadian-born panel (left panel) is especially striking. The outmigration rates of foreign-born PR students fall between the rates of international and Canadian-born students, which presumably their deeper social and familial ties to Canada. Whereas the cumulative outmigration rates of foreign-born PRs reach 30 percent, for Canadian-born students they peak at 20 percent. Nonetheless, there is no evidence for either group that the largescale downsizing of Blackberry, a prominent local employer of UWaterloo graduates, between 2010 and 2014 had *any* impact on the propensity of graduates to seek job opportunities outside Canada. This finding speaks directly to concerns that Canadian “brain drain” to the U.S. has been worsening over time.

Figure 6: Rates of outmigration in the first three years after graduation, by student skill



In Figure 6 we examine the relation between the incidence of outmigration after graduation and student skill. As in Figure 5, outmigration in the first year after graduation is inferred when no T1 is filed one, two, and three years after graduation, and as in Figure 4, we use a non-parametric estimator to capture potential non-linearities.

The most salient feature of Figure 6 is the contrast in the slope of the international student line in comparison to other students. While international students at the top end of the skill distribution are *least* likely to leave Canada after graduation, among foreign-born PRs and Canadian-born students, the best students are *most* likely to leave. Rates of outmigration are, however, substantially higher for international students across the skill distribution. At the 5<sup>th</sup> percentile (the left endpoint of each line), international students are four times more likely to outmigrate than foreign-born PRs (40 versus 10 percent) and eight times more likely than Canadian-born students (40 versus 5 percent), whereas at the 95<sup>th</sup> percentile (the right end point) they are less than two times more likely than foreign-born PRs to outmigrate (28 versus 16 percent) and less than three times more likely than Canadian-born students (28 versus 10 percent).

An interpretation of the contrasting pattern for international students is that their migration choices are influenced not only by job opportunities abroad but also by barriers to Canadian settlement imposed by the immigration system. While the lowest skilled foreign students are likely to have the poorest job prospects outside Canada, they are also least likely to obtain the skilled Canadian work experience necessary to clear the hurdles of the Canadian PR selection system. For Canadian-born and foreign-born PR graduates, on the other hand, there are no barriers for the lowest skilled graduates to settle in Canada. In addition, Canadian citizens in many professional occupations, including scientists and engineers, are eligible to work in the U.S. through Trade NAFTA (TN) work visas. Assuming U.S. employers are drawing from the top end of the student skill distribution, this should elevate outmigration of the best Canadian-born graduates, as well as foreign-born PR graduates, many of whom are presumably Canadian citizens at the time of their graduation. Because international students are ineligible for TN visas, on the other hand, the best foreign student graduates are not pulled from Canada by more attractive job offers.

It is worth noting that the slope of the outmigration-skill relation for Canadian-born students in Figure 6 is substantial and suggests that students at the 95<sup>th</sup> percentile of the skill distribution are leaving Canada upon graduation at twice the rate of students at the 5<sup>th</sup> percentile (10 versus 5 percent). While the outmigration rate of students at the 95<sup>th</sup> percentile is more than twice as high for international than Canadian-born students, there were nearly five times more Canadian-born than international student graduates over the sample period. This suggests that Canadian-born graduates of UWaterloo are contributing more in absolute numbers to the Canadian “brain drain” than international student graduates of UWaterloo.

#### 5.1.4. Return migration

Outmigration rates paint an incomplete picture because graduates who choose to leave Canada after graduation sometimes return. And if return migration rates are higher among the highest quality graduates, outmigration rates will exaggerate “brain drain.”

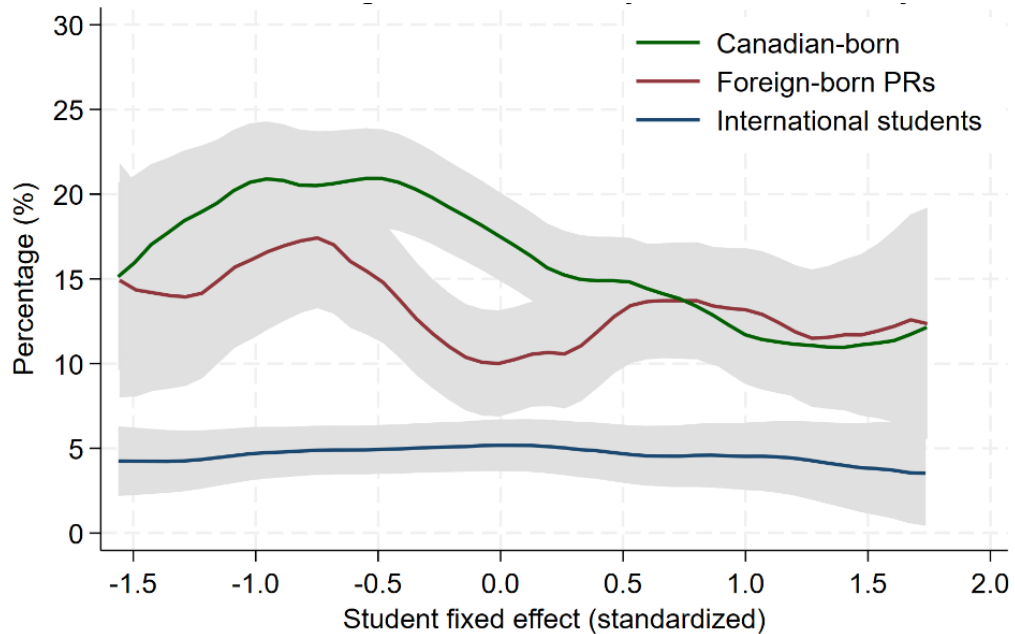
To examine return migration rates, we restrict attention to students who outmigrated upon graduation (did not file a T1 in the first three years after graduation) and plot the percentages who filed a T1 in either the fourth or fifth year after graduation.<sup>25</sup> In Figure 7 we plot the results from nonparametric

---

<sup>25</sup> Alternatively, we have estimated return migration using self-reports of leaving and returning to Canada from individual T1 records. The overall return migration rate within 5 years of outmigration is 16.2 and 13.3 percent for Canadian-born and foreign-born PR students, respectively, almost exactly the same percentages found in the main analysis. The return migration rates within 10 years are as expected higher at 26.4 and 19.9 percent, respectively. For international students the samples are too small to use this method because they rarely report leaving on their T1.

regressions of the incidence of return migration on student skill. Not surprisingly, given their stronger ties, Canadian-born students who outmigrated appear more likely to return (16.5 percent) than foreign-born PR students (13.0 percent) and much more likely than international students (4.4 percent). However, the impact of their higher return rates on reducing “brain drain” is lessened by the fact that return rates appear substantially higher among students at the lower end of the skill distribution than at the top. In fact, at the 95<sup>th</sup> percentile of the skill distribution the difference in return migration rates of international and Canadian-born students is only marginally statistically significant (the 95 percent confidence intervals nearly overlap).

Figure 7: Rates of return migration, by student skill



Notes: Sample restricted to students who graduated in the 2005-2015 period and who did not file a T1 in each of the first three years after graduation (students who left upon graduation). Return migration is defined as the presence of a T1 in either the fourth or fifth year after graduation. Estimated between 5th and 95th percentiles of grade distribution.

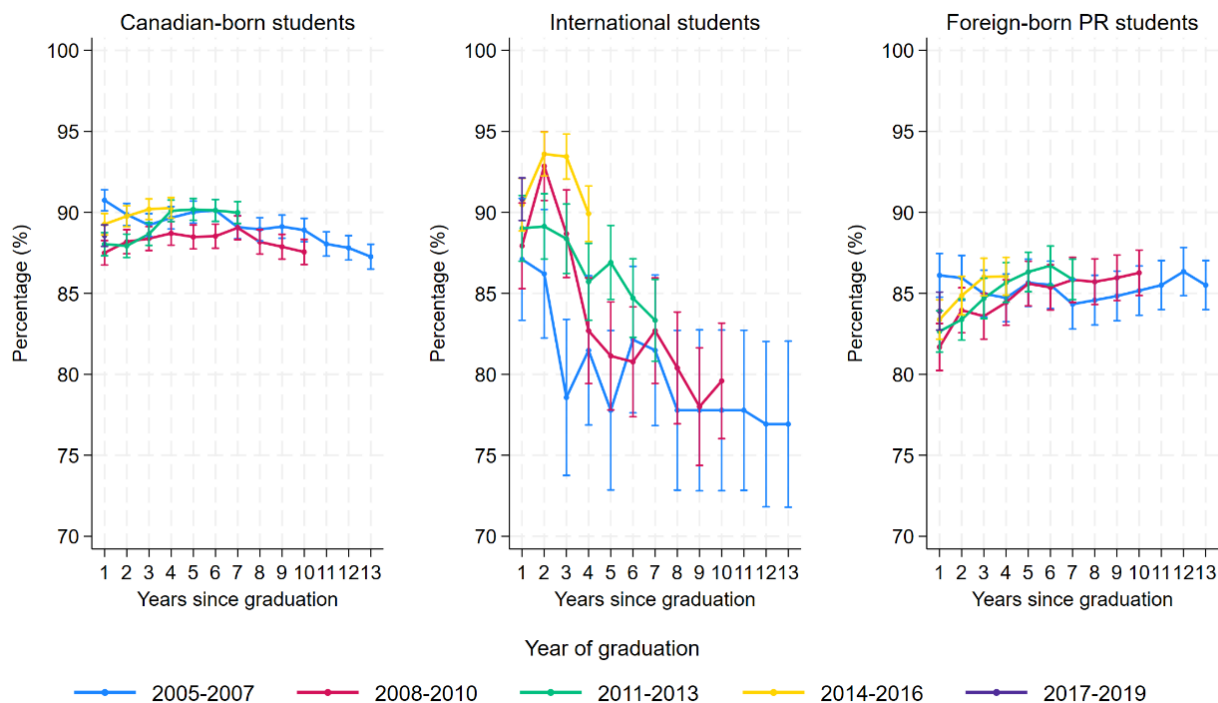
## 5.2. Post-graduation labour market earnings across graduation cohorts

We now turn to examining the labour market outcomes of UWaterloo’s graduates. Before examining the levels of average T4 earnings, we examine the fraction of students that filed income tax returns and the proportion of T1 filers who reported positive T4 earnings.

