Skilled Immigrants: Economic Contribution and Policy Implications

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1. Introduction

Firms compete globally to attract skilled workers – particularly in the fields of science and technology – and many countries have adopted immigration policies or programs favoring skilled foreign labor. Proponents of such policies argue that skills are scarce and, as a result, employers have difficulty finding qualified workers using domestic supply alone, which limits innovation and growth that would benefit large swaths of the economy. Opponents argue that no domestic skill shortage exists, and that employers simply want to hire cheap foreign labor that will undermine the wages and employment opportunities of native-born workers.

Many economic analyses of the costs and benefits of skilled immigration focus on the US and its H-1B program. H-1B permits are aimed at filling positions in specialty occupations that typically require a bachelor's degree. Permits are valid for three years and can be renewed for a total of six years. The US limits new H-1B issuances to employees of for-profit firms to 85,000 per year.[2] Firms would clearly like to hire more H-1B workers: in some years, all available permits are allocated within the first week of the application period. However, critics note that less than half of science, technology, engineering, and mathematics (STEM) graduates in the United States work in STEM fields. Moreover, there are high-profile cases in which U.S. workers have been required to train H-1B workers only to be later replaced by them.

This paper provides a review of the literature on the economic effects of highly skilled immigrants, with a focus on the US experience.

2. U.S. Trends

Skilled foreign-born workers have become increasingly important to the American economy. As shown in **Table 1**, the foreign-born share of employment rose from 6.2% in 1980 to 16.4% in 2010. The trends and levels of the foreign-born share of employed college graduates follow very similar patterns. Foreign workers comprise a disproportionate share of college graduates employed in STEM fields – the foreign-born share of STEM employment is approximately twice as large as values for overall and college-graduate employment, growing from 11.1% to 27.2% over this period.

[TABLE 1 AROUND HERE]

[1] The authors thank Lídia Farré, Delia Furtado and Kevin Shih for helpful comments. All errors and omissions are, of course, our own. We acknowledge generous financial support from NSF grant number 1535561.

[2] The annual cap has been 65,000 permits for general applications since fiscal year 2004. An additional 20,000 permits have been available for workers with advanced degrees from U.S. institutions since 2005. New employees of institutions of primary, secondary or higher education; non-profit organizations affiliated to institutions of higher education; and research agencies at government or non-profit institutions are exempt from caps.

The H-1B program is rather large. In 2014, the US issued 315,857 H-1B permits, 40% of which were for initial employment and the rest for renewals.[3] Permit allocation is highly concentrated. Indian (70%) and Chinese (8%) workers account for over three-quarters of issuances. Canadians receive the third most permits, but account for just 2.2% of the total. Among occupations, 65% of permits are awarded to computer-related occupations, with an additional 9% going to workers in architecture, engineering and surveying.

It is interesting to compare these data to the corresponding figures from a decade earlier. The U.S. issued a quantitatively similar 287,418 permits in 2004. However, the distribution of permits was substantially less concentrated. Indians (43%), Chinese (9%), and Canadian (4.7%) citizens were the most common recipients, but accounted for just 57% of the total; 44.5% were allocated to computer-related workers, and 12.1% went to employees in architecture, engineering, and surveying.

3. The Effects of Skilled Immigration

3.1. Labor Market Outcomes

To best understand the labor market effects of skilled immigration, one must take into account specialization, comparative advantage, and spillover effects driven by entrepreneurship and innovation.

3.1.1. Specialization and Comparative Advantage

Among college-educated workers, foreign labor has a comparative advantage in STEM work. Potential causes of this phenomenon include international differences in education systems, transferability of STEM skills across national borders, and policy-induced selection biases.[4] In any case, 46% of college-educated foreign workers majored in a STEM field, whereas only 28% of native college graduates did. Even among STEM graduates, foreign workers are far more likely to have acquired a degree in engineering, computer science, mathematics, and physics, whereas natives more commonly pursue biological sciences and psychology (Figure 1).

