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Knowledge Synthesis Report

How will Canadian technology clusters continue to thrive and remain competitive in managing STEM migration for innovation and growth?

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Canada's 'Innovation Agenda' and its provincial counterparts stress the importance of attracting and retaining skilled migrants, especially those with education and skills in science, technology, engineering, and mathematics (STEM) for innovation, growth and global competitiveness. Over the last few years, both federal and provincial governments have intensified their efforts to assist Canadian technology clusters in their recruitment and retention of foreign STEM talent.

This report examines current existing provincial and federal migration policy programs, with the aim to foster a deeper understanding of the role that these programs play in attracting and retaining STEM migrant talent. It critically assesses the existing knowledge, while also identifying important gaps of knowledge.

We will consistently update this report in the format of an 'evergreen' document, in which we will continue to incorporate new knowledge and findings to meet the needs of policy makers, industrial stakeholders and other non-academic and academic audiences. The most recent version of this report can be downloaded from the project website www.migrationforinnovation.info

In recognition that immigration in Canada is a shared responsibility between federal and provincial governments, this report will be supplemented by four additional profiles summarizing findings concerning the federal level and three of Canada's leading provinces in innovation and STEM migration: British Columbia, Ontario and Quebec. These profiles will become available from our project's website. Furthermore, to provide insights into global approaches and the strategies, successes, and shortcomings of Canada's foreign competitors in STEM recruitment, and in response to requests by stakeholders who were consulted before the beginning of this project, a selected number of foreign country profiles will also be made available online.

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For further information on this report and our research project, visit www.migrationforinnovation.info, join us on Twitter @migrateinnovate, or contact the principal investigator: Dr. Martin Geiger, Assistant Professor, Politics of Human Migration and Mobility, Carleton University, Department of Political Science and Institute of European, Russian and Eurasian Studies, D696 Loeb, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, martin.geiger@carleton.ca).

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Key messages

- **STEM migration is vitally important for innovation and maintaining Canada's growth and global competitiveness, and must be increased in the short term;**

  Domestic STEM labour supply is not sufficient to meet the short- and long-term demand of industries and technology clusters in Canada. The recruitment and retention of STEM migrant talent must be increased to meet pressing labour market needs.

- **Canada must develop a way to balance both short- and long-term immigration objectives; and in the intensifying global race for talent, Canada must maintain its leadership in managed migration;**

  The short-term objective of meeting immediate labour market needs must be balanced with the long-term objective of building human capital domestically to remain innovative and competitive. Canada lacks an overall strategy on how to respond effectively to labour market needs, and to changing economic, political, and social environments that can quickly affect employer needs. In the intensifying global race for talent, Canada requires better knowledge of competitor countries and their experiences in managing STEM migration for innovation.

- **While provincial nominations remain an important tool to retain talent, Canada's federal and provincial programs must be better coordinated to avoid confliction and to better promote innovation;**

  There is a lack of coordination between the objectives and processes of federal and provincial programs. Federal and provincial governments must consult with industry, municipal, and other relevant non-governmental stakeholders at the level of technology clusters, and take measures to address their concerns through a coordinated strategy. Immigration for innovation and growth must be approached as a wider and better coordinated strategy at all levels of policy-making.

- **Problems with program requirements persist and negatively affect STEM recruitment, and lack of data prevents the proper evaluation of the current management of STEM talent migration;**

  Certain program requirements and instruments (e.g. NOC codes, LMIAs) obstruct effective STEM recruitment and retention, and therefore must be re-evaluated within the context of high-skilled labour which supports innovation. Meanwhile, the lack of information on what programs industries utilize for managing STEM migration makes it difficult to assess STEM recruitment and retention, and their outcomes.

- **There is a need for better understanding of the social, economic, and political factors determining STEM talent migration.**

  STEM migrants continue to face poorer economic outcomes due in part to de-skilling associated with a lack of recognition of foreign credentials, language barriers, and a lack of professional networks. Greater awareness and understanding of the social, economic, and political factors which determine migrant decisions is required. This is increasingly important for successful recruitment and retention efforts.

Executive summary

In an intensifying global race for talent, Canada must take the time to critically (re)assess the fundamental role between migration and innovation. Canada is often quick to announce new programs to capitalize on current trends (for example, the new 'Global Skills Strategy' as pillar of the national 'Innovation Strategy'). However, little attention has been given overall to how Canadian innovators, businesses, and clusters attract and retain STEM talent over the short- and long-term through immigration programs like the federal and provincial economic streams. This is problematic because Canada is strongly dependent on STEM migration to fill labour market needs, and global competitors are becoming increasingly able to compete for the limited pool of STEM talent available.

This report seeks to supplement the discussion by providing insight into Canada's capacity to attract and retain high-skilled migrants, specifically those with education and/or skills in Science, Technology, Engineering, and Mathematics (STEM). We focus on STEM talent due to its perceived necessity in spurring future innovations and facilitating greater competitiveness and growth. Our findings suggest that Canada and Canadian clusters lack crucial insights and knowledge on how to attract and retain foreign-born STEM talent. Competitors in other countries are said to recruit STEM migrant talent in higher numbers and at a much faster rate. There is, therefore, a clear necessity for transnational policy-learning, policy adaptation, and enhanced policy development leading to an improvement and greater competitiveness of Canada's immigration programs, making the goals of this study highly salient and timely.

We began this study by examining current conditions in STEM-reliant labour markets, with the understanding that innovation strongly depends on continuous inflows of new knowledge and ideas from fresh talent. Across the country, stakeholders overwhelmingly cited that a lack of skilled talent hindered their ability to build, maintain, and grow their business and competitiveness. This problem was especially acute in high-technology sectors, and is only anticipated to grow. In British Columbia, these shortcomings were attributed to a lack of access associated with unequal supply-demand ratios and a subsequent inability to source necessary talent from abroad. In Ontario, retention was much more problematic than access. Both provinces suffered from skills mismatch. Meanwhile, Quebec is struggling to increase international student enrolment, considered to be a key source for STEM talent in the province.

We then explored the ongoing tension in immigration between short- and long-term objectives. Short-term objectives are concerned with meeting immediate labour market needs, whereas long-term objectives focus on building domestic human capital to supplement and support future labour market needs. While Canada's immigration policy has historically favoured short-term objectives, within the last two decades it has shifted to focus on long-term objectives and building human capital. However, this shift has come at the expense of short-term labour market gaps, and we found that there remains a lack of overall strategy and tools to concurrently address both objectives effectively. Canada's focus on building long-term talent has often hindered the ability for provinces to quickly attract the talent necessary to foster innovation in the short-term.

We also identified issues both in the relationship between the federal and provincial immigration programs, and the tools which support immigration generally. Interestingly, we found that there is growing tension, and opportunity for confliction, between federal and provincial migration programs. We attribute this to the fact that within the context of STEM talent, the programs –designed to accomplish radically different objectives– significantly overlap in the types of candidates which they attract. We suspect this overlap has resulted in Canada's two immigration policies fighting over the same internal candidates and consequently running the risk of excluding qualified foreign-sourced talent as a result. However, if Canada truly wants to attract the 'best and the brightest', immediate efforts must be made to coordinate these policies so that the widest amount of talent is invited.

We further found that traditional immigration tools are hindering the ability of Canadian industries to attract and retain top STEM talent. In particular, Labour Market Impact Assessments (LMIAs), which are often necessary to hire talent short-term, are perceived as too restrictive and inflexible for industries where STEM talent plays an important role. Meanwhile, the National Occupation Class (NOC) matrix, relevant to both temporary labour and permanent resident eligibility, has been unable to keep pace with the shifting job descriptions and duties prevalent in STEM industries, hindering the ability of Canadian businesses to initially attract and retain talent. One noted exception is the enhanced, post-November 2016 'Express Entry' management system: this system has been instrumental in quickly identifying those who best meet Canada's selection criteria, and STEM migrants in particular have benefitted from the new points allocation which prioritizes education over LMIAs. However, while these changes make it easier for STEM migrants to qualify for federal streams, this has also increased the risk for confliction between federal and provincial programs.

Finally, we attempted to examine non-program specific factors which impact STEM migrants' decisions to come to Canada and remain in Canada. Here, scholars have predominantly

focused on the fact that STEM migrants continue to face poor economic outcomes which they largely attributed to de-skilling, language barriers, and lack of professional networks. Keeping this in mind, we suggest that additional research is necessary to identify which factors, including those which are non-econo-centric or 'soft', impact the decision-making of STEM migrant talent.

From our findings, we provide five key insights and suggestions of use to policy-makers and practitioners:

- STEM migration is vitally important for innovation and maintaining Canada's growth and global competitiveness, and must be increased in the short term;
- Canada must develop a way to balance both short- and long-term immigration objectives; and in the intensifying global race for talent, Canada must maintain its leadership in managed migration;
- While provincial nominations remain an important tool to retain talent, Canada's federal and provincial programs must be better coordinated to avoid confliction and to better promote innovation;
- Problems with program requirements persist and negatively affect STEM recruitment, and lack of data prevents the proper evaluation of the current management of STEM talent migration;
- There is a need for better understanding of the social, economic, and political factors determining STEM talent migration.