While not reported in any figure, slightly under 90 percent of Canadian-born graduates filed a T1 in the year after graduation compared to a little more than 80 percent of foreign-born PR students and 50-60 percent of international students. For all groups, the rates of T1 filing decline with years since graduation but somewhat more for international and foreign-born PR students reflecting their higher outmigration rates.<sup>26</sup> While T1 filing rates of international students have trended upwards over time as more take up post-graduate work permits, there are no clear trends in T1 filing rates across cohorts for Canadian-born and foreign-born PR students.

<sup>26</sup> For the 2005-2007 graduating cohorts, T1 filing rates thirteen years after graduation are roughly 80, 65, and 45 percent for Canadian-born, foreign-born PR, and international students, respectively.

Figure 8: Percentage with positive T4 earnings conditional on T1 filing, by year of graduation and years since graduation



In Figure 8, we plot the percentages of T1 filers who had positive T4 earnings. For the earliest cohort (2005-2007), T4 earnings rates are consistently higher for Canadian-born (left panel) than foreign-born students (middle and right panel). While the differences are small (90 percent compared to 86-87 percent), for the most recent cohorts, international students are, if anything, more likely to have T4 earnings than Canadian-born students. This may be explained by the decline in foreign students' transitions to graduate school that is evident in Figure 1. A comparable increase is not evident among foreign-born PRs. The consistently lower likelihood of T4 earnings for this group may be explained by higher rates of enrolment in graduate programs but we have no way to test this hypothesis directly.<sup>27</sup> It is not, however, explained by higher self-employment rates as foreign-born PR graduates are, if anything, less likely than international or Canadian-born students to report self-employment income.<sup>28</sup>

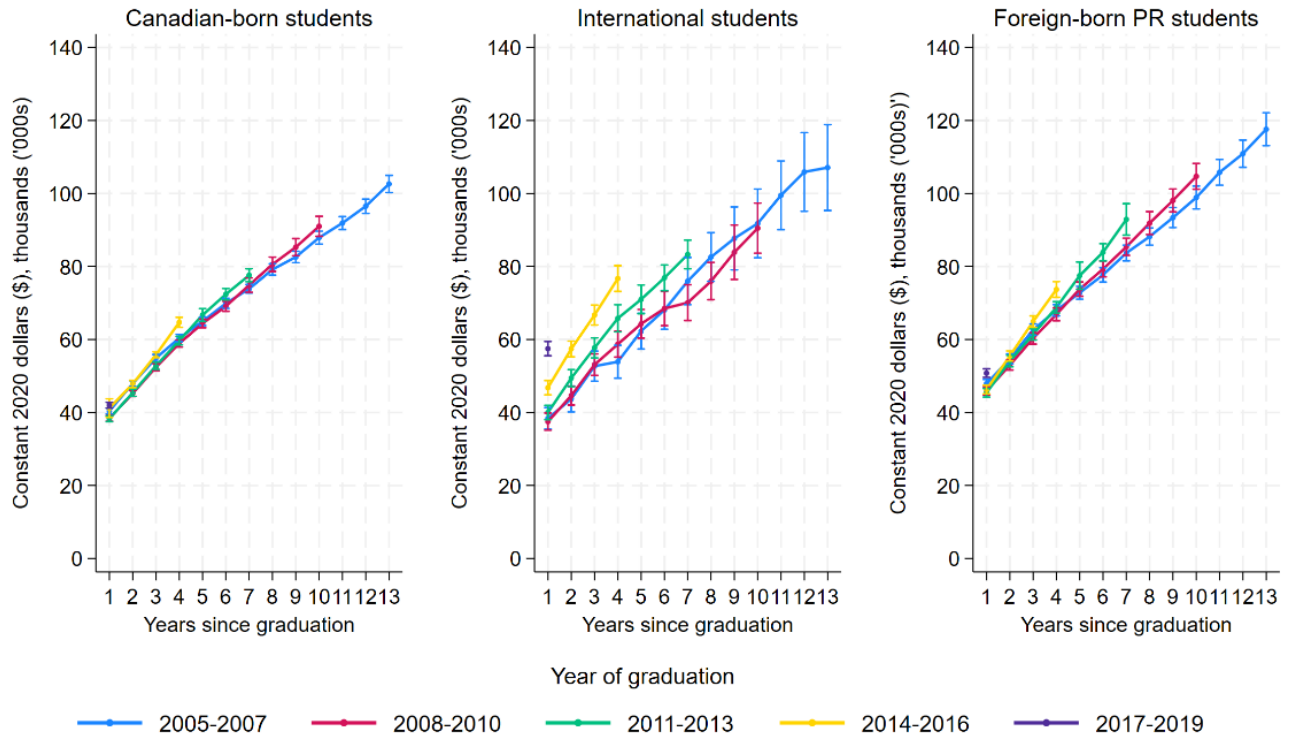
In Figure 9, we plot average T4 earnings of graduates who filed a T1 and reported positive T4 earnings. Focusing first on Canadian-born graduates (left panel), average earnings after graduation start at \$40,000 (constant 2020 dollars) and increase roughly linearly reaching slightly above \$100,000 twelve years later. The stability of the earnings profiles over 15 consecutive cohorts of graduates is remarkable. There is no evidence consistent with declining economic returns to a university education. In fact, if anything, more recent cohorts are experiencing greater earnings growth than earlier cohorts. For example, the average earnings of the 2014-2016 cohorts was \$64,700 four years after graduation, up from \$60,400 for the 2005-2007 cohorts, a 7.1 percent and statistically significant increase.

<sup>27</sup> An option is to examine foreign-born PRs' relative reporting of tuition tax credits in their post-graduation T1 returns but we are hesitant to draw conclusions from these differences as foreign-born students may have different knowledge of and incentives to claim these credits while they are in school.

<sup>28</sup> These results are available from the authors on request.



Figure 9: Average T4 earnings conditional on positive T4 earnings, by year of graduation and years since graduating



The earnings profiles of foreign-born PR graduates (right panel) are different in two respects. First, their average earnings start slightly higher and increase slightly faster than that of Canadian-born graduates. After thirteen years, average earnings are closer to \$120,000 compared to \$100,000. Second, the steepening of the profiles across graduation cohorts is more pronounced. Comparing the 2014-2016 and 2005-2007 cohorts, average real earnings are up 8.4 percent compared to 7.1 percent for Canadian-born graduates. Once again, the results are inconsistent with the belief that the return to a university education is declining over time, although it is unclear to what extent the improvement reflects changes in how labour markets value skill as opposed to improvements in the skills of more recent graduates of UWaterloo.

Last, we turn to the international student graduates (middle panel). Once again there is evidence of profile steepening. However, the most striking result is that international students overall have higher average earnings throughout the first 13 years of their careers, driven by a substantial increase in the starting earnings of the 2014-2016 and 2017-2019 cohorts. While the earnings profile of the 2005-2007 cohort looks almost identical to the Canadian-born profile for the same cohort, average earnings of the 2014-2016 and 2017-2019 cohorts of foreign students are much higher. For example, international students who graduated in 2017-2019 were on average earning \$57,500 one year after graduation. Their Canadian-born counterparts were, in comparison, earning \$42,000 on average, a 37 percent difference. The difference in the median earnings of these two groups is even bigger -- \$56,400 versus \$38,700, a 46 percent difference.

What explains the dramatic improvement in the earnings of UWaterloo’s international student graduates? The estimates of the year of graduation cohort fixed effects ( $c_i$ ) in equation (1), which we

discuss in Section 5.4, trend upward from zero in 2006 to 15-17 log points by 2019 (2005 is the reference group). This is true regardless of whether or not the field of study and student skill variables are included in the regression. This suggests that foreign students' earnings gains are not explained by increasing enrolment in academic programs that have always produced higher earnings, such as computer science or engineering, or by increasing skills of foreign students.

