

Why do STEM immigrants do better in one country than another?

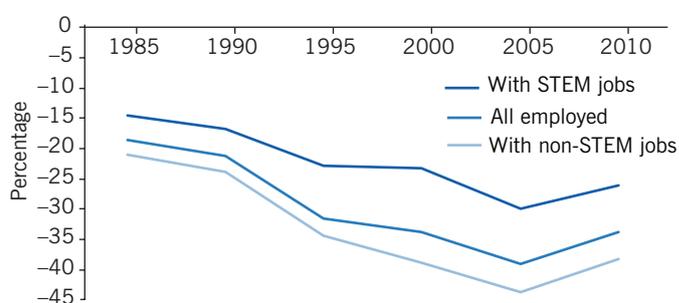
Where STEM immigrants were educated strongly influences their economic success and possibly their impact on innovation

Keywords: STEM skills, immigrant selection, US-Canada differences

ELEVATOR PITCH

Canada, the US, and most Western countries are looking to STEM (science, technology, engineering, and mathematics) immigrants to boost innovation and economic growth. Canada in particular has welcomed many STEM immigrants over the past quarter of a century. In the US, there is an ongoing debate about whether the H-1B visa program is being used effectively to attract more STEM immigrants. Interestingly, significant differences exist between the two countries in earnings and likely the innovation activity of highly educated immigrants, which highlights the likely role of immigration policy in determining such outcomes.

Earnings gaps between immigrant and Canadian-born STEM-educated workers



Note: Adjusted for age, gender, geographic location, education level, weeks worked, and full/part-time status.

Source: Based on data in [1].

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KEY FINDINGS

Pros

- ⊕ Immigration leads to a large supply of highly educated STEM workers in some countries, such as Canada and the US.
- ⊕ Highly educated immigrants contribute disproportionately to patent filing activity in the US and perhaps other countries largely due to the high proportion educated in STEM fields.
- ⊕ In the US, highly educated immigrants working in STEM jobs have a relatively small entry earnings gap with the native born, and “catch up” to the native born very quickly.

Cons

- ⊖ The earnings gap between highly educated immigrants and native STEM employees is much larger in some countries, like Canada, than in others, namely the US.
- ⊖ STEM-educated immigrants who do not find STEM jobs can face very poor economic outcomes, as observed in Canada.
- ⊖ Economic and possibly innovation outcomes are much more positive for STEM immigrants educated in Western developed nations than in developing countries.

AUTHOR'S MAIN MESSAGE

Simply attracting highly educated STEM immigrants does not necessarily result in technical innovation and productivity gains. The host country should be concerned with the immigrant selection process and how STEM immigrants respond to it, the supply (number) of STEM immigrants added to the labor force through immigration, where the immigrants are educated, and any potential barriers to their economic integration. Involving employers appears to improve the selection process. In some cases, smaller and better-targeted STEM immigrant selection programs may be more useful than large increases in the number of STEM immigrants, as in Canada.

MOTIVATION

STEM skills are increasingly regarded as essential to innovation, productivity growth, and competitiveness [2]. Immigrants provide a significant proportion of many countries' STEM skills. In Canada, for example, in 2016 immigrants accounted for 47% of bachelor level STEM employment, and almost two-thirds (63%) of master's and doctorate level STEM jobs. In the US, in 2013 immigrants accounted for 17% of the US labor force, 15% of STEM employment at the bachelor's degree level, 18% at the master's level, and 29% of PhDs in STEM jobs [3].

Given immigrants' role in providing STEM skills, knowledge of their outcomes is essential. For example, is there evidence of a disproportionate contribution to innovation? After a short adjustment period, do STEM immigrants do as well economically as the native born, and are there differences between countries? And if so, why?

This article focuses on the outcomes of STEM immigrants in Canada and the US. Given the very different circumstances regarding STEM immigration in these two countries, general conclusions can be drawn that will be useful to other developed nations. The article begins with an examination of STEM immigrants' economic outcomes and then moves on to their contribution to innovation.