[FIGURES 1 AND 2 AROUND HERE]

Specialization is important because it implies that native-born workers can respond to immigration by moving into occupations in which they have a comparative advantage. Such movement might not be dictated by degree alone: Figure 2 shows it is common for both native and foreign-born STEM graduates to work in non-STEM occupations, though natives are more heavily represented in non-STEM jobs.

Though some observers might refer to this as displacement, others would instead call it a rational and optimal response that helps protect native-born workers from direct labor market competition with immigrants. **Peri and Sparber (2011)** argue that highly educated native-born workers respond to inflows of foreign-labor by moving into occupations requiring more language and communication skills relative to quantitative skills. Measured changes occur over the course of a year, implying that the response is unlikely to arise after the acquisition of additional schooling.

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[3] See the *2014 Report on the Characteristics of H-1B Specialty Occupation Workers* (USCIS).
[4] See **Orrenius and Zavodny (2015), Amuedo-Dorantes and Furtado (2016)**, and **Shih (2016)** for recent work related to skilled immigration and schooling issues.

A native worker might move from being a computer programmer to the manager of a software firm, for example. The authors do not, however, study the wage implications of this reallocation.

Importantly, comparative advantage might also offer insights into why some studies focusing on narrower sets of skills and labor markets find that immigration reduces native labor market opportunities. If the analysis is limited to a specific occupation, it will not capture labor movements into other occupations. And if workers have limited transferability of skills across occupations, losses might be particularly severe.

Borjas and Doran (2012) provide an example of this type of work. They analyze the post-1992 influx of Soviet mathematicians to the U.S. and find that it led to displacement of American mathematicians in those fields, pushing them to lower quality institutions, presumably harming their career prospects. Their results suggest that the net increase in mathematical output in these Soviet-dominated fields was essentially awash. If Ph.D. mathematicians have less job market mobility than the average college-educated worker, or if the methodology cannot measure movements into alternative careers, then it would not be surprising to estimate severely negative effects of the Soviet influx.

Similarly, **Cortes and Pan (2014, 2015)** focus on the market for registered nurses.[5] The U.S. and several European countries could be experiencing a shortage of nurses, partly due to bottlenecks in supply and partly to sustained growth in healthcare demand stemming from an ageing population. Their 2014 study examines the effects of nurse importation on the supply of U.S.-born nurses. They find evidence for displacement (or specialization) both at the city and state level, and argue that natives who would have gone into nursing now choose to become teachers.[6] In their 2015 follow-up study, they show that Filipino nurses in the U.S. enjoy a wage premium that is not explained by observed differences in worker or job characteristics. They conclude that these nurses are highly positively selected compared to native nurses. Taken together, these studies suggest that nurse importation does not seem to be a very effective way to increase the overall supply of nurses though it does seem to increase the quality of the average nurse, which may translate into better health outcomes for patients.

3.1.2. Innovation

Further insight into the relationship between inflows of foreign STEM workers and the labor market outcomes of their native counterparts requires an understanding of technology. Simply put, immigrants specialize in science and engineering work. Scientists and engineers are responsible for most of the technological progress in recent decades. Technology creates gains that spill over to many sectors of the economy, and is the key to generating long-term, sustained, economic growth. Given these important links, it is not surprising that economists interested in the economic effects of skilled immigration have analyzed how these inflows have influenced innovation including patenting and publishing activity.

Hunt and Gauthier-Loiselle (2010) exploit variation across U.S. states and over time and find that patent rates among immigrants are twice as large as among natives. This patenting advantage is fully explained by immigrants' higher concentration in science and engineering, as opposed to reflecting higher innovation productivity among immigrants. They do not find crowding out of

[5] The typical education level at entry for this occupation is a bachelor's degree.
[6] These results are also consistent with the negative effects of (low-skilled) immigration on wages in the household services sector and the prices of low-skilled services more generally (**Cortes 2008, Farre et al. 2011, Frattini 2014, Furtado 2016**).

native inventors either. In fact, their findings suggest that there may be small positive spillovers in research productivity. **Hunt (2011)** adds an important policy insight by examining innovation activity among immigrants on the basis of the type of permit at the time of their first entry into the United States. She finds that those who entered on a student/trainee visa or a temporary work permit (such as an H-1B) exhibit a large advantage over natives in wages, patenting, publishing, and in the likelihood to start companies than similar natives.

