Immigrant STEM Workers in the Canadian Economy: Skill Utilization and Earnings

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March 2018

Abstract

This study examines trends in the education-occupation match and earnings outcomes of STEM (Science, Technology, Engineering, and Math) educated immigrants, and compares them with the outcomes of their Canadian-born counterparts. Over the 1985 to 2010 period, both education-occupation match and earnings outcomes deteriorated among immigrant STEM graduates, while remaining more or less constant among Canadian-born STEM graduates. The decline in education-occupation match was concentrated among recent immigrants entering during the 2000s. Both immigrant STEM graduates and non-STEM graduates experienced similar declines in relative earnings. Finally, the earnings gap between immigrant and Canadian-born STEM graduates did not close quickly with years in Canada.

Keywords: Immigration, STEM fields of study, STEM occupations, earnings

1. Introduction

Immigrants contribute disproportionately to the supply of university graduates educated in the fields of Science, Technology, Engineering, and Math (STEM) in Canada. In 2011, about one-half of all STEM educated university graduates aged 25 to 54 in Canada were immigrants. The large over-representation of immigrants among STEM graduates was primarily the result of the increasing selection of well-educated immigrants and the high concentration of university-educated immigrants in the STEM fields of study over the 1990s and 2000s.

The importance of STEM educated workers to the Canadian economy was aptly stated by the Council of Canadian Academics (CCA) (2015) in an overview report. “STEM skills have been advanced as central to innovation and productivity growth, which are in turn necessary for improving standards of living. … (P)roductivity growth is also about working smarter. The fundamental skills required for STEM literacy, such as problem solving, technological proficiency, and numeracy, represent essential components of working smarter.” (p.vi)

The CCA report also noted the uncertainty and lack of Canadian research on how STEM skills uniquely contribute to innovation and productivity. They note that ”while the theoretical reasons for a link between STEM skills and innovation are clear, there is currently limited evidence on the specific contribution of advanced STEM skills to productivity growth, or the magnitude of these effects”. Just as elusive is knowledge of the contribution of immigrant STEM workers to productivity and innovation. Two recent American studies suggest that highly educated immigrants in the STEM fields do contribute disproportionately to the filing of patents, and hence likely contribute disproportionately to innovation, particularly in technical industries (Hunt and Gauthier-Loiselle 2010; Kerr and Lincoln 2010). However, a study that replicated Kerr and Lincoln found very different results for Canada. They showed that immigrants STEM workers did not contribute disproportionately to the filing of patents, and if anything Canadian born STEM workers had the patenting advantage (Skuterud and Zhang 2016)

Although there are reasons to believe that STEM workers contribute disproportionately to productivity growth, there is very little direct evidence of such a link. Results from the only major Canadian study on the effects of STEM on productivity suggest that foreign STEM workers generate significant spillover benefits for Canadian-born workers and increase the wages of non-STEM university educated workers (Peri & Shih, 2013). In the absence of other evidence, economists often turn to earnings gaps as a proxy for productivity differentials. As was noted in the CAA (2016) report, “one of the ways of capturing the role of human capital is to look at

wages. Several factors affect wages, including productivity. Thus, studies often use wages (and wage premiums) as an indicator of labour productivity".

This paper focuses on the labour market outcomes of immigrant and Canadian-born university graduates trained in STEM fields. Given that about one half of the university educated STEM labour supply in Canada consist of immigrants, and given the ongoing discussion regarding the appropriate level of immigration of STEM workers, knowledge of their economic outcomes is by itself pertinent and important. Our main objective is to inform researchers and policy analysts of the economic success, or lack of it, of immigrants educated in STEM fields. Five separate measures are employed to determine both the utilization of stem educated immigrants in the Canadian labour market, and the earnings performance over the 1986 to 2011 period. Together, this evidence paints a picture of the performance of STEM educated immigrants in the Canadian economy.

These measures of labour market outcomes can also provide some *indirect* evidence of STEM educated immigrants' ability to *potentially* affect innovation and productivity in STEM occupations. Focusing on the change in the utilization of STEM educated immigrants allows us to determine if they are in the types of jobs where they have the *opportunity* to influence innovation in the STEM areas. Regarding productivity, as noted above, in the absence of direct evidence, earnings premiums and gaps can be thought of as rough proxies for relative productivity. For all these reasons, we focus on the labour market outcomes of immigrants educated in STEM fields.

2. Previous Studies

While there are numerous studies focusing on the labour market outcomes of STEM workers in general (see Council of Canadian Academics, 2015 for a recent review), there have been few studies focusing on the outcomes of *immigrant* STEM workers.

One early Canadian study (Boyd and Thomas 2001) found that compared to their Canadian-born counterparts, immigrants trained in engineering were less likely to be in the labor force or employed. When employed, they were less likely to be employed in engineering related occupations. Four recent studies are particularly relevant to the topics addressed here. Using census data, Blit, Skuterud and Zhang (2016) found that the probability of a STEM graduate being employed in a STEM occupation increased over the 1986 to 2006 period for the Canadian-born, but fell for immigrants. Even immigrant STEM graduates who received their

education in Canada had a lower probability of being employed in a STEM occupation than their Canadian-born counterparts. They suggest that the declining share of immigrant STEM graduates working in STEM occupations would limit their ability to contribute to innovation in Canada.