We can think of four alternative explanations. First, it may be that labour market returns to skill have evolved differently across fields of study and foreign students are concentrated in fields where earnings have increased most. Indeed, the data reveal that post-2013 earnings increased most in three fields: computer science; electrical, computer and software engineering; and business and management. If we drop these three sectors, Figure 9 no longer shows a clear trend of increasing international student earnings across cohorts. Second, the gains may reflect institutional learning in screening foreign applicants for admission. This could result in the quality of international students improving over time in ways that are not fully captured by their academic grades. Consistent with this hypothesis, adding student grades in communications courses seems to explain almost half of the post-2013 international student earnings increase.<sup>29</sup> Third, perhaps as the share of foreign students increased, UWaterloo developed programs to foster their success such as language courses and career training. Consistent with this explanation, we find that the fraction of students with at least one communications course increases over time, from a low of 30.7 percent for the 2005 graduating cohort to a high of 70. percent for 2020 graduates. Fourth, the tuition fee premiums that foreign students pay at UWaterloo have increased over time. Perhaps this has resulted in more debt for foreign student graduates which has incentivized them to place less weight on non-pecuniary job attributes when selecting between competing job offers and to increase their annual work hours in their first jobs after graduation. Moreover, as tuition fees increased international students accumulated larger tuition credits during their schooling, resulting in a lower effective marginal tax rate upon graduation, giving them more of an incentive to seek higher paying jobs or work more hours.

### 5.3. Conditional earnings of UWaterloo's international students

Labour market earnings of UWaterloo's recent international student graduates are, no doubt, impressive, as they outperform even that of Canadian-born UWaterloo students. In deciding which candidates to prioritize for economic-class immigration, the unconditional earnings of international students are what matters. Nonetheless, it is worth understanding the source of this advantage. And is there any evidence that international students struggle in comparison to Canadian-born students graduating from the same academic programs? Does the UWaterloo data provide any evidence of immigrant earnings gaps among similarly educated graduates? Does the data provide any evidence consistent with the skill underutilization hypothesis?

Table 2 reports the results from estimating five variants of equation (1). Each specification is estimated using the pooled sample of observations on the full-time annual T4 earnings of UWaterloo graduates (309,100 observations in total). Specification (1) excludes controls for field of study, co-op education, and student skill. The following three specifications progressively add these controls in this order. Of primary interest are the estimates of  $\beta_1$  and  $\beta_2$  which identify the difference in the average post-graduation earnings of UWaterloo's international and foreign-born PR students, respectively, when

---

<sup>29</sup> When we run an OLS regression as in equation (1) but with an added dummy for whether an observation is for an international student in the year 2014 or later. The coefficient on the dummy implies a post-2013 earnings increase of approximately 8% for international students, but drops to almost half that magnitude when student communications grades are added to the equation.

compared to Canadian-born students. In the fifth and final column we add interactions of student skill and the international student and foreign-born PR dummy variables. Of primary interest here is whether there is evidence of lower returns to skill for immigrant students, consistent with the skill underutilization hypothesis.

In line with earlier results, when we do not condition on field of study, UWaterloo's immigrant graduates outperform Canadian-born graduates. Across all the graduation cohorts and years since graduation, the advantage in mean earnings is 5.1 log points. This is roughly a 5 percent difference or, for example, the difference between average annual earnings of \$60,000 and \$63,139. For foreign-born PRs, the earnings advantage is twice as big (10.4 log points). Allowing the years-since-graduation profile to differ for international and foreign-born PR students does little to change these estimates. In other words, the international student earnings advantage is persistent and shows no signs of declining over the first 15 years of graduates' careers.

However, conditioning on field of study in the second column of Table 2 reverses these earnings advantages. For international students, the 5.1 log point advantage becomes a 10.7 log point disadvantage, while for foreign-born PRs the advantage of 10.4 log points becomes a 1.3 log point disadvantage. The field of study fixed effects reveal a clustering of fields into three broad groups. Earnings are highest for electrical computer and software engineering graduates, followed by business and management, and computer science graduates.<sup>30</sup> They are lowest for humanities and languages, followed by recreation and fitness, social science, health and human services, natural resources and conservation, and natural sciences. The gaps between the top and bottom group are substantial – gaps range from 47 to 34 log point gaps relative to computer science. Mathematics and statistics, and other engineering fields fall between these two groups but are closer to the top – 17 and 9 log point gaps relative to computer science, respectively. The earnings advantage of UWaterloo's immigrant students is entirely explained by the fact that 69 and 63 percent of international and foreign-born PR students, respectively, graduate with degrees in the top and intermediate groups compared to only 37 percent of Canadian-born students.

We have already seen that UWaterloo's international students are less likely than Canadian-born students to be enrolled in co-op programs, while foreign-born PR students are more likely (see Table 1). Can this account for international students' bigger earnings disparity conditional on field of study? The third column of Table 2 reveals a substantial earnings advantage of 17.2 log points for co-op students. While it is tempting to interpret this as a casual effect of co-op education, it is of course also possible that higher quality and more career ambitious students who would have had the highest earnings for reasons that have nothing to do with their co-op education are the students who choose co-op. Regardless, conditioning on co-op education reduces the estimated earnings gap for international students from 10.7 to 5.7 log points, while it does essentially nothing to change the small gap of 1.3 log points for foreign-born PRs.

What explains the fact that international students earn roughly 6 percent less than Canadian-born students graduating from similar programs? If this is a consequence of being an immigrant, perhaps reflecting employer discrimination against racial and ethnic minorities, why do foreign-born PR students not experience the same disparity? In the final column of Table 2, we add our measure of student skill to the regression. The estimated coefficient on the student skill variable is 0.054, telling us that a one standard deviation increase in skill is associated with a 5.4 percent increase in a students' annual T4 earnings after graduation. However, because there is essentially no difference in the average skill of

---

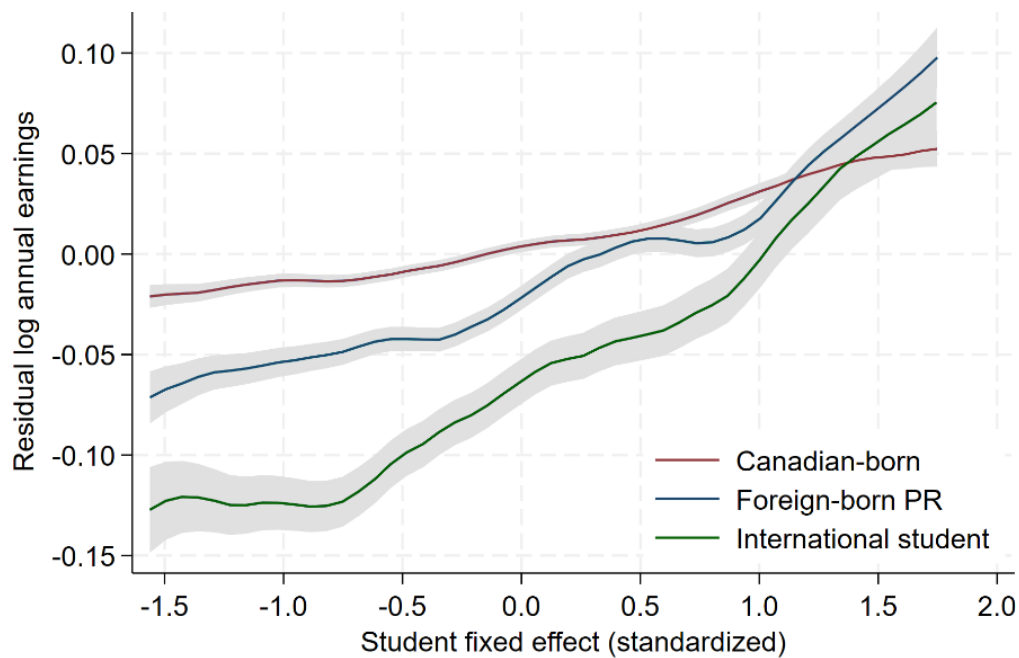
<sup>30</sup> Note that these are also the three fields with the highest PR transition rates (see Figure 3).

immigrant students within fields of study, conditioning on skill does nothing to change the estimated earnings gap of international students and reduces the gap for foreign-born PRs slightly so that it is now almost exactly zero.

The fourth specification of Table 2 imposes the restriction that the return to skill is equal for immigrant and Canadian-born students. But the skill underutilization hypothesis is that the return to skill is lower for immigrant students. Interacting student skill with the international and foreign-born PR dummy variables, shown in the final column of Table 2, reveals that returns to skill are, in fact, much *higher* for immigrant students. For international students, the interaction estimate is 0.057, telling us that the return to skill is more than twice as large as the return of 0.042 for Canadian-born students. For foreign-born PRs, on the other hand, the interaction estimate is 0.027. In both cases, the interactions are highly statistically significant. These estimates are entirely inconsistent with the skill underutilization hypothesis.

In Figure 10, we estimate these returns to measured skill non-parametrically. We do this by first obtaining the residuals ( $\hat{u}_{it}$ ) from the fourth specification of Table 2 excluding the student skill variable, and then regressing the residuals on student skill by student type using a kernel weighted local polynomial estimator. Residual log annual earnings plotted on the vertical axis is the percentage difference (divided by 100) in earnings relative to the average Canadian-born graduate with the same characteristics, including field of study.

Figure 10: Conditional post-graduation earnings gaps, by student skill



Notes: Residual log annual earnings from a linear regression that conditions on field of study, coop, years since graduation (quadratic), age (quadratic), provincial unemployment rate, and gender.