Kerr and Lincoln (2010) find that increases in the stock of H-1B workers in a city are associated with increases in patents by inventors with Indian and Chinese surnames. Once again, they do not find evidence of displacement in native patenting rates.[7] Rather, their results suggest that growth in the national stock of H-1B workers leads to an increase in the employment of immigrant scientists and engineers in more dependent cities, with no evidence of native displacement or detrimental wage effects.

Not all patents are created equally. The majority of patents concern innovations with limited impact on production. Only a small fraction develop into innovations with a large impact on productivity. **Kerr and Kerr (2015)** analyze the effects of skilled immigration on the production of high-quality patents. Specifically, they focus on global collaborative patents, defined as patents where at least one of the inventors is located in the U.S. and at least another is not. After arguing that these patents tend to be more relevant than patents where all investors are located in the US, they document that collaborative patents are more likely to originate in U.S. firms with more inventors with ethnic surnames.[8] Furthermore, they also provide evidence of links between the ethnicity of the inventors and the countries where their surnames originated.

Historical analysis by **Moser, Voena, and Waldinger (2014)** find that Jewish emigres from Nazi Germany "revolutionized U.S. science" and increased patenting by U.S. inventors in emigres' fields by 31%. Similarly, **Borjas and Doran (2012)** find that interactions with "superstar scientists" generate positive peer effects that enhance research productivity, providing further confirmation of the findings in **Azoulay et al. (2010).**

Peri, Sparber, and Shih (2015) assess direct labor market implications of skilled foreign-labor flows by employing an identification strategy based on the 1980 geographic distribution of foreign-born STEM workers interacted with variation over time in the annual H-1B cap between 1990 and 2010. They argue that immigrants were responsible for 80% of the growth of the STEM workforce between 1990 and 2010, and about 40% of the productivity growth of the American economy over the same period. This activity caused positive spillovers that increased the wage of native college graduates and, to a lesser extent, also the wage of non-college graduates.

3.1.3. Entrepreneurship

In addition to productivity-enhancing peer effects, another potential positive effect of skilled immigration on skilled natives' labor market outcomes is that immigrants become entrepreneurs. By creating new firms with differentiated products, skilled immigrants may generate increased demand for skilled native workers.[9]

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[7] The authors provide further confirmation for this finding using firm-level analysis based on a sample of 77 firms with high patenting activity.

[8] Their patents data do not identify the nationality or country of birth of the inventors. Thus they focus on the ethnic origin of the inventors' surnames.

[9] H-1B holders are unlikely to play much of a role as business owners given that these permits are tied to a specific employer-employee relationship. However, H-1B permits allow for "dual

The key questions in this literature are whether entrepreneurship rates among immigrants are higher or lower than among natives, and whether immigrant businesses generate income and employment or are instead simply the response to insurmountable barriers to employment. While the higher rates of entrepreneurship among immigrants have been documented for several countries (**Fairlie and Lofstrom (2015)**), evidence on the other questions is still sparse due to data limitations.

In a widely cited analysis, **Wadhwa et al. (2007)** built a large sample of engineering and technology companies founded between 1995 and 2005. They found that about 1 in 4 companies had at least one key foreign-born founder. These immigrant startups generated $52 billion in sales and employed close to 0.5 million workers. Further progress along this line of inquiry is being done by **Kerr and Kerr (2016)**. Their study makes a large data contribution by creating a large employer-employee dataset containing information on sources of corporate financing, as well as firm and worker characteristics, for the period 1995-2008.[10] Confirming the results in Wadhwa et al. (2007), they find that about 1 in 4 entrepreneurs are immigrants. They also argue that immigrant firms are (1) more likely to receive financing from venture capital than native-led businesses; (2) tend to engage in more risky ventures by concentrating in high-wage, high-tech sectors; and (3) perform better than native businesses in terms of employment growth, even controlling for city, industry and cohort. Businesses founded by immigrants who came to the U.S. by age 18 display stronger growth patterns than those founded by individuals who migrated as adults.