A major report by the Council of Canadian Academics on STEM skills and economic prosperity (2015) came to a number of relevant conclusions. It found that there was no general supply/demand imbalance regarding STEM skills in the Canadian labour market. It also suggested that Canada's productivity problem is not simply a shortage of STEM workers. Like Blit et al (2016), the CCA report found that the majority of STEM educated workers work in non-STEM fields. This held for both immigrants and the Canadian-born. But this was not seen as an issue. The STEM skills are relevant and useful in many types of jobs, and can open doors for the STEM educated workers. The report also noted that immigrant university graduates were much more likely to be educated in a STEM field than Canadian-born graduates, but immigrant STEM graduates had higher unemployment and lower employment rates than their Canadian born counterparts.

Boyd and Tian (2016) used data from the 2011 National Household Survey to examine the skill-occupation match and earnings of STEM educated immigrants. They included immigrants aged 30 to 64 and excluded those who entered Canada under the age of 25. Similar to other studies, they showed that STEM educated immigrants were less likely to work in a STEM occupation than the Canadian born. This difference was associated with the language ability of immigrants and the fact that they were more likely to have received their degrees from outside of Canada. They further found that STEM educated immigrants working in STEM fields earned 14% less (unadjusted) than the Canadian born. The gap reduced to 13% after controlling for differences in age, gender, marital status, place of residence and visible minority status. Further analysis showed that the remaining gap was mostly accounted for by differences in the location of education and language ability.

A U.S study by Hanson and Slaughter (2015) pooled data from the 1990 and 2000 US censuses, and the 2010-to-2012 American Community Survey, and focused on individuals aged 25 to 54 working full-time full-year. They found that in the cross-section, STEM workers earned roughly 19% more that individuals working in non-STEM jobs, controlling for education and age. They also found that while there was a significant earnings gap between immigrants and the American born working in non-STEM occupations (around 10%), there was virtually no average earnings difference between American-born and immigrant workers in STEM fields. This is

different from what was reported for Canada above. Looking at earnings assimilation, Hanson and Slaughter showed that after entering the U.S., STEM-educated immigrant workers in STEM jobs experienced only a very small entry earnings gap with their American born counterparts of around 6%, and this gap disappeared after about six years, after which they earned more than the American born. Immigrants in non-STEM jobs experienced a much larger entry earnings gap with the American born in similar jobs, at around -.25 log points, and only after 20 years did this gap disappear.

The education-job match is used as one measure of labour market utilization in this paper. No previous research on this issue referring specifically to immigrant STEM workers was found. Chiswick and Miller (2011) focused on high skilled workers in general in the U.S., and found that high skilled US immigrants tended to be significantly overeducated relative to the jobs they held. The extent of the over education declined with years spent in the US. Other research has been conducted for immigrants as a whole. Both for the US (Chiswick and Miller 2009) and Canada (Galarneau and Morissette 2008) it was found that over-education is more common among immigrant than non-immigrant workers.

This paper differs from previous studies in a number of ways. First, the topic is placed within a historical context by examining the trend over a quarter century. Second, outcomes for immigrant graduates are produced both for those educated in *STEM fields of study*, and subsequently for those working in *STEM occupations*. Third, to determine utilization in the labour market, measures of both the type of job found (STEM and non-STEM) and the educational requirements in the job are employed. Finally, both cross-sectional and longitudinal earnings patterns among immigrant STEM graduates are used to assess their economic success in the Canadian economy.

3. Data, Measures and Methods

3.1 Data

This study uses the 20% sample micro data files from the 1986, 1991, 1996, 2001 and 2006 censuses of Canada, and the 2011 National Household Survey (NHS).[1] The study population contains individuals who were age 25 to 54 and with at least a bachelor's degree. In the

[1] The 1981 and earlier censuses did not collect information on field of study.

analysis on earnings, the sample includes only those who had positive annual employment income, and excludes immigrants who arrived in the year of the census and the year before the census because they did not have any or a full-year earnings in the year before the census for which the earnings data were collected. For the most part of the analysis, we further restrict the immigrant sample to those whose age at immigration was at least 23 (so they would reach age 25 in the census year). This age range is most relevant to policy considerations regarding the selection of STEM immigrants. Immigrants who arrived at a younger age are often the dependents of working age immigrants or international students, and are likely to receive at least some of their education in Canada and have earnings profiles similar to the Canadian born (Schaafsma and Sweetman 2001). Most adult immigrants received their education outside of Canada. It is the outcomes of these immigrants that are of interest in this paper. In some cases, we also conduct analyses that include immigrants entering under age 23, in order to provide a benchmark.

3.2 Measures

The STEM fields of study are drawn from Statistics Canada's groupings based on the 2011 Classification of Instructional Programs (CIP) for the 2011 NHS (see online Appendix 1). These groupings can be directly matched to the 2006 CIP in the 2006 census. The 2006 Census also contains the Major Filed of Study (MFS) codes that were used in the censuses from 1986 to 2001. In order to map the STEM fields identified in the CIP to the MFS, we classify a MFS field as STEM if at least one-half of the individuals would be classified as in a STEM field based on the CIP classification. At the individual level, 98% of university graduates in the CIP STEM fields would also be identified in STEM fields based on the mapped MFS in the 2006 census. The mapped MFS from the 2006 census are applied to the 1986 to 2001 census.