Consistent with the regression estimates, the results point to much higher returns to skill for immigrant students, especially international students. Far from their skills being underutilized, international students' skills are much more important in determining their post-graduation earnings than are the skills of their Canadian-born classmates. In fact, for immigrant students whose measured skill is more than one standard deviation above the average, there is no evidence of earnings disparity relative to Canadian-born students with the same level of skill. This is a remarkable result given the widespread

belief that immigrant earnings gaps reflect skill underutilization. Earnings gaps in excess of 5 log points exist entirely in the bottom half of the skill distribution. For international students, there is a substantial earnings penalty for having low skills, while Canadian-born students are able to somehow buffer themselves against this penalty. What explains this difference?

Using linked employer-employee data, Dostie, Li, Card, and Parent (2023) find that a significant portion of Canadian immigrant earnings gaps are not explained by differences in the skills of workers, but rather by differences in the wages that firms pay equally productive workers. Perhaps the way that Canadian-born students who struggle academically to overcome similar challenges in the labour market is by sorting themselves into firms that pay higher wage premia. This, of course, begs the question why low skilled immigrants do not use the strategy.<sup>31</sup> As suggested by the evidence of Bowlus, Miyairi and Robinson (2016), the explanation may be that international student graduates lack the social networks necessary to generate job offers from firms offering wage premia. With time, they may overcome this handicap, but within the first 15 years of their careers, when we observe graduates' earnings, the job search challenges of international students at the lower end of the skill distribution will have their biggest impact.

To gain additional insight into the nature of the earnings shortfall of international students, in Figure 11 we cut the gap in two alternative dimensions. First, in estimating the fourth specification, we add an interaction of the international student indicator with an indicator of whether student  $i$  had PR status in year  $t$ . This interaction will capture the causal effect of obtaining PR status on the post-graduation earnings of former international students, as well any selection effect, if the students who obtain PR status are self-selected or screened by the government in a way that is related to their future earnings. It will not, however, reflect an effect of living in Canada for longer since we also condition on years since graduation and age. Second, in Figure 11, we distinguish international and foreign-born PR students by their region of birth. The log earnings differences that are plotted along the horizontal axis are expected earnings relative to the average Canadian-born graduate with the same observable characteristics.

First, the earnings gaps tend to be bigger for former international students without PR status than for those with PR status. This is consistent with PR status having a beneficial impact on graduates' earnings, which may reflect that employers are less willing to offer jobs or make training investments in job candidates without PR status because there is a risk that these individuals will be forced to resign when their work permits expire. It is, however, also consistent with the students who struggle to find jobs commensurate with their degrees having greater difficulty in satisfying the requirements of the government's PR selection system. There is, however, little difference in the gaps of former international students who have obtained PR status and foreign-born graduates who had PR status when they began their studies at UWaterloo (although the standard errors for the latter are much smaller reflecting their much larger sample sizes).

---

<sup>31</sup> This explanation also assumes that Canadian-born graduates are negatively sorted into firms that pay higher wage premia. This would occur if students who know they can rely on social networks to obtain high paying jobs after graduation opt to put less effort into their studies resulting in lower academic standing. Dostie, Li, Card and Parent (2023), however, find that the correlation between worker and firm effects in their data is positive, although weak, for both natives (0.071) and immigrants (0.041), but their worker fixed effects based may be capture something different from our student fixed effects. Also, what is true among all workers in the Canadian population may not be true in our select sample of UWaterloo bachelor's graduates.

Figure 11: Conditional post-graduation earnings gaps by, students' PR status and region of birth

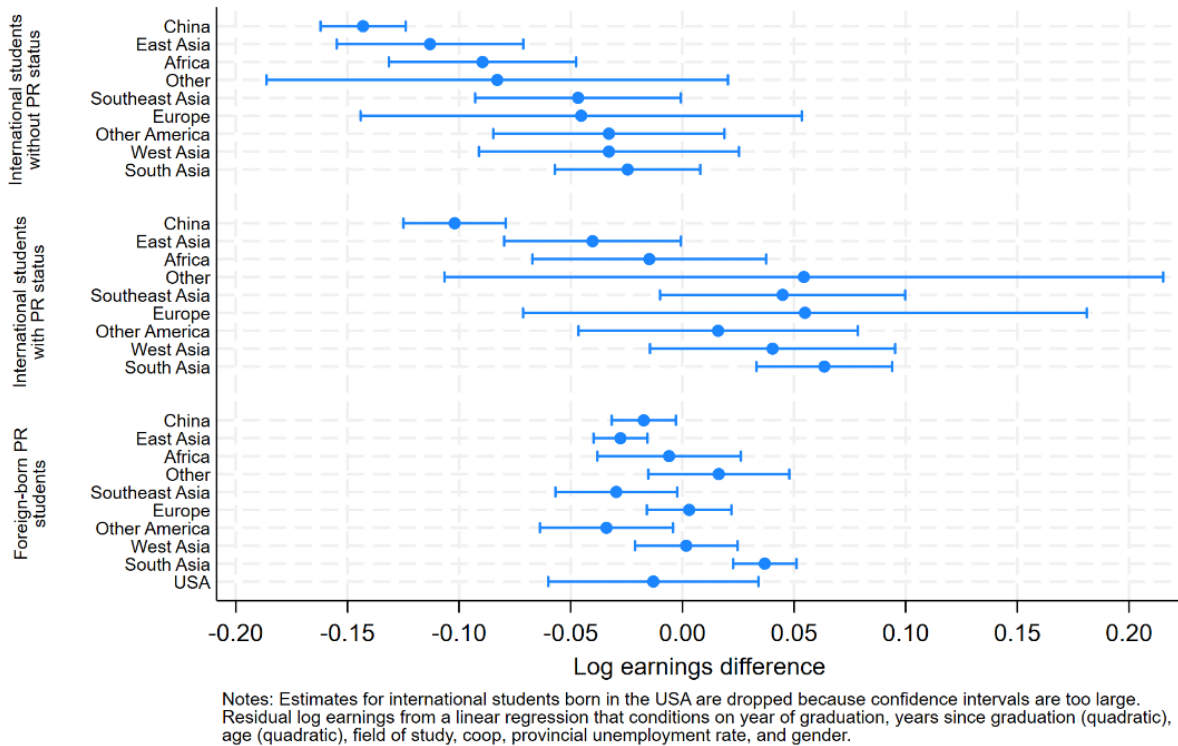


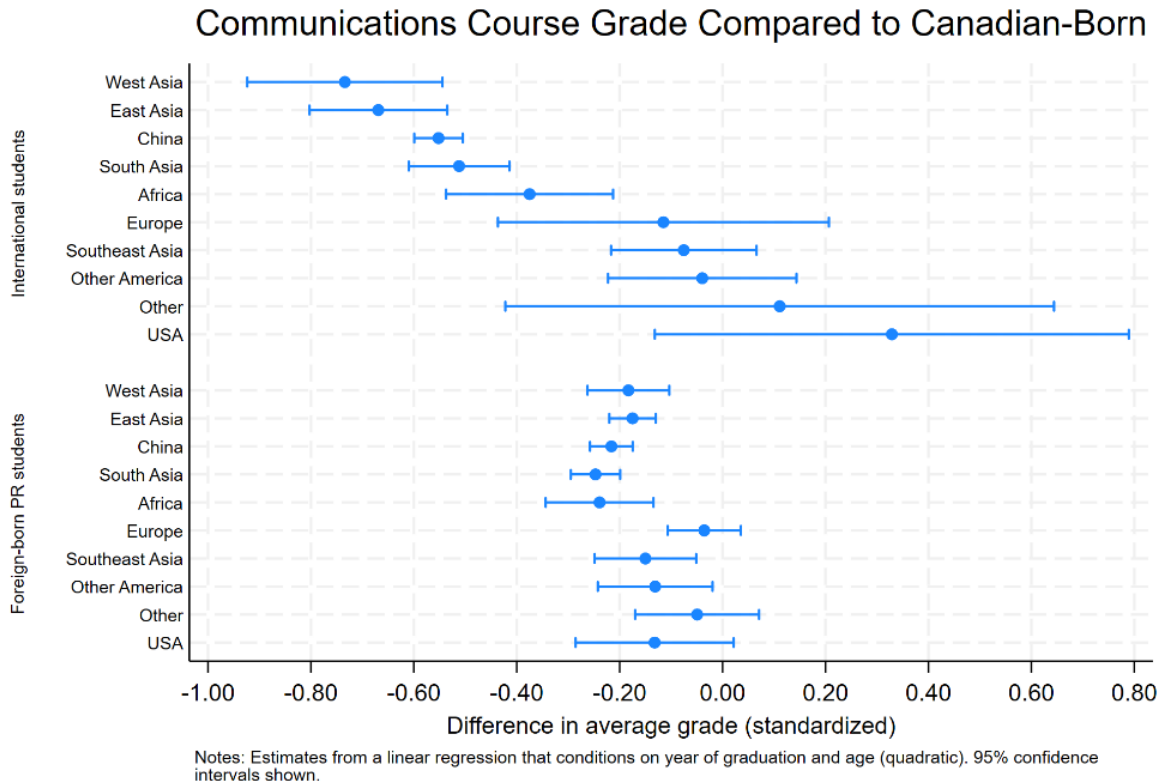
Figure 11 also reveals substantially larger earnings gaps for East Asian students, especially Chinese-born students. The average post-graduation earnings of Chinese-born students who hold work permits is 14 log points below their Canadian-born counterparts graduating from the same academic programs with similar academic standing, while it is 10 log points lower for Chinese-born students who have transitioned to Canadian PR status. These are substantial earnings gaps. What explains them? Is it evidence of skill underutilization?