DISCUSSION OF PROS AND CONS

The concentration of highly educated immigrants in STEM disciplines

Many developed countries rely on technological innovation and employment to drive their economies. Workers in STEM employment play an outsized role in this process, and in many Western countries a relatively large proportion of those working in STEM jobs are immigrants. Two primary examples include Canada and the US, where highly educated immigrants are much more likely than the native-born to be educated in a STEM discipline. In 2003, highly educated US immigrants were more than twice as likely as a native born person to have been educated in a STEM field; 25.2% of immigrants were educated in computer science, mathematics, physical sciences, or engineering (the main STEM fields), compared to 10.6% of the native-born population [4]. The picture is very similar in Canada, where in 2011, highly educated immigrants were twice as likely to have a STEM degree as the highly educated native born [1]. These patterns have existed for many years, and almost certainly continue today.

This high concentration in STEM education sets up an opportunity for a disproportionate contribution by highly educated immigrants to technical innovation, and possibly productivity growth. The importance of STEM-educated workers to an economy was aptly stated in a major Canadian review of STEM skills [2]. "STEM skills have been advanced as central to innovation and productivity growth which are in turn necessary for improving standards of living. The fundamental skills required for STEM literacy, such as problem solving, technological proficiency and numeracy, represent essential components of working smarter, which is about productivity growth." But the review also notes that "while the theoretical reasons for the 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."

Earnings and occupational outcomes

Earnings outcomes of highly educated immigrants

In the absence of any research directly comparing the economic outcomes of STEM immigrants across countries, this article begins by looking at Canada–US comparisons of labor market outcomes of all “recent” immigrants with at least a bachelor’s degree. For any given year, “recent” immigrants refers to relatively new immigrants who entered during the previous five years.

Over the 1980–2005 period, the relative (to the comparable native born) wages of highly educated recent immigrants followed very different paths in Canada and the US. Generally superior outcomes were observed in the US, particularly since 1990. By 2005, relative entry wages of highly educated immigrants in the US were at about the same level as they were in 1980, but in Canada they were significantly lower. Furthermore, the university wage premium for new immigrants (the difference between the wages of comparable university-educated and high school graduates) was similar in both countries in 1980 but by 2000 this premium was considerably higher in the US [5].

Another recent study examined the labor market performance of university-educated male recent immigrants in Australia, Canada, and the US between 1991 and 2011 [6]. The authors find a large and persistent relative (to the comparable native born) earnings advantage among highly educated immigrant men in the US relative to those in Canada and Australia. They suggest that the results point to the influence of the H-1B visa program, which allows US employers to hire highly educated foreign workers in specialized occupations for three to six years. Permanent residency often follows. These highly skilled US immigrants avoid the job search that has traditionally been required in Canada and Australia, although this is now changing to some extent in both countries. They also note, however, that the US advantage persisted even when Australia moved to an employer-sponsored selection system more comparable with that of the US. The authors believe that the available evidence suggests that the US advantage is most consistent with the positive selectivity of US immigrants, that is, the tendency of higher-ability immigrants to select the US over other countries. This positive selectivity is driven, at least in part, by the larger economic returns to higher skills in the US (i.e. the larger university wage premium).