Finally, and of note, our review process was frequently met with inadequate and unavailable statistics, data, and scholarship. In terms of STEM migration in particular, there is a lack of, and lack of access to, systematically-collected and analyzed data. Government reports, statistics, and other related information are a) often non-existent, as they have never been conducted; b) extremely unsystematic, with collection methodologies drastically diverting across studies; or c) in many cases, not accessible to non-government audiences. A lack of coordinated and systematic data further restricted our ability to provide cross-provincial, federal-provincial, and international comparisons. We therefore highly recommend that more data be collected on these various topics, disaggregated to isolate STEM migrant experiences, so as to inform future policies.

In sum, we found that Canada and its clusters currently lack the knowledge and strategies to successfully compete in the race for STEM talent. There is arguably no solid political, economic, nor academic insight into how clusters attract and retain STEM migrants, let alone how immigration policies impact these processes. In order to rise to this challenge and ensure that Canada's immigration program benefits rather than hinders Canadian industries to innovate, Canadian policy-makers must take a critical look at how current tools and programs are failing STEM professionals.

Knowledge Synthesis Report

1) Context

Globalization has led to a concentration of economic activity and innovation within confined localities or 'clusters' like Kitchener-Waterloo and the Silicon Valley (Bathelt et al, 2013; Saxenian, 1999). Clusters as *"geographic concentrations of interconnected companies"* (Porter, 1998a: 77) rely on specialists in science, technology, engineering, and mathematics (STEM) (for example, Atkinson and Mayo, 2010; Mishagina, 2012).

STEM talent is often scarce, and albeit stronger efforts and better education and training are required to generate a much needed and stronger local supply of STEM talent (e.g. Halliwell, 2013), technology clusters, in order to maintain their innovativeness and competitiveness depend on facilitating continuous in-flows of new knowledge and ideas from beyond their locally confined cluster areas (Grabher, 1993; Bathelt et al, 2004; Glückler, 2013). While scholarship on skilled migration and the innovativeness and competitiveness of technology clusters and advanced economies has grown significantly (for example, Granovetter, 1985; Bathelt and Hecht, 1990; Grabher, 1993; Crevoisier, 1996; Porter, 1998a/b; Shachar, 2013; Czaika and Parsons, 2016), we know little about STEM migrant recruitment and the applicability and outcomes of existing government programs. As the 'global race for talent' intensifies, clusters face considerable challenges in generating, attracting and retaining sufficient STEM labour (for example, Shachar, 2006; Docquier and Machado, 2016).

Canada, a self-declared but also internationally recognized *"global leader in managed migration"* (CIC, 2015: 11; see Ongley and Pearson, 1995; Papademetriou and Sumption, 2011; Hiebert, 2016), should be well positioned to meet this challenge. However, as noted during the launch of its Federal 'Innovation Agenda' (GoC, 2016), Canada lags significantly behind other countries that recruit STEM talent *"in higher numbers and at a much faster rate"* (Bains, 2016; Chagger, 2016). While in recent years federal and provincial governments have repeatedly adjusted their policies and launched new programs to become more competitive in recruiting and retaining STEM and other highly skilled migrants (e.g. 'Express Entry', 2015), there is a need for better knowledge and understanding of these programs, their outcomes, and on how they can be enhanced to promote greater innovativeness and competitiveness.

It is vitally important that Canada, Canadian clusters, and Canadian industries remain globally competitive. Global competitiveness is not only concerned with Canada's short and medium-term economic forecasts or its ability to generate new knowledge and innovations. It also importantly requires that Canada be a leader in the global race to attract and retain the STEM talent perceived as necessary for spurring future innovations and facilitating greater competitiveness and growth. While Canada has for decades been acknowledged as a champion in targeted and skill-oriented migration, other countries have started to emulate Canada's programs and may by now have become even more successful in attracting STEM migrant talent. This is problematic because Canada remains strongly dependent on STEM migration and, therefore, cannot become complacent should it wish to become a stronger innovator and global competitor

(Reitz, 2005; Mishagina, 2012; Boyd, 2014; CCC, 2016; Desiderio and Hooper, 2016; PoC, 2016a/b; Silcoff, 2016; McDaniel et al, 2013). The strong business acumen, unbridled interest, and acute need for STEM talent has recently become more obvious, and Prime Minister Trudeau himself to directly approach and encourage STEM talent to relocate from the U.S. to Canada's very own 'Silicon Valleys' in the wake of travel bans and increased anti-immigration sentiments across the US (Maclean's, 2017; Trudeau, 2017). To attract this STEM talent to support the new national 'Innovation Strategy', Canada introduced the 'Global Skills Strategy', a program which reduces the processing times of certain highly-skilled migrants to just under two weeks (IRCC, 2017a; GoC, 2016a).

2) Implications

As it has become clear during stakeholder consultations that preceded this project, there is a very limited understanding in Canada and among government and industry leaders of the precise factors of success in STEM talent recruitment and in programs of targeted skill-based migration. Firstly, Canadian clusters and their supporting industries lack crucial insights and knowledge concerning how their foreign competitors manage STEM talent migration. Though Canada's federal government has instituted new policies designed to attract global STEM talent in support of its focus on innovation, Canada and Canadian industries still face significant difficulties and hurdles when seeking to attract and retain STEM migrant talent. As there is no general and sound understanding of the precise factors of why other countries may be more successful and can recruit 'more' STEM talent and 'faster' than Canada, then abrupt reactionary policy changes unavoidably, while posing their own challenges, also reveal the fundamental flaws in existing programs and gaps in understanding and knowledge. There is a clear necessity for transnational policy-learning, policy adaptation, and enhanced policy development leading to an improvement of Canada's migration programs, which make the goals of this study highly salient and timely.

This report is the result of a thorough examination of the existing state of knowledge and prevailing gaps of understanding in Canada about the management of foreign STEM talent for innovation and growth. Our goal is to assist industrial lobbying and policy-making in building better immigration programs and improving the responsiveness and adaptivity of Canada's immigration programs and pathways in anticipation of changing political, social and economic circumstances, or changes in employer needs.

Our research has identified five implications of note for policy and practice:

1. **STEM migration is vitally important for innovation and maintaining Canada's growth and global competitiveness, and must be increased in the short term.** Innovation strongly depends on continuous inflows of new knowledge and ideas from beyond confined cluster areas. Domestic STEM labour supply in Canada is not sufficient to meet the short- and long-term demand of industries and technology clusters in Canada. STEM stakeholders overwhelmingly cite a lack of access to a skilled talent pool as a major hindrance to building, maintaining, and growing their business and competitiveness. This problem is especially

acute in high-technology sectors and is only anticipated to grow. STEM immigration must be increased and strongly facilitated if Canada is to remain innovative and competitive.

2. **Canada must develop a way to balance both short- and long-term immigration objectives; and in the intensifying global race for talent, Canada must maintain its leadership in managed migration.** Canada must find the right balance between the short-term objective of meeting immediate labour market needs; and the long-term objective of building domestic human capital to supplement and support future labour market needs to maintain its innovativeness and global competitiveness. Canada has historically opted in favour of short-term objectives, and only in the last two decades switched to a longer-term model. However, this shift has resulted in short-term labour market gaps, and there remains a lack of overall strategy on how to address both needs concurrently. While adjustments of the 'Express Entry' selection rubric may be a step towards a better balance in the STEM sector, Canada must continue to develop a system that addresses both short- and long-term considerations if it is to successfully respond and adapt to changing economic, social, and (geo)political environments. In an intensifying global race for talent, Canada also requires better knowledge of competitor countries and their experiences in managing STEM migration for innovation and growth.
3. **While provincial nominations remain an important tool to retain talent, Canada's federal and provincial programs must be better coordinated to avoid confliction and to better promote innovation**. There is growing tension, repetition, and opportunity for conflicting policies and procedures between federal and provincial migration programs. Federally-controlled skilled migration through the 'Foreign Skilled Worker Program' (FSWP) and 'Canadian Experience Class' (CEC) are designed to admit candidates on their perceived long-term suitability as flexible workers, not for their suitability in meeting short-term provincial labour demands. Unfortunately, these pathways are also attracting the same candidates who would qualify for 'Provincial Nominee Programs' (PNPs) and, because their applications are quicker and easier to process, may serve to undermine provincial efforts to retain their own workers using PNP. We suspect this overlap has resulted in Canada's two immigration policies fighting over the same internal candidates, which runs the risk of excluding qualified foreign-sourced talent as a result. If Canada truly wants to attract the 'best and the brightest', immediate efforts must be made to coordinate these policies so that the widest amount of talent is invited.
4. **Problems with program requirements persist and negatively affect STEM recruitment, and lack of data prevents the proper evaluation of the current management of STEM talent migration.** Labour Market Impact Assessment (LMIA) requirements are considered too restrictive and inflexible for industries where STEM talent plays an important role. Meanwhile, National Occupation Class codes are not keeping pace with industry advances. Program requirements and these tools have strong negative consequences for the recruitment and retention of STEM migrant talent and pose serious challenges, hindering Canada's

industries to attract and retain top talent. New programs like the federal government's ambitious 'Global Skills Strategy' are unlikely to succeed based on these existing practices, tools and requirements. While additional programs designed to attract and retain talent have been created at the federal ('Canadian Experience Class') and provincial (various international student classes) levels, no public data exists on whether they are used by STEM professionals, let alone the effect these programs currently have. More information is therefore needed to best assess the utility and outcomes of these current approaches.