The identification of STEM occupations was based on the classification used by Boyd and Tian (2016) who in turn followed the classification used in the U.S. Bureau of the Census and other US studies (Landivar 2013a, 2013b; Langdon et al. 2011; Lowell 2010). The STEM occupations for the 2011 National Occupational Classification (NOC) codes that are specified by Boyd and Tian (2016) are listed in online Appendix 2. These STEM occupations can be straightforwardly matched to the NOC codes used in the 2001 to 2006 Census and the Standard Occupational Classification (SOC) codes used in the 1991 and 1996 Census. For the 1986 census which used the 1980 SOC, the same or similar occupation titles as in the 1991 SOC STEM occupations were identified as STEM occupations.

Part of the analysis involves the classification of educational requirement for each occupation. The NOC codes used in 2001, 2006 and 2011 contain information on the skill requirements associated with each occupation. These codes reflect the education or training required to do the job. In this paper the skill requirements are aggregated to three levels; high (an occupation requiring a university degree), medium (requiring 2 or 3 years of college or technical school, or secondary school plus at least 2 years specialized on-the-job training), and low (1 to 4 years secondary school and less than 2 years on-the-job training). For the 1991 and 1996 censuses, the SOC can be easily converted to NOC codes, and the appropriate educational requirement applied.[2] The 1980 SOC used in the 1986 census cannot be directly matched to the 1991 SOC. However, in the 1991 census, occupations were coded both in the 1981 SOC and the 1991 SOC. To derive educational requirement for the 1980 SOC, we computed the mean shares of high-, medium, and low-skills based on the 1991 SOC codes for each 1981 SOC code. We experimented with various combinations and adopt the criteria that produced the best matches, and applied the derived skill levels to the 1986 census.[3]

3.3 Multivariate Models of Earnings Differences

In multivariate models comparing group differences in annual earnings, several variables are included to control for group differences in socio-demographic composition: age, age squared, education, geographic regions, weeks worked, full-time/part-time status, language, visible minority status. Since only workers with a university degree are included in the study, the education variable distinguishes bachelor's and graduate degrees. Geographic regions are based on province except that Atlantic provinces are combined as one region. Language is coded as 6 categories based on the combination of mother tongue and self-reported official language: mother tongue is English, mother tongue is French, mother is non-English/French but speak English, mother is non- English/French but speak French, mother is non-English/French

[2] See the paper by Frank and Hou (2017) for a general description of the skill requirements codes, and a discussion of how to assign skill level requirements to management occupations.

[3] Among individuals who were identified as in high skill occupations in the 1991 SOC, 81.1% would be identified as so with the derived 1980 SOC codes; 76.8% of medium skill in the 1991 SOC would be classified so in the 1980 SOC, and 77.2% low-skilled in the SOC would be so in the 1980 SOC. At the aggregate level, the 1991 SOC classified 33.3% occupations as high skill, 39.1% as medium, and 27.6% as low skill. The corresponding shares based on the derived 1980 SOC are 33.9%, 39.7% and 26.4%. The detail codes are available from the authors.

but speak both English and French, mother tongue is non-English/French and do not speak English or French. Visible minority status is coded as visible minorities vs. non visible minorities.

We first model the immigrant-Canadian born differences in cross-sectional annual earnings for all STEM graduates aged 25-54 (see online Appendix 3 for 2010 for example). Two models are run. Model 1 includes an immigrant dummy variable, a "STEM Field" dummy, a term interacting the immigrant and STEM field dummies, and control variables including age and age squared, gender, geographic location, education level, weeks worked and full-time/part-time status as defined above. Model two adds the language variable and visible minority status.

Next, the immigrant-Canadian born earnings differences among STEM graduates working in STEM occupations are modelled. The same two models described in the paragraph above are used, except the "STEM FIELD" dummy variable is replaced by a "STEM OCCUPATION" variable, and the sample is restricted to Canadian-born and immigrant STEM graduates (see online Appendix 4 for 2010 for example).

Using synthetic cohort data for six entering immigrant cohorts between 1986 and 2011, the change with years in Canada in the immigrant-Canadian born earnings gap for each cohort is modelled. Data from the 1986 to 2011 censuses are used to generate the quasi longitudinal earnings trajectories. For example, to track the earnings of the cohort of immigrants entering between 1990 and 1994, we follow immigrants who entered Canada between 1990 and 1994[4] in the 1996, 2001, and 2006 censuses. In that way we track the average earnings of various cohorts for up to their first 15 years in Canada.

Two models are employed in the synthetic cohort analysis. The independent variables for both models include variables for the six arrival cohorts between 1980 and 2009 (Specifically the 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, and 2005-2009 arrival cohorts), years since immigration and its squared term to allow for a non-linear earnings trajectory. Cohorts are interacted with years since immigration and its squared term to allow each cohort a unique earnings trajectory. Model 1 also includes controls for age and age squared, gender, education, region of residence, weeks worked, and full-time/part-time status. Model 2 incorporates all of the independent variables in model 1, and adds controls for language and visible minority status.

[4] As explained the data section, immigrants who arrived in the census year and the year prior to the census were excluded from the analysis.

4. Results

4.1 STEM Educated Immigrants

In 2011, immigrants represented about 20.6% of the Canadian population. However, they accounted for one-half of all university graduates trained in the STEM fields (Table 1). This share of immigrants in Canada's university-educated STEM labour supply increased from about one-third (35%) in 1986 and 1991. This change was due to the rising share of the Canadian population who were immigrants, the rising share of immigrants who were university educated, and the rising share of the immigrant university graduates trained in STEM fields.

