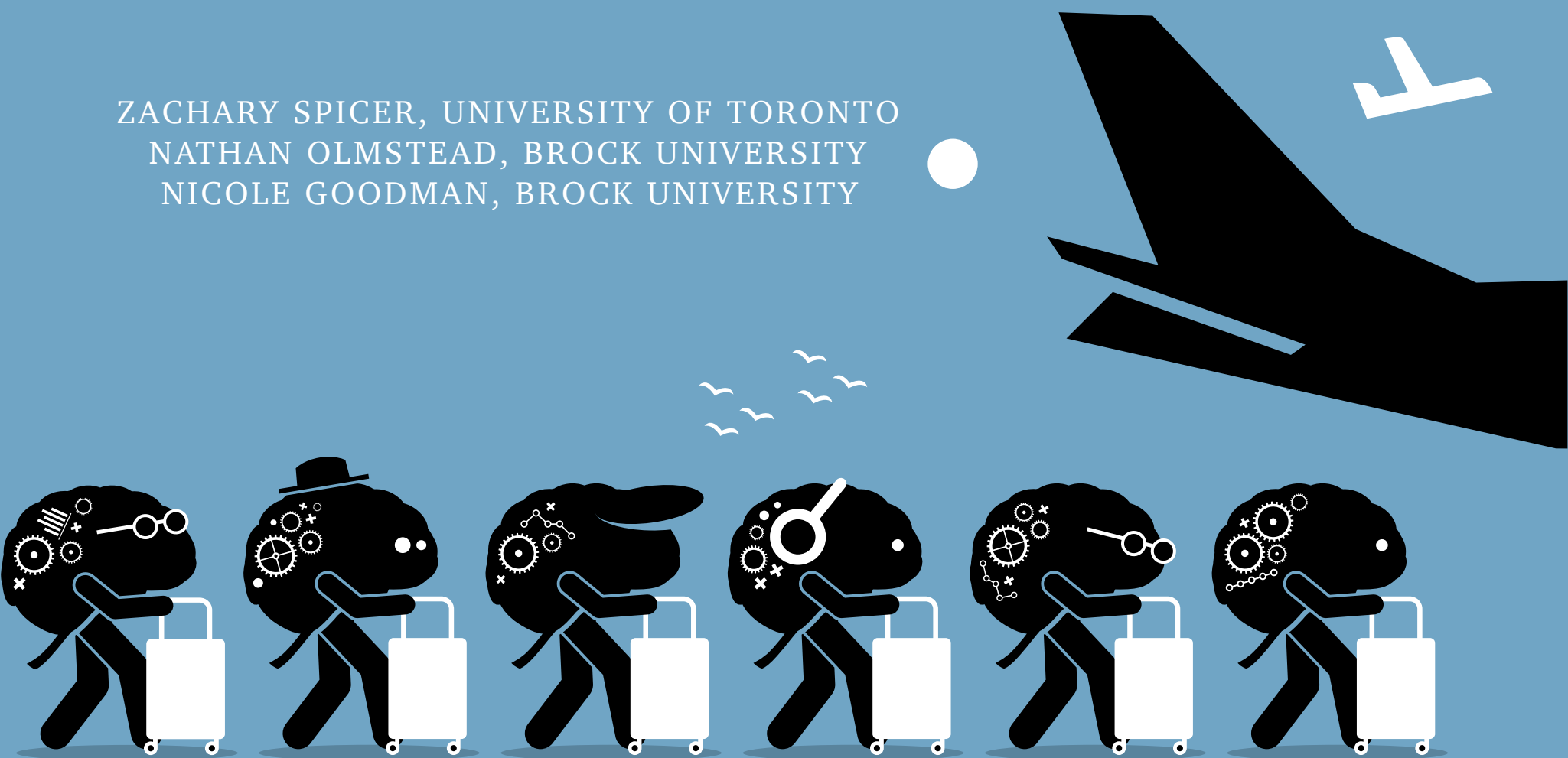


# REVERSING THE BRAIN DRAIN:

## Where is Canadian STEM Talent Going?

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delvinia **Mitacs**

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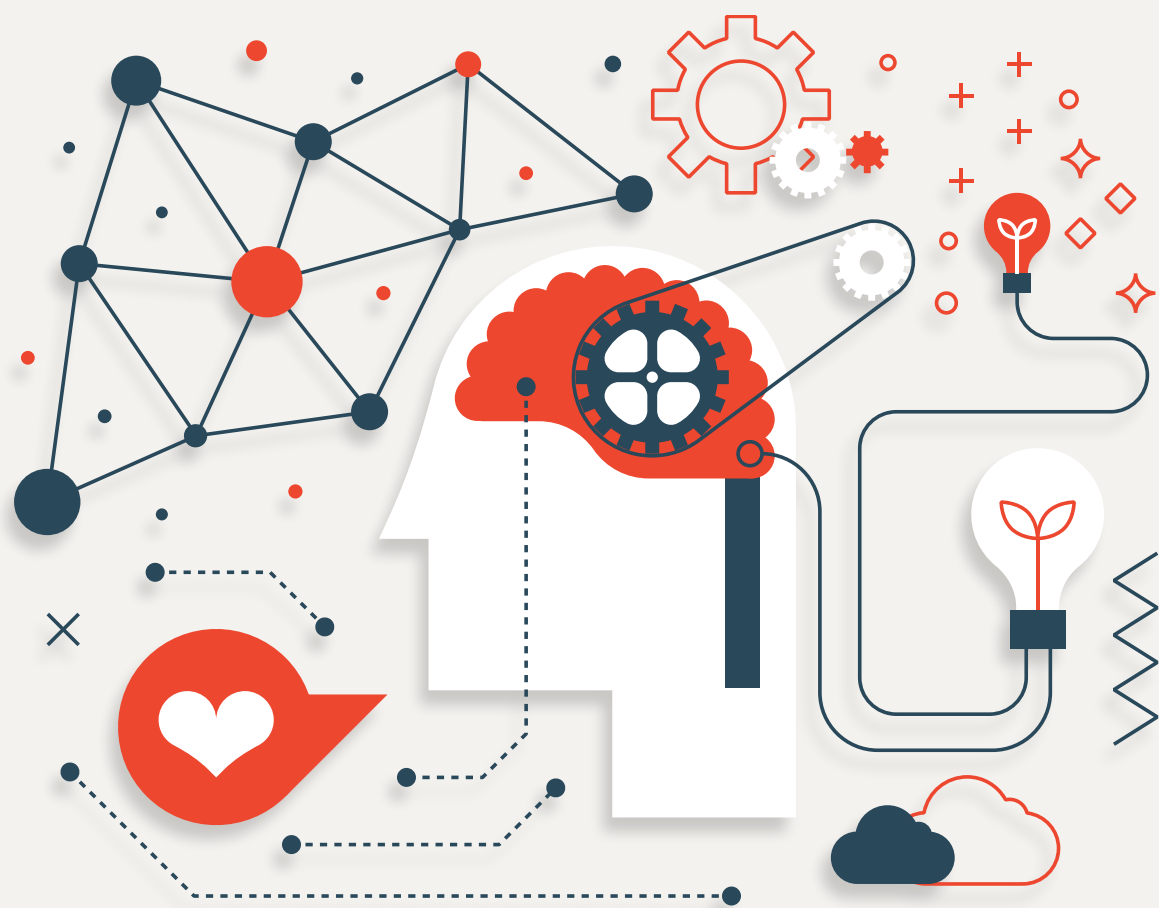
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# FOREWORD

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As the CEO of a Canadian scale-up, few topics cue such an impassioned discussion as the brain drain epidemic plaguing our tech sector. It's not surprising that the most admired names in tech – Amazon, Apple, Microsoft, Facebook, and Google – are all clamouring to recruit our best Canadian STEM talent. After all, the reputation of our competitive innovation ecosystem and world leading higher education system is proving a boon for our tech scene.

While the prestige of having graduates hired by these notable companies is undeniable for our academic institutions, it also means the domestic tech industry will face increasing constraints and pressures beset by talent shortages if our most promising talent continues to leave Canada to work for companies in the United States.

In my many conversations with fellow tech industry CEOs, access to the necessary human capital needed to grow has been identified as a significant inhibitor to scale. While we understand that this is a problem, very little research has been done on why these graduates are leaving and what can be done to help Canadian firms retain talent.

Without a more accurate understanding of why the best and brightest Canadian graduates are choosing to leave, it is impossible for Canadian firms to determine the best way to retain talent. Simply complaining about the situation is not my style, and instead of being part of the problem, as a Canadian tech scaleup CEO, I felt that we needed to part of the solution. This is why my firm chose to address the issue by funding this report.

This research is just the beginning. It gives us a glimpse into what is occurring as STEM students graduate, but it also provides a perspective of the decision-making process they go through when choosing jobs from the graduates themselves. With this research in hand, we now have evidence-based recommendations and strategic building blocks for a national talent retention strategy that Canadian tech companies, higher education institutions and government can collaborate on to address the misconception that the best jobs are outside of Canada.

I would like to acknowledge the efforts and insights of the research team: Zachary Spicer of the University of Toronto as well as Nathan Olmstead of Brock University. This research project could not have been achieved without the incredible collaboration and supervision of Nicole Goodman from Brock University and David Wolfe from the University of Toronto. I would also like to thank Carl Rodrigues and Chadi Elkadri, from SOTI, for your invaluable input and advice throughout the project. Thank you to Mitacs for supporting the project through the funding of its Accelerate program. And a thank you needs to always go out to Deborah Huntley, for keeping the administration of this project on track.

Adam Froman, CEO of Delvinia

# NOTE TO THE READER

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This work was industry-initiated and funded by Delvinia with matching funds from a Mitacs Accelerate award. Academic researchers were selected from the University of Toronto and Brock University to devise the research design, collect data and carry out analysis. Zachary Spicer (University of Toronto) led the research with the support of Nathan Olmstead (Brock University) and Nicole Goodman (Brock University) and oversight by David Wolfe (Innovation Policy Lab, University of Toronto).

The authors would like to thank the interviewees for their participation in the research and contribution to the report. Because of our research ethics protocol, we cannot mention their names, but we would like them to know that we appreciate their time and comments. We would also like to thank Chris Wormald who was kind enough to discuss our research at a very early stage and help us navigate this research area. Finally, we are grateful to Joey Loi and Atef Chaudhury who provided very helpful comments to us at the early stage of this project and were instrumental in allowing us to better understand human talent migration in the technology sector.

# EXECUTIVE SUMMARY

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This report examines brain drain among Canadian STEM graduates. Drawing on the LinkedIn profile data of 2015 and 2016 STEM graduates from the Universities of Toronto, British Columbia and Waterloo, and 35 interviews with select graduates, we answer three questions:

1. Where are recent Canadian STEM graduates seeking employment?
2. If Canadian STEM graduates have opted to work abroad, why was this choice made?
3. What are the best strategies for public and private sector leaders to retain STEM talent?

The following are key findings from the research, which are explained more fully in the report:

## **Evidence of Brain Drain in STEM fields**

- One in four of the STEM graduates in our sample opted to work outside of Canada.

## **Talent Migration is High in Technology-Focused STEM Programs**

- Two thirds (66%) of software engineering students are leaving Canada for work after graduation.
- Brain drain is also high in: computer engineering (30%), computer science (30%), engineering science (27%), and systems design engineering (24%).
- Programs such as biology (0%) and chemistry (3.5%) have low migration of graduates.

## **Where are STEM graduates that leave Canada going?**

- The United States is the destination of choice for those who choose to work abroad (81.51%).
- Most of those working in the United States find employment in California, Washington State and New York – states home to large, multinational technology firms such as Amazon and Google.

## **Why are STEM graduates seeking work in the United States?**

- Higher pay, firm reputation, and the scope of work are the top three reasons STEM graduates are choosing to start their careers in the US.

### *Pay*

- STEM graduates reported that salaries paid in the United States are usually 20% to 30% higher than a comparable position in Canada.
- This extra income was seen as important for paying off student loans faster.

### ***Reputation***

- Reputation working for some of the largest technology companies motivates recent graduates to work in the US. They want to have these companies listed on their resumes to enhance future career opportunities.

### ***Scope of Work***

- Respondents indicated that working for Canadian technology does not allow one to experience as many projects or tasks. Many of those interviewed argued that since Canadian firms tend to be smaller, there is a narrower scope of work and one may, therefore, be confined to working on a single project or task for a prolonged period of time.
- It was communicated that US companies often provide a greater array of tasks and responsibilities for new graduates.

### **Recommendations**

The report concludes with recommendations for Canadian technology firms, government and post-secondary institutions to retain and attract top talent.

### **Canadian Technology Firms**

- Consider increasing salaries and compensation packages to bring them more in line with those available in the United States.
- Introduce and/or continue the practice of signing bonuses and other creative compensation, such as paying off a certain percentage of student debt for newer hires after a predetermined period of time, or providing stock options or performance bonuses tied to company performance.
- Introduce a comprehensive communications strategy to convey firm success to potential workers, including a plan to penetrate media and outreach networks in major American technology hubs.
- Develop an increased presence on university campuses, such as hosting hackathons, creating lab sponsorships, holding social events or supporting guest speakers;
- Openly communicate long-term planning and fiscal health. This is information prospective talent craves when considering a move back to Canada.
- Increase compensation for co-op placements, providing more incentive for potential co-op students to apply with domestic firms.
- Continue to build relationships and increase recruitment efforts during and after co-op placements by following-up with talent and continuing as a presence throughout their education.