5. **There is a need for better understanding of the social, economic, and political factors determining STEM talent migration.** The literature largely attributes poorer economic outcomes to continued problems in the recognition of foreign credentials, the de-skilling of professionals, language barriers and a lack of professional networks. It is also important to note that aside from wage and employment considerations, fast access to work and other permits (for example, study or work permits for accompanying partners or dependents), permanent residency and citizenship, as well as 'soft' factors (such as political climate, style of living, work-life balance) strongly determine the decision-making of STEM migrants when choosing their destination. There is need for an improved understanding of the various and highly complex social, economic, and political factors determining STEM talent migration, and successful recruitment and retention.

3) Methodology

This report synthesizes and critically assesses the existing state of knowledge on STEM migrant recruitment and retention in Canada. Importantly, it identifies strengths and important gaps in knowledge and understanding, and makes recommendations for further research. While the report predominantly focuses on the last ten years of policy development and implementation, it also draws on information and knowledge concerning the historical evolution of Canada's recruitment and retention of highly skilled and STEM migrants.

Research for this report was guided by the following questions:

- What policies, programs, and strategies exist to facilitate and manage STEM migration?
- What is known about the effectiveness and outcomes of these programs?
- What are the experiences of industry and other stakeholders who have used these programs?
- What can be learned from the existing knowledge, prevailing gaps in policies, understanding of stakeholders' experiences, and outcomes in recruiting and retaining STEM talent?
- How can these insights contribute to enhancing and developing better programs and policies which will promote greater innovativeness and competitiveness of industries and technology clusters?

The research conducted for compiling this report has involved two methods for identifying, synthesizing and assessing the state of knowledge:

1) Research, collection and critical assessment of primary documents: accessible information and knowledge disseminated by relevant government, industrial, and related stakeholders (for example, think tanks and chambers of commerce), including policies and programs for highly skilled migrants and STEM migrant talent recruitment in Canada at both the federal and provincial level (focusing on three provinces of strong STEM immigration and innovation: British Columbia, Ontario and Quebec); industry and other stakeholder media statements, reports, assessments, and other published information; government evaluations, statements, and reports; statistics on STEM and highly skilled migration; and general information provided on employment and economic trends in Canada and the three focus provinces.

2) Research, collection and critical assessment of secondary documents: i.e. scholarly literature: relevance of STEM migration for the Canadian economy and clusters in the three focus provinces; critical appraisals, insights, viewpoints, and evaluations into Canadian migration policy programs; historical development of targeted and skill-focused economic migration to Canada and Canadian immigration policies in general; political and socio-economic contextual factors of (STEM) migrant worker recruitment and retention in Canada, the three focus provinces and their clusters.

4) Results

While there has been a growing interest in attracting highly-skilled migrants in recent years, this report concludes that we are not equipped with the tools nor the knowledge to attract foreign-born STEM talent efficiently and strategically. Scholars have yet to examine STEM migration in Canada, and there is a need for a detailed, fact-based assessment of the success and outcomes of Canada's recruitment and retention of STEM migrant talent against global competitors.

Our research was severely limited due to multiple factors. While we found that Canada has a growing need for foreign-born STEM labour in both the short- and long-term, we also found that there has been almost no research conducted on how Canadian clusters and industries navigate existing policy programs, nor studies on how they recruit foreign talent in general. Without being able to identify how recruitment or retention is currently done, it is extremely difficult to offer solutions on how to maintain or improve Canada's ability to attract and retain STEM talent through managed migration, and how to successfully compete in the global race for talent.

A lack of accessible data significantly contributes to the overwhelming gaps in knowledge about where (foreign-born) STEM talent currently is recruited and retained, and how it contributes to innovation in Canada and beyond. We further lack knowledge about where STEM professionals may be needed in the future, both geographically and sectorally; and what immigration pathways are best suited to meet current and future needs. We must prepare for future challenges like those seen in the current high-tech boom, especially in the context of a dramatically changing (geo)political and economic environment for Canada (for example, US

administration and presidency on immigration and free trade, related agreements on NAFTA mobility).

Canada has not yet found the right balance between meeting short- and long-term objectives, resulting in severe labour shortages in STEM-dominated sectors. Furthermore, we found that the programs and tools currently in place are insufficient, and oftentimes have a dampening rather than supporting effect. For example, the national occupation system and its classification codes (NOC codes), and the labour market impact assessment (LMIAs) requirements imposed on most flows of STEM labour migration, negatively impact the ability of Canadian businesses to reliably and effectively attract and retain STEM talent This negatively impacts innovation in the short-term, and indicates a lack of a coordinated strategy to facilitate growth in innovation and global competitiveness through increased STEM mobility in the long-term. The lack of coordination between federal and provincial immigration programs in Canada is particularly concerning, as they appear to compete to retain talent in Canada while neglecting those outside of it. Finally, there is little understanding of what factors impact foreign-born STEM professionals' decisions to (not) come or stay in Canada, making it difficult to identify how to make Canada a more attractive destination. There is an urgent need, even for Canada as a (self-)declared leader of managed migration, to learn from international competitors and their management of STEM talent migration.

Overall, this lack of baseline knowledge made answering our initial research questions exceedingly difficult within the context of this 'knowledge synthesis' exercise.

Identified knowledge and research gaps:

1) Missing data collection, synthesis, and access: There is a lack of, and lack of access to, systematically-collected and analyzed data. Government reports, statistics, and other related information are a) non-existent, as they have never been conducted on this topic area; b) extremely unsystematic, with collection methodologies drastically diverting across studies; and c) in many cases, not accessible to non-government stakeholders. In several cases, our research team was simply unable to find open-access information that could have better informed our report. The largest issue, however, is a lack of coordinated and systematic data, which restricted our ability to provide cross-provincial, federal-provincial or international comparisons. This is particularly problematic in relation to data collected on behalf of 'Provincial Nominee Programs', as a lack of standardized collection and methodology makes provincial comparisons impossible (Canada, 2009: 27; CIC, 2011: 34). Furthermore, many provinces do not have formal labour market strategies which link labour market shortages to immigration. It is therefore difficult to assess to what extent admitted provincial nominees actually meet labour-market needs.
2) The role of sub-state entities is neglected: Scholarly and policy-related discussions continue to concentrate exclusively on the global, inter-state, and national (central state/federal) levels when examining the competition for talent, and when designing and justifying certain immigration programs and policy strategies (for example, the federal 'Innovation Agenda'

and programs such as 'Express Entry'). Especially given that immigration is strongly driven by non-state actors at sub-state levels and concerns and impacts all levels of government, we believe that there has been inadequate and insubstantial discussion of how stakeholders at the sub-state level, including but not limited to clusters, agglomerations, distinct municipalities, and provincial and regional levels, navigate and evaluate existing policies and programs. There has also been limited discussion on how the recruitment and retention of STEM migrant talent for innovation and growth 'work' at these levels in practice.

3) Dominance of policy statements in lieu of empirical studies and independent assessments: A general impression gained throughout this project is that government sources on STEM migration and highly-skilled migration consists, to a large extent, of policy and media statements, short inconsistent and incomplete website reports, and extremely limited data sets. There is only a very low number of actual policy evaluations that are accessible to the public. Information and knowledge provided by non-governmental stakeholders is typically limited to these stakeholders' media statements and policy viewpoints. For example, in parliamentary hearings, there are very few reliable and independent evaluations and reports conducted on the crucial topic of highly-skilled and STEM migration. Notable exceptions include reports published by e.g. the Conference Board of Canada (study on 'Immigrants as Innovators: Boosting Canada's Global Competitiveness'; The Conference Board of Canada, 2010), the Canadian Chamber of Commerce ('Immigration for a Competitive Canada: Why Highly Skilled International Talent Is At Risk'; Canadian Chamber of Commerce, 2016), the study of Ferrer et al ('New Directions in Immigration Policy'; Ferrer et al, 2014), and various helpful but hard-to-find Statistics Canada tables, whose information however has not been analyzed by publicly-available reports (see, for example, Statistics Canada, 2015).