The proportion of the university graduates who studied in a STEM field was higher among immigrants than the Canadian-born, and rose among immigrants (up to 2006) while remaining stable among the Canadian-born. Among immigrant graduates, the proportion in STEM fields rose from 31% in 1986 and 1991 to 37% in 2011. Among the Canadian born, the share of the university graduates in STEM fields was constant at around 19%. By 2011, immigrant graduates were close to twice as likely as the Canadian born to have studied in a STEM field.

4.2 The Utilization in STEM Occupations and the Educational Requirements of the Job

Over one half of STEM educated workers do not work in STEM occupations. This is true for both immigrants and the Canadian-born. STEM graduates, including engineers, have always tended to work in non-STEM fields, because of either potentially higher earnings in other occupations or a lack of job opening in a directly related field. In the US it is estimated that there are three times as many graduates in science and engineering fields each year as there are openings in related occupations (CCA 2015). A similar situation likely exists in Canada. But this is not necessarily a poor outcome. The CCA report stressed that the skills acquired in a STEM education are transferable and useful in a host of occupations, and this may be of benefit, both individually and to society as a whole.

Among the Canadian born, the share of STEM graduates in STEM occupations (the utilization rate) remained quite constant, at between 46% and 47% between 1991 and 2011 (Table 2). Among STEM educated immigrants, the utilization rates were lower during the 2000's – at around 41.3%[5] – than previous periods, which displayed an average 43.5% utilization.

[5] Estimates by Blit, Skuterud and Zhang (2016) and the CCA report (2015) placed the share at between 35% and 39%. These discrepancies are likely due to differences in the definition of STEM occupations, and in the population analyzed.

Furthermore, during the 2000's they were lower than that observed among the Canadian born counterparts ; 5.3 percentage points lower in 2006 and 4.3 percentage points in 2011.

Most of the decline during the 2000's in the utilization rate (the share working in STEM jobs) of immigrant STEM graduates occurred among recent immigrants – those who arrive in Canada in the five years prior to the census year. For example, between 2001 and 2011, the utilization rate among recent immigrants fell 11.8 percentage points. Only about one third of recent STEM educated immigrants were working in STEM jobs in 2006 and 2011. This is much lower than the utilization rate observed among recent immigrants in the period between 1986 and 2001, with the exception of the recession period of the early 1990s (Table 2). A similar decline is not observed among immigrants in Canada for six or more years.

Equally telling is the change during the 1990s and 2000s in the educational requirements of the jobs held by STEM university-educated immigrants and the Canadian born (Table 3). Generally speaking, the educational requirement of the jobs held by STEM graduates has been constant among the Canadian-born over the past quarter century, while falling among immigrants. Specifically, among the employed STEM graduates, the share in a job requiring a university degree was quite stable over the 1986 to 2011 period among the Canadian born in the 61% to 65% range. In contrast, this share was both lower and falling among immigrants, from 53.0% in 1986 to 41% in 2011. By 2011, Canadian-born STEM graduates were as 1.5 times as likely to hold a job requiring a university degree as their immigrant counterparts.

This general trend was observed both among STEM graduates who worked in STEM and non-STEM occupations. Among the latter, the share working in jobs requiring a university degree was quite constant among the Canadian-born, at around 41% to 44%. However, it was both lower and falling among immigrants, falling from 33% in 1991 to 22% in 2011 (Table 3). By 2011 the Canadian-born STEM graduates, when working in non-STEM jobs, were twice as likely as immigrants to be in a job requiring a university degree. Many STEM educated Canadian born who either cannot find or choose not to find a STEM job end up in good jobs. The same cannot be said for their immigrant counterparts, for whom it is find a STEM job or end up in a poor quality job.

Among STEM graduates working in STEM occupations, there was a similar trend but not as dramatic. Not all STEM occupations require a university degree, notably engineering, architectural and other technologies. The share of Canadian-born STEM graduates in STEM jobs that do not require university education was between 9% and 12% over the period. Among immigrants, it was between 12% and 19%, reaching its highest in 2011.

The educational requirements of the STEM jobs held by recent immigrants also fell during the 2000s, from 88% in 2001 (reflecting the high-tech boom) to 78% by 2011. Among recent immigrant STEM graduates working in non-STEM jobs, the job quality has always been low. Only 20% of these non-STEM jobs required a university degree, a number more or less constant since 1991. This compared with 42% among the Canadian-born STEM graduates in non-STEM jobs.

Taken together, these results indicate that the utilization of STEM educated immigrants in both STEM jobs and jobs requiring a university degree was lower during the 2000's than that observed among Canadian-born STEM educated, and declined considerably over the last quarter-century. This suggests that the ability of STEM educated immigrants, as a group, to utilize their STEM specific skills is both low relative to the Canadian born, and declining. It likely also suggests that their opportunity to affect innovation in the STEM area is not what it once was, and is perhaps below that of the Canadian born. This is consistent with the findings in Blit et al (2016).

4.3 The Change in Cross-sectional Earnings Differences, 1985 to 2010

Although their utilization in the Canadian labour market was different during the 2000's than earlier periods, and different from that of the Canadian born, it is not clear what effect this had on the earnings of immigrants educated in STEM fields. For example, it may be that those who manage to find a STEM job are doing as well as ever, and the problem rests with those unable to locate STEM related employment. It may also be that STEM educated immigrants do very poorly during the first few years in Canada, but manage to "catch up" to the Canadian born counterparts after a period of time. To address these issues we examine both cross-sectional earnings differences and the earnings trajectories of entering cohorts of immigrants.