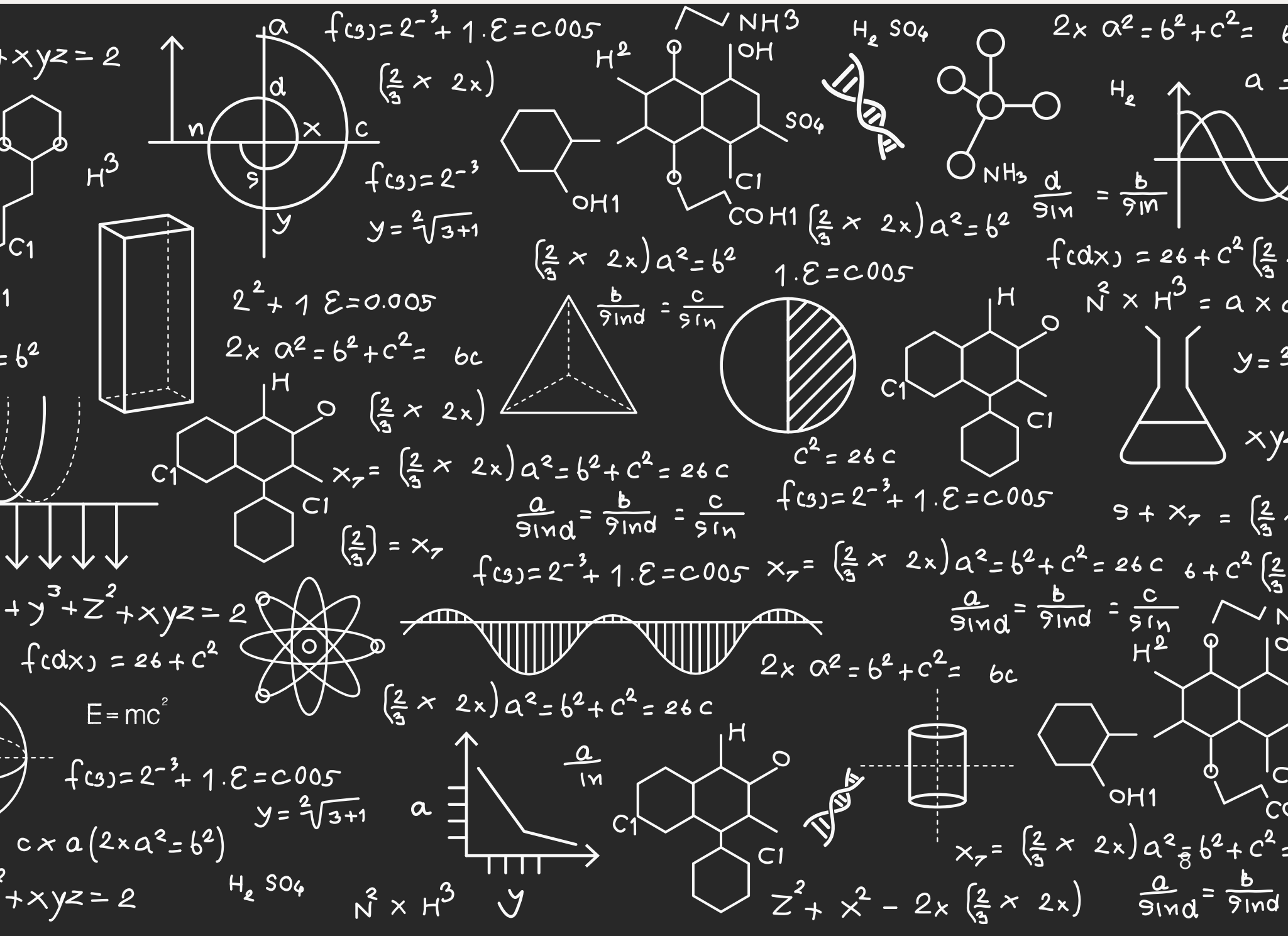


## Government

- Consider the development of interest relief programs on student loans for recent graduates from certain STEM programs, allowing Canadian firms to more readily compete with American competitors for talent.
- Create measures to help Canadian technology firms close the gap in co-op compensation, such as introducing programs to assist smaller firms in matching co-op pay.
- Government at all levels should continue to invest in innovation and research with the goal of increasing the density of Canada's technology sector, providing a more attractive climate for global and domestic talent.

## Post-Secondary

- Prioritize Canadian co-op placements later in student tenure and work with Canadian firms in securing top students for placements prior to their graduation.
- Develop strategies to counter prevailing peer-pressure to seek work exclusively in the United States.





# INTRODUCTION

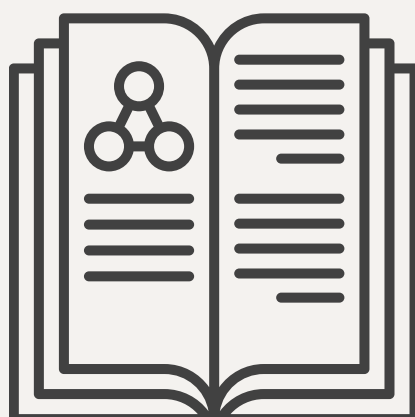
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The British Royal Society first coined the term “brain drain” in the early 1950s to describe the outflow of scientists and technologists from Great Britain to the United States and Canada (Cervantes and Guellec 2002). This process involves large-scale emigration of talented individuals, educated in one country, but who choose to work in other countries to seek out higher salaries, prestige or greater occupational mobility. While this phenomenon has been long debated and discussed, policy-makers in Canada are often left wondering why highly skilled Canadian workers opt to work abroad. The brain drain has a number of important economic consequences for the private and public sectors. Two of the most prominent include; first, that investment in education in one country may not lead to faster economic growth if large number of highly educated workers leave the country for employment elsewhere (Carrington and Detragiache 1999). Second, domestic firms may be deprived of the best talent available to them, never having the opportunity to attract newly educated and highly skilled individuals who may have helped grow their operations.

The discussion of brain drain in Canada has mostly focused on doctors and other skilled medical staff (see Finnie 2001; Martineau 2004) despite the fact that a number of authors and policy-makers have been alarmed in recent years about human capital flight to technology clusters (Yoon 2017). The purpose of this report is to explore whether brain drain is occurring in Canadian STEM (science, technology, engineering, and mathematics) programs. To better understand the nature of brain drain amongst Canada’s STEM graduates we answer three questions:

- Where are recent Canadian STEM graduates seeking employment?
- If Canadian STEM graduates have opted to work abroad, why was this choice made?
- What are the best strategies for public and private sector leaders to retain STEM talent?

We find evidence of brain drain in Canada’s technology and innovation sector, with one in four of the STEM graduates in our sample opting to work outside of Canada. Higher migration rates are seen in technology-focused programs, such as computer science and software engineering. We find that the prospects of earning higher salaries, working for market leaders and being able to complete a wide range of projects were key motivators for seeking employment in the United States.



# A REVIEW OF THE CANADIAN BRAIN DRAIN

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## The Emergence of Brain Drain Research

As described above, the term “brain drain” was coined by the British Royal Society in the early 1950s to describe the outflow of scientists and technologists from Great Britain to the United States and Canada (Cervantes and Guellec 2002). Concern at the time was that highly skilled workers, most prominently trained physicians and nurses, were choosing to leave the country to pursue higher wages, research funding, and opportunity elsewhere (Johnson 1964). Concern soon became widespread, with politicians and policy-makers around the world similarly alarmed about the potential loss of valuable workers to the United States (and OECD countries more generally).



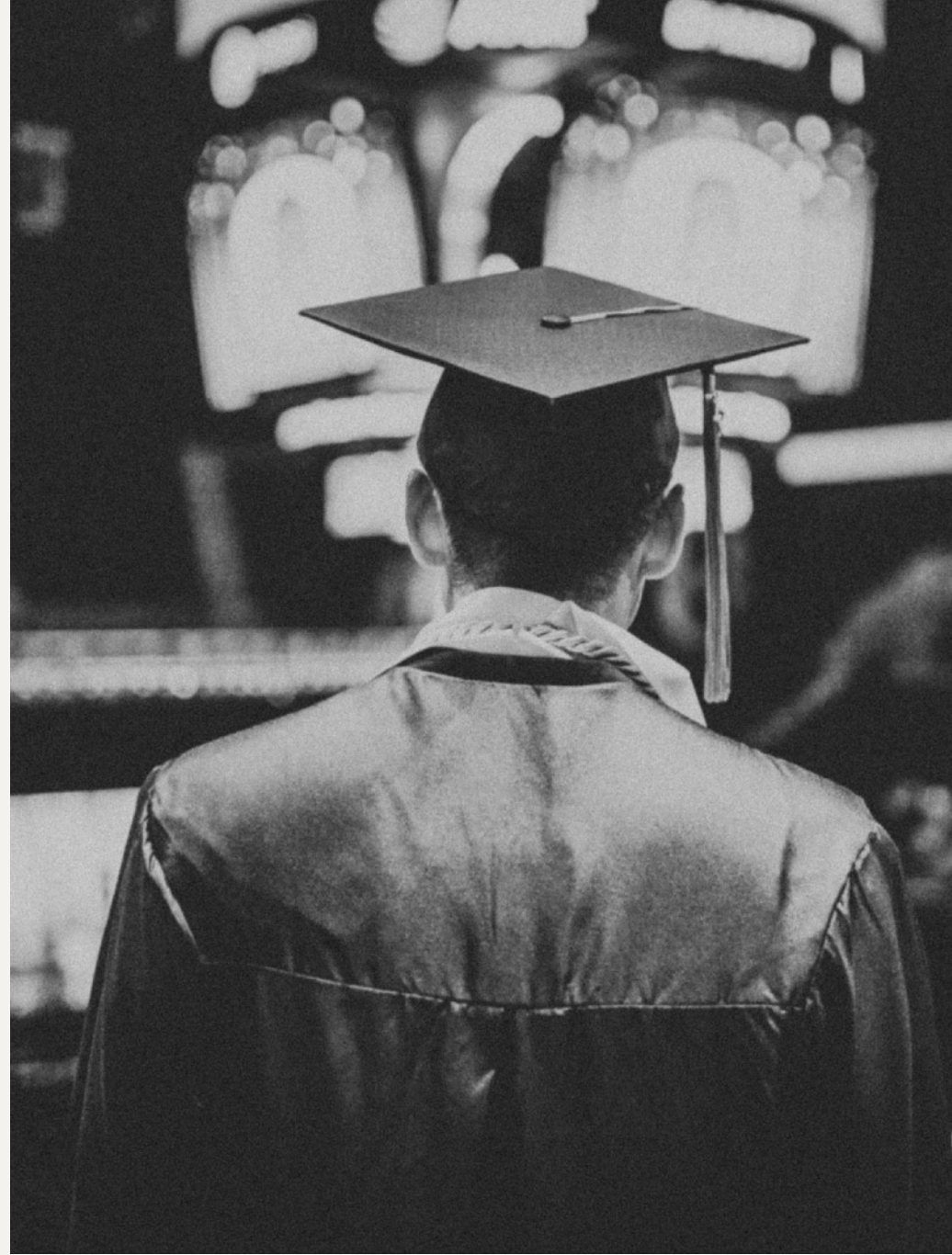
Concerns about brain drain have remained relatively consistent since the term was first coined, peaking in the 1990s and carrying through to present day, with hundreds of articles committed to studying the phenomenon (Gibson and McKenzie 2011). The scope of brain drain research has also broadened from its initial focus on medical professionals to review the migratory patterns of the highly skilled more generally, including engineers, scientists, and other tertiary educated individuals choosing to leave their home country after graduation (Docquier and Marfouk 2006; Docquier and Rapoport 2006; Beine, Docquier and Rapoport 2008). There is also concern, though beyond the scope of some studies, that a similar brain drain can be observed at the level of graduate studies, with foreign students taking up approximately a quarter of all science and engineering graduate students in the United States during the mid-1990s (Johnson and Regets 1998).

Within a decade of concern about brain drain emerging in the United Kingdom, similar conversations became prevalent within Canada, peaking in the 1990s (Johnson 1964; Carrington and Detragiache 1999; Helliwell 1999). Early research called attention to the alarming rate at which newly graduated doctors were moving to the United States, with nearly 25% leaving Canada for the United States throughout the 1990s (Zhao et al 2000). Yet, while medical fields continued to be the primary focus for brain drain researchers in Canada, other industries of choice for Canadian emigrants also remained relatively consistent. As Zhao et al (2000) report, Canadian emigration to the United States during the 1990s was also driven by the following sectors: education, architecture, engineering, computer science, and finance.



Much of Canada's talent losses during this time have been attributed to migrants seeking higher salaries and new opportunities abroad, especially in the tech sector (Zhao et al 2000; Kesselman 2001; Saltzman 2017). In particular, while Canadian policy has stemmed wage inequality in Canada relative to the US, it has also driven highly skilled graduates to seek more lucrative positions south of the border (Kesselman 2001). It is a trend reflected in brain drain more generally, with wage differentials explaining up to 58% of bilateral migration between originating countries and the United States (Docquier and Rapoport 2011). Others have put forward a number of secondary explanations, including Canada's higher personal income taxes (Pigeon 2000) and the impact of a low Canadian dollar (Mintz 2016; Yakabuski 2016).