It is our opinion that new, original research using mixed methods (for example elite interviews with key policy and industry stakeholders, or access to information requests) is necessary before a substantial collection and assessment of existing knowledge and practice-relevant information can be undertaken. For the purposes of this report, the ability to conduct empirical research would have been extremely useful and helped to address these profound knowledge gaps. Unfortunately, such efforts were not available to the principal applicant nor his team due to the funding and time frame provided, and the research restrictions and regulations tied to this grant.

Suggestions for additional research areas:

Some topics fell outside of the scope of this report, or due to a lack of information and data were not considered, but nevertheless would warrant further investigation when considering the interaction of immigration, foreign-born STEM talent, and innovation:

- The recruitment and retention of STEM talent in Canada's competitor countries and clusters in innovation, and the global race for high-skilled migration.
- The relevance of social, economic, and political factors in shaping and determining STEM talent migration, recruitment and retention, and outcomes of STEM migration, including the role of gender (e.g. Hango, 2015), age, origin, and existing skills and their 'mismatch' (for

example, Aydede and Dar, 2016), changing political (for example, swift government changes on immigration), economic (for example, dissolution of free trade arrangements) and social (for example, right-wing populism and xenophobia) and other, often neglected supposedly 'soft factors' (for example, Dobrowolsky and Ramos, 2014).

- Transnational communities and transnational diaspora entrepreneurs, and their impact on innovation, growth and development, as well as recruitment, retention and migration/mobility of STEM talent, as examined in the EU-funded Horizon 2020 project 'DiasporaLink' (http://www.diasporalink.com).
- The risk of multinationals to Canadian intellectual property and innovation. Yoshua Bengio, a pioneer and leader in artificial intelligence, emphasizes that Canadian businesses must be given access to the best and the brightest migrants. While multinationals such as Google, Facebook, and Microsoft are all establishing subsidiary branches in Canadian cities, Bengio warns that the best way to protect Canadian-developed and Canadian-nurtured innovation and advances is to ensure that STEM professionals –whether grown domestically or invited to Canada– work for Canadian companies, and that Canadian companies have the support they need to attract the best and the brightest (CBC, 2017).
- Research examining historical examples of high-tech booms in Canada (for example, in the 1990s associated with the .com bubble), and lessons that can be learned from the current demand for high-skilled labour and future of recruitment and retention (Picot, 2013: 7-9), and whether stronger investments and efforts in local STEM education in Canada are able to offset future industrial demand (Halliwell, 2013).
- The likely impact of artificial intelligence on STEM labour markets, future industry demands, and STEM talent migration.
- Regionalization as a strategy for attracting STEM workers. Margaret Walton-Roberts notes that instead of forcing high-skilled immigrants to settle outside of urban centres, Ontario should encourage municipalities to develop immigrant attraction initiatives of their own. This community-driven approach has the potential to promote regional economic and innovative growth outside of city centres, and expand opportunities for innovation (Walton-Roberts, 2007).

5) State of knowledge

5.1 STEM migration is vitally important for innovation and maintaining Canada's growth and global competitiveness, and must be increased in the short term.

Our knowledge synthesis identifies that while Canada is facing a labour shortage across all sectors, this shortage appears especially acute in the STEM field (Kustec, 2012). All three provinces studied as part of this report (British Columbia, Ontario, and Quebec) distinctly identify that while attracting and retaining top talent is a key necessity for their long-term innovation agendas, access to talent supply to meet both short and anticipated long-term needs

remains a considerable challenge (Montréal International et al, 2011; Emploi-Québec, 2015; BC Multiculturalism, 2012; ICT Council, 2016/2017; BC Tech Association, 2016; ON Chamber of Commerce, 2014; KPMG, 2016). This is concerning because STEM-educated workers are considered key inputs to Canada's national innovation system, due in part to the *"scope and nature of their labour market activities"* (Hango, 2015). STEM professionals' expertise in research and development (R&D) and knowledge dissemination are integral to shifting towards, maintaining, and successfully expanding a knowledge-based economy. Furthermore, STEM-reliant sectors generate high economic returns and act as a major income generator at the federal and provincial level (Statistics Canada, 2017; BC Stats 2017: 24; BC, 2017: 3; Techno Montréal, 2013: 3).

Provinces surveyed commonly identify a mismatch between STEM skills taught in educational settings, and required STEM skills in the private sector. This mismatch acts as a major impediment to their industries' access to talent (ON Chamber of Commerce, 2014). National data seems to support this concern: while approximately 2.19 million individuals in Canada hold a degree from a STEM field, only 1.28 million (or 58.4%) of these individuals were employed in the STEM sector, with the lowest number working in technology, mathematics, and computer science (Statistics Canada, 2011/2016). Educational institutions are often cited as failing to keep pace with dynamically emerging, developing, and changing industry needs (Vancouver Economic Commission, 2016). This results in employers with STEM needs expanding cooperative and/or internship opportunities to ensure that the 'workers of tomorrow' are best equipped to transition seamlessly from post-secondary institutions into the actual workforce (Randstad, 2015). However, it is important to note that new graduates, re-training, and re-qualification are generally regarded as failing to keep pace with labour market demand.

In addition to these common concerns, each province has unique problems. Industry stakeholders in British Columbia are particularly concerned about the lack of domestic supply of STEM professionals necessary to meet local labour market needs, especially given BC's extremely rapid growth and expansion of key industries (BC Multiculturalism, 2012; Work BC, 2016; BC Chamber of Commerce, 2014; BC Tech Association, 2016; O'Neil 2016). Access to talent is attributed to the low domestic supply of highly skilled workers in STEM fields, and BC's overall inability to bring in enough international STEM talent due to the existing immigration caps both at the federal and provincial level. Ontario stakeholders attribute their labour shortages to an aging population, low birth rates, low reception levels of federally-sponsored high-skilled workers, and net emigration from Ontario to other provinces (ON Chamber of Commerce, 2014/2016; Municipalities of Ontario, 2008/2012/2017). At the same time, compounding these issues, is the lack of consensus and information STEM labour shortages in Ontario. Meanwhile, industry and other public stakeholders in Quebec point out that the province is experiencing stagnating international student enrolment rates (e.g. Chambre de commerce du Montréal métropolitain, 2016). This is considered problematic because international students are more frequently STEM-educated graduates than their domestic counterparts. It also is problematic because aside from direct immigration of STEM talent,

graduates of foreign origin who have studied in Canada in STEM fields form an important source of skilled STEM labour.

The fact that few Canadians are working in the STEM field to begin with, coupled with the fact that many who hold STEM degrees are affected by de-skilling and qualification mismatch that hinder their effectiveness from the beginning, underlines the importance of targeted recruitment of STEM migrant talent has on ensuring Canada's future, both in the short- and long-term. Studies show that immigrants occupy an important role in advancing Canada's STEM-reliant sectors. For example, 40% of the Information and Communications Technology (ICT) industry is comprised of immigrant workers, and their share will likely continue to grow (ICT Council, 2016).

Foreign-born STEM professionals also represent an important demographic among STEM degree holders in Canada. While immigrants constitute just under one-quarter (24.6%) of all working-age adults in Canada, they represent just over half (50.8%) of those with STEM degrees. Of those with degrees, just over one-third earned their STEM degree in Canada, while the majority (66%) completed their degree outside Canada (Statistics Canada, 2016). Furthermore, immigrants who earned their degrees in Canada were 14% more likely to study in a STEM field than their Canadian counterparts (34% versus 20%, respectively) (GoC, 2014). When this age gap is narrowed to 25-34 years of age, these numbers increase: 46% of university-educated immigrant males and 23% of university-educated immigrant females hold STEM degrees, compared to 32% and 12% of their Canadian-born counterparts (Statistics Canada, 2015). This is especially important when considering that young adults constitute a majority of Canada's emerging technology sector workers (Brookfield Institute, 2016). Unfortunately, no studies have been completed on the immigrant successes in transition into the workforce.

Notably, the Conference Board of Canada in 2010 found a positive relationship between net migration and country-level innovation, suggesting that the benefits from immigration are not tied solely to meeting short-term labour-market needs. Immigrants foster innovation by diversifying the workplace, leading to better ideas when brainstorming. They also expand Canadian markets through personal and professional networks, leading to increases in trade, import/exports, and foreign direct investment (The Conference Board of Canada, 2010: 10-13).

All of this suggests that Canada should consider expanding short- and long-term immigration opportunities for high-skilled workers.

5.2 Canada must develop a way to balance both short- and long-term immigration objectives; and in the intensifying global race for talent, Canada must maintain its leadership in managed migration.