Besides their role as entrepreneurs, skilled immigrants may also affect firm creation indirectly. **Di Giovanni et al. (2015)** build a large-scale model of international trade where the number of firms and products is endogenous and determined, in part, by the size of the workforce. In their setup skilled immigrants have a larger effect than unskilled ones because the former embody more units of efficiency of labor. Their simulations suggest that natives in countries of net immigration are better off due to increased product variety available for consumption and as intermediate inputs. Additionally, remittances compensate most origin countries for their labor loss. Thus, almost all countries in the world are better off than in the absence of migration.

In conclusion, the evidence suggests that immigrants have higher entrepreneurship rates than natives, and that immigrant-led businesses are important sources of income and employment. The creation of businesses induced, directly or indirectly, by immigration appears to generate significant welfare gains that also benefit the countries of origin. Taken together, these studies provide support to the idea that immigrants with advanced training in science and engineering improve, or at least do not harm, the labor market outcomes of natives with similar skills. These empirical findings suggest that skilled labor in STEM may be an important ingredient for innovation and economic growth.

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intent", that is, do not rule out transitions to permanent residency. Most likely, it is at that point that these workers may consider founding their own businesses.

[10] The employer-employee data is drawn from the Longitudinal Employer Household Dynamics (LEHD) database. These data have many strengths but also some limitations. For instance, the identity of the founders is not explicitly included and needs to be inferred. Specifically, the top 3 initial earners are assumed to be the founders. In addition, the data only include firms with employees, leaving out the self-employed. Some states were included from 1995, but some others were added to the LEHD later in the period.

3.2. Firm productivity, growth and profitability

Motivated by the positive association between skilled immigration and innovation, a series of recent studies has sought to examine whether this has translated into productivity gains at the firm level.[11]

Paserman (2013) studies the migration of skilled workers from the former USSR to Israel, focusing on the consequences for firm-level productivity, measured as output per worker. His results point toward differential effects across industries. He finds a negative correlation between the immigrant share and output per worker in low-tech industries, but a positive association in high-tech industries. **Ghosh, Mayda and Ortega (2014)** exploit the sharp reduction in the annual H-1B cap that took place in 2004 to try to identify the effects of foreign-born skilled workers on firm-level outcomes. Their estimates imply that if the cap on H-1B permits were relaxed, a subset of firms – particularly research and development firms that rely heavily on H-1B workers – would experience gains in productivity, firm size, and profits.

Compared to the previous studies, the analysis in **Doran, Gelber and Isen (2014 NBER, 2016)** benefits from a cleaner identification strategy. H-1B applications received on the last date of receipt in fiscal years 2006 and 2007 were subject to a random lottery to determine which workers would receive permits. These authors find that firms that effectively won the lottery (because the workers they wish to hire were able to secure a permit) experience substantial crowding out of native employees, at most modest effects on patenting activity, reduced wages, and higher profits. These results are in stark contrast with several studies reviewed above. While this may be driven by their cleaner identification strategy, it is also possible that the differences arise from the fact that in the two years in their sample, only the applications received on the last receipt day were subject to random assignment. It is difficult to rule out that the marginal contribution of skilled workers to these firms may be below that of firms hiring H-1B workers earlier in the year.

4. Open Questions and Policy Implications

Most analyses find that skilled immigrants improve outcomes for the macroeconomy, but several open questions remain that are worth exploring. Answers to these questions should inform prudent policy-making.

As with any economic study, causality is a concern. Do foreign skilled workers enhance the labor market opportunities of native-born workers, or do strong economic conditions attract foreign labor? The existing literature has used a mix of instrumental variable strategies, natural experiments, difference-in-difference estimation, and randomization to address these issues. To the extent that disparities in conclusions remain, further work should be done to reconcile them.