Though Canada compensates for some of these shortcomings in other ways, including a much more extensive and accessible social safety net, these offerings are often redundant for those able to earn significantly higher incomes while also receiving extensive health insurance through their employers (Helliwell 1999). To this point, as Zhao et al (2000) report, Canadian emigrants to the United States were seven times more likely (4.0% of movers versus 0.6% for the general population) to report incomes of more than \$150,000 (CAD) in 1996. Movers were also five times as likely to report incomes of between \$100,000 and \$149,999 (CAD) (4.0% for movers versus 0.9% for the general population). Interestingly, similar gaps are not observed within Canada, where immigrants, including American migrants, have nearly identical salaries to their homegrown counterparts (Zhao et al 2000; Helliwell 1999).



As Helliwell (1999) suggests, there are also secondary differences between Canada and the United States that should not be taken for granted in understanding the Canadian brain drain. Helliwell argues that Canadians are much more willing to move, both interprovincially and internationally, than Americans. These nomadic tendencies are exaggerated by the fact that the border between Canada and the United States is, as Helliwell writes, "a semi-permeable membrane through which information travels northward much more readily than southward" (1999, p. 13). Canadians, in other words, feel more familiar with the United States than vice versa, owing to the widespread availability of American media, news, and goods north of the border (1999). As a result, Canadians are much less hesitant to move to the United States for their career.



Finally, there are several discouraging perceived differences between Canada's managerial, entrepreneurial, and venture-capital classes and those of the United States, with Canadians perceived as being less interested in the risk-taking and innovation responsible for American success (Kesselman 2001). Indeed, there is little doubt that the United States outperformed Canadian business in its investment in research and development, investing nearly twice as much as Canada between 1980 and 1995 (measured as a share of GDP) (Kesselman 2001). By contrast, Canada's economy remained heavily reliant on, and committed to, resource-based industries that pay generously for low-skilled labour (Kesselman 2001). As we highlight below, many of these gaps in performance between the United States and Canada have persisted. Consequently, the United States was, and continues to be thought of as the leader in research and innovation for many young Canadian graduates. These practical and cultural enticements are cultivated by the fact that, under NAFTA, qualifying Canadians can readily gain entry to the United States if they are offered an American job (Zhao et al 2000; Iqbal 2000). There is even evidence that, post-9/11, this recruitment of Canadian graduates became much less passive, with Canada being perceived by American companies as "a country comprised of low-risk citizens" (Labonte et al 2006).





## The Impact of the Brain Drain

On the one hand, concern over brain drain is inspired, justifiably, by the disproportionate rate at which the highly skilled choose to emigrate. The majority of those who choose to leave their home country are highly educated, making brain drain the driving force of international migration (Docquier and Rapoport 2011). The rate of emigration for those with post-secondary schooling is over seven times greater than that of individuals with only primary education, and more than three times higher than individuals with only secondary schooling (Gibson and McKenzie 2011). Much of this is because high-skill emigration is generally less sensitive to the financial burdens or distancing involved in relocation, and is favoured by selective immigration policies that privilege skilled workers among receiving countries (Cervantes and Guellec 2002; Docquier and Rapoport 2011). The globalization of companies has also helped aid the flow of the brain drain, with intra-company transfers accounting for 5-10% of the skilled emigration to the United States during the 1990s (Cervantes and Guellec 2002). It is important to note, also, that the disproportion is even more inflated for women, who are over-represented in the brain drain itself. This is likely due to the fact that home-country education rates for women are lower than for men in many of the developing countries losing their highly skilled workers to the United States (Docquier and Rapoport 2011; Gibson and McKenzie 2011; Docquier, Lowell and Marfouk 2009; Dumont, Martin, and Spielvogel 2007). That these emigrants are highly valued by their home country is implied in the very terminology being used to describe their leaving, insofar as “drain” conveys, as Johnson (1965) noted early, “a strong implication of serious loss.”

On the other hand, however, research on the impact of brain drain has produced much more complicated results. Some, for example, have argued that the impact of the brain drain is essentially neutral. As Docquier and Rapoport (2011) summarize, much of the early research on brain drain is in this vein, suggesting that the benefits of free migration nullify the cost of losing highly talented human capital. These benefits include, but are not limited to, remittances, return migration, and networking (Grubel and Scott 1966; Bhagwati and Hamada 1974; McCulloch and Yellen 1997; Gibson and McKenzie 2011). In more abstract terms, Cervantes and Guellec (2002) suggest that the “international mobility of skilled workers can generate global benefits by improving knowledge flows and satisfying the demand for skills” (p. 40). Their point is echoed more recently by Seguin, State, Singer, and Daar (2006) who concur that the diaspora of the brain drain can aid in the technological and economic development of home countries through the sharing of knowledge integral to this development.

Moreover, even those that concede that these positive effects may not be enough on their own to offset losses to the brain drain nevertheless speculate that the brain drain itself, inspired by higher returns for education experienced abroad, may nevertheless entice more people to invest in education at home in hopes of qualifying for such returns (Adams 2003; Mountford 1997; Vidal 1998; Beine et al 2001; Beine et al 2008). There is some evidence of this to the extent that even while the highly skilled are much more likely to leave their home country, these numbers prove to be relatively low in absolute terms, with some suggesting that less than 10% of the best educated population in labour-exporting countries choose to leave (Adams 2003). This positive perception of the brain drain has made its way into the mainstream, with some politicians, such as India’s Prime Minister Manmohan Singh, choosing to celebrate the potential “brain gain” brought about by sending their highly skilled workers to OECD countries (Gibson and McKenzie 2011).

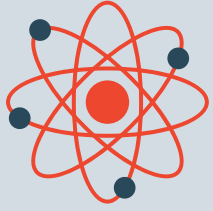
Others have reached conclusions much more in line with popular opinion. Even those committed to identifying the positive effects of the brain drain described above (Grubel and Scott 1966; Bhagwati and Hamada 1974; McCulloch and Yellen 1977) nevertheless conclude that “the welfare of those left behind would still fall given that the social return to education exceeds its private return” (Beine et al 2008, p. 631). The financial and abstract benefits of talent emigration, this research contends, nevertheless fail to make up for the cost of investing in tertiary education in the first place.

***“ON THE OTHER HAND, WHILE CANADA MAY RECEIVE PLENTY OF HIGHLY SKILLED WORKERS FROM AROUND THE WORLD, IT IS ALSO LOSING MANY OF ITS OWN HIGHLY SKILLED WORKFORCE TO THE UNITED STATES AND THE CONSEQUENCES OF THESE LOSSES CANNOT BE IGNORED.”***

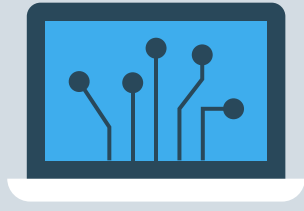
Most recent research has sought to complicate this view of the brain drain by parsing out the conditions under which the brain drain yields positive or negative results. Beine et al (2008), for example, specify that the brain drain appears to negatively impact a country when the rate of migration for those with a post-secondary education surpasses 20%, though these losses are offset by the absolute gains of so-called “winning countries.” Because of this, claiming the brain drain as a positive global force more generally serves to distract from the “relatively high losses” of select countries. Indeed, while India, China and Russia dominate in terms of the raw number of individuals they export to the OECD, it is smaller countries, especially those located more closely to the United States, that experience the brunt of the brain drain’s negative impact (Docquier and Rapoport 2011).

The impact of the brain drain has proven especially nuanced in the Canadian context. On the one hand, losses to the United States are compensated for in the form of immigration from other countries, although this is a phenomenon not experienced in all industries (Cervantes and Guellec 2002). Canada also receives more return migration than many of the developing countries most heavily impacted by the brain drain, with many who leave for the United States returning at some point in their careers (Zhao et al 2000; Helliwell 1999). This suggests that brain drain is driven by the general mobility of the highly skilled, which, at the same time that it facilitates migration to the United States, also often makes migration between advanced countries like Canada and the United States temporary (Cervantes and Guellec 2002).

On the other hand, while Canada may receive plenty of highly skilled workers from around the world, it is also losing many of its own highly skilled workforce to the United States and the consequences of these losses cannot be ignored (Kesselman 2001). As described above, the secondary benefits of brain drain fail to make up for the lost investment in education. Furthermore, those leaving are often top students. A 1995 study of Canadian graduates leaving for the United States, for example, found that over 44% of emigrants ranked themselves in the top 10% of their graduating class (Frank and Belair 1999). Finally, while the brain drain has not resulted in skill shortages at the aggregate level, it remains possible that workplace shortages can emerge in particular sectors. A study by the Software Human Resources Council of Canada, for example, suggests that Canadian firms experienced a shortage of computer programmers in the 1990s (Library of Parliament, 2000). It is unclear whether these costs nullify Canada’s benefit from the international brain drain, though understanding and minimizing losses can only serve to benefit Canada’s position in the international market.



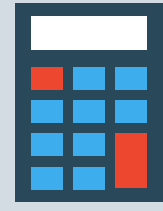
SCIENCE



TECHNOLOGY



ENGINEERING



MATHEMATICS

## Brain Drain, Canadian Policy, and Contemporary Concerns

The prevalent view among Canadian politicians and policy-makers is that emigration of highly skilled individuals is something worth investigating and, if possible, preventing. As early as the 1980s, Canada, alongside other countries such as Germany, Australia, and the United Kingdom, has made a concerted effort to stem the flow of the brain drain, introducing quality-selective immigration policies and engaging more actively in the international competition to attract global talent (Beine et al 2008; Cervantes and Guellec 2002). Canada, in particular, has seen the brain drain reduced in response to the shrinking income gap between itself and the United States along with the improved accessibility of higher education in Canada (Helliwell 1999; Labonte et al 2006; Vermond 2017). Yet, while Canada is, according to some, better than it ever has been at retaining top talent, holes remain and concern over high skilled migration to Silicon Valley is common (Allen 2015; Gibson and McKenzie 2011).

A recent profile of the 2016 graduating class of Systems Design Engineering students from the University of Waterloo has only fueled these concerns, as over 60% of the class secured jobs in the United States before graduation (Loi 2017).

Furthermore, a recent LinkedIn report shows that the city of Toronto, one of Canada's hubs for technological innovation and industry, continues to lose talent to the United States (LinkedIn 2017; Tencer 2017).<sup>1</sup> According to the report, for every 10,000 LinkedIn members located in Toronto in 2016, 1.34 members left for San Francisco, 1.01 left for New York, and 0.58 left for Los Angeles (LinkedIn 2017; Tencer 2017). Both the LinkedIn report and the Waterloo class profile reveal that most high-skilled emigrants to the United States are congregating in and around San Francisco and New York City, supporting Beine et al's (2008) conclusion that, while globalization has made relocation among the highly skilled easier, it has also increased the tendency for high-talent individuals to concentrate where talent is already abundant (Loi 2017; LinkedIn 2017). Whereas Kesselman (2001) reflected on the concentration of high-skilled workers in the United States as an unsustainable consequence of rapid growth at the turn of the millennium, these recent reports suggest that such trends have continued unabated. Any hope of a so-called "reverse brain drain" following the 2016 United States election and the subsequent volatility of the American economy has also proven ungrounded, with any claim to the contrary being largely based on the anecdotal evidence of a select few (Blackwell 2017; Vermond 2017).

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<sup>1</sup> A microcosm of Canada's own brain drain, the city of Toronto, despite its losses to the United States, continues to receive highly skilled workers from other cities around Canada, with the majority of these domestic migrants coming from Montreal (5.06 per 10,000), Kitchener (2.68 per 10,000), and Calgary (2.53 in 10,000). Toronto also receives a significant number of international immigrants (LinkedIn 2017).



Canada's continued losses to brain drain should not come as a surprise insofar as the root causes uncovered in the early research, such as opportunity and potential income, have persisted in more nuanced ways beneath the surface. In particular, while the per-capita income gap between the United States has narrowed, the gap has remained significant in the tech sector (Helliwell 1999; Zhao et al 2000; Zarifa and Walters 2008). Loi (2017), for example, reports that Systems Design Engineering emigrants to the United States made an average base salary of \$143,000 (CAD), more than twice of those who remained in Canada (\$65,000 CAD). Moreover, as the Waterloo report suggests, the move to work in the United States is driven partly by the country's much more lucrative and readily available co-op positions, with 65% of students acquiring full-time employment at the same place they conducted their co-op (Loi 2017). Even these co-ops have proven much more lucrative, with co-ops in the United States paying nearly twice as much per hour as their Canadian counterparts (Loi 2017). Though we unpack these discrepancies below, their persistence suggests that Canada has failed to address some of its most stark shortcomings relative to the United States as a potential for global talent.