A limitation of our measure of student skill is that it captures academic achievement and skills on a single dimension. A Chinese-born student with English-language difficulties may consistently rank at the top of their course grade distributions in technical courses with no written or oral communication evaluation but may struggle with English language proficiency in Canadian job interviews and workplaces. Recognizing the importance of students' communications skills, the Faculty of Mathematics at UWaterloo requires students in all their programs to complete an English-language communications course. In our sample of 86,250 graduates, 48,236 completed at least one of these communications courses. The correlation between the average communications course grade of students and their student fixed effect from equation (1) is 0.44 in the full sample and only slightly smaller (0.43) among international students. This suggests that grades in communications courses capture variation in skills that are distinct from those in other courses.

Restricting attention to students who have completed at least one communications course and one year of positive post-graduation T4 earnings, we regress the average grade in communication courses on the student's age (quadratic), a full set of graduation year fixed effects, and the region of birth fixed effects interacted with the international and foreign-born PR indicators. The coefficient on these interaction variables indicates the average communications course grades of immigrant students relative Canadian-

born students who graduated in the same year. The estimates and their 95 percent confidence intervals are plotted in Figure 12.

Figure 12: Relative average grade of foreign-born students in communications courses

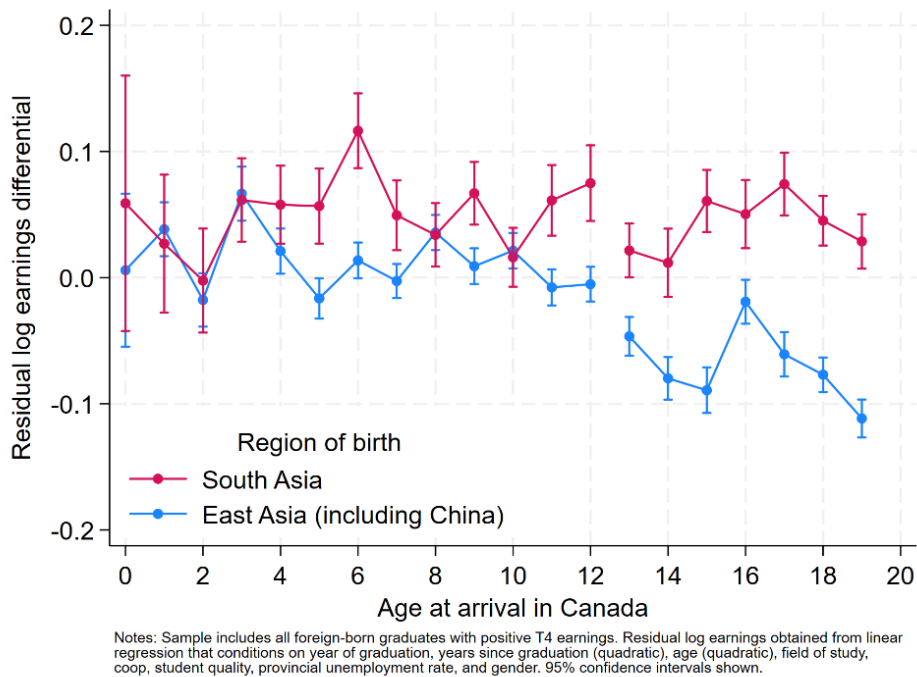


Consistent with the earnings gaps in Figure 11, the estimates reveal substantial deficiencies in language skills among international students from East Asia, including China. Grade shortfalls in excess of one-half of a standard deviation are also evident for international students from West Asia and South Asia. However, the gaps are substantially smaller for students from the same origin regions who were Canadian PRs when they enrolled at UWaterloo. A likely explanation is that these students arrived in Canada at younger ages and therefore had more exposure to English prior to completing their communications courses at UWaterloo.

The “critical period hypothesis” in the psychobiological literature posits that there is a critical period in which a person is able to learn a second language with native proficiency.<sup>32</sup> That period is believed to occur between the age of 2 and shortly before puberty is reached. Beyond this age, the ability to learn a new language declines rapidly. This implies the existence of a discontinuity in the empirical relationship between an immigrants’ age at arrival in the host country and their proficiency in the host country’s language during adulthood. Bleakley and Chin (2004) exploit this discontinuity to identify a causal effect of immigrant language skills on earnings using U.S. Census data.

<sup>32</sup> The “critical period hypothesis” was first proposed by Lenneberg (1967) who attributed the effect of age to physiological changes that occur with puberty that result in a sharp reduction in a person’s ability to learn a new language, especially with respect to sound production and grammatical structure.

Figure 13: Conditional earnings gaps by age at immigration



In Figure 13, we combine the samples of international and foreign-born PR students and examine their conditional earnings gaps from the fourth specification of Table 2 by their age of arrival in Canada. Since pre-migration exposure to English is likely higher for South than East Asian students, we also make the distinction between students from these two origin regions. The results are striking. We find no evidence of any earnings gap for South Asian students or evidence of declining earnings with migration at older ages. A student’s age at migration, after conditioning on their field of study and academic achievement does not appear to have *any* influence on their relative earnings. There is similarly no evidence of earnings gaps for East Asian students who arrived in Canada in their pre-teenage years. However, the differences are consistently negative and statistically significant for East Asian students who arrived in Canada in their teenage years. The discontinuity at age 13 is entirely consistent with the “critical period hypothesis” and the conjecture that the earnings gaps of UWaterloo’s East Asian graduates reflects their English language proficiency.

The literature examining age-at-arrival effects has found that it is mediated through an individual’s education (Clarke 2016). In other words, schooling attainment of immigrants who migrate at older ages is lower, which in turn results in lower earnings. However, our estimates suggest that the age-at-migration effect exists even when comparing Canadian immigrants who completed the same program in the same university with similar academic standing. This implies that the effect is mediated through mechanisms beyond educational attainment. One possibility, of which we are aware of no evidence, is that English language proficiency may impact a student’s formation of intercultural social networks, which may in turn affect their job finding rates after graduation. Alternatively, the link between a students’ age at migration and their Canadian labour market earnings may reflect a direct effect of language proficiency on job search success or workplace productivity. Regardless, the UWaterloo data does not provide any clear evidence consistent with the hypothesis that foreign students’ skills are underutilized in Canadian labour markets.



#### 5.4. Relative earnings of UWaterloo graduates

Is the impressive labour market performance of UWaterloo’s international student graduates, especially in more recent years, a widespread phenomenon or are UWaterloo’s international students exceptional? To answer this question, we turn to the NGS data.

Recall that the NGS allows us to compare annual labour income (T4 earnings plus self-employment income) 1-2 years after graduation for three graduation cohorts: 2005, 2010, and 2015. We compare UWaterloo’s graduates to two groups in the NGS: (i) community college graduates; and (ii) university Bachelor’s graduates. In Figure 14, we plot kernel density estimates of the unconditional income distributions for these three groups separately for Canadian-born, international, and foreign-born PR students.

Figure 14: Distribution of employment income 1-2 years after graduation, by student and school type