If robust evidence for aggregate gains exists, it will not necessarily imply that a limitless number of guest worker permits is optimal. The current H-1B limit is 85,000 per year, but the annual cap was 195,000 in 2001-2003. The cap likely should be raised, but to what number? Perhaps the system can be made more flexible, instituting a cap that varies over time to accommodate fluctuations in economic activity or in the sectoral composition of the economy.

[11] Note that the firm-level analysis is likely to provide a lower bound for the (potential) effects of skilled immigration on productivity because it will fail to account for spillovers to other firms (**Greenstone et al. 2010**).

If limits to skilled immigration continue, policy-makers should consider alternative allocation mechanisms. The current assignment of H-1B permits is determined on a first-come, first-serve basis, combined with the use of lotteries when the number of cap-bound petitions exceeds the cap. While this system may work well in years where H-1B demand is low relative to the cap, in years of high demand most permits end up being randomly allocated. While this system is ostensibly fair, it is unlikely to be efficient. **Sparber (2014)** estimates large potential gains (of about $4 billion annually) from moving to a system that keeps the cap constant but matches foreign workers to the companies with the highest marginal product of foreign skilled labor.

Critics in the popular press and elsewhere often cite concerns that foreign guest workers are underpaid relative to natives. Moreover, concentration of H-1B permits fuels concern that the program is over-used by Indian-owned technology companies that intend to outsource U.S. jobs overseas.[12] However, more systematic analyses fail to find evidence of net job loss, although distributional effects could occur. If segments of the labor force are hurt by foreign labor flows, economists should work to identify those groups and propose possible redistribution schemes so that displaced workers can be compensated or retrained, so that aggregate economic gains are distributed more evenly.

[12] The U.S. Department of Labor (2014) reports that seven of the top ten firms receiving certified H-1B positions in 2014 have Indian headquarters or major operation: Cognizant, Wipro, Tata, Infosys, iGate, Mphasis, and Syntel. See **Hira (2007, 2010)**, **Machils and Thibodeau (2014)**, **Matloff (2008, 2013),** or **Preston (2015)** for further comment.

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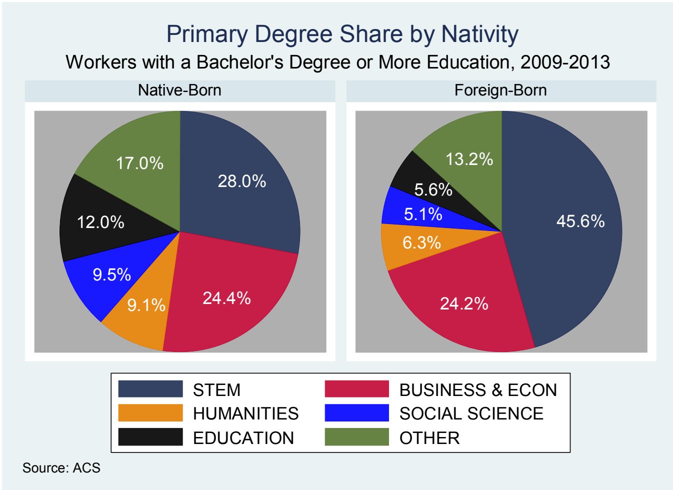
Tables and Figures

Table 1: Percent of foreign-born in U.S. Employment.

	Employment Total (%)	**Employed College graduates (%)**	**Employed College graduates in STEM (%)**
1980	6.2	6.8	11.1
1990	8.8	9.0	14.2
2000	13.3	12.8	22.7
2010	16.4	15.5	27.2

Notes: This Table reports a fragment of Table 1 in Peri, Shih and Sparber (2015). The figures are obtained by the authors' calculations using IPUMS Census data from 1980-2010. The relevant population includes only non- institutionalized individuals between age 18 and 65, who have worked at least one week in the previous year and report identified occupations. The statistics exclude those with unknown, unreported, or military occupations, and individuals without a clearly identified birthplace who do not possess U.S. citizenship through parents with U.S. citizenship. STEM occupations are defined according to the O*NET 4% definition. College educated workers have a bachelor degree or higher. Columns 1 and 2 refer to the whole country. In column 3 the sample is comprised of 219 consistently identified MSAs throughout the 1980-2010 period.