Throughout Canada's history, policy makers have struggled to adhere to a coherent policy on immigration. Most scholarship on Canada's development of an economic-based immigration policy focuses on Canada's fluctuating prioritization of short-term market needs and long-term demographic goals (for example, Green and Green, 2004; Knowles, 1997; Nakache and Baglay, 2013; O'Shea, 2009; Seidle, 2013; Reitz 2005/2013). Scholars agree that until the late 1980s,

short-term considerations played a major role in immigration policy. The 'Immigration Regulations' (1967), which first established Canada's points-based rubric system, favoured short-term needs almost as much as long-term goals by virtue of its points allocation (by, for example, granting points to pre-arranged employment and destination locations) (Green and Green, 2004).

According to Green and Green, *"40% of the possible points were based on assessment of predicted short term success in the applicant's intended occupation and destination"* (Green and Green, 2004: 119). Nine years later, in the 'Immigration Act' of 1976, the points rubric placed more emphasis on practical training and experiences at the expense of settlement suitability and education, indicating a preference for facilitating a timely response to short-term labour market needs (Knowles, 1997: 210; Kerr, 1986; Green and Green, 1999: 433). By 1982, the federal government went so far as to restrict independent immigration only to those who held pre-arranged employment in a blatant effort to protect the domestic labour market from an alleged surplus supply of foreign workers (Kerr, 1986: 4; Green and Green, 2004: 122; Ferrer et al, 2014: 2). These restrictions in particular had a severe chilling effect on high-skilled migration: whereas in 1973 independent immigrants who intended to enter professional, technical, manufacturing, or construction occupations comprised roughly half of the total number of working immigrants, by 1982 they accounted for only 34.5% (Kerr, 1986: 12). While this pre-arranged employment requirement was eased four years later, its 1986 replacement was a similarly restrictive system where economic immigrants would only be admitted if they entered 'open occupations'. The list of 'open occupations' was compiled based on labour market projections and assessed quarterly by the Department of Employment and Immigration (Ferrer et al 2014: 2).

However, despite such emphasis on short-term success in early policies, scholars note that long-term immigration objectives –defined as building human capital through sustained immigration, rather than solely addressing short-term labour market gaps– were frequently alluded to as a goal throughout Canada's history. For example, the federal government's 'White Paper' of 1966 called for a greater alignment of immigration with long-term economic interests, and advocated for a strong focus on recruiting 'qualified' immigrants who would support the economy. It also warned against unchecked sponsorship of what it considered 'economically-unqualified' family members (Raska et al). Years later, a Joint Senate-House of Commons Committee formed in response to a scathing government report condemning immigration for its hidden costs, and the committee concluded that *"Canada should continue to be a country of immigration"* (Knowles, 1997: 207).

It was not until the mid 1980s that long-term objectives came to the forefront of Canadian immigration policy. Between 1982 and 1986, the selection rubric was radically overhauled, with more emphasis placed on longer-term human capital skills (age and language) and less emphasis on short-term indicators (such as job offers) (Kerr, 1986: 6-7). Adding a factor ('levels') into the points-based system changed an applicant's points score depending on if immigration was desired (greater point allocation) or not (lower point allocation). This allowed the federal government to control the number of economic immigrants invited to come, without having to rely on manipulating application processing times (Kerr, 1986: 8). Furthermore, exceptions to the restrictive 'open occupation' policy created a system where if individuals fell into certain pre-

defined high-skilled categories (for example, lawyers), some of which likely encompassed what would now be considered STEM professionals, in an effort to address the dramatic drop in such workers experienced in the previous decade (Kerr, 1986: 7). Together, these changes represented a major attempt at managing economic-based immigration from a *"core skills/competencies"* lens, as opposed to solely a *"labour market needs"* lens (O'Shea, 2009: 8). As a result of these changes, immigration levels increased substantially: *"[…] from 83,402 in 1985[,] to 99,219 in 1986, and then to 152,098 in 1987"* (Green and Green, 1999: 434). Despite a short decrease in the mid 1990s, this upward trend has continued, and immigration is now sustained at approximately 250,000 annually, with many calling for this threshold to be increased to at around 300,000 (Statistics Canada, 2016a).

This shift towards a long-term perspective has resulted in a number of radical changes in Canada's approach to immigration. Firstly, the points rubric has been amended on several occasions to better prioritize what are considered long-term determinants of success, such as age, language skills, and advanced/post-secondary education (Knowles, 2016: 242). Too many amendments have been made over the years to detail in this report. Most recently, Canadian educational experiences, French-language capabilities, and the presence of siblings (perceived to benefit positive economic and social integration) have attracted additional points, whereas the importance of job offers has significantly dropped (600 to 50/200 points) (GoC, 2017b; IRCC, 2017a). To scholars, such changes represent a wider shift in prioritizing *"immigrants who have the education, skills, and language to adapt readily to [Canada's] new economy,"* a policy formalized in the current mandate of the 2001 'Immigration and Refugee Protection Act' (Knowles, 2009: 10: Green and Green, 2004: 129; Ferrer et al 2014: 3).

Secondarily, by taking a long-term approach, Canada created tools to better control the number and skills characteristics of immigrants who were invited to come. Prior to the mid-1980s, Canada had no mechanism other than application processing times to limit and regulate migrant applicants (Green and Green, 2004: 119-121). Those who were approved were selected based on what types of applications were prioritized for processing (economic or family), and on a first-come, first-serve basis (Green and Green, 2004: 122). Immigration numbers followed a procyclical/absorptive model, whereby more applicants were approved in times of economic strength and less during economic downturn (Green and Green, 2004; Picot and Sweetman, 2012: 4). Shortly after the introduction of the pre-discussed 'levels' factor in 1986, the federal government gained the power to set upward 'caps' both on the number of immigrants invited to apply, and to impact the composition of those who were invited by establishing desired percentages of the whole for each category (Green and Green, 2004: 124). This gave them the tools to enact policies which prioritized economic immigration above family sponsorship. Immigration levels themselves were shifted away from the pro-cyclical/absorptive model and instead decided annually in consultation with the provinces, independent of current-day economic considerations (Knowles, 2016: 236; Kelley and Trebilcock, 2010: 394).

Thirdly, Canada began prioritizing what is now known as 'economic immigration'. Prior to the 1980s economic immigration and its associated points-based ranking remained largely sidelined in favour of non-economic immigration streams, including family sponsorship or on a

humanitarian basis (Kerr, 1986: 4; Green and Green, 2004: 119). Once a longer-term approach was normalized, however, this quickly shifted. Suddenly Canada was interested in attracting *"immigrants who have the education, skills, and language to adapt readily to [Canada's] new economy"* (Knowles, 2016: 244; O'Shea 2009: 10). A '60/40' economic/non-economic split policy was established shortly thereafter, and has guided the decision on how many immigrants to accept annually selection since.

The most important changes brought about by this long-term approach came with the introduction of the 'Express Entry' management system in 2015. 'Express Entry' was introduced to increase responsiveness to labour market and regional needs by decreasing the application processing time and providing greater flexibility in selection and application management (IRCC, 2016: 4). Its ability to rank and compare skilled applicants allows the federal government to actively identify and invite those it considers most qualified to come to Canada, by virtue of which criteria are granted the most points. This represents a significant shift away from the previous model where the points established a minimum threshold, and everything aside was determined on first-come first-serve basis. While Express Entry struggled at the beginning to attract high-skilled labour (and instead prioritized cooks and other semi-skilled positions), subsequent amendments to the rubric show promising results (IRCC, 2015; IRCC, 2017a: 17 reports however 70% of the applicants as already residing in Canada; CIC News, 2016). In 2016, candidates with skills and experience as IT Professionals (NOC 21) were the largest group of candidates invited to apply. Similarly, openings for software engineers increased from 3% to 4% around the same time (IRCC, 2016: 13). This is likely due to their high transitional skills rather than their specific experiences in STEM professions. IRCC recognized that *"88% of individuals were invited on their human capital points alone"* (IRCC, 2017a: 12), perhaps indicating that in the long-term, a human capital approach may be able to meet the needs of the high-skilled domestic labour market. However, no research has been conducted which addresses this insight.

It is important to note that despite Canada's perceived shift towards the points-based selection of immigrants to favour long-term objectives (human capital precursors), short-term objectives have never fully been eradicated from the system. Instead, short-term labour market needs are now managed through additional programs outside of the core Federal permanent residency program for high-skilled workers, namely the 'Temporary Foreign Worker Program' and various 'Provincial Nominee Programs' (O'Shea 2009: 18-20; Ferrer et al, 2014: 7-11). Additional programs and/or those programs no longer in existence have been introduced over the years. They had in common that they aimed to address specific short-term labour market needs, similar to the 'in demand occupation list' used in the 1980s and encompassing the current 'Global Skills Strategy'. The applicability and functionality of these programs are assessed in section 5.4 of this report.