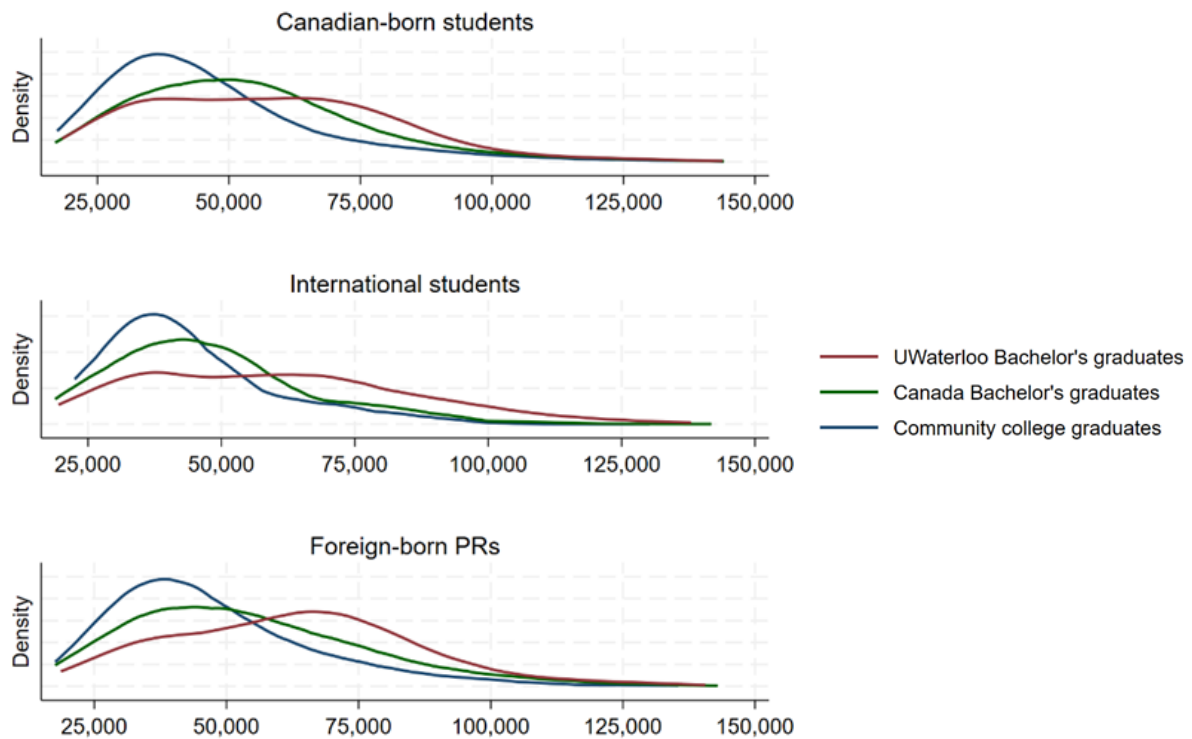


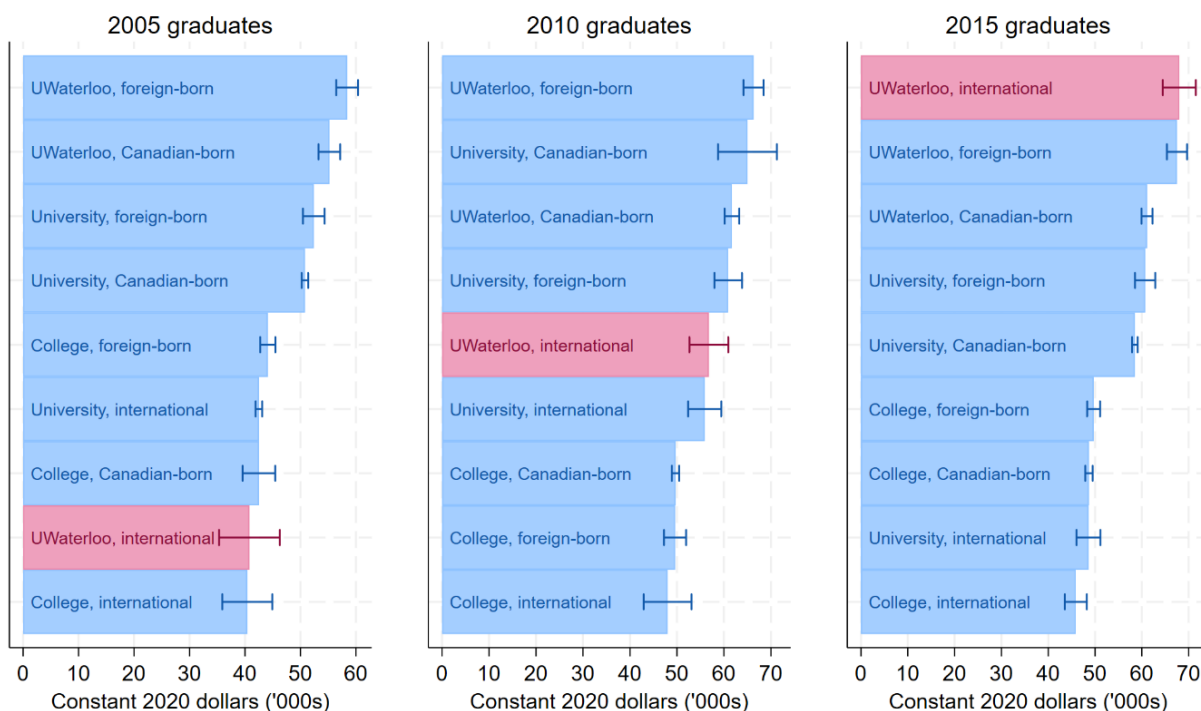
Figure 14 reveals that UWaterloo’s graduates are exceptional, especially their foreign-born students. The UWaterloo distributions stochastically dominate the comparison distributions in all three panels of Figure 14, but the earnings advantages for UWaterloo’s international and foreign-born PR graduates (bottom two panels) are substantially bigger than for Canadian-born graduates.<sup>33</sup> Note in particular the larger vertical differences between the UWaterloo and two other density functions above \$75,000 in the bottom two panels. In fact, there is substantial density even above \$100,000 for UWaterloo’s international students but nothing for other postsecondary graduates. Also striking is that the modes (peaks) of the Canadian-born distributions (top panel) dominate the international and foreign-born distributions (bottom two panels) for both the college and university NGS distributions. The Canadian-

<sup>33</sup> First-order stochastic dominance means that the cumulative density of the UWaterloo distribution is less than cumulative density of the other distributions at every earnings level (point along the x-axis).

born advantage over international students is particularly evident for NGS’s university graduates. Among UWaterloo graduates, however, there is no obvious Canadian-born advantage. In fact, foreign-born PR graduates of UWaterloo are much less likely than their Canadian-born counterparts to have earnings below \$60,000.

In Figure 15, we rank the average annual labour income of the groups in Figure 14 separately by graduate cohorts. Positioning UWaterloo’s international student graduates in a horse race with other graduates reveals, once again, that they are exceptional. Among 2005 graduates, UWaterloo’s international students ranked second last, only outperforming international student college graduates and only by a negligible and statistically insignificant amount. Five years later, they were in the middle of the pack, outperforming all college graduates by upwards of \$7,000. However, by 2015, UWaterloo’s international students’ average annual labour income of \$68,000 surpassed all other graduates. Whatever the explanation is for the remarkable performance of UWaterloo’s more recent international student graduates, it appears to be something exceptional to UWaterloo.

Figure 15: Average labour income of graduates 1-2 years after graduation, by school and student type



Note: Income of 2005 graduates is one year after graduation. Income of 2010 and 2015 graduates is two years after graduation. Estimates for university and college graduates are from the National Graduates Survey and are nationally representative.

Figure 15 reveals another striking result in light of where international student enrolments have increased most since 2005. International student college graduates have consistently had the lowest average labour income by substantial margins. Yet, the growth in international student enrolments has been heavily concentrated in the college sector, as discussed in Section 2. Clearly, this growth is inconsistent with an international education strategy focused on economic growth objectives. Perhaps more striking, the ranking of international students with Bachelor’s degrees across all Canadian universities dropped to second last in 2015. In the most recent data, this group is performing on par with all Canadian-born college graduates and earning upwards of \$10,000 less than Canadian-born and

foreign-born PR university graduates at the national level. The deterioration in the average earnings of international students at Canadian universities in the NGS is consistent with the relative growth of international student enrolments outside of the U15 research-intensive universities. Again, the results in Figure 15 suggest that this growth is poorly aligned with efforts to leverage immigration to boost average income in the population.

How much of the exceptional performance of UWaterloo's international students reflects their relative concentration in STEM fields, such as computer science and engineering, which produce superior labour outcomes for all graduates regardless of what university they graduate from? In Table 3, we report results from pooling the 2005, 2010, 2015 NGS and UWaterloo graduation cohorts and regressing their log annual labour income on indicators of the nine student groups in Figure 14 and 15 (UWaterloo, university, and college by Canadian-born, international, and foreign-born PR), as well as controls for age (quadratic), gender (binary), graduation year (3 categories), province of residence (10 categories), coop education (binary), and field of study (44 categories).

The first column of Table 3 shows that UWaterloo's international student graduates have a 25.7 log point earnings advantage over Canadian-born college graduates (the reference group) and a 9.8 log point advantage (0.257 versus 0.159) over Canadian-born university graduates in the NGS. Their higher earnings point to the potential of the *International Education Strategy* to contribute to economic growth by affecting the mix of programs and institutions where international students study and from where new PRs are selected.

To better understand the source of these higher earnings, columns 2 and 3 condition on field of study and being enrolled in a coop program. Conditioning on field of study (column 2), the UWaterloo international student advantage over Canadian-born college graduates is unchanged (25.2 log points instead of 25.7) but their advantage over other university graduates nationally becomes almost exactly zero. Adding the indicator for being enrolled in a coop program (column 3), brings the difference even closer to zero (point estimates are 0.249 and 0.250). For Canadian-born UWaterloo grads, conditioning on field of study and coop education similarly reduces their advantage from 7.1 (0.230 versus 0.159 in the first column) to 3.3 log points (0.283 versus 0.250 in the third column) and for foreign-born PR UWaterloo grads from 17.6 (0.335 versus 0.159) to 5.6 log points (0.306 versus 0.250). These results reveal that the UWaterloo advantage relative to Canadian-born graduates from elsewhere largely reflects the concentration of UWaterloo grads in STEM fields, especially computer science, math and engineering, and their high participation in coop programs.