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## **Investment in Canadian STEM**

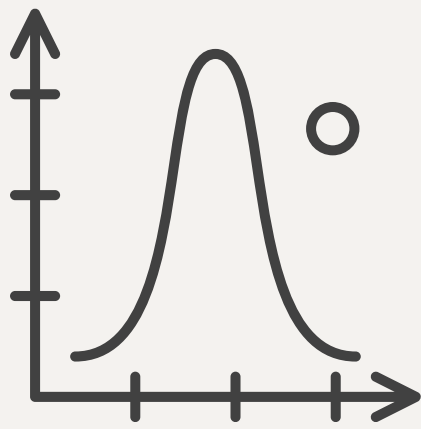
Though Canada's losses to the brain drain may be mitigated by the number of highly skilled migrants Canada receives from around the world, there is still reason to be concerned over the alarming rate at which Canadian graduates leave for the United States. While their departure does not necessarily result in workforce shortages in Canada at an aggregate level, some sectors, especially technology sectors, have expressed concern over the number of available workers in their field (Library of Parliament, 2000; Froman 2018). Emigrating students also represent lost investments for federal and provincial governments, as well as post-secondary institutions that allocate their own resources toward specialized funding for STEM students. In 2015 alone, the Ontario government invested over \$2.6 billion in basic operating grants for post-secondary institutions across the province based on full-time enrollment, with an additional \$0.9 billion being allocated toward specialized grants focusing on performance, growth, and accessibility (Ministry of Training, Colleges and Universities, 2015). Of this basic operating funding, full-time students in upper year science, nursing, engineering, and architecture programs (35% of total enrollment in the province) earned more funding for their universities than did upper-year arts and humanities students (39% of enrollment across the province). Put differently, STEM students are weighted more heavily in provincial funding calculations than other students. Under the 2015-2016 model, this amounted to the provincial government investing a total of \$28,093 (CAD) per student for an average four-year Bachelor of Science (Graham and MacIsaac 2016; Ontario University Registrars' Association, 2016). During this same period (2015-2016), post-secondary institutions in British Columbia received \$1.8 billion (CAD) from the provincial government in the form of basic operating grants (Ministry of Advanced Education, Skills and Training, 2016). With 181,110 full-time students registered 2015-2016, the BC government invested approximately, \$9,951.30 (CAD) per student in core funding to its post-secondary institutions (2016).

Canada, however, has not seen these investments translate into an industry landscape that can compete with that of the United States. As Findlay and Dodd (2016) report in their exhaustive summary of the economic climate of science and technology in Canada, despite significant investments in STEM education, Canada's investment in the fundamental research and development required for a thriving tech industry has been middling at best. Between 2006 and 2013, they report, Canada's Gross Domestic Expenditure on Research and Development (GERD) declined from approximately 2% of GDP to 1.62%, during which time many OECD and G7 countries increased their own GERD contributions (Findlay and Dodd 2016). As a result, Canada went from 16th in GERD intensity in 2006 to 24th in 2013 (Science, Technology and Innovation Council, 2015).

Business investment in research and development has also been poor, with Canada's business enterprise research and development per unit GDP (BERD intensity) dropping from 1.18% in 2005 to 0.82% by 2013 – half of the OECD average (Organization for Economic Co-Operation and Development, 2016). A recent report by the Science, Technology and Innovation Council (STIC) also ranked Canada 26th among international competitors in this regard (2015). As the report notes, Canada's BERD intensity remains less than half (36%) of the threshold of the top five countries (Israel, Korea, Japan, Chinese Taipei and Finland). Canada's BERD intensity also remains only half that of the United States (0.82% versus 1.96%) who nevertheless only sits 11th internationally (2015).<sup>2</sup> These same differences persist when looking at investments in information and communication technologies specifically, with Canada's ICT investment per worker only half that of the United States in 2013, albeit 71% of the top five threshold (2015). In short, Canadian businesses struggle to compete in the international push for innovation, a reinforcing pattern insofar as the presence of large innovating firms is a driving force of innovation in smaller firms and the anchoring of innovation clusters (2015). It would be unfair to blame these shortcomings directly on Canadian businesses, however, with direct investment in business innovation on behalf of the federal and provincial governments decreasing during this time, making Canadian businesses rely more heavily on indirect support (such as tax incentives) than other countries (STIC 2015).<sup>3</sup>

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This discrepancy manifests in Canada's relatively poor performance in absorbing science, technology, and innovation talent into the labour force (Science, Technology and Innovation Council, 2015). Despite performing relatively well in terms of knowledge production and the education of highly skilled workers, Science and Technology related occupations accounted for only 30% of total employment in Canada in 2011, placing Canada directly in the middle of the 42 countries surveyed by the STIC report (2015). In the private sector, in particular, the number of business enterprise researchers per thousand employees dropped from 6.9 to 6.6, likewise dropping Canada from 7th in 2005 to 15th in 2012 and decreasing their proximity to the top five threshold from 85% to 66% (2015). In short, as Findlay and Dodd (2016) conclude, Canada is losing ground to its international competitors in the STEM market, providing less opportunity for young researchers to participate in key innovations in the private sector domestically. This only serves to reinforce the perception that the best opportunities for STEM graduates involve emigration.



There is evidence to suggest that this disparaging economic picture of Canada's STEM market was driven by Canada's political climate at the time. Between 2008 and 2013, for example, \$596 million was cut from science and technology at the federal level, eliminating the equivalent of 2,141 full-time positions (Professional Institute of the Public Service of Canada, 2014). Moreover, the funding that was made available in 2013 remained overwhelmingly focused on industry, with only 20% of the annual budget allocated to the fundamental research necessary to a thriving technology sector (Hoag, 2011). During this time, over 80% of those sitting on the National Research Council believed that the government was doing a poor job of maintaining or improving Canada's national standing in technology and innovation in particular (Professional Institute of the Public Service, 2014).

This disparaging view of Canada's tech industry continues to be reflected in the discrepancy between Canadian and American salaries among tech workers, with salary discrepancy remaining a key potential contributor to Canada's brain drain. A 2018 report by the job board Hired, for example, suggests that the average tech worker (defined by Hired as software engineers, designers, product managers, and data analytics roles) in Toronto continue to make significantly less than their counterparts in large cities across the United States (Table 1). While the average tech worker's salary in Toronto is increasing at a faster rate than those in the United States, they continue to lag behind workers in major tech hubs like Seattle and the Bay Area. More promising is the fact that Toronto salaries supersede salaries from other non-American cities studied, suggesting that while Canada's tech market continues to be overshadowed by that of the United States, Canada maintains a more generous reputation among OECD countries.

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<sup>2</sup> Interestingly, Canada approaches the threshold of the top five countries when it comes to higher education expenditures on research and development as a share of GDP (HERD intensity) (~84%) suggesting that Canada's lagging behind international competitors is most prominent in the private sector. In fact, while funding for research and development activities increased in the higher education sector and provincial government, these increases were offset by funding declines in business and federal government. These trends are particularly discouraging given that Canada has ranked relatively high in investments in research at the level of higher education, has universities that rank relatively well internationally, and has a number of highly cited researchers working at its leading universities, especially relative to Canada's small population (STIC 2015 report)

<sup>3</sup> This discrepancy manifests in Canada's relatively poor performance in absorbing science, technology, and innovation talent into the labour force (Science, Technology and Innovation Council, 2015). Despite performing relatively well in terms of knowledge production and the education of highly skilled workers, Science and Technology related occupations accounted for only 30% of total employment in Canada in 2011, placing Canada directly in the middle of the 42 countries surveyed by the STIC report (2015). In the private sector, in particular, the number of business enterprise researchers per thousand employees dropped from 6.9 to 6.6, likewise dropping Canada from 7<sup>th</sup> in 2005 to 15<sup>th</sup> in 2012 and decreasing their proximity to the top five threshold from 85% to 66% (2015). In short, as Findlay and Dodd (2016) conclude, Canada is losing ground to its international competitors in the STEM market, providing less opportunity for young researchers to participate in key innovations in the private sector domestically. This only serves to reinforce the perception that the best opportunities for STEM graduates involve emigration.

**Table 1: Average Salaries for Tech Workers Across Select Cities (USD)**

City	Average Salary (2017)	% Increase from 2016	Adjusted Salary (2017)*
SF Bay Area	140k	5.18%	142k
Seattle	132k	2.33%	182k
New York	129k	5.74%	136k
Los Angeles	129k	5.74%	182k
Austin	118k	7.27%	202k
Boston	117k	-0.85%	150k
Washington, DC	116k	6.42%	148k
Chicago	113k	6.60%	173k
Denver	112k	-1.75%	177k
San Diego	108k	0.94%	166k
London, UK	78k	6.85%	100k
<b>Toronto</b>	<b>73k</b>	<b>7.35%</b>	<b>126k</b>
Paris	56k	-5.08%	85k

Source: Hired (2018), *State of Salaries Report*. Available at: <https://hired.com/state-of-salaries-2018#yoy-changes>

\*This figure represents the average salary adjusted for the cost of living relative to the cost of living in San Francisco. In other words, making 73k (USD) in Toronto (where it is cheaper to live) is the equivalent of making 126k (USD) in San Francisco.

The recently released 2018 federal budget attempts to address some of these discouraging trends, including significant investments in fundamental research through the Canadian granting councils (Department of Finance, 2018). This includes an additional \$6.5 billion to be invested in so-called “progress” initiatives between 2018 and 2023, with a special emphasis on five “innovation superclusters” under a proposed Innovation and Skills Plan: artificial intelligence-powered supply chains between Montreal and the Quebec City-Waterloo corridor, advanced manufacturing in Southern Ontario, data-driven enterprises in British Columbia, Protein Industries Canada in the Prairie Provinces, and Canada’s ocean economy in Atlantic Canada (Department of Finance, 2018). More generally, the budget proposes advanced manufacturing, agri-food, clean technology, digital industries, health/bio-sciences and clean resources as key venues for Canadian job creation moving forward, with the goal of doubling the number of high-growth companies in Canada (from approximately 14,000 to 28,000) by 2025 (Department of Finance, 2018). To this end, the budget proposes an investment of \$700 million over five years, with \$150 million per year ongoing, towards business research and development projects, increasing the threshold for funding from \$1 million to \$10 million to help Canadian companies compete with larger projects around the world.

This expanded threshold is representative of a shifted focus from supporting smaller projects to supporting “larger projects that can lead to significant job creation,” along with investments designed to help these high-growth companies compete in American markets (Department of Finance 2018, p. 103). Finally, the budget proposes \$572.5 million over five years, with \$52 million per year ongoing, for the creation of a Digital Research Infrastructure Strategy to address the growing focus on Big Data in the tech-sector.

Understanding the impact of these new investments on brain drain will be imperative moving forward, not only because these new investments are meant to reverse alarming trends in Canada’s global STEM performance but, also, because many of these investments continue to be focused on STEM education. More specifically, the 2018 budget aims to put Canada first among G7 countries in terms of overall spending on higher education research when measured as a share of GDP (Department of Finance, 2018). Moreover, this focus on STEM education persists at the provincial level. The new Ontario funding model, adopted in 2017-2018, continues to weigh science and engineering students more heavily than arts and humanities students in its allocation of core operating grants, with grants towards medical professionals significantly exceeding both (Ministry of Advanced Education and Skills Development, 2017). If federal investments in research and development prove insufficient in reinvigorating Canada’s STEM market, a large portion of these historic investments in Canadian education may continue to be lost to the brain drain.

## Data and Approach

To better understand brain drain amongst Canada’s STEM graduates, we asked three research questions:

1. Where are recent Canadian STEM graduates seeking employment?
2. If Canadian STEM graduates have opted to work abroad, why was this choice made?
3. What are the best strategies for public and private sector leaders to retain STEM talent?

To answer the first two questions, we collected and analyzed the LinkedIn profile information of 2015 and 2016 <sup>4</sup> graduates from select programs in three STEM-focused universities in Canada: the University of Waterloo, the University of Toronto, and the University of British Columbia. <sup>5</sup> Selected majors and graduation years are listed below, in Table 2. <sup>6</sup>

We began with 30,000 graduates across 34 STEM programs. To make the data collection more manageable we developed a sample of 22 programs, which produced 6,603 graduates. Of this group, 4,096 graduates had an accessible LinkedIn profile and 3,181 (78%) had their current position listed. The final sample includes 3,162 graduates who had complete information on their LinkedIn profiles, meaning they had a current position and location listed. This sample includes 684 graduates from the University of British Columbia, 1,643 from the University of Waterloo, and

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<sup>4</sup> This timeframe was selected because it is recent enough to draw meaningful conclusions about public and private sector attitudes and practices towards talent retention, but long enough that graduates have had time to establish themselves in a career and perhaps experience one or more job changes and relocations.