Finally, in a globally intensifying race for talent, Canada requires better knowledge of its competitor countries and their clusters, and their experiences in managing STEM migration for innovation and growth. While Canada serves often as a 'posterchild' of tailored and well-managed economic migration, the absence of detailed studies about how industries, technology clusters, and countries compare with Canada is astonishing. While there is growing interest in

global comparisons (e.g. Ongley and Pearson, 1995; Papademetriou and Sumption, 2011; Shachar 2006/2013), according to stakeholders that were consulted before the beginning of this project, there is no sound practice-related knowledge and academic scholarship able to inform Canadian clusters, industries, and governments about strategies and programs pursued in competitor countries. Canada cannot become complacent as it is strongly dependent on continuous in-flows of new STEM migrant talent. Canada therefore must ensure the effective retention of STEM talent, both educated and trained in Canada and coming from abroad, as well as prevent excessive 'brain drain' of Canadian STEM professionals to other countries and their clusters. Other countries have started to emulate Canada's programs and may have become more successful than Canada in attracting STEM migrant talent. There is urgent need for Canada's clusters and industries to regain and expand global leadership with the help of enhanced provincial and federal programs and immigrant pathways for STEM migrant talent.

5.3 While provincial nominations remain an important tool to retain talent, Canada's federal and provincial programs must be better coordinated to avoid confliction and to better promote innovation.

Provincial Nominee Programs (PNPs) are an extremely important pathway for immigrants to obtain Canadian permanent residency, and an important way for provinces to attract STEM talent. The PNPs devolve immigration from strictly a federal responsibility by empowering provincial policy-makers to both attract their own immigrants, and to choose what type of immigrants (and ultimately, who) are invited to stay in the province as permanent residents, subject only to a limited oversight role by the federal government (Bagley, 2012: 123; O'Shea, 2009: 12; CIC, 2011: 1). PNPs therefore offer a pathway to permanent residency which does not rely on applicants being selected from the massive pool of applications like in the federal Express Entry system (with the exception of 'enhanced nominations', see: GoC, 2017a). Every province (except Quebec, enjoying an autonomous immigration system under the '*Canada-Quebec Accord'* of 1991) and two territories have enacted some version of a PNP, designed to suit specific provincial needs. In 2015 (the most recently available data), individuals with PNP nominations made up over 26% of arrivals under economic streams. However, it is important to note that PNPs are not restricted to solely economic classes: as of 2010, six provinces had family reunification streams, and four have streams for international students (Seidle, 2013: 8).

The PNP is acknowledged as an important retention tool for provinces to select specific skills and/or experiences to remain in the province, both to meet short-term needs and to build long-term capacity for industries and innovation hubs within their provinces (ON Expert Panel, 2012: 7; Ministère de l'Immigration, de la Diversité et de l'Inclusion, 2016: 28-29; Nakache and Baglay, 2013: 334-357; Kapur and Jacek, 2012: 2). Both Ontario and BC have specific employer job-offer categories which allow employers to offer foreign workers who skills match approved high-skill (0, A, or B) National Occupation Codes (NOCs) pathways to residency, thereby making their job offers more valuable (e.g. GoO, 2011: 24; GoO, 2017b). Specific to STEM retention, BC has recently launched a 'Tech Pilot', which seeks to retain workers with desired

STEM skills/experiences (as determined by specific pre-identified NOC codes) by offering them priority processing, personalized assistance with the application process, and more opportunities to be invited to apply than what is regularly issued (Canada Visa, 2017). PNPs are also often utilized as a retention tool for international students. British Columbia, for example, has created new classes which link public post-secondary education with immigration programs, creating easier pathways to permanent residence and ultimately, citizenship, for international students studying in Canada (Seidle, 2013: 13). These enhancements have made post-secondary institutions a critical component of British Columbia's talent retention and immigration policy, especially in relation to its efforts to increase STEM worker supply, as they ensure that those who study and wish to remain in BC do not require extensive years of on-the-job experience in order to qualify to stay. Ontario has created similar pathways for international students (GoO, 2017a).

Yet, despite the increasing popularity of PNP, recent critical academic scholarship is scarce. Two notable exceptions are the review and assessment of current policy changes by Ferrer et al (Ferrer et al, 2014: 7-16) and Sasha Bagley's 2012 report, which explores the complex interactions between federal-provincial immigration policies. Bagley concludes that there remains a need for more coordination in objectives and process between Ottawa and the provinces (Baglay, 2012: 121-141). While outdated in terms of program overviews, Bagley's insights nevertheless remain salient, and outline a very real risk for increasing programmatic confliction, both in terms of processes and objectives, between the federal and provincial levels. Take, for example, the 'Canadian Experience Class' (CEC). This federal class was recently developed as a pathway to permanent residency for temporary foreign workers and foreign graduates with qualifying Canadian work experience. The rationale behind the creation of the CEC is that it provided employers (by virtue of job offers) and universities (by virtue of their admissions criteria) a larger role in selecting desirable immigrants in order to meet short- and medium-term economic goals – goals which are strikingly similar to many PNP classes (Ferrer at al, 2014: 10). Similarly, recent changes in the distribution of points in the 'Federal Skilled Worker Program' (fewer points for LMIAs and more points for education) has rendered it a much more attractive and attainable pathway, especially for highly-educated STEM talent.

Overall, these similarities and overlaps will likely lead to confliction between the programs. High-skilled STEM talent may prioritize applying through federal streams due to their relative ease in terms of time, cost, and requirements when compared to their provincial counterparts. However, there is no available data nor scholarship on how much conflict and overlap exists between programs, nor is their sufficient scholarship which discusses the implications for STEM attraction and retention. There is also a significant knowledge gap on whether and to what extent PNPs impact provinces' ability to innovate. PNP pathways most often favour those candidates who already reside and/or work in the province and who also have requisite skills, rather than seeking to attract the 'best and brightest' that are globally available.

One exception amongst the literature is a sustained concern that PNPs will be used as a backdoor for those who would otherwise not qualify under federal programs due to low human capital scores, undermining the federal government's long-term focus on building a flexible and adaptive workforce through immigration (IRCC, 2017c). The federal government has attempted

to fix the risk of confliction between federal and provincial migration pathways by limiting the number of nominations each province can issue to disincentivize duplication of federal programs at the provincial level (Seidle, 2013: 7). However, this has had an extremely negative impact on provincial capability to meet short-term needs, as the caps interfere with the ability to hire much needed talent from abroad (see above, section 5.1). Ontario is particularly concerned that this cap negatively impacts its ability to attract necessary economic immigrants to the province, as those who come through the federal pathways are increasingly less likely to settle in Ontario despite the province's best efforts to attract them (ON Expert Panel, 2012: 24).

In sum, while the PNP constitutes an important pathway for economic immigrants to come to Canada, many factors hinder its applicability for success in the context of STEM attraction and retention.

5.4 Problems with program requirements persist and negatively affect STEM recruitment, and lack of data prevents the proper evaluation of the current management of STEM talent migration.

5.4.1 Recruitment

Under the 'Temporary Foreign Worker Program' (TFWP), Canadian employers can hire temporary foreign talent using two mechanisms. The first option is to hire a foreigner who falls under various 'International Mobility Programs' (IMP) or free trade agreements (FTA). Migrants who fall under IMP categories can be issued an 'open' work permit, which allow them to work without the employer obtaining an 'Labour Market Impact Assessment' (LMIA) (CIC, 2016b). Unfortunately, the IMP class is much more popular than its TFWP counterpart in attracting talent (in 2015, at least twice the number of individuals arrived under one of these exceptions as did in the second category we discuss below), we do not know which program is most popular amongst STEM professionals. This is largely because we do not know the occupational skills of workers arriving under IMP/FTA schemes, as there currently is no mechanism for collecting such data (Office of the Parliamentary Budget Officer, 2015: 13; CIC, 2016a: 13). No scholarly research has been conducted on the effects of IMPs on the labour market, let alone for STEM-educated individuals. It is also important to note that given the complex and ever-changing environment of free-trade/mobility agreements (as this brief is being written, NAFTA is under review), the IMP may increase or decrease significantly in importance. Should NAFTA be revoked, this may have immense consequences on Canada's ability to attract talent from the U.S., and also potentially impact its ability to retain domestic talent. The significance of revoking NAFTA remains unclear, as statistics on STEM professional mobility through NAFTA are unavailable.

Foreign nationals who do not fall under an IMP or FTA exception must apply for an LMIA-supported work permit. To be granted the permit, the foreigner's employer must obtain approval from the federal government to hire them in the form of an LMIA. LMIAs' require employers to 'test' the labour market by demonstrating that there are no qualified Canadians or permanent residents for the position available; and that the position itself is fair, assessed in terms

of wage and working conditions, which must be equivalent to those enjoyed by Canadians (GoC, 2014b).