However, for international students deciding what school to enroll in, or for IRCC choosing which graduates to prioritize for immigration, it is the comparison to international, not Canadian-born graduates, from other institutions that matters. In this case, conditioning on field of study and coop education does not wipe out the UWaterloo advantage. Comparing UWaterloo's international students to their counterparts in the NGS, we identify a 22.5 log point advantage in the first column of Table 3 (0.257 versus 0.0316) which falls to 10.8 log points (0.249 versus 0.101) when we control for field of study and coop education. The advantage of a UWaterloo degree over a similar degree from elsewhere is almost identical for foreign-born PRs (10.1 log points), but as noted in the previous paragraph, is essentially zero for Canadian-born students. It is interesting, but perhaps not surprising in light of these estimates, that UWaterloo is also exceptional in attracting foreign-born students. Over the span of our sample, UWaterloo's share of bachelor's students that is foreign born has consistently been 2.6 times higher than the average at Canadian universities (28.4 versus 11.0 percent in 2005, 37.4 versus 14.4 percent in 2015). Whatever the source of the UWaterloo advantage is for immigrant students, it would appear that they or their parents are aware of it.

## 6. Conclusion

We find that UWaterloo's international students transition to PR status at nearly twice the national rate and have average Canadian earnings after graduation that surpass the average earnings of UWaterloo's Canadian-born graduates and bachelor's graduates nationally. Moreover, their earnings advantage appears to be growing over time and is entirely accounted for by their relative concentration in engineering and technology fields. Comparing UWaterloo students graduating from the same programs, we find no evidence of foreign student earnings gaps at the top end of the skill distribution, but gaps exist at the lower end, and these gaps appear to be entirely explained by differences in English language proficiency. Overall, we find no evidence of underutilization of the skills of UWaterloo's international student graduates in Canadian labour markets.

Our findings emphasize the economic potential of Canada's *International Education Strategy*. However, they also emphasize that realizing that potential calls for a more targeted approach that prioritizes the quality of foreign students over their quantity. The potential of the *Strategy* lies in its capacity to attract and educate top global talent to boost the average human capital of the population. It does not lie in prioritizing business needs for lower skilled labour.

How best to realize this potential? In our view, the single most important step is to offer international students a single transparent pathway to PR status that relies exclusively on an enhanced Comprehensive Ranking System (CRS) to select candidates with the highest expected future Canadian earnings. The success of the CRS in predicting immigrants' future Canadian earnings can be enhanced significantly by adding applicants' fields of study and school identities to the set of criteria used. If computer science graduates from UWaterloo are consistently outperforming other graduates, their CRS scores should reflect this advantage. In addition, the Canadian earnings levels of holders of PGWPs should be used in the CRS since there is no better predictor of an individual's future earnings than their past earnings.

Our analysis finds remarkably little difference in the PR transition rates of UWaterloo's highest and lowest quality graduates. Whereas 61 percent of international students at the 95th percentile of skill distribution transition to PR status within 8 years of enrolment at UWaterloo, 46 percent of students at the 5th percentile make the same transition. Realizing the economic potential of foreign students requires more targeted selection. And while an enhanced CRS can improve selection, it is not sufficient and may, in fact, be a relatively blunt policy instrument. Policies aimed at influencing the choices that the world's best and brightest students make themselves about where to study and settle after graduation are likely to be more impactful. We find that UWaterloo's foreign students are less than three times more likely than their Canadian-born counterparts with similar academic achievement to leave Canada after graduation, yet their tuition fees are five times higher. Why not use targeted tuition subsidies to attract exceptional prospective foreign students to the country's top university programs in technology and engineering? Or why not offer top graduates income tax incentives or a reimbursement of international student tuition fees to settle and work in Canada after graduation?

Our research-intensive universities, like UWaterloo, that offer students Canadian work opportunities through their cooperative education programs have the potential to attract top global talent. While we hear much government rhetoric about attracting top global talent, we see little to no concerted policy efforts to move the dial on this margin. If the government is serious about leveraging the economic potential of international students, it is time they focus on students in top programs at top universities who embody the human capital that will drive economic growth.

## REFERENCES

- Abowd, John, Robert Creecy, and Francis Kramarz (2002), "Computing Person and Firm Effects Using Linked Longitudinal Employer-Employee Data." U.S. Census Bureau Technical Working Paper TP-2002-06.
- Abowd, John, Francis Kramarz, and David Margolis (1999), "High Wage Workers and High Wage Firms," *Econometrica* 67: 251–333.
- Andrews, M.J., L. Gill, T. Schank, and R. Upward (2008), "High Wage Workers and Low Wage Firms: Negative Assortative Matching or Limited Mobility Bias?" *Journal of the Royal Statistical Society* 171(3): 673–697.
- Aydemir, Abdurrahman and Chris Robinson (2008), "Global labour markets, return and onward migration," *Canadian Journal of Economics* 41(4): 1285-1311.
- Banerjee, Rupa, Danielle Lamb and Laura Lam (2024), "Use It or Lose It: The Problem of Labour Underutilization Among Immigrant Workers in Canada," *Industrial Relations* 55(4): 1-20.
- Berard-Chagnon, Julien, Jackie Tang and Benoit St-Jean (2019), "Immigrant emigration: results from the longitudinal immigration database (IMDB), Statistics Canada, Demography Division.
- Blit, Joel, Mikal Skuterud and Jue Zhang (2020), "Can Skilled Immigration Raise Innovation? Evidence from Canadian Cities," *Journal of Economic Geography* 20(4): 879-901.
- Bowlus, Audra, Masashi Miyairi and Chris Robinson (2016), "Immigrant Job Search Assimilation in Canada," *Canadian Journal of Economics* 49(1): 5-51.
- Chen, Zong Jia and Mikal Skuterud (2018), "The Relative Labour Market Performance of Former International Students: Evidence from the Canadian National Graduates Survey," *Canadian Public Policy* 44(3): 207-225.
- Chen, Zong Jia and Mikal Skuterud (2020), "The Relative Academic Achievement of International Students: Evidence from an Ontario University," *Canadian Public Policy* 46(1): 125-144.
- Chia, G., and P.W. Miller (2008), "Tertiary Performance, Field of Study and Graduate Starting Salaries," *Australian Economic Review* 41 (1): 15 – 31.
- Choi, Youjin, Eden Crossman and Feng Hou (2021), "International Students as a Source of Labour Supply: Transition to Permanent Residency," Economic and Social Reports, Statistics Canada.
- Clarke, Andrew and Mikal Skuterud (2013), "Why Do Immigrant Workers in Australia Perform Better Than Those in Canada? Is it the Immigrants or Their Labour Markets?" *Canadian Journal of Economics*, November 2013.
- Clarke, Andrew and Mikal Skuterud (2016), "A Comparative Analysis of Immigrant Skills and Their Utilization in Australia, Canada, and the USA," *Journal of Population Economics* 29: 849-882.
- Clarke, Andrew, Ana Ferrer and Mikal Skuterud (2019), "A Comparative Analysis of the Labor Market Performance of University-Educated Immigrants in Australia, Canada, and the United States: Does Policy Matter?", *Journal of Labor Economics* 37(S2): S443-S490.

Crossman, Eden, Feng Hou and Garnett Picot (2021), "Are the Gaps in Labour Market Outcomes Between Immigrants and Their Canadian-Born Counterparts Starting to Close?", *Economic and Social Reports* 1(4), Statistics Canada.

Dostie, Benoit, Jiang Li, David Card and Daniel Parent (2023), "Employer Policies and the Immigrant-Native Earnings Gap," *Journal of Econometrics* 233: 544-567.

Doyle, Matthew, Mikal Skuterud and Christopher Worswick (2024), "The Economics of Canadian Immigration Levels," *Canadian Journal of Economics*, forthcoming.

Dryburgh, Heather and Jason Hamel (2004), "Immigrants in demand: staying or leaving?" *Canadian Social Trends* 74: 12-17. Statistics Canada Catalogue no. 11-008-X.

Ferrer, Ana, David Green and Craig Riddell (2006), "The Effect of Literacy on Immigrant Earnings," *Journal of Human Resources* 41(2): 380-410.

Ferrer, Ana, Garnett Picot and Craig Riddell (2014), "New Directions in Immigration Policy: Canada's Evolving Approach to the Selection of Economic Immigrants," *International Migration Review* 48(3): 846-867.

Heckman, James J. (1998), "Detecting Discrimination," *Journal of Economic Perspectives* 12(2): 101-116.

Hou, Feng and Yuqian Lu (2017), "International Students, Immigration and Earnings Growth: The Effect of a Pre-Immigration Host-Country University Education," *IZA Journal of Development and Migration* 7(1): 1-24.

Jones, E.B., and J.D. Jackson (1990), "College Grades and Labour Market Rewards." *Journal of Human Resources* 25 (2): 253-266.

Lenneberg, Erik H. (1967), *Biological Foundations of Language*, New York: Wiley.

Oreopoulos, Philip (2011), "Why Do Skilled Immigrants Struggle in the Labor Market? A Field Experiment with Thirteen Thousand Resumes," *American Economic Journal: Economic Policy* 3: 148-171.

Parliamentary Budget Office (2024), "Income Dynamics of New Immigrants to Canada," Ottawa, Canada.

Picot, Garnett and Feng Hou (2018), "Immigrant STEM Workers in the Canadian Economy: Skill Utilization and Earnings," *Canadian Public Policy* 44(S1): S113-S124.