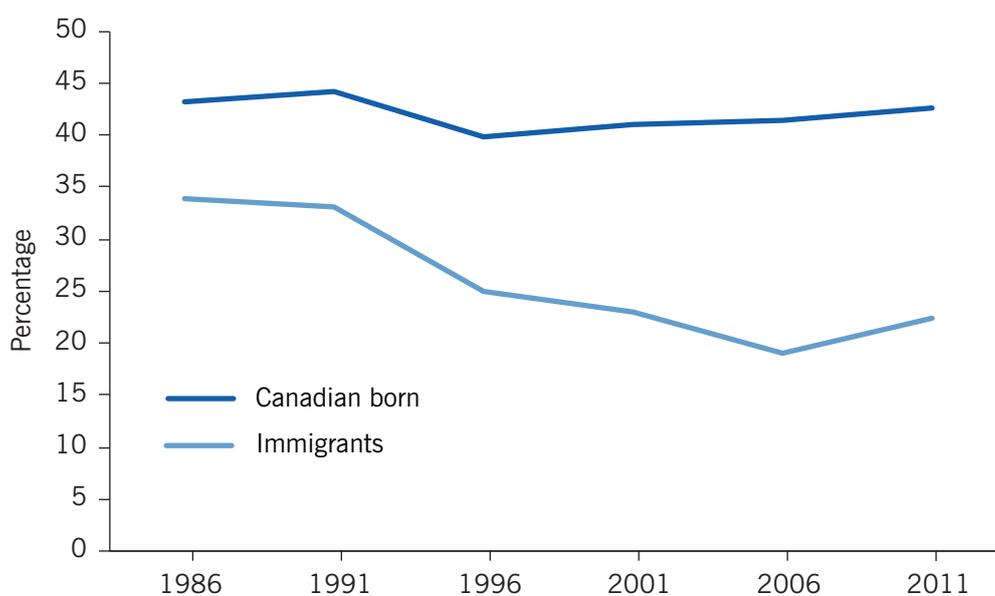
Both of the above studies focus on high-skilled recent immigrants (i.e. those who have been in the country for five years or less). Given that many high-skilled immigrants in the US enter with prearranged jobs, while those in Canada do not (at least until the very recent past), it may not be surprising that US immigrants perform better economically during the first few years after immigrating. Whether Canadian high-skilled immigrants’ relative earnings “catch up” to those of their US counterparts as they acquire more experience in the host country is uncertain. However, the limited available evidence suggests that they do not [6]. Furthermore, if positive selection is a primary cause of this advantage, then it will likely persist as immigrants acquire more experience in the host country. It is also clear that the university wage premium is greater in the US than Canada [3].

Occupational and earnings outcomes of STEM immigrants: Evidence from Canada

While research on the economic outcomes of STEM immigrants is generally quite recent and limited, there is somewhat more available for Canada. The significant findings for Canada include:

- (i) *On average, employed STEM-educated immigrants display economic outcomes significantly inferior to those of their Canadian-born counterparts* [1], [2]. Earnings outcomes among the employed university-educated STEM immigrants deteriorated over the 1986–2011 period, while remaining more or less constant among their comparable Canadian-born counterparts. The proportion of university-educated immigrant STEM workers aged 25–54 in jobs requiring a university degree fell from 53% to 41% over the period, compared to a constant 63% among the Canadian born. Employed immigrant STEM workers earned much less than their Canadian-born counterparts. The adjusted negative earnings gap between STEM immigrants and the Canadian born roughly doubled during this period, increasing from 18% in 1985 to 34% in 2010 [1].
- (ii) *Country of education is a major determinant of the immigrant–native born earnings gap.* This result holds especially for STEM immigrants [7]. STEM immigrants educated in Canada, the US, the UK, and France had relatively small negative earnings gaps compared to the Canadian born, while those educated in developing countries had very large gaps. In 2010, STEM immigrants educated in 12 developing countries and working in high-skilled occupations earned from 15% to 50% less than their Canadian-born counterparts, while those working in other less-skilled occupations earned from 33% to 60% less [7]. Immigrants educated in the Philippines and China are among the largest groups of STEM immigrants entering Canada, but they have among the worst occupational and earnings outcomes among immigrants from developing countries.
- (iii) *If STEM-educated immigrants did not find a STEM job, they tended to find very poor jobs.* More than half of STEM-educated immigrants find themselves in non-STEM jobs [1], [2], [8]. The same is true for Canadian-born STEM graduates. A Council of Canadian Academics report argues that this is not particularly significant, since STEM skills

Figure 1. Share of university-level jobs among STEM-educated workers with non-STEM jobs