4.3.1 Earnings Differences for Immigrants in STEM Fields of Study

We start with the earnings premium enjoyed by STEM educated university graduates. Two multivariate models are run. The dependent variable in both models is the log of annual earnings. The results from model one indicate the difference in earnings after controlling for the basic human capital and working time variables (see the Data, Measures and Methods section for details). Model two indicates how much of the earnings gap observed in model one is associated with the language and visible minority status of immigrants. The visible minority variable may be a proxy for other variables, such as the country where the immigrant received

their education, and the quality of the labour market experience of STEM graduates before entering Canada.

After controlling for basic demographic and working time variables (Table 4, model 1), STEM graduates as a whole enjoy a small earnings advantage relative to those educated in non-STEM fields, and this advantage changed little over time. In 1985, Canadian-born STEM educated graduates earned.046 log points (4.7%) more than their non-STEM educated colleagues. In 2010, this advantage was 0.041 log point (Table 4). STEM education was associated a slightly higher earnings advantage among immigrants (.076 log points in 2010) than among the Canadian born. These results are purely descriptive and say nothing about the origins of the earnings differential between STEM and non-STEM educated workers. They may reflect higher ability individuals being selected into STEM fields, or possibly compensating differentials for the higher personal and financial cost of being trained in a STEM field, or possibly even rents earned by companies that hire STEM educated workers, and then sharing those rents with the employees.

Relative to STEM educated Canadian-born workers, STEM educated immigrants earned -.206 log points (or 19%) less than their Canadian born colleagues, by 2005 the difference was -.494 log points, and by 2010 -.413 log points (Table 4, second panel, model one). Much of this earnings gap was associated with the difference between immigrants and the Canadian born in language skills and visible minority status. After adding controls for these variables, the 2010 earnings disadvantage, for example, falls from -.413 log points to -.227. However, the increase over time in the earnings disadvantage is observed in both sets of results.

Immigrants educated in non-STEM fields experienced a similar decline in their earnings relative to the Canadian-born in non-STEM fields (Table 4, bottom panel). Model 2 results showed that the earnings gap expanded from -.148 log points in 1985 to -.266 in 2010. These gaps were very similar to those observed for STEM educated immigrants. It seems that the decline in immigrant earnings (relative to the Canadian born) hit both STEM and non-STEM educated immigrants in roughly the same way. Being educated in a STEM field did not protect immigrants from this relative decline over time.

4.3.2 Earnings Differences for Immigrants in STEM Occupations

To determine whether the earnings disadvantage of immigrant STEM graduates depends on whether they work in STEM occupations, this section conducts an analysis separately for those in STEM and non-STEM occupations. Again, two models similar to those described above are

employed. Controlling for differences in basic demographics and working time (Table 5, top panel, model 1), immigrant STEM graduates working in a STEM occupation earned less than their Canadian-born counterparts over the entire study period. The magnitude of this earnings gap doubled from -.157 log points (roughly 15% less) in 1985 to -.303 log points (26%) in 2010. After controlling for language and visible minority status in model 2, much of this difference disappears. Here, the earnings gap of immigrant STEM graduates working in STEM fields were around 4% lower in 1985, increasing to around 9% lower in the 2000s (Table 5).

An even larger earnings disadvantage is observed among immigrant STEM graduates who do work in a STEM occupation, compared to similar Canadian-born. Controlling for demographics and working time (Table 5, second panel, model 1), immigrants in non-STEM occupations saw their earnings gaps with their Canadian-born counterparts increased from -.236 log points in 1985 to -.482 in 2010. Even after differences in language and visible minority status are accounted for, the gap still increased from -.116 log points to -.277.

The earnings results to this point excluded immigrants who entered Canada under the age of 23 for reasons mentioned in the Data section. Additional analysis finds that including immigrants entering Canada under age 23 does produce better relative outcomes for immigrants, but the general trends observed above still hold[6].

4.4 The Earnings Trajectories of STEM Educated Workers

STEM immigrants may experience a smaller earnings gap relative to the Canadian born upon entry to Canada, but a steeper earnings trajectory over time in Canada, than non-STEM immigrants. This pattern was observed in the U.S. It may be related to greater labour demand for STEM workers, and superior earnings assimilation because of fewer issues with language, credential recognition, and discrimination. This section asks whether such a pattern is observed in Canada, and also asks whether earnings assimilation improved among successive cohorts of STEM immigrants over the past quarter century, again possibly reflecting a general increase in the demand for STEM immigrants.

In this section, the analysis is designed to show, for each of six arrival cohorts of immigrants between 1986 and 2011, the change in the immigrant–Canadian born earnings gap

[6] For example, in model 1 the earnings gap of immigrant STEM graduates relative to the Canadian born increased from -.143 log points in 1985 to -.332 log points in 2010. This compared with -.206 to -.414 when immigrants entering under the age of 23 are excluded. Among immigrant STEM graduates who work in STEM jobs, the earnings gap with the Canadian-born increased from -.10 log points in 1985 to -.24 in 2010, compared to -.158 to -.392 when those entering under age 23 are excluded. Including younger immigrants at entry alters the levels, but the trends remain very similar.

as immigrants acquire Canadian experience. That is, how did the earnings trajectory develop over time for each immigrant cohort? Two regression models are used to estimate the earnings gaps. The dependent variable is the log of annual earnings. Model one controls for basic demographic and working time, and estimates the basic adjusted earnings gap. Model two adds language and visible minority status, and indicates what share of the earnings gap observed in model one is associated with language and visible minority status.