Table 2: Select University Programs and Majors

Select Majors				
University	Engineering	Math	Computer Science	Science
Waterloo	Software Engineering (181)	Mathematics (1434)	Computer Science (708)*	Chemistry (43)
	Computer Engineering (268)			Physics (59)
	Electrical Engineering (274)			
	Systems Design Engineering (178)			
Toronto	Engineering Science (369)		Computer Science (134)***	Woodsworth Science (Hon) (630)
	Chemical Engineering (213)			Woodsworth Science (33) **
	Electrical Engineering (256)			
	Computer Engineering (289)			
British Columbia	Computer Engineering (211)	Mathematics (139)	Computer Science (459)	Chemistry (111)
	Electrical Engineering (302)			Physics (64)
	Mechanical Engineering (248)			

N=6603

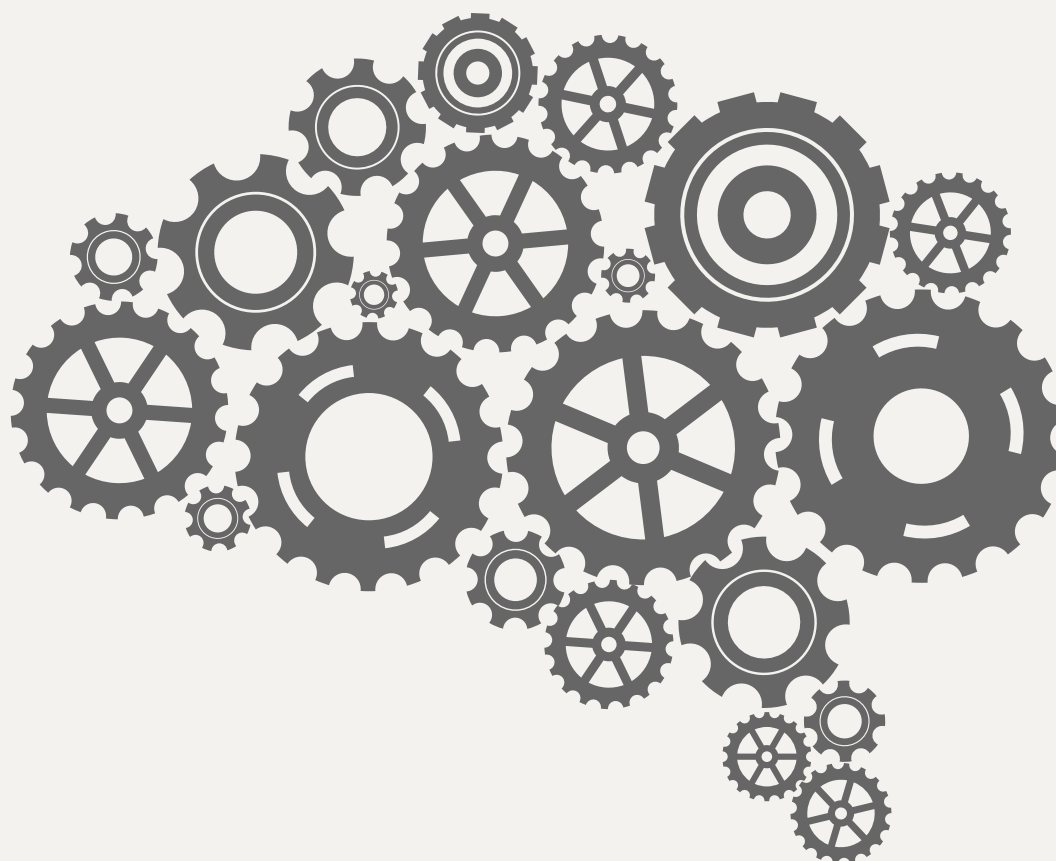
\* Computer science at UWaterloo is offered through the Faculty of Mathematics. Students can obtain a Bachelor of Mathematics in Computer Science or a Bachelor of Computer Science

\*\*University of Toronto students study and graduate through affiliated colleges. Therefore, we are unable to distinguish certain science graduates from convocation records alone. Every attempt was made to obtain program-specific graduate records. Woodsworth is the University of Toronto’s largest college. We gathered data from those enrolled in Science programs graduating through Woodsworth College

\*\*\*Ordinarily, computer science students graduate through their individual colleges. An exception was made in 2015 (Spring) for the Computer Science program’s 50th anniversary.

<sup>5</sup> These three universities consistently score at or near the top of numerous Canadian university rankings, such as *Macleans*, in STEM fields.

<sup>6</sup> Best efforts were made to select similar programs. However, it should be noted that the three universities do not have the exact same programs.



Using LinkedIn to gather data is a new approach that has been utilized in a number of fields (see Feldman and Lowe 2015; Jiang et al. 2014; Ng and Stuart 2016; Vinodrai and Spiegel 2017). It allowed us to determine where graduates are located and which companies they work for (including firm size, location, industry sector, and length of tenure). Most existing research on talent retention and human capital migration in Canada is either largely prescriptive (Edge and MacLaine 2015) or uses information gained from focus groups (Rajasekaran 2010). One of the significant obstacles for research on brain drain is the limited availability of reliable data (Gibson and McKenzie 2011; Adams 2003). Regarding Canadians, in particular, those emigrating to the United States are underrepresented in immigration figures insofar as, under NAFTA, they are able to live in the United States for extended periods of time without ever converting to permanent status (Zhao et al 2000). More generally, data collected on high-skilled migrant workers often fails to differentiate between those educated in the United States and those educated in their home country, meaning that emigration rates for college graduates are often skewed by those who moved to the United States as children (Docquier and Rapoport 2011). As such, this study creates unique space in the debate about talent retention by utilizing a large, original dataset.

We also carried out interviews with individuals identified from the LinkedIn database. A total of 650 individuals were contacted to take part. Persons were selected if they were educated at one of the three schools in our sample (Waterloo, Toronto, British Columbia) and work abroad. Potential interviewees were contacted via LinkedIn through a request to connect. A total of 143 accepted the request and were asked to participate in a brief research interview. Thirty-five interviews were completed for a response rate of 24% (based on graduates who accepted our connection request). Respondents were asked questions about their co-op experience (if any), motivations for seeking work in the United States, working conditions and remuneration, impression of leading Canadian firms in their sector, the aspirations of their peers during their education to work in the United States, the recruitment process after graduation, and what (if anything) could be done to persuade them to work in Canada in the future.

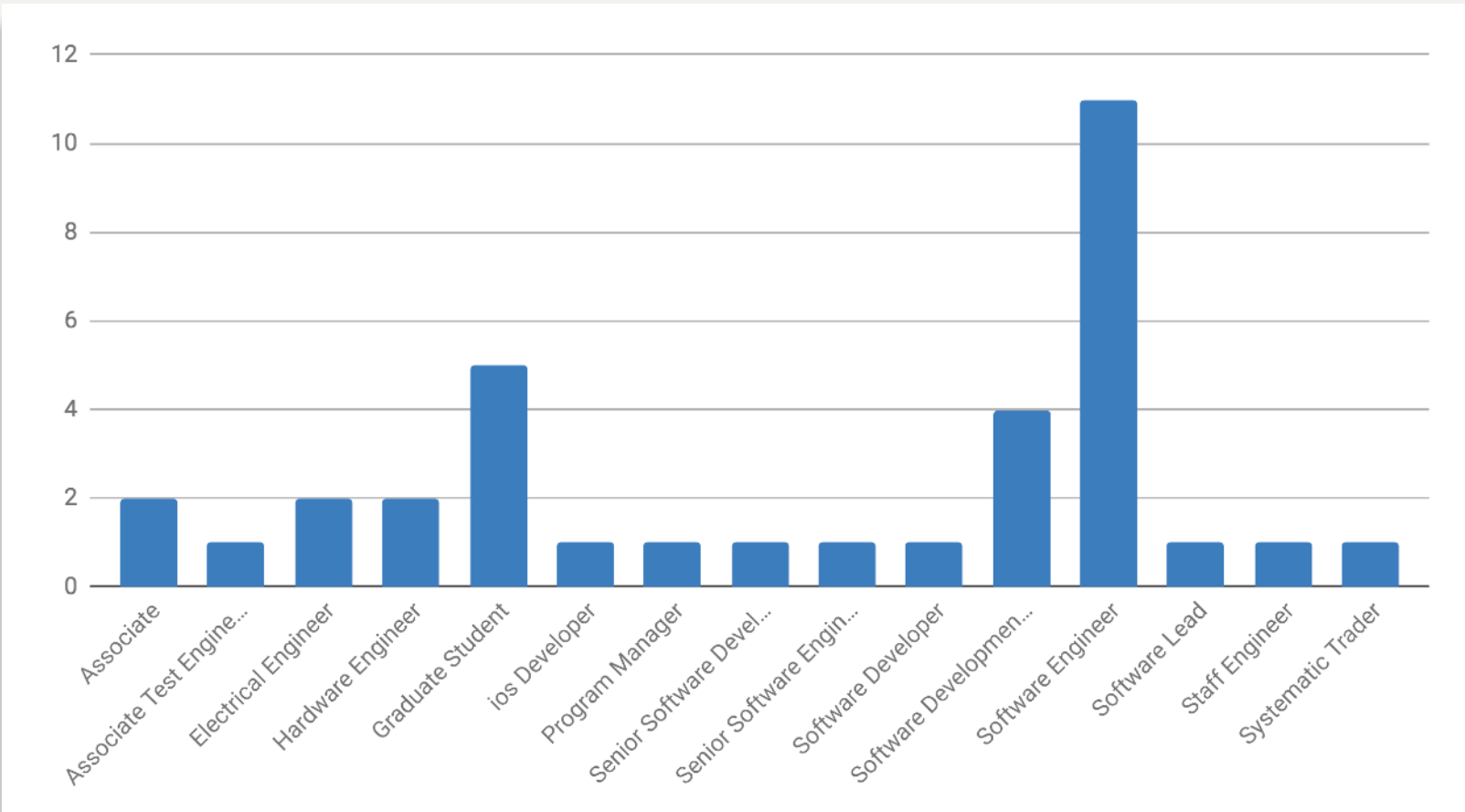


Key highlights of those interviewed include:

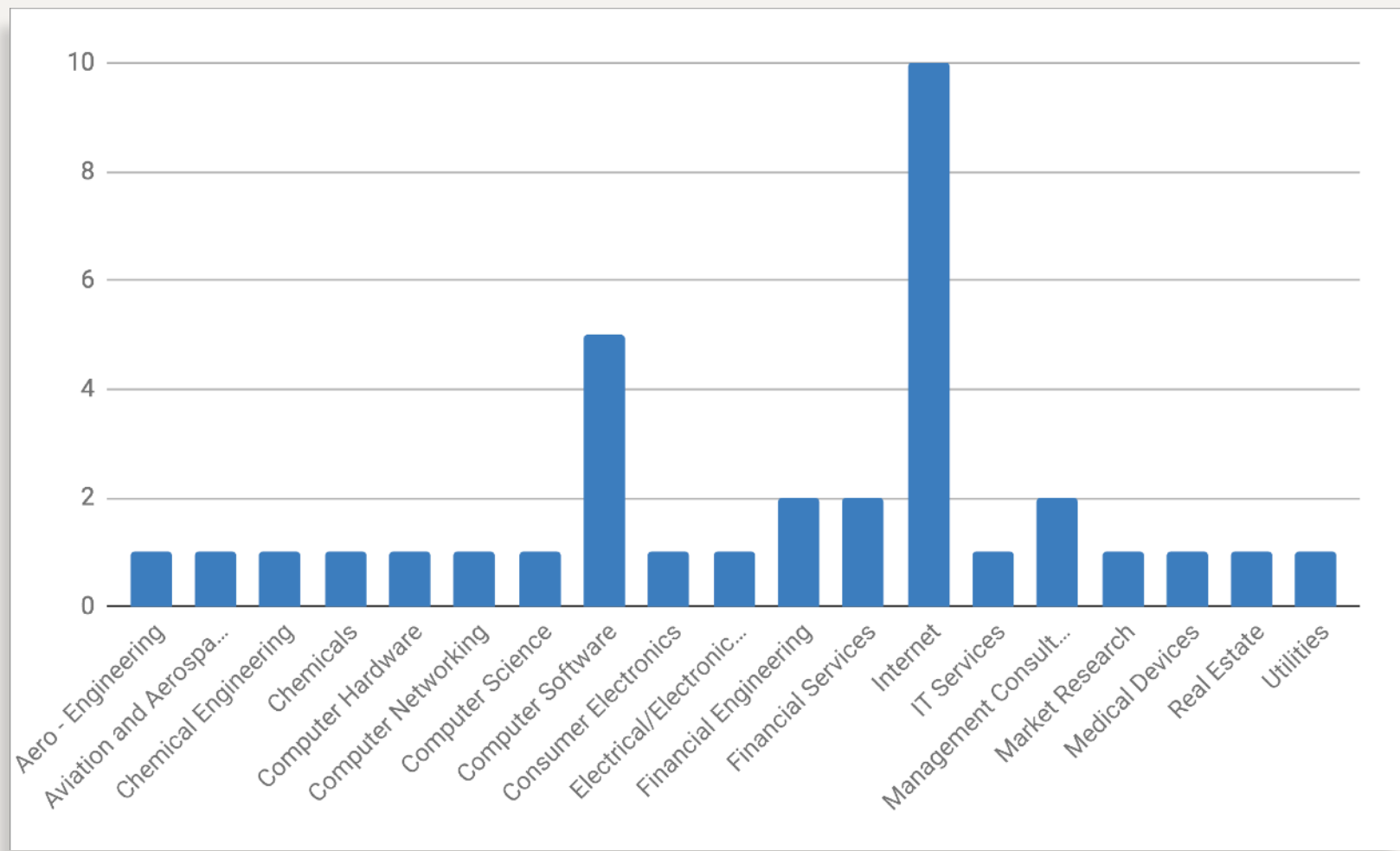
- Graduation Year: 17 graduated in 2015, 18 in 2016
- University: 6 respondents graduated from the University of British Columbia, 8 from the University of Toronto, 21 from the University of Waterloo
- Program: 2 respondents graduated with a degree in chemical engineering, 3 in computer engineering, 15 in computer science, 6 in electrical engineering, 2 in engineering science, 3 in mathematics, 1 in software engineering, 3 in software design engineering
- Location: 15 of those interviewed were located in California, 1 in Colorado, 1 in Washington, DC, 1 in Illinois, 1 in Louisiana, 1 in Massachusetts, 2 in Michigan, 4 in New York, 1 in Pennsylvania, 1 in Texas, and 7 in Washington State

To respect privacy, participants are not quoted directly. Charts 1 and 2, present the job title and industry of those interviewed, as presented on LinkedIn. The majority of respondents work in the tech industry or hold positions related to their education in engineering or computer science. Five interviewees were graduate students at American universities, but had American work or co-op experience and provided valuable insight for our study.