Figure 1


Primary Degree Share by Nativity
Workers with a Bachelor's Degree or More Education, 2009-2013
Native-Born
Foreign-Born
17.0%
28.0%
12.0%
9.5%
9.1%
24.4%
13.2%
5.6%
5.1%
6.3%
45.6%
24.2%
STEM
BUSINESS & ECON
HUMANITIES
SOCIAL SCIENCE
EDUCATION
OTHER
Source: ACS

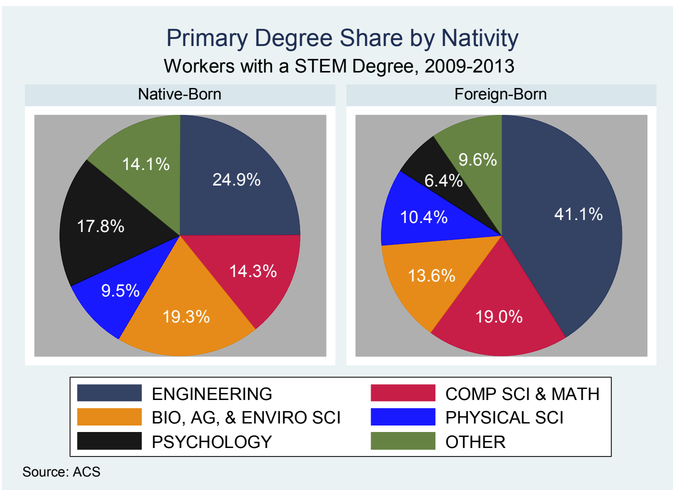
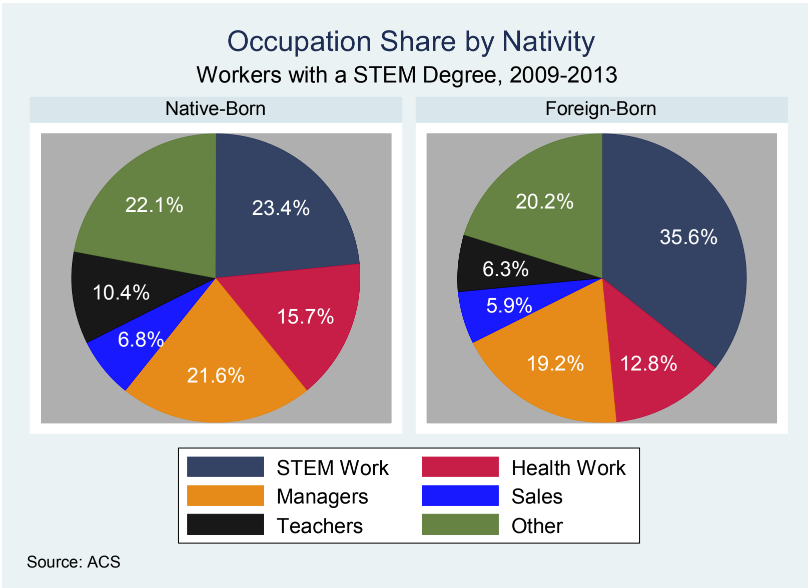

Primary Degree Share by Nativity
Workers with a STEM Degree, 2009-2013
Native-Born
Foreign-Born
14.1%
24.9%
17.8%
14.3%
9.5%
19.3%
9.6%
6.4%
10.4%
41.1%
13.6%
19.0%
ENGINEERING
COMP SCI & MATH
BIO, AG, & ENVIRO SCI
PHYSICAL SCI
PSYCHOLOGY
OTHER
Source: ACS

Table 2


Occupation Share by Nativity
Workers with a STEM Degree, 2009-2013
Native-Born
Foreign-Born
22.1%
23.4%
10.4%
15.7%
6.8%
21.6%
20.2%
35.6%
6.3%
5.9%
19.2%
12.8%
STEM Work
Health Work
Managers
Sales
Teachers
Other
Source: ACS