The results in Table 6 show that STEM educated immigrant workers have entry earnings (one year after entry) that are far below the earnings of their Canadian born STEM educated counterparts, and these entry earnings gaps show no sign of improving among more recent cohorts. The entry earnings gap also varied with economic conditions, as the gap was particularly large among the cohorts entering during the early 1990s recession and high tech downturn of the early 2000s. But even for the most recent cohort studied (2005-to-2009 entry cohort) the gap was -.451 log points, well above that for the 1980s and late 1990s cohorts.

The rate of catch-up to the Canadian born was slow (Table 6). Even after ten years in Canada the immigrant-Canadian born earnings gap remained at around -.33 log points (roughly 28%) for the late 1980s and 1990s cohorts, and after 15 years between -.261 and -.295 log points.

Much of this earnings gap could be due to differences between immigrants and the Canadian born in language and visible minority status. But even after adjusting the results for these differences the entry earnings gap remains large, and catch-up rate very slow. In model 2 (Table 6), the entry earnings gap remains between -.182 and -.549 log points across the six entry cohorts; and most importantly, the gap for the most recent cohort (2005-to-2009), at -.242 log points, was well above that of the late 1980s and late 1990s cohorts, although it was smaller than that observed during the poor economic conditions for immigrant STEM graduates in the early 1990s and early 2000s.

And catch-up remained somewhat elusive in the model 2 results. After 10 years in Canada, the gap was around -0.126 to -0.153 log points (or 12% to 14% lower than among comparable Canadian-born STEM educated) for the cohorts since the late 1980s, and after 15 years between -.062 and -.105 log points.

The above analysis referred to all immigrant STEM graduates aged 25 to 54. Immigrant STEM graduates who found STEM jobs did experience better outcomes. Controlling for demographics and working time (Table 7, model 1), the entry earning gap was -.197 log points

for the most recent 2005-to-2009 cohort, compared to -.561 for those in non-STEM jobs. Model 2 results suggest that most of this -.197 log points entry earning gap was associated with language and visible minority status, as the gap falls to -.074 once these controls are added. As expected, outcomes were particularly poor for cohorts entering during the recession of the early 1990s and the high-tech downturn of the early 2000s, even among those holding STEM jobs. The entry earnings gaps (model 1) were -.460 and -.598 log points respectively for these two periods (Table 7).

Aside from these two difficult economic periods, there is little sign of any trend in the entry earnings gap for STEM educated immigrants working in STEM occupations. It was roughly the same for the latest cohort (2005-to-2009) as for the earliest cohort (1980-to-1984).

Catch-up to their Canadian-born counterparts was at best partial for immigrant STEM graduates working in STEM jobs (Table 7). After 10 years in Canada the earnings among the 1995-to-1999 entering cohort remained about 20% below that of their Canadian-born counterparts, controlling for basic demographics and working time (model 1). This was similar to the pattern observed for earlier entering cohorts and no trend over time is evident. Again, about one-half of this gap relates to language and visible minority status, as the gap fell to about -11% after 10 years once these controls are added (model 2).

Among immigrant STEM graduates working in non-STEM fields, there is an evident trend. More recent cohorts were less able to close the earnings gap with the Canadian born relative to earlier cohorts. There was an increase in the earnings gap after any given number of years in Canada from the 1980-to-1984 cohort to the most recent cohort (Table 7). For example, after 10 years in Canada the earnings gap was -.283 log points for the 1980-to-1984 cohort increasing to -.514 points for the 1995-to-1999 cohort (model 1 for those not working in STEM occupations).

These results suggest that the earnings gap is much more severe among STEM educated immigrants unable to find STEM jobs. Nonetheless, those findings STEM jobs experienced significant entry earnings gap and relatively slow catch-up (model 1 results). Language issues and visible minority status played a significant role in these outcomes. But from an immigrant selection perspective, the focus must be on the outcomes for all STEM educated immigrants, not just those that find STEM jobs.

5. Conclusion

In general, outcomes among the university STEM educated immigrants deteriorated over the 1986 to 2011 period, while remaining more or less constant among their Canadian-born counterparts. And the deterioration observed among immigrant STEM graduates was similar to that among immigrant graduates in non-STEM fields of study. Being educated in a STEM field did not protect immigrants from the relative (to the Canadian-born) decline in economic outcomes since the early 1980s.

This paper examines the differences in both skill utilization and earnings between immigrant and the Canadian-born university graduates educated in STEM fields. The utilization of STEM educated immigrants in STEM jobs (i.e., the share of STEM educated immigrants working in STEM occupations) was the same as that observed among the Canadian born in 1986 and 1991, but by 2011 it was 4 percentage points lower. This utilization rate remained constant over time among the Canadian born, but declined among the immigrant STEM graduates. The decline was concentrated almost entirely among recent immigrants (in Canada for 5 years or less) over the 2000s. Their utilization in STEM jobs was at a historical low. The educational requirements in jobs held by the STEM educated immigrants reflect this pattern. For example, by 2011, 64% of Canadian born STEM graduates were in jobs requiring a university degree, compared to 47% among their immigrant counterparts, down from 57% in 1991. In particular, STEM educated immigrants who did not find a STEM job found themselves in very poor quality jobs as measured by educational requirements. For them, it seemed that it was find a STEM job, or end up with a very poor job. The same is not necessarily true for the Canadian born who did not find a STEM job. Earnings patterns told the same story. The Council of Canadian Academics (2015) argued that the skills acquired through STEM education would stand the graduates in good stead in the labour market, even if they were not working in a STEM occupation. That may be true for the Canadian born, but it does not seem to be true for most immigrants in this situation.