**Figure 1: Job Title of Interview Respondents**



**Figure 2: Industry of Interview Respondents**

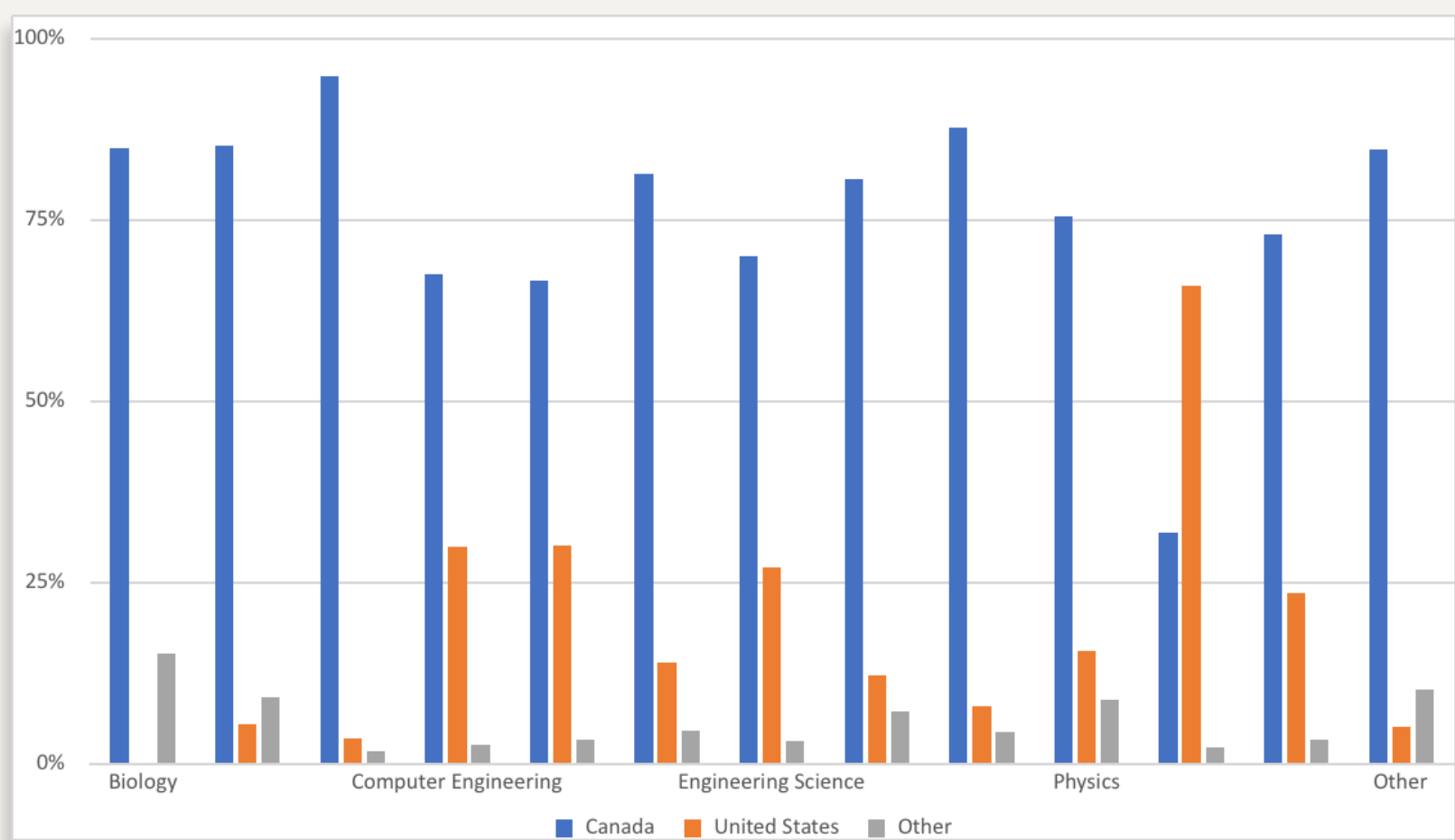


**Findings**

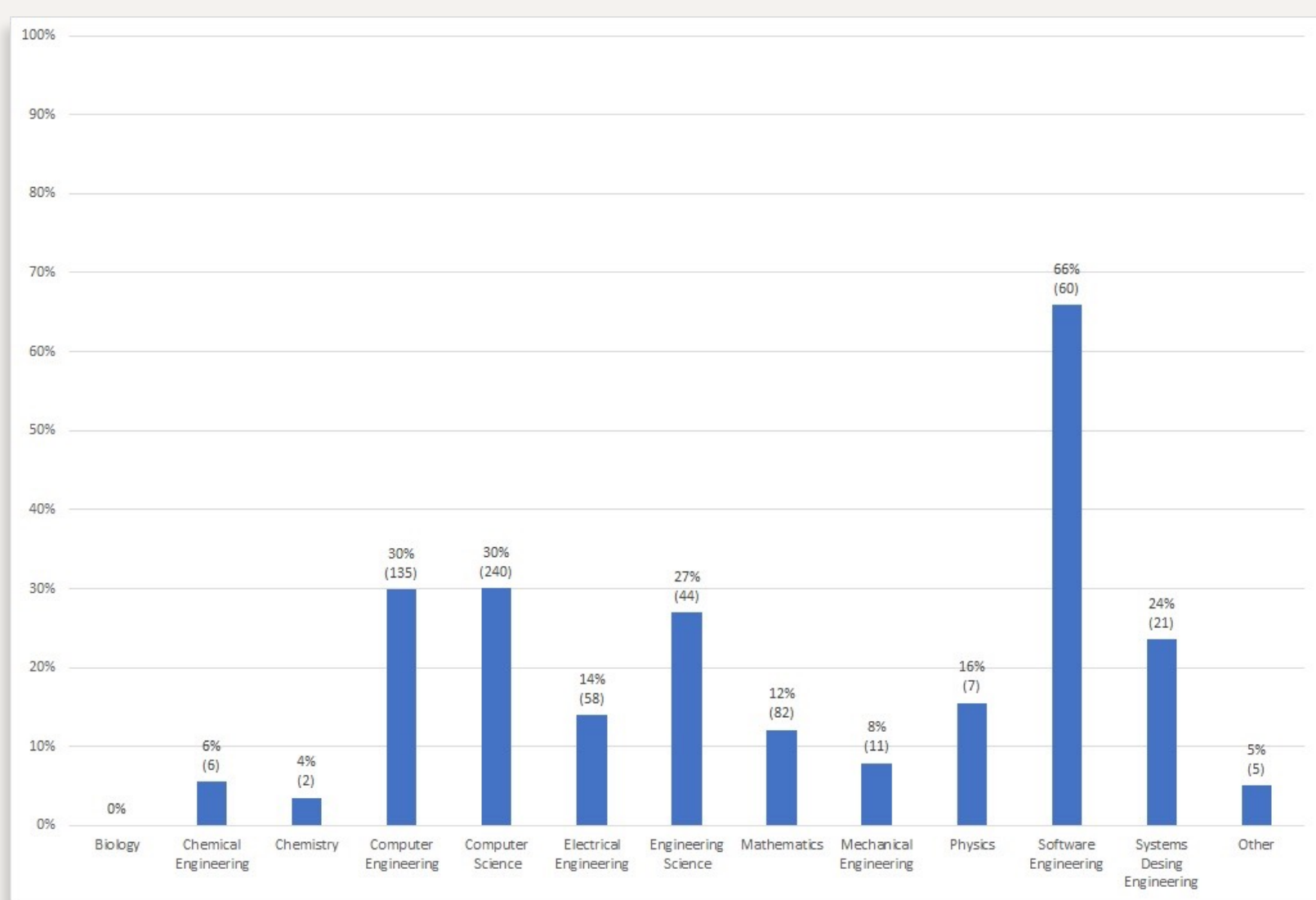
Scholarly literature points out that brain drain negatively impacts a country when the rate of migration for highly educated graduates surpasses 20%. By this standard, we find some alarming trends. One in four of the STEM graduates in our sample are currently working outside of Canada. Human talent migration is highest in the areas of computer engineering (30%), computer science (30%), engineering science (27%), systems design engineering (24%), and software engineering (66%). These are areas of talent that are essential to the success of Canada’s scale-up tech firms and the innovation sector. Not all STEM graduates are migrating in equal numbers, however. Certain programs such as biology (0%) and chemistry (3.5%) see low rates of migration. The international market for STEM graduates appears to lean primarily to those in the technology and innovation sector.

Of those who choose to work abroad, the United States (81.51%) is the destination of choice. Most graduates work in California (54%) and Washington State (21%) - states home to large, multinational technology companies, such as Amazon and Google. New York State (11%) was the third most popular destination among US-bound STEM graduates. Massachusetts (3.3%) and Illinois (2.4%) were also popular destinations.

**Figure 3: Geographic Distribution of Graduates by Program**



**Figure 4: Migration to the United States by Program**



The most popular occupation for graduates trained in Canada and working abroad was Software Engineer (43.52%).<sup>7</sup> Similarly, the two most common industries (based on LinkedIn's data) were Internet (37.85%) and Computer Software (18.48%), with Financial Services, Consumer Electronics, and IT Services rounding out the top-five. Unsurprisingly, the top-ten employers for emigrants to the United States were Microsoft (9.39%), Google (8.79%), Facebook (7.30%), Amazon (5.51%), Apple (3.43%), Uber (1.92%), Amazon Web Services (1.64%), Pinterest (1.49%), Square (1.49%), and Bloomberg LP (1.34%). Even for those who chose to remain in Canada, many found employment with American-based companies. The top ten employers for those choosing to remain in Canada with tech-based degrees (as outlined above) were Amazon (3.92%), IBM (2.78%), SAP (2.20%), Google (1.34%), Intel Corporation (1.05%), Scotiabank (0.96%), Shopify (0.96%), Electronic Arts (EA) (0.86%), AMD (0.86%), and Arista Networks (0.86%). Of these, only two, Scotiabank (Toronto) and Shopify (Ottawa), are Canadian-based.

Although the number of those employed by the top ten companies is small in absolute terms, this is due to the diversity of the field for highly skilled tech workers. The top ten employers, may collectively, account for only 16% (164) of those with tech degrees in Canada, however, the remaining 84% of tech degree graduates (881) are distributed across 576 different employers. This suggests that while there is consolidation of highly skilled tech graduates by a small group of companies, there is also plenty of opportunity for those with tech degrees to find employment in Canada outside of these dominant circles.



Those interviewed confirmed there is an undeniable pull to work in the United States. Most interviewees indicated their engagement with American firms began during their co-op work terms. All but six of those interviewed completed at least one co-op term, with most doing more than one. In fact, certain programs have up to six co-op placements. A usual pattern for interviewees was to do their first placement or first group of placements in Canada, and subsequent placements in the United States. While we heard from some respondents that their personal living situation, such as their partner or spouse getting a permanent job or pursuing further education in the United States played a role in their move, the vast majority opted to work in the United States for one of three main reasons: *pay, firm reputation, and the scope of work.*

As outlined in Table 1, the disparity in salary between American and Canadian cities is vast. Many interviewees remarked that the salaries paid in the United States are 20% to 30% higher than those paid for comparable positions in Canada. The desire to make more money is understandable, but the appeal for many was the ability to pay back student loans at a faster rate. Most of those interviewed carried substantial debt from their undergraduate education and reported some degree of anxiety related to the size and interest rates of such loans. Working in the United States, even temporarily, is seen as a way to begin chipping away at this debt.

<sup>7</sup> For the sake of precision, this is based on the number of individuals who specifically listed "Software Engineer" as their current position. A number of others listed similar, if not equivalent, positions (such as "Software Development Engineer," "Assistant Software Engineer," "Software Engineer Team Lead" etc.) LinkedIn's custom-entry system makes it difficult to pinpoint the exact number of individuals that might be considered "Software Engineers" without making assumptions about equivalences.

Second, a number of respondents communicated that the firm reputation is a strong motivator for seeking employment in the United States. Out of respect for the privacy of those interviewed, we will not be releasing the names of these companies, but most worked for large, multi-national technology firms. Working for some of the largest companies in the technology world has a great appeal for many students. We heard from many who admired the reputation of these companies as leading innovators doing cutting edge work. Many also indicated they wanted to have these companies listed on their resumes to enhance future career opportunities.