Picot, Garnett and Feng Hou (2019), "Skill Utilization and Earnings of STEM-educated Immigrants in Canada: Differences by Degree Level and Field of Study," Analytical Studies Branch Research Paper Series, Statistics Canada, Catalogue no. 11F0019M – NO. 435.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain (2005), "Teachers, Schools, and Academic Achievement," *Econometrica* 73(2): 417-458.

Rothstein, Jesse (2010), "Teacher Quality in Educational Production: Tracking, Decay, and Student Achievement," *Quarterly Journal of Economics* 125(1): 175-214.

Royal Bank of Canada Economics, "Canada's Growth Challenge: Why the economy is stuck in neutral," June 4, 2024. (<https://thoughtleadership.rbc.com/canadas-growth-challenge-why-the-economy-is-stuck-in-neutral/>)

Sweetman, Arthur and Casey Warman (2014), "Former Temporary Foreign Workers and International Students as Sources of Permanent Immigration." *Canadian Public Policy* 40(4): 392-407.

Table 1: Sample means

	International students		Foreign-born PR students		Canadian-born students	
	Mean	St. error	Mean	St. error	Mean	St. error
Age	23.716	(0.022)	23.795	(0.018)	24.263	(0.021)
Female	0.465	(0.005)	0.417	(0.003)	0.488	(0.002)
<i>Graduation year</i>						
2005-2007	0.054	(0.002)	0.133	(0.002)	0.165	(0.002)
2008-2010	0.093	(0.003)	0.144	(0.002)	0.158	(0.002)
2011-2013	0.139	(0.003)	0.177	(0.003)	0.172	(0.002)
2014-2016	0.189	(0.004)	0.193	(0.003)	0.184	(0.002)
2017-2019	0.272	(0.004)	0.208	(0.003)	0.190	(0.002)
2020-2021	0.253	(0.004)	0.144	(0.002)	0.131	(0.002)
<i>Region of birth</i>						
Africa	0.042	(0.002)	0.037	(0.001)	--	--
China	0.635	(0.005)	0.259	(0.003)	--	--
East Asia	0.070	(0.003)	0.213	(0.003)	--	--
Europe	0.011	(0.001)	0.090	(0.002)	--	--
Other	0.005	(0.001)	0.032	(0.001)	--	--
Other America	0.036	(0.002)	0.031	(0.001)	--	--
South Asia	0.110	(0.003)	0.197	(0.003)	--	--
Southeast Asia	0.045	(0.002)	0.039	(0.001)	--	--
USA	0.010	(0.001)	0.020	(0.001)	--	--
West Asia	0.034	(0.002)	0.081	(0.002)	--	--
<i>Field of study</i>						
Arts and design	0.009	(0.001)	0.033	(0.001)	0.052	(0.001)
Business and management	0.210	(0.004)	0.160	(0.002)	0.077	(0.001)
Computer science	0.133	(0.003)	0.108	(0.002)	0.057	(0.001)
Computer and software engineering	0.053	(0.002)	0.120	(0.002)	0.053	(0.001)
Engineering other	0.087	(0.003)	0.152	(0.002)	0.132	(0.002)
Health and human services	0.013	(0.001)	0.043	(0.001)	0.054	(0.001)
Humanities and languages	0.046	(0.002)	0.044	(0.001)	0.118	(0.001)
Mathematics and statistics	0.205	(0.004)	0.092	(0.002)	0.051	(0.001)
Natural resources and conservation	0.041	(0.002)	0.015	(0.001)	0.037	(0.001)
Natural sciences	0.087	(0.003)	0.098	(0.002)	0.113	(0.001)
Recreation and fitness	0.006	(0.001)	0.023	(0.001)	0.077	(0.001)
Social sciences	0.111	(0.003)	0.113	(0.002)	0.180	(0.002)
Coop program	0.362	(0.005)	0.639	(0.003)	0.486	(0.002)
Student fixed effect (standardized)	0.055	(0.010)	0.070	(0.007)	-0.041	(0.004)

Any administrative data linkage	0.919	(0.003)	1.000	--	0.980	(0.001)
IMDB linkage	0.900	(0.003)	1.000	--	-	--
Filed T1 in any year	0.861	(0.003)	0.993	(0.001)	0.980	(0.001)
Filed T1 in any year after graduation	0.498	(0.005)	0.757	(0.003)	0.811	(0.002)

Number of observations	10,980	22,570	52,700
------------------------	--------	--------	--------

Note: Sample includes all students who graduated from the University of Waterloo with a bachelor's degree between 2005 and 2021.



Table 2: Relative post-graduation annual T4 earnings of UWaterloo's international and foreign-born PR students

	(1)	(2)	(3)	(4)	(5)
International student	0.0513*** (0.0074)	-0.1070*** (0.0072)	-0.0574*** (0.0069)	-0.0579*** (0.0067)	-0.0640*** (0.0067)
Foreign-born PR student	0.1040*** (0.0042)	-0.0130*** (0.0039)	-0.0135*** (0.0038)	-0.0065* (0.0038)	-0.0081** (0.0038)
Years since graduation	0.0740*** (0.0016)	0.0769*** (0.0015)	0.0779*** (0.0016)	0.0754*** (0.0015)	0.0751*** (0.0015)
Years since graduation squared	-0.0213*** (0.0008)	-0.0259*** (0.0008)	-0.0265*** (0.0008)	-0.0252*** (0.0008)	-0.0252*** (0.0008)
Age	0.0313*** (0.0031)	0.0387*** (0.0030)	0.0370*** (0.0031)	0.0422*** (0.0030)	0.0428*** (0.0030)
Age squared	-0.0034*** (0.0004)	-0.0035*** (0.0004)	-0.0032*** (0.0004)	-0.0040*** (0.0004)	-0.0041*** (0.0004)
Provincial unemployment rate	0.0054*** (0.0005)	0.0053*** (0.0005)	0.0052*** (0.0005)	0.0052*** (0.0005)	0.0051*** (0.0005)
Female	-0.2250*** (0.0037)	-0.0904*** (0.0036)	-0.0980*** (0.0036)	-0.1040*** (0.0035)	-0.1040*** (0.0035)
Co-op education	--	--	0.1720*** (0.0047)	0.1410*** (0.0047)	0.1410*** (0.0047)
Student skill	--	--	--	0.0538*** (0.0021)	0.0419*** (0.0025)
Student skill * International					0.0573*** (0.0058)
Student skill * Foreign-born PR					0.0271*** (0.0039)
Graduation year fixed effects	YES	YES	YES	YES	YES
Field of study fixed effects	NO	YES	YES	YES	YES
Constant	10.24*** (0.0529)	10.25*** (0.0520)	10.14*** (0.0528)	10.07*** (0.0515)	10.06*** (0.0515)
R-squared	0.201	0.340	0.354	0.362	0.363
Number of observations	309,100	309,100	309,100	309,100	309,100

Notes: Field of study includes 77 categories and computer science if the reference group. \*\*\*, \*\*, \* indicate statistical significance at the 10%, 5%, and 1% levels. Standard errors are clustered by student ID.

Table 3: Relative log employment income one year after graduation of University of Waterloo graduates

	(1)	(2)	(3)
<i>Canadian-born student</i>			
UWaterloo bachelor's	0.230*** (0.0071)	0.304*** (0.0075)	0.283*** (0.0076)
Canada bachelor's (College diploma)	0.159*** (0.0046)	0.245*** (0.0051)	0.250*** (0.0051)
	--	--	--
<i>International student</i>			
UWaterloo bachelor's	0.257*** (0.0183)	0.252*** (0.0176)	0.249*** (0.0176)
Canada bachelor's	0.0316** (0.0150)	0.0942*** (0.0144)	0.101*** (0.0143)
College diploma	-0.100*** (0.0157)	-0.102*** (0.0148)	-0.0981*** (0.0147)
<i>Foreign-born PR student</i>			
UWaterloo bachelor's	0.335*** (0.0099)	0.335*** (0.0100)	0.306*** (0.0101)
Canada bachelor's	0.136*** (0.0083)	0.189*** (0.0082)	0.195*** (0.0082)
College diploma	-0.0616*** (0.0092)	-0.0768*** (0.0086)	-0.0765*** (0.0085)
Age	0.0286*** (0.000894)	0.0287*** (0.000844)	0.0292*** (0.000841)
Age squared/100	-0.0226*** (0.0010)	-0.0228*** (0.0009)	-0.0231*** (0.0009)
Female	-0.0723*** (0.0038)	-0.0348*** (0.0037)	-0.0330*** (0.0036)
Co-op education	--	--	0.0894*** (0.0048)
Graduation year fixed effects	YES	YES	YES
Province of residence fixed effects	YES	YES	YES
Field of study fixed effects	NO	YES	YES
Constant	10.02*** (0.0177)	10.01*** (0.0173)	9.971*** (0.0174)
R-squared	0.124	0.240	0.246
Number of observations	45,500	45,500	45,500

Notes: Least squares estimates from a linear regression model. Sample are 2006, 2012, and 2017 graduates and employment income is T4 earnings plus self-employment income in 2007, 2013, and 2018, respectively. Canada bachelor's and college graduate samples are from National Graduates

Surveys (NGS). Field of study fixed effects include 44 categories and computer science is the reference group. \*\*\*, \*\*, \* indicate statistical significance at the 10%, 5%, and 1% levels.