Stakeholders have been very vocal in stating that LMIAs are not an effective tool in high technology and other important STEM sectors (e.g. CCC, 2016: 3). So-called 'transition plans', a requirement for obtaining an LMIA, which requires businesses to outline how their temporary needs will be addressed long-term and how migrant workers hired will later be replaced by domestic workers, have also been identified as 'ill-suited' or 'unrealistic' for companies looking to hire highly specialized individuals, such as top global innovators or specialized health professionals, who often cannot be found domestically. *"[In the case of] the high-tech industry, which operates on fixed-term employment contracts and is often in need of securing employees within short deadlines, requirements like the Transition Plan and the LMIA were described as particularly onerous"* (PoC, 2016: chapter 3, section A(1); ITAC and ESAC, 2014: 6).

Meanwhile, the average wage against which LMIAs are assessed is often considered to be unrealistic for hiring new talent, hindering employer's desires to hire those without much experience (CCC, 2016: 20). The wage must at least meet industry 'average' standards, as determined by Economic and Social Development Canada (ESDC). Wage determinations as assessed by ESDC do not take into consideration the different wages professionals may earn, due to their (lack of) seniority in a position. Instead, the average is calculated across all seniority levels, artificially inflating the actual average wage of a new hire. As a result, employers are unable to recruit young, less-experienced talent because it is too expensive, an unfortunate effect given that it is young minds which most often are the most innovative and that Canada, has a rapidly aging workforce.

Finally, due to the discretionary nature of their approval and a lack of firm timeline commitments, *"employers face uncertainty and an inability to plan […] These hurdles, combined with the shared industry experiences of dealing with lengthy audits (one of every four employers), have resulted in employers trying to avoid the LMIA process altogether"* (Vancouver Economic Commission, 2016: 18-19). This ultimately results in less opportunities for innovation because talented individuals are being screened out, leading to talent shortages, and undermining the diversification of Canadian businesses, a proven contributor to increased innovation (The Conference Board of Canada, 2010: 11-13).

To address concerns with program understanding and processing times, in Budget 2017, the federal government launched the 'Global Skills Strategy' class as part of the TFWP. This strategy aims to target *"high-growth Canadian companies that need to access global talent to facilitate and accelerate investments that create jobs and growth"* and *"global companies that are making large investments, relocating to Canada, establishing new [or expanding] production, and creating new Canadian jobs"* (GoC, 2016). The strategy guarantees a two-week turnaround on work and associated permits in an attempt to attract foreign talent more effectively and competitively (IRCC 2017b). While the 'Global Skills Strategy' theoretically solves processing time concerns, as long as two-weeks standards are upheld, there are concerns that this stream is unpopular with employers due to the additional monitoring and employer compliance

requirements such as the 'Labour Market Benefits Plan' (e.g. McMurtry and Chang, 2017). Given the novelty of the program, further assessments have yet to be completed.

Straddling the line between recruit and retention (as it applies to both processes), is the National Occupation Classification (NOC) Matrix. The NOC matrix is *"the national reference on occupations in Canada"* and is managed by Statistics Canada and Economic, Social, and Development Canada (ESDC, 2017). It attempts to identify, define, and group all occupations into similar 'Unit Groups' by cross-referencing each position's "skills". In the immigration context, Immigration, Refugees, and Citizenship Canada cross-references applicants' work experiences and education levels. This process classifies them into the appropriate Unit Group and economic class when determining whether an LMIA should be issued, and whether an individual fits into a particular immigration 'class'. Many stakeholders identify that the NOC framework is outdated and, in its current form, cannot adequately respond to the fast-paced and increasing specialization of work in high-technology industries in a timely nor predictable manner. Many also complain that program officers are inconsistent in rule application across offices, and are unable to fully understand or adapt to quickly evolving job descriptions within STEM sectors, leading to problems when it comes to filing LMIA or permanent residency applications (PoC, 2016a/b; CCC, 2016: 16). Some stakeholders note that they lost foreign candidates due to the difference of interpretation of the NOC by (now) ESDC Canada during the LMIA process, despite lengthy conversations, documentation and explanations (e.g. Vancouver Economic Commission, 2016: 18). Oftentimes, it is difficult to reach ESDC staff to even proffer explanations. Many experienced users state that it is impossible for the NOC system to keep pace with the increasingly stratified roles in innovative sectors, and that NOC codes should not be relied upon to derive meaningful data on which to build policy (Vancouver Economic Commission, 2016: 18).

5.4.2 Retention

Canada places a strong emphasis on attracting international students, in part due to the associated additional revenue their higher tuitions provide to dwindling university budgets. Canada's provinces employ various strategies to retain international students following their graduation within the province. The main instrument Canadian provinces are using are specifically-catered Provincial Nominee Programs (PNPs). While research shows that these programs provide important and effective pathways for STEM migrant talent to find employment and remain in the province, employers still often see international graduates as 'risky hires' due to the complicated immigration policies and lengthy immigration procedures (e.g. Scott et al, 2015). This perception underscores the need for immigration-specific information and training, as well as promotion of diversity in Canadian businesses, especially among small-and-medium sized enterprises (CBIE, 2016: 4).

The literature identified associated problems with skilled professionals applying through Express Entry. For example, 'Express Entry' acts as a barrier for high-skilled individuals with fixed-term employment contracts, because no points are awarded for such contracts in difference

to permanent employment contracts (PoC, 2016: 4). Time-limited, fixed-term contracts are, however, frequent in STEM-centered and innovation-strong sectors, so this impact disproportionately affects STEM professionals. Furthermore, the 'Comprehensive Ranking System' (CRS) points (upon which Express Entry is based) allocated to age greatly undervalue older mid-career executives with substantial senior work experience. This is problematic considering that mid to senior-level executives are able to bring knowledge and skills from their previous employment and other clusters, unlike their younger counterparts that have remained during all their studies within the province and/or have far less experience. One suggestion to overcome this has been to provide additional points for sector-experience at the NOC 0 level (e.g. CCC, 2016: 12; Alboim and Cohl, 2012: 23). What is most concerning however is the lack of data and analysis on recruitment. We do not know what pathways STEM professionals utilize in coming to Canada, let alone which ones are most effective at achieving outcomes. We do not know how prevalent NOC code misunderstandings are, or if they are disproportionately affecting certain areas of STEM. We do not know how, or if Canadian innovation companies are working around rigorous LMIA requirements. This, in particular, requires extensive future research.

5.4.3 STEM recruitment and retention: Learning from Quebec and foreign competitors

Quebec's autonomous immigration regime fares better than its Canadian/provincial counterparts in attracting temporary foreign talent. In Quebec, the net number of 'Temporary Foreign Workers' (TFWs), as well as those in STEM occupations, have shown a continued increase (CIC News, 2017). This may be attributed to the ability of Quebecois employers to sideline the equivalent of LMIA requirements (known as the 'Cértificat d'acceptation du Québec', CAQ), with the explicit approval of the province (Ministère de l'Immigration, de la Diversité et de l'Inclusion, 2016).

Moreover, Québec has recently developed a strategy regarding STEM recruitment and innovation to keep itself innovative and attractive to R&D investment for the next five years ('Stratégie de Recherche et Innovation 2017-2022'). As a result, it is of high strategic value for the province to offer these CAQ exemptions. TFWs with LMIAs have, in consequence, decreased from 3,165 in 2015 to 2,780 in 2016; only 560 LMIAs were recorded in the first quarter of 2017 (CIC News, 2017).

Furthermore, since February 24, 2017, the Quebec immigration ministry (MIDI) has announced a list of occupations, including high skill STEM occupations, which will be subject to simplified processing when hiring TFWs (Immigration Québec, 2017a). These professions include various engineering specializations (civil, mechanical, aerospace, computer science), computer programming, engineering technicians, and web developers and game developers. This programming was justified by the argument that immigrants with pre-existing and province-approved 'validated job offers' could integrate more quickly into the Québec labour market (Immigration Québec, 2017b).

Many of the immigration program requirements and tools currently used by Canada to administer and regulate immigration have a negative impact on stakeholders' ability to attract and retain STEM talent. This impacts stakeholders' ability to innovate, and inhibits their ability to be

globally competitive. Significant changes need to be made to immigration tools, in attempts to allow them to respond to Canada's growing STEM needs. Quebec's model of discretionary easing of bureaucratic requirements in the high-tech sector promises flexibility and recourse for well-meaning employers, while maintaining protection against labour exploitation and fraud. Stakeholders across Canada are keen to identify similar short-term 'quick wins', but continue to demonstrate interest in ongoing investments while striving to achieve a new and better approach to STEM talent labour supply (Vancouver Economic Commission, 2016: 24). In this context, learning from industries, clusters and countries abroad, and those foreign competitors' management of STEM talent migration will improve innovation and growth in Canada.

5.5 There is a need for better understanding of the social, economic, and political factors determining STEM talent migration.