Companies of this size often have offices throughout the world, including Canada. Many interviewees indicated that they prefer being at the headquarters for these companies, which are located in the United States. Some company campuses have thousands of other workers, including senior management and executives. Working at a corporate headquarters also provides a greater variety of tasks to work on, allowing for a variety of projects to be involved with. The same

opportunities are not always available at the offices located elsewhere in the world, many of which are mainly used for sales.

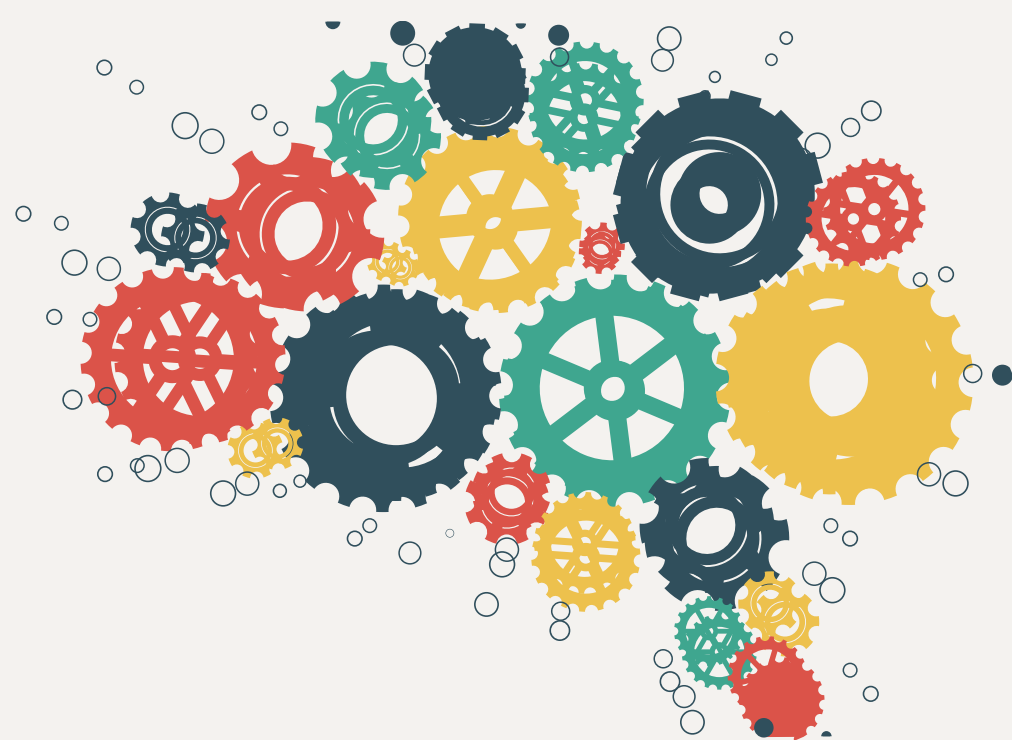
The final primary reason we heard for seeking out work in the United States is the scope of the work. Many respondents argued that working for smaller Canadian firms narrows the options for projects or tasks. There is a belief that being with a smaller Canadian firm means that you may be working on a specific project or task throughout your time with that company, while working at the headquarters of a large multi-national means that you are able to work on a variety of projects and in a variety of roles. We also heard about other factors motivating respondents to seek out work in the United States. Some identified working abroad as an adventure. Many appreciated living independently in a new country and exploring new parts of the world that they had not previously been exposed to. Some—particularly those living and working in Silicon Valley—identified the climate as an incentive to work in the United States. Certain respondents identified the networking and mentorship opportunities available in large, American technology hubs as a positive feature of working in the United States.

The rate of migration from technology-focused programs to the United States relative to the other programs we investigated is higher across all three schools. Between these schools, the average difference in emigration between tech and non-tech graduates is 17.6%, with tech-based emigration consistently higher than migration from other disciplines. The difference is most substantial at the University of Waterloo, where migration from technology programs is 27.19% higher than migration from other discipline studied. These differences are presented in Table 3.

**Table 3: Differences in Migration Rates**

Program	British Columbia	Toronto	Waterloo
Computer Engineering, Computer Science, Engineering Science, Systems Design Engineering, Software Engineering	18.85%	25.32%	40.56%
Biology, Chemical Engineering, Electrical Engineering, Mathematics, Mechanical Engineering, Physics, Other	10.70%	5.99%	13.37%
Difference (Tech - Other)	8.15%	17.53%	27.19%

Based upon the interviews, it is not surprising that more University of Waterloo graduates sought to work in the United States. Many respondents remarked that there was pressure from their peers to seek work with large American technology firms, buoyed by a “Cali or bust” maxim – a meme that has been discussed elsewhere (see Akhtar 2017). Respondents indicated that this maxim was present throughout their time at the university, and propagated over several programs, such as software and systems design engineering. The presence of this maxim made students feel they at least needed to explore the possibility of working in the United States. Respondents were clear, however, that faculty never echoed this mantra and we did not hear from any of those we interviewed that faculty had pressured students to work outside of Canada. Graduates from the University of Toronto or the University of British Columbia did not relay the same comments, although graduates from both universities acknowledged that many of their peers discussed working in the United States. It appears, however, that the same peer-led pressure was not present at all universities. While we heard that faculty did not encourage students to seek out employment in the United States, we also heard they did not counter the narrative. In fact, respondents reported that each university was mainly agnostic about career destinations for graduates.





# RECOMMENDATIONS

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Examining a sample of Canadian STEM graduates from three large Canadian universities, we find evidence of “brain drain” in Canada’s technology and innovation sector. While we see some human capital talent migration across STEM fields, it is highest in programs directly related to computer science and engineering. The United States is the main destination of choice for those who seek work abroad, with large American multi-national technology firms the main beneficiaries.

The good news for Canadian firms is that almost all interviewees indicate they plan to return to Canada at some point in their careers. Although the precise timing is unclear, the important point is that there is a desire to explore career opportunities in Canada at some point. In addition, many interviewees communicated that they prefer the Canadian social safety net and feel threatened by the current US political climate.

Canadian start-ups and scale-ups can attract and retain top tech talent. This section outlines actionable recommendations that can be implemented to increase retention of STEM talent in Canada, particularly in the areas of computer science and software programming and engineering. Recommendations are organized in three groups, those targeted for the private sector, government, and post-secondary institutions. Acting swiftly on these items could mean the difference between brain drain worsening in these fields or an accelerated tech sector supported by top Canadian talent. Long-term, taking action could mean the difference between modest or significant growth in Canada’s innovation sector, bringing with it important implications for our economy.

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## Recommendations for Canadian Technology Firms

**Improvements in Compensation** - Compensation is a key impediment for STEM graduates staying in, and returning to, Canada. Salaries are much higher in the United States and often come with signing bonuses and stock options. Student debt was a major concern communicated by graduates and companies could leverage this to attract graduates. In addition, graduates going to the US like to be rewarded for company performance. Tying this into compensation packages would enhance the competitiveness of Canadian firms when it comes to retaining Canadian STEM talent. To remain competitive and retain talent, Canadian firms should consider:

- Increasing salaries and compensation packages to match those available in the United States.
- Introducing and/or continuing signing bonuses and other creative compensation measures, such as paying off a certain percentage of student debt for newer hire after a predetermined period of time, providing stock options or performance bonuses tied to company performance.



**Better Communicate Investments in Innovation and Research Development** - The Canadian technology sector remains underdeveloped. Few respondents were able to identify many technology firms outside of Shopify and Blackberry. Many are interested in the Canadian technology eco-system, but have trouble keeping up with sector developments. Canadian firms should continue their innovative work and development to grow the sector, but communicate their achievements more broadly. Canadian firms should also consider:

- Introducing a comprehensive, multi-audience communication strategy that speaks to potential workers.
- Finding new and innovative ways to penetrate media and outreach networks in major foreign technology hubs, such as Silicon Valley.
- Increasing their presence on Canadian university campuses and exploring partnerships with Canadian universities to enhance students' awareness of their business operations, goals and brands. This could include participation in hackathons, lab sponsorships, social events or promotion of special guest speakers.

**Adopt an Open, Purposeful Information Dissemination Strategy** - Those interviewed crave information about the activities of Canadian firms. Their experience has led them to believe that the Canadian technology sector is more insular than other foreign markets. Those who have left Canada to work abroad report a desire to return under the right circumstances. Compensation is part of this, however, respondents said they want to join innovative firms that are primed for success, but find it hard to assess firm performance or planning from afar. To incentivize Canadian STEM graduates to return to Canada they need to know what is happening in Canada.

- Canadian firms need to be more open about long-term planning. Graduates want to know what companies are doing, which companies are scaling, and the products they are releasing.
- Do not assume existing news about firm activities will make it to those working in major American technology hubs. Information dissemination strategies need to be purposeful and targeted.
- Recruitment efforts should include information on long-term planning and allowing workers to understand their ability to grow their career along with the firm.

**Re-Think Co-op Strategies** - The current co-op system results in Canadian firms getting student placements early on which means top STEM students are being trained during their placements, only to have them leave for their last co-op placements and eventually a permanent position in the United States. Canadian firms need better access to students in later co-op placements. Companies could consider the following:

- Increase compensation for co-op placements. The disparity in pay between Canadian and American co-op placements is significant. Whereas a co-op student at a Canadian firm will make approximately \$20.00 per hour, they will make close to \$50.00 (USD) in the United States.
- Allow students to take on a broader set of responsibilities. Respondents described Canadian firms as having a narrow scope of work, worrying that if they take a job in Canada they will not have the ability to work on a variety of different projects. This impression largely stems from original co-op placements when, as students early in their undergraduate education, they were not afforded the ability to oversee or participate meaningfully in projects. Allowing for a greater variety of work at the co-op level would help to dispel this belief.
- Amplifying recruitment efforts during co-op. Some respondents communicated that many companies did not keep in touch after co-op placements. Maintaining relationships with co-op students after they leave, keeping them informed of exciting company developments, and circling back as graduation nears could improve recruitment and retention.

## **Recommendations for Government**

**Close the Compensation Gap** - Compensation is the largest impediment for Canadian-trained STEM graduates returning to Canada. While the onus to reverse this trend falls to the Canadian technology sector, governments can support industry by helping to alleviate the stress from student loans, which would put Canadian firms in a better position to compete for talent.



-Consider measures to alleviate the stress of government student loans for those graduating from select STEM programs at Canadian universities. This could resemble the Resident Loan Interest Relief Program for Canadian medical professionals, who are not required to pay principal or interest on loans granted during their medical residency.

**Develop Programming to Improve Co-op** - The co-op pipeline is crucial to recruitment and retention. Canadian firms can take action in this area, but government can offer strategic support to ensure students are compensated on par with American placements.

- Develop initiatives to help Canadian technology firms close the gap in co-op pay between American and Canadian firms, which can incentivize students from Canadian post-secondary institutions to pursue co-op placements closer to home.

**Continue Investment in Innovation and Research Development** - Continue and increase investment in innovation and research and development to ensure the Canadian technology sector remains competitive. Increasing this investment will enhance the innovation capacity of Canadian companies and promote their ability to scale.

An attractive feature of working abroad is the density of the technology sector. Those interviewed indicated this was a large factor in their decision to leave Canada. Government at all levels need to continue efforts to enhance domestic technology development. Many of the large multi-nationals that attract top Canadian talent are clustered in places like Silicon Valley. These locations provide STEM graduates with a unique networking and work environment. To address this, government should enhance efforts to increase the density of our technology hubs.<sup>8</sup> These types of strategies have successfully retained nationals in countries such as India, the Republic of Korea, Singapore, and Taiwan.

## **Recommendations for Post-Secondary Schools**

**Develop Programming to Improve Co-op** - There is a key supporting role post-secondary institutions can play to promote recruitment and retention from co-op placements. Additional supports will work to ensure that co-op is a meaningful work opportunity for students and provides a full sense of the scope of work in the Canadian technology sector.

- Develop programming that ensures the last co-op placement a student completes is with a Canadian firm. This would not hinder the ability of a student to work with an American firm at some other stage of their co-op experience, but Canadian firms should be prioritized later in the co-op process, allowing students to get a fuller sense of their operations and scope of work.
- Develop programming and communications that encourage students to explore work options in Canada. This would work to counter the prevailing pressure some students feel to work in the United States. Graduates communicated that peer pressure to seek employment in the United States was prevalent and frustrating. Simply put, maxims such as “Cali or bust” need to perish and while Canadian universities had no responsibility in starting this mantra, they have the ability to counteract it.