Source: Picot, G., and F. Hou, “Immigrant STEM workers in the Canadian economy: Skill utilization and earnings.” *Canadian Public Policy* 44:S1 (2018): S113–S124 [1].

are relevant and useful in many types of jobs outside of STEM occupations, and can open doors for STEM-educated workers [2]. This assertion likely holds for Canadian-born STEM-educated workers, but less so for immigrant STEM workers. If university-educated STEM immigrants did not find a STEM job, their economic outcomes were particularly poor. In 2011, only 22% found a job requiring a university degree compared to 42% among the Canadian born (Figure 1), and they earned 38% less than the Canadian born in a similar situation (see illustration on p. 1). STEM-educated immigrants working in STEM occupations did better economically, but still registered a significant gap with the Canadian born (illustration on p. 1).

Country comparisons

As mentioned previously, there is a general dearth of research examining cross-country comparisons of STEM immigrant outcomes. Based on the limited research available, the economic outcomes of university-educated STEM immigrants in the US appear to be superior to those observed for Canada. Unfortunately, no research could be found on the outcomes of STEM-educated immigrants who worked in non-STEM jobs in the US, so the focus here is on workers employed in STEM occupations.

In the US, relative (to the US born) earnings of highly educated male immigrants employed in STEM jobs changed little between 1990 and 2012 [3]. In Canada, meanwhile, relative (to the Canadian born) earnings of highly educated immigrants in STEM jobs deteriorated significantly. The adjusted negative earnings gap increased by 65% between 1990 and 2010 [1].

The cross-sectional immigrant-native born earnings gap for workers in STEM occupations appears to be larger in Canada than in the US. Pooled data from 1990, 2000, and 2012 in the US reveal an immigrant-adjusted wage discount of -4% [3]. More or less comparable results for Canada suggest an adjusted wage discount of somewhere between -9% and -26% in 2010, depending on whether language and visible minority status are taken into account. Another study, focusing on recent immigrants, found that the relative (to the native born) wages of immigrants working in STEM jobs were much higher in the US than in Canada or Australia [6]. Analyses of two specific STEM disciplines, engineering and computer science, provide similar results. Relative earnings outcomes were far superior in the US.

Perhaps more informative than the cross-sectional results reported above is the time required for the immigrant workers in STEM jobs to reach parity with their native-born counterparts. In the US, this was about six years, after which the (adjusted) earnings of immigrants working in STEM occupations exceeded those of the US born by about 4%. On the other hand, after ten years in Canada, the adjusted negative earnings gap remained somewhere between 7% and 20%, depending on the controls included. Even after 15 years the gap was in the 5% to 15% range.

To summarize, whether speaking of highly educated immigrants in general, or the subset of highly educated immigrants working in STEM jobs, relative (to the native born) earnings results are much more positive in the US than in Canada. There has been considerable deterioration in Canada over the past few decades, but no such trend is evident in the US. As mentioned, these comparative results refer only to workers in STEM jobs. Due to a lack of data, comparisons could not be made for STEM-educated

immigrants working in non-STEM jobs, where the issue of lower relative earnings was most evident in Canada.

The contribution to innovation by highly educated immigrants

Patent filing among highly educated immigrants: Evidence from the US

Recent US research has focused on a number of questions related to immigrants and innovation. Most of these studies focus on immigrants and patents, which are used as a proxy for technological innovation. The main question posed is: have high-skilled immigrants contributed disproportionately to the innovative output over the recent past? The research suggests that the answer is yes. It has been known for some time that immigrants are overrepresented in high-end innovation activity. For example, while in 2012 approximately only 12% of the US population were immigrants, 26% of the US-based Nobel Prize recipients over the previous decade were immigrants. In addition, immigrants are overrepresented among both the 250 most cited authors and among the scientific members of the National Academy of Sciences, and the National Academy of Engineering [4]. There is a similar overrepresentation by immigrants in the filing of patents in the US. Immigrants accounted for 24% of patents, twice their population share [4]. Many other studies come to a similar conclusion, including [9], [10].