Generally speaking, the economic outcomes of new immigrants have, since the 1980s, continued to worsen despite the fact that they are more educated and have higher human capital scores than their predecessors (Knowles, 2016: 253). More than ten years ago, Statistics Canada's 'Longitudinal Survey of Immigrants to Canada' found that after two years of job hunting, almost 60% of immigrants were not working in their desired occupations (CIC, 2006: 3). This is largely attributed to skill discounting, i.e. the devaluation and lack of recognition of skills and foreign credentials (Municipalities of Ontario, 2008: 16).

While Statistic Canada's study is now extremely outdated, there is nothing in the literature to suggest that outcomes have changed. According to information provided by Ontario's Association of Municipalities, Canada is estimated to lose $5.9 billion dollars annually by under-employing internationally trained workers (Association of Municipalities of Ontario, 2008: 16); and Ontario provides the greatest insight into the loss this causes: in Waterloo, immigrants *"performed below the labour force with respect to employment rates and income levels — despite having education levels [greater] than the employed labour force overall"* (ON Expert Panel, 2012: 7; McFadden and Janzen, 2007: 104).

Meanwhile, the Higher Education Quality Council of Ontario found that one-fifth of Canadian engineering graduates in Ontario may be under-employed, and that internationally-trained engineers with no pre-arranged employment were 14% less likely than their Canadian counterparts to be working in their sector (Higher Education Quality Council of Ontario, 2014: 23; see also Boyd, 2013: 170-183; Blit et al, 2017: 12). This 'brain waste' is not limited to just engineering: it occurs across high-skilled sectors (Reitz, 2013: 157-158; Blit et al, 2017: 3; Picot and Sweetman, 2012).

Both the provinces and federal government are taking steps to change this. For example, British Columbia's 'Skills Connect for Immigrants Program" aims to help skilled immigrants move quickly into jobs that match their qualifications (Skuterud and Su, 2012: 20), while 'Immigrant Pathways to Alternative Careers in Technology', established by the Immigrant Services Society of British Columbia, assists provincial newcomers in matching their skill sets with occupations in the technology sector, and helps employers hire newcomers with in-demand

skills for technical jobs (ISS of BC, 2017). Furthermore, the federal government now also required an 'Educational Credential Assessment' (ECA) as part of its 'Express Entry' requirements, in part to assure Canadian employers that degrees are equivalent. However, no studies have examined whether ECA's have had any real impact on lowering immigrant barriers to the workforce. However, as such, this requirement may do nothing more than further complicate and slow the application process, negatively impacting the mobility of highly-skilled STEM talent. While de-skilling is the most prevalent condition associated with low immigrant economic outcomes, it is not the only obstacle. Language barriers and lack of professional networks also substantially contribute to lower incomes and inflexibility in the workplace, and equally affect high tech employers and STEM professionals alike (Boyd, 2013: 170-183; Blit et al, 2017: 12).

Quebec, in particular, is struggling to balance its desire for high levels of French fluency against the desire to attract and retain innovators and those educated in STEM fields, as its immigration system highly favours French-speaking applicants at all stages (Gouvernement du Québec, 2015). Language fluency also has an impact on STEM professionals' dependants, and may influence professional's decisions to move even if they can find a position. While Quebec is considering taking some steps to facilitate the integration of non-fluent French speakers into the labour market, such efforts do not address dependent needs. This leaves Quebec at a significant disadvantage when it comes to attracting top talent from abroad, similar to the experience of France itself.

For foreign STEM talent, in general, language requirements, access to professional networks, and additional factors such as dependent's comfort levels count strongly into their own decision-making. Though there is a growing awareness of these non-econo-centric factors and how they affect and shape STEM professionals' migration decisions (for example, Dobrowolsky and Ramos, 2014), there is still very limited understanding of how STEM migrant's considerations of wages, employment conditions, the possibility of gaining fast access for themselves and their dependents to work, study, and transition from temporary workers to eventually citizenship. Further 'soft factors' such as the political climate of destination countries, work-life-balance, and style of work should be further explored (see for example Hercog, 2014; Shachar, 2006/2013). More research this field will ultimately provide policy-makers and industry stakeholders with important guidance in enhancing existing immigration programs and recruitment and retention strategies for STEM migrant talent.

6) Knowledge mobilization

Following the release of this report (October 23, 2017), we will engage government, industrial and other relevant audiences (e.g. chambers of commerce, think tanks) through the following *five knowledge mobilization strategies:*

(i) Project website: www.migrationforinnovation.info is this project's dedicated website. Our final Knowledge Synthesis Report is available for free pdf-download from this website.

Through our website, our Twitter account (@migrateinnovate) and existing contacts to relevant stakeholders we will also inform about our four knowledge mobilization events (iv).

(ii) Knowledge synthesis report as 'evergreen' document: this report will be consistently updated by our research team. We will incorporate new knowledge and findings to meet the needs of policy-makers, industrial stakeholders and other non-academic as well as academic audiences.

(iii) Supplementary provincial, federal and foreign profiles. Our knowledge synthesis report will be supplemented by four additional profiles summarizing findings concerning the federal level and three of Canada's leading provinces in innovation and STEM migration (British Columbia, Ontario and Quebec) in greater detail. Furthermore, to provide insights into global approaches and crucial information about the strategies, successes, and shortcomings of Canada's foreign competitors in STEM recruitment, a selected number of foreign country profiles will also be made available online.

(iv) Knowledge mobilization events (stakeholder workshops): Our team will implement four workshops in four leading innovation clusters and main STEM migration destinations in Canada: Greater Toronto Area, Montreal, Ottawa and Vancouver. The first workshops are planned for late fall 2017 and will be held in Vancouver and Kitchener-Waterloo, while at the beginning of 2018 two workshops will be organized in Montreal and Ottawa. We will invite to each of these workshops approximately 20 representatives from industry and top tier innovation companies, different relevant government institutions (municipal, provincial and federal) and leading think tanks and other relevant institutions (e.g. chambers of commerce). We will present the findings of our knowledge synthesis report and our additional insights derived by compiling research for our supplementary provincial, federal and foreign profiles. Feedback and insights from stakeholders will inform our report which will be updated following our four workshops ('evergreen' document).

(v) Scholarly outcomes: In addition to our synthesis report and accompanying provincial, federal and foreign profiles the members of our team have already been invited to publish findings in scholarly outlets, including a new peer-reviewed international handbook on talent migration (ed. by Yipeng Liu, Newcastle Business School). The principal investigator and his team members will in addition give regularly talks about this project and its findings at scholarly workshops at and beyond Carleton.

7) Conclusions

Our knowledge synthesis project was guided by the main question *'how will Canada and Canadian technology clusters continue to thrive and remain competitive in managing STEM migration for innovation and growth?'*

What we found is that Canada and clusters in Canada are currently facing significant hurdles in the competition for STEM migrant talent. Canadian governments and industries also seem

extremely unprepared and uninformed to be able to successfully compete for STEM talent. There is insufficient data and academic insight into how federal, provincial and municipal authorities facilitate the attraction and retention of STEM talent in the highly-skilled economy. There is also insufficient study of how business innovation across Canada, specifically among highly-innovative clusters, are being affected by barriers to attracting and retaining STEM talent. To rise to this challenge and ensure that Canada's immigration program benefits rather than hinders Canadian industries to innovate, Canadian policy-makers must take a critical look at how current tools and programs are failing STEM professionals. In particular, we suggest the following:

- ➢ Canada is well advised to expand and facilitate STEM migration opportunities in support of continued innovation and long-term growth. Moreover, it urgently needs to develop a longer-term strategy for building greater responsiveness and adaptivity in its migration management system. The current profound changes in economic, social and (geo)political order (e.g. uncertain future of NAFTA) are a vivid proof that Canada needs to become better prepared to withstand 'shocks' and expand its existing knowledge and experience in managed migration and turn it in an effective, better balanced and successful leadership.
- ➢ Canada must re-evaluate the roles, objectives, and processes of its immigration programs at the federal and provincial levels to ensure they do not conflict with one another, and to ensure that they both attract and retain skilled STEM labour. Canada has to more actively engage in the global competition for talent and become a global innovator and leader in targeted migration for innovation and growth. To this aim, industries and governments in Canada need to gain interest in the management of STEM migrant talent in other countries and clusters.
- ➢ Canada must reassess the utility and efficacy of NOC codes and LMIAs, which are often criticized as being an unduly restrictive and inflexible method of assessing the potential of highly skilled STEM workers in an ever-innovative labour market. Existing tools need to be retooled and enhanced to better serve the interests and requirements of federal government aspirations, industries and STEM migrants alike. They must be developed to facilitate rather than hinder Canadian business' access to the world's 'best and brightest' STEM talent.
- ➢ Canada must do more to ensure equity and equal economic outcomes between foreign and domestic-born STEM professionals. Long-term diminishing returns to highly skilled workers in STEM fields will cultivate a socio-economically and politically negative reputation for Canada and Canadian industries; AND
- ➢ Canada must also make a better concerted effort to collect and analyze the information necessary to truly enact evidence-based policy-making within the context of migration management in support of innovation.

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