The cross-sectional negative earnings gap between the immigrant and Canadian born STEM graduates roughly doubled between 1985 and 2010. About half of this earnings gap was related to differences in language ability and visible minority status, which may be reflecting other differences such as country of education and labour market experience (Li and Sweetman 2014; Warman, Sweetman and Goldmann 2015). Finally, the entry earnings gap between STEM educated immigrants and their Canadian-born counterparts was large by historical standards for the cohort entering Canada in the late 2000s, and in general the earning gap did not close quickly with years in Canada.

The above results referred to all immigrants educated in STEM fields, including those who worked in a STEM occupation, and the more than one half who did not. The trends in outcomes among those who found STEM jobs were somewhat different. Although the adjusted cross-sectional earnings differential between STEM educated immigrants in STEM jobs and their Canadian born counterparts roughly doubled between 1985 and 2011, there was no increase across entering cohorts between the early 1980s and late 2000s in the entry earnings gap, aside from the rise in the gap during economic downturns. In fact, those STEM workers entering the late 2000s who could find a STEM job had a relatively low entry earnings gap by historical standards (relative to the Canadian-born). However, the entry earnings gap closed slowly with years in Canada. Among the cohorts for which data were available the gap was about 20% after 10 years in Canada. Similar U.S. results focusing on the 1990 to 2012 period, and immigrants in STEM occupations – with controls for age, education, gender and race - found an entry earnings gap of about 6%, and a complete closing of the gap after 5 years in the U.S. (Hanson and Slaughter 2015).

Considerable deterioration in outcomes was observed among the more than half – and increasing share – of STEM educated immigrants who did not find a STEM job. Among the Canadian born in this situation, the share working in jobs requiring a university degree was quite stable, around 44%. In contrast, among immigrants, the share was both lower and falling; it fell from 33% in 1991 to 22% in 2011. The cross-sectional annual earnings gap (adjusted) between immigrant and the Canadian born STEM graduates in non-STEM jobs was large, and doubled between 1985 and 2010. The entry earnings gap for the late 2000s cohort was also large, and more recent cohorts on immigrant STEM graduates working in non-STEM jobs have seen their ability to close the earnings gap with the Canadian-born deteriorate relative to earlier cohorts.

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Table 1
University graduates in STEM fields of study, aged 25 to 54

	Year					
	1986	1991	1996	2001	2006	2011
	percent					
Percent of university graduates in STEM fields who are immigrants	35.1	35.1	38.8	44.4	48.7	49.4
Percent of university graduates in STEM fields						
All immigrants	31.2*	31.5	32.8	37.2	39.0	36.9
Immigrants in Canada 1 to 5 years	37.0	35.4	39.8	47.8	44.6	35.2
Canadian-born	18.7	18.8	18.2	18.7	19.3	19.3

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Note: * this number means that 31.2% of all immigrant university graduates were eduated in STEM fields.

Table 2
STEM educated graduates working in STEM occupations, aged 25 to 54

	Year					
	1986	1991	1996	2001	2006	2011
	percent					
Percent of STEM university graduates working in STEM occupations						
Canadian-born	42.8	46.2	45.8	47.5	46.4	45.9
Immigrants	43.0	45.9	39.3	45.9	41.1	41.6
Immigrants by years of residencein Canada						
1 to 5 years	43.8	43.7	35.5	47.4	36.9	35.6
6 to 10 years	45.2	49.7	41.2	44.7	48.1	43.5
11 to 15 years	43.2	47.2	46.5	43.2	42.6	48.1
15 to 20 years	39.6	46.4	44.1	47.1	41.7	43.4
Over 20 years	40.7	42.5	39.1	43.0	41.0	41.5

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Table 3
Percent of jobs held that require a university degree, university graduates aged 25 to 54

	Year					
	1986	1991	1996	2001	2006	2011
	percent of jobs requiring a university degree					
Educated in STEM field						
Canadian-born	63.8	65.1	61.0	62.9	62.1	62.3
Immigrants	52.9	51.6	42.4	44.4	40.4	40.7
STEM educated working in STEM occupations						
Canadian-born	91.7	89.6	87.6	91.0	91.8	88.6
Immigrants	87.4	84.7	83.2	87.8	86.5	81.2
Immigrants in Canada 1 to 5 years	85.9	80.7	82.4	88.2	83.0	78.3
STEM educated working in non-STEM occupations						
Canadian-born	43.1	44.1	39.9	41.0	41.4	42.5
Immigrants	33.8	33.0	24.9	22.9	19.0	22.3
Immigrants in Canada 1 to 5 years	23.0	20.5	18.7	18.6	15.1	20.3

Note: Excludes immigrants who arrive in Canada under age 23.