The second question is: why is this disproportionate patent filing observed? The research suggests that it is primarily because immigrants are much more likely than their US-born counterparts to be educated in STEM fields that are associated with patent filing, such as engineering and science. These educational choices among immigrants can explain most of the patent filing difference between highly educated immigrants and their US-born counterparts [4], [9]. Whether positive selection into the US of STEM immigrants plays a role is not clear. At least one author concludes that immigration is associated with higher levels of innovation for the US [9].

Some research suggests, however, that the impact of immigration on innovation depends not only on the overall share of immigrants educated in STEM fields, but also on where they come from and how they enter the US. The importance for immigrant earnings outcomes of the country in which an immigrant receives their education has been noted previously, and it may also be true for innovation behaviour [11]. Research has also found that immigrants who enter the US on offers of employment are most likely to engage in skilled activities. Other research finds that highly educated immigrants entering on student visas and through the H-1B visa program tend to have more positive results regarding patenting behavior [12]. Those on student visas likely find an employer following graduation, and those entering through the visa program already have job offers.

Canada–US comparisons

There is very little recent Canadian research on the topic of immigrants and patent filing, with only two studies seemingly in circulation. The first study replicates the methodology employed in a US study in order to make direct comparisons with the US results [9]. The authors find that the impact of Canadian skilled immigration on patent rates has been relatively modest in comparison to the US. They show that an

increase in the Canadian-born highly skilled population would increase patents more than a comparable increase in highly skilled immigrants. The authors do find that STEM-educated immigrants in Canada who find a STEM job appear to raise patent rates in a significant way, but only one-third to one-half of STEM-educated immigrants in Canada find such jobs.

The second study, by the same authors, uses a very different methodology to examine patent filing rates by ethnic minorities (whether immigrant or Canadian born) [13]. The authors find that some ethnic groups, notably those with Korean, Japanese, or Chinese ancestry, display higher patent filing rates than the Canadian born university-educated. Most of this advantage could be explained by the higher shares among those groups with high levels of education who are employed in STEM occupations, similar to the US findings. In particular the higher share with a doctoral degree is important. Some indirect evidence suggests that highly educated immigrants may disproportionately contribute to patent filing in Canada. The evidence on this point remains mixed however, especially regarding whether STEM-educated immigrants contribute disproportionately to patent filing, which represents a key point of interest for this article.

Why the superior outcomes in the US?

There is little direct research on this question, though a number of possible explanations exist, including:

- (i) *The greater supply of STEM immigrants in Canada.* As noted earlier, immigrants constitute a much higher percentage of the STEM workforce in Canada than in the US. In particular, the number of highly skilled STEM immigrants entering Canada rose significantly during the 1990s in response to the high-tech boom, and has stayed at very high levels since then [8]. Canada does not face a general shortage of STEM workers [2]. In the absence of a shortage, employers looking for STEM workers may have a tendency to hire STEM graduates from universities in countries that they are familiar with, and with experience from countries with economies similar to Canada's.
- (ii) *Differences in the method of selection of highly skilled immigrants.* Many highly skilled immigrants in the US have a job offer (e.g. through the H-1B program), or are visa students who relatively frequently get invited to interviews by prospective employers. Research has shown that immigrants who enter the US contingent on offers of employment are most likely to engage in skilled activities [11]. US immigrants who entered on a student/trainee visa or a temporary work visa have a large advantage over natives in wages, patenting, and publishing; much of this advantage is due to their higher levels of education [4]. Those who enter as regular permanent residents do not outperform the US born. In Canada, traditionally very few STEM-educated immigrants had a prearranged job upon arrival. The points-based system in use since the 1960s selected economic immigrants on the basis of their education, work experience, and possibly occupation, but did not stress prearranged employment. This is currently changing; many new economic immigrants are selected by employers to hold jobs in Canada prior to becoming permanent residents. However, this does not apply to most economic and STEM immigrants currently working in Canada. They entered under the traditional point system. Embedding employer-

based selection in the points-based selection system can improve the evaluation of education and experience. For example, in the traditional point system, there is no distinction between degrees from different countries or universities, or degrees in different fields of study. Employers can make distinctions between degree types, and infer important information regarding the quality of a candidate and the disciplines in high demand.