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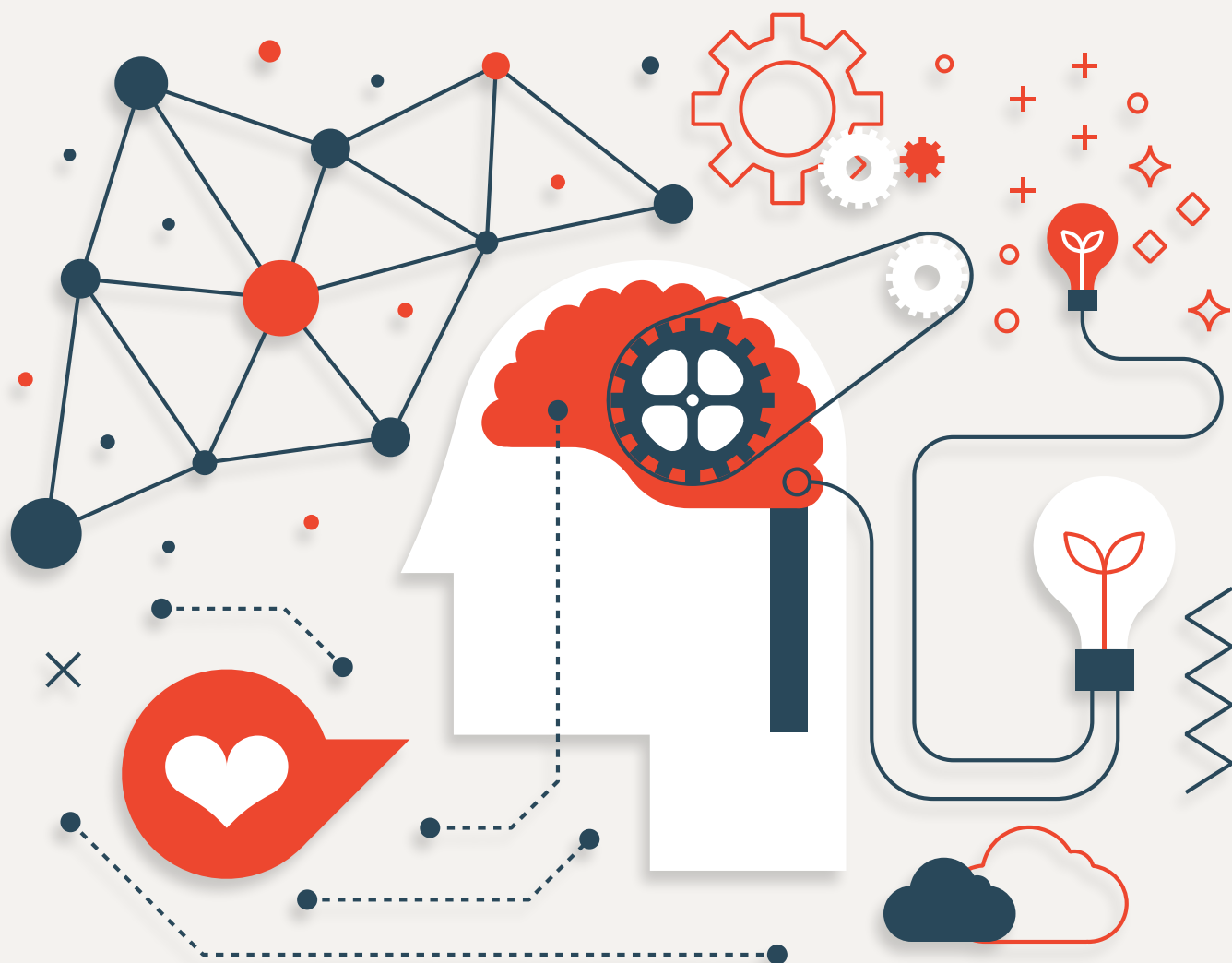
<sup>8</sup> Cervantes and Guellec (2002), have similarly made this point, arguing that, “developing centres of excellence for scientific research and framing the conditions for innovation and high tech entrepreneurship can make a country attractive to highly skilled workers, both from within the country and from outside”.



# CONCLUDING THOUGHTS

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While we find clear evidence of brain drain in the Canadian technology and innovation sector, the good news is that it can be reversed. Top Canadian talent still has a strong affinity for Canada, with many welcoming an opportunity to return. However, the conditions for this return need to be right. Docquier and Rapoport (2011) make this point quite clear, arguing that, "...the conditions under which a country is gaining or losing are not a matter of fate; to a large extent they depend on the public policies adopted in the receiving and sending countries." There is opportunity for Canada to capitalize. Many graduates we interviewed admired the scale and prestige of the American technology sector, but lamented the American political climate and approach to social policy. They also reported feelings of isolation and occasional loneliness. Canadian firms can win back talent, but the effort to do so needs to be proactive, impactful, comprehensive, and *collaborative*. Simply put, Canadian technology firms need the support of government and the post-secondary sector to ensure the Canadian economy benefits from the investments being made in our homegrown talent.



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## Addendum:

# RESEARCH NOTE ON DATA AND METHODOLOGY

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**May 9, 2018**

## Context

The report, “Reversing the Brain Drain: Where is Canadian STEM Talent Going?” has received considerable attention among the media, as well as within policy and academic circles. The report is intended to broadly translate and disseminate findings from our research in an accessible fashion to contribute to the national conversation on human talent migration in STEM fields and identify possible solutions for talent retention. This note supplements the report by providing further detail regarding the data, methodology and limitations of the research to promote clarity in the interpretation and analysis of findings.

### Research Note Highlights

- “Reversing the Brain Drain: Where is Canadian STEM Talent Going?” examines a sample of graduates from certain STEM programs at three Canadian universities, not all STEM graduates at all universities. The findings, as stated in the report, are limited to select programs at select institutions and should not be seen as evidence of a generalized trend.
- LinkedIn is a useful and increasingly popular tool to conduct research on employment trends and labour migration. Like any approach, it presents certain advantages and limitations. A limitation of drawing on LinkedIn is that not every graduate will have a profile, and some profiles may not be up-to-date.
- Results do not show high levels of migration among the sample of STEM graduates compiled for the study. Migration of graduates from certain STEM programs in the sample, such as biology and chemistry, is low or non-existent. Only certain programs – namely those related to the information technology sector – have high migration rates.

## Research Aim

The aim of the research is to improve understanding of the nature of talent migration among STEM graduates in Canada and assess *the extent to which* migration is occurring. A second, and equally important, aim is to better understand *why* human talent migration occurs and, third, *what can be done* about it. To address these questions, the study has two components: data collected from the LinkedIn profiles of recent graduates (2015 and 2016) and 35 interviews with those who have left Canada to work abroad. The interviews provide context for why migration is occurring and insight into what steps may be taken by the private sector, government and post-secondary institutions to minimize migration.

## Research Design

### *Selection of Universities*

To make the study manageable in a four-month timeframe (the timeframe established by the Mitacs research grant) we opted to select universities considered by popular sources (i.e., Maclean's) to have the top STEM programs in Canada: the universities of Waterloo, Toronto and British Columbia. Recognizing the universities and their programs are contextual, looking at the top schools and programs in Canada was intended to get a sense of the extent to which the country's top talent was leaving or staying.

### *Data and Approach*

Determining the career paths of graduates after they leave university is challenging. Many post-secondary institutions struggle to maintain accurate contact information about alumni. We evaluated this challenge in determining which research design would be suitable to compile a sample for the study.

One possibility was alumni information drawn directly from universities. In this we encountered a number of challenges, namely privacy concerns about providing alumni data to third parties. We placed requests with all three universities to acquire such records, but our requests were either ignored or rejected. We also had concerns about the reliability of this data, given that many graduates may not have a current address with their alumni association. Some universities also undertake their own alumni surveys but not all data is publicly available.

Other sources of data on graduates such as Statistics Canada's National Graduates Survey, last carried out in 2013 (for the 2009/10 cohort)<sup>1</sup>, and the Council of Ontario Universities (COU) survey of 2014 graduates carried out by CCI Research, are more dated<sup>2</sup>. The COU survey is also self-selected sample and more limited in scope. MaRS conducted a more recent survey to contribute to the conversation on talent<sup>3</sup>.

This survey includes data from 589 professionals between the ages of 23 and 55, however not all are recent graduates or have a university degree and a good portion of the sample (273 respondents) were marketing and sales professionals.

In addition, these data sources would not provide contact information to directly approach recent graduates for interviews. The interview component of the research design was critical to gaining additional explanatory insight into *why* graduates leave and *what* can be done to retain them. Given these aims, LinkedIn presented an attractive method for reaching out to recent graduates and recruiting participants for interviews.

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<sup>1</sup> Data for the most recent Statistics Canada's National Graduates Survey was collected between April 2 and September 1, 2013. The survey does have a question that asks about the country in which a graduates first employer is/was located with response options of Canada, the US or other, however data for this question is not available online and must be requested. In addition, using LinkedIn provided for more nuanced information as the destination of all grads would be visible is a location other than the United States was a hot spot.

<sup>2</sup> Data from the 2018 release was taken from a 2014 survey. This data provides the authors with the ability to determine the career path of graduates after they leave university. The report, however, does not include figures for migration or current work location for recent graduates

<sup>3</sup> The MaRS survey can be found here: [https://live-studio-y.pantheonsite.io/wp-content/uploads/2018/01/Talent\\_Fuels\\_Tech\\_Report.pdf](https://live-studio-y.pantheonsite.io/wp-content/uploads/2018/01/Talent_Fuels_Tech_Report.pdf)

LinkedIn proved useful to determine where graduates were living and working after graduation. This study is not the first to draw on LinkedIn as a research tool (see Feldman and Lowe 2015; Jiang et al. 2014; Ng and Stuart 2016; Vindorai and Spigel 2017). There are significant benefits to this approach, namely that those with a LinkedIn profile often list their education and employer. This provided for the inclusion of information such as firm location, firm size and sector. LinkedIn also provided the opportunity to contact individuals included in the sample (after they accepted a “connection” request) for possible interviews to gain explanatory insight as to why graduates are leaving Canada and what might incentivize them to stay.

While using LinkedIn as a research tool has a number of benefits, it also comes with limitations. First, not everyone has a LinkedIn profile and those who do not may be less likely to be in the workforce altogether. Those with a profile may have included false or exaggerated information or may not have kept their information up to date. While these are drawbacks, those active on LinkedIn have an incentive to keep their information current, which was seen as a benefit for the study. LinkedIn also has a large user base (over 500 million users) providing a good indication of its popularity<sup>4</sup>. To address the aims of this study LinkedIn was a useful tool for building a sample of STEM graduates from the universities of Waterloo, Toronto and British Columbia.

#### *Selection of Disciplines/ Programs*

LinkedIn prohibits users from scraping its platform for information. Data was requested directly from LinkedIn, but these requests were not granted. As such, this study relied on manual collection of user information from LinkedIn. Given the magnitude of this task, we narrowed program selection to those that are relatively consistent across the three schools, and data from these provided the final sample used in the report. The selected sample was chosen based on consultation with industry experts and individuals that had carried out previous research on the topic. It includes majors that are not directly technology focused--such as mathematics, chemistry and biology--and include representation from all of the STEM areas (math, technology, engineering and science).

The study finds, however, that migration is not even across all the selected disciplines including those that are seen as being traditionally information technology focused.

Migration in our sample was highest among information technology related majors, such as computer engineering and computer science, which is made clear in the Executive Summary and throughout the report. As such, our research can be taken to indicate only that there is a migration phenomenon among several majors related to information technology, not a generalized phenomenon across all STEM majors. This finding is consistent with research that involved surveys of graduates from individual programs (see Loi 2017). To re-iterate, this is only a sample and is not generalizable to the total population of STEM graduates in Canada.

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<sup>4</sup> Please see <http://fortune.com/2017/04/24/linkedin-users/>



Controls for international students were not applied in the study. While we acknowledge that migration will be affected by the proportion of graduates in a given program who are international students, and therefore less likely to have remained in Canada under any circumstances, country of origin is not included in profile information on LinkedIn – another potential drawback of using the platform to build a database – and was therefore not available to track in the study's sample. Further research that distinguishes between domestic and international graduates would be welcome. However, given the limitations of the data source, this was not possible in this study.

The study framework was peer reviewed through the Mitacs application process and approved by the Research Ethics Boards at Brock University and the University of Toronto.

### **Putting the Findings in Context**

Despite the limitations of the research design, there are interesting findings for those interested in human capital talent migration.

Along with the profile data from LinkedIn, interviews were carried out with 35 graduates who left Canada to work abroad. These graduates indicated that higher pay, firm reputation and scope of work are the reasons they sought employment outside of Canada. In response, a series of recommendations for industry, government and the post-secondary sector were proposed in the report, which have been well received.

Human capital talent migration or “brain drain” is not unique to Canada and is in fact a global phenomenon. Many countries are struggling with the challenge of retaining highly talented and highly educated domestic graduates. The report not only demonstrates that Canada is not immune to brain drain, but also that those in certain STEM programs are highly sought after by international firms and being attracted to work abroad under the right conditions. Interviews with graduates identify a series of factors that may incentivize graduates to return to Canada. The report also outlines concrete, actionable recommendations to stimulate a national conversation about what industry, government and post-secondary institutions can do to retain our best and brightest.

### **Stepping Stone to Further Research**

Given the difficulty of doing research on this topic, the lack of easily accessible data and the dearth of good studies to date, we see our report as providing an incremental improvement in knowledge and a stepping stone for others to investigate further. It is intended to translate study findings to a lay audience and to stimulate conversation on the topic of brain drain in STEM fields.. Further exploration of this issue is needed and groups that carry out surveys of graduates such as Statistics Canada, COU and others might consider including questions that would allow for updated and more comprehensive tracking of where graduates across all STEM disciplines at Canadian and Ontario universities are finding employment.

This is not the final word on the subject, but rather the start of a larger program. Papers intended for academic publication will also be produced from this study and will provide further analysis on the topic. If you are interested in being added to a mailing list to receive advance copies of such publications please join our mailing list by clicking [HERE](#).