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Table 4
Estimated difference in annual earnings for various groups, STEM and non-STEM educated university graduates 25 to 54 years old

	Year					
	1985	**1990**	**1995**	**2000**	**2005**	**2010**
	Log points					
STEM vs. non-STEM educated						
Canadian-born: model 1 coefficient	0.046*	0.025	0.047	0.054	0.040	0.041
standard error	0.004	0.004	0.004	0.003	0.003	0.003
Immigrants: model 1 coefficient	0.077	0.065	0.027	0.091	0.052	0.076
standard error	0.008	0.007	0.007	0.006	0.005	0.004
STEM educated: immigrants vs. Canadian-born						
Model 1 coefficient	-0.206	-0.238	-0.380	-0.413	-0.494	-0.413
standard error	0.007	0.006	0.006	0.005	0.005	0.004
Model 2 coefficient	-0.104	-0.055	-0.193	-0.217	-0.291	-0.227
standard error	0.008	0.007	0.005	0.006	0.006	0.005
Non-STEM educated: immigrants vs. Canadian-born						
Model 1 coefficient	-0.237	-0.279	-0.360	-0.450	-0.507	-0.449
standard error	0.005	0.004	0.004	0.004	0.004	0.003
Model 2 coefficient	-0.148	-0.109	-0.193	-0.264	-0.315	-0.266
standard error	0.006	0.005	0.007	0.005	0.005	0.004

Note: Excludes immigrants who arrived in Canada under age 23. * This number means that among the Canadian-born STEM graduates earned 0.046 log points (or about 4.6%) more than their non-STEM graduates. All coefficients are statistically significant at $p<0.001$

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Table 5
Estimated difference in annual earnings for various groups; in STEM and non-STEM occupations, university graduates 25 to 54 years old

		Year					
		1985	1990	1995	2000	2005	2010
		log points					
STEM educated working in STEM occupations: immigrants vs. Canadian-born							
Model 1	coefficient	-0.157	-0.183	-0.258	-0.263	-0.354	-0.303
	standard error	0.010	0.009	0.009	0.008	0.007	0.007
Model 2	coefficient	-0.041	0.010†	-0.057	-0.056	-0.130	-0.097
	standard error	0.012	0.011	0.011	0.010	0.009	0.008
STEM educated working in non-STEM occupations: immigrants vs. Canadian-born							
Model 1	coefficient	-0.236	-0.271	-0.422	-0.490	-0.576	-0.482
	standard error	0.009	0.009	0.008	0.008	0.007	0.006
Model 2	coefficient	-0.116	-0.082	-0.218	-0.280	-0.347	-0.277
	standard error	0.011	0.010	0.010	0.010	0.009	0.008
STEM educated: immigrants in STEM occupations vs. immigrants in non-STEM occupations							
Model 1	coefficient	0.078	0.088	0.163	0.227	0.222	0.180
	standard error	0.013	0.012	0.012	0.010	0.009	0.009
Model 2	coefficient	0.075	0.091	0.161	0.224	0.217	0.179
	standard error	0.013	0.012	0.012	0.010	0.009	0.008

Note: Excludes immigrants under age 23 at entry to Canada. † not statistically significant, other coefficients are significant at p<0.001

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Table 6 Estimated earnings gap between immigrants and the Canadian born, university graduates aged 25 to 54, by STEM fields of study and entry cohort

	Years since immigration			
	1	5	10	15
In STEM fields of study		Log point		
Model 1				
1980-1984	-0.336	-0.292	-0.244	-0.205
1985-1989	-0.379	-0.369	-0.341	-0.295
1990-1994	-0.609	-0.462	-0.332	-0.261
1995-1999	-0.403	-0.384	-0.335	
2000-2004	-0.758	-0.519		
2005-2009	-0.451			
Model 2				
1980-1984	-0.188	-0.137	-0.085	-0.043
1985-1989	-0.182	-0.179	-0.153	-0.105
1990-1994	-0.418	-0.270	-0.136	-0.062
1995-1999	-0.199	-0.177	-0.126	
2000-2004	-0.549	-0.297		
2005-2009	-0.242			

Note: Excludes immigrants under age 23 at entry to Canada.

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey

Table 7. Estimated earnings gap between immigrants and the Canadian born, university graduates with STEM fields of study, aged 25 to 54, by STEM occupation and entry cohort

	Years since immigration			
	1	5	10	15
Working in STEM occupations	Log point			
Model 1				
1980-1984	-0.202	-0.220	-0.218	-0.190
1985-1989	-0.306	-0.295	-0.259	-0.199
1990-1994	-0.460	-0.320	-0.198	-0.136
1995-1999	-0.262	-0.243	-0.202	
2000-2004	-0.598	-0.363		
2005-2009	-0.197			
Model 2				
1980-1984	-0.118	-0.125	-0.115	-0.084
1985-1989	-0.185	-0.175	-0.139	-0.077
1990-1994	-0.342	-0.198	-0.074	-0.010
1995-1999	-0.132	-0.111	-0.069	
2000-2004	-0.472	-0.226		
2005-2009	-0.074			
Not working in STEM occupations				
Model 1				
1980-1984	-0.396	-0.339	-0.283	-0.244
1985-1989	-0.427	-0.426	-0.414	-0.389
1990-1994	-0.691	-0.577	-0.465	-0.387
1995-1999	-0.596	-0.576	-0.514	
2000-2004	-0.800	-0.643		
2005-2009	-0.561			
Model 2				
1980-1984	-0.200	-0.144	-0.089	-0.048
1985-1989	-0.183	-0.193	-0.186	-0.156
1990-1994	-0.450	-0.335	-0.221	-0.139
1995-1999	-0.346	-0.322	-0.257	
2000-2004	-0.540	-0.371		
2005-2009	-0.303			

Note: Excludes immigrants under age 23 at entry to Canada.

Sources: 1986 to 2006 Census of Population and 2011 National Household Survey