- (iii) *The more positive selection by immigrants entering the US.* The US has a reputation for being the number one choice for many STEM immigrants at the top of the ability distribution. It may be that the innate skills of STEM immigrants entering the US are, on average, higher than those entering Canada or other developed countries. One Canadian study concluded that this was a primary cause of the higher relative earnings in the US [6]. The economic return to a university education (i.e. the university wage premium) is higher in the US than in Canada [5], as well as most other industrialized countries. It is even higher among university-educated STEM graduates in the US. Overall, the situation may increase the likelihood of a high-ability immigrant selecting the US rather than Canada or other developed countries.
- (iv) *Differences in country of education.* Research has clearly shown that country of education is one of the most important determinants of earnings (and possibly innovation outcomes), along with language and race/visible minority status. Country of education may vary significantly between STEM immigrants. Recent research has found that the impact of immigration on innovation depends not only on the overall numbers of educated immigrants but where they come from and how they enter [11]. STEM immigrants educated in non-Western countries may not do as well economically as others because the quality of their education may be lower (or perceived to be so). Moreover, in the absence of a shortage of STEM workers, employers may prefer to hire those educated in Western countries. The lack of recognition of some credentials by professional associations in the host country—either for valid or invalid reasons—may prevent immigrants from developing countries from obtaining university-level STEM jobs, or from being promoted. Discrimination may also play a role, as might language or cultural issues that prevent immigrants from fully utilizing their STEM education.
- (v) *Differences in industrial structure.* Factors unrelated to immigration policies and practices may also contribute to the superior outcomes in the US. For example, the greater concentration of high-tech companies in the US economy and the associated higher demand for STEM-educated workers could contribute to superior outcomes in the US.

LIMITATIONS AND GAPS

There are several limitations that must be considered in relation to this research. First, no studies have directly compared the earnings and innovation activities of STEM-educated immigrants in Canada and the US, nor have any tried to assess the determinants of the differences. Second, US research on STEM immigrants' economic outcomes is very limited. Finally, research on STEM immigrants' patent filing activity in Canada is limited and anything but definitive. More research from other developed countries on the outcomes of STEM immigrants would also contribute to policy development in this important area.

SUMMARY AND POLICY ADVICE

Highly educated immigrants in countries like Canada and the US are disproportionately educated in STEM fields, compared with the native born. This sets up an opportunity for highly educated immigrants to disproportionately contribute to technical innovation, and therefore productivity gains and GDP growth. However, simply attracting STEM immigrants does not automatically deliver such benefits. The Canada–US comparison around this topic points to a number of factors that could potentially affect the success of STEM immigrants in a country, including how the STEM immigrants self-select into a country, how they are selected by the country, where they are educated, how well they integrate into the labor market, and possible barriers to such integration. The supply of STEM immigrants likely also plays a role in determining their success. For instance, over the past few decades, the relative supply of STEM immigrants was much smaller in the US than in Canada, while the respective labor demand may have been larger. This would have obvious implications for their outcomes in each respective country.

It would appear that involving employers (as is done in the H-1B visa selection in the US and with foreign students finding jobs) improves the selection process for STEM immigrants. Certainly, Canada and Australia have been moving in this direction for the past few years. Finally, in countries where STEM immigrants' economic and innovation outcomes are not particularly strong, simply increasing the number of STEM immigrants using the existing selection system is not likely to generate large benefits, as one risks simply getting more of the same. This has historically been the case in Canada, although it may be changing with increased employer involvement. Smaller and better targeted STEM immigrant selection programs may be more useful in such countries.

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Competing interests

The IZA World of Labor project is committed to the IZA Code of Conduct. The authors declare to have observed the principles outlined in the code.

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Further reading

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