U.S. Skilled Immigrant Employment and Public Firms

Rasha Ashraf[1] and Rina Ray[2]

1.   *J. Mack Robinson College of Business, Georgia State University, Atlanta, GA.*
2.   *University of Colorado Denver Business School, Denver, CO.*

A B S T R A C T

Characteristics of skilled immigrant workers – age, educational attainment, and occupational skills –changed after the U.S. immigration policy shock of 2004 when the maximum number of new skilled immigrant visas was reduced to 90,000. We observe a higher (lower) probability of hiring younger (older) skilled immigrants after the policy shock. Larger firms, firms that are high growth, that have low financial distress risk, and that make large investment in R&D are more likely to hire skilled immigrants. Most of the demand for skilled immigrants is in computer-related occupations, in science and mathematics, and in engineering and architecture. Younger skilled immigrants seem to substitute older skilled immigrants, and skilled immigrant hiring is correlated with firm-level capital investment in research and innovation for occupations related to science and mathematics.

Keywords: age-cohort, education, occupation, research and development (R&D), skilled immigrants

JEL classification: G30, G38, J24, J61

1. Introduction

Skilled immigrants make significant contributions to the long-term growth and development of their host-countries. The earliest recorded evidence of this outcome related to the immigration of skilled workers, knowledge and technology diffusion, and spillover goes back to the migration of the Huguenots, or French Protestant diaspora, to Prussia (Hornung, 2014) in the 17th century C.E. The significant positive impact of immigration of the Austro-German scientists to the U.S. around World War II has also been analyzed in great detail (Moser et al., 2014). [1] College-educated immigrants encourage innovation among the host-country population (Hunt and Gauthier-Loiselle, 2010), among immigrants and/or ethnic population in the host country (Kerr and Lincoln, 2010; Borjas et al., 2017), increase total factor productivity, are responsible for wage gain among host-country workers (Peri et al., 2015a), and create new long-term employment (Peri et al., 2015b) in the fields of Science, Technology, Engineering, and Mathematics (STEM).

Quite a few studies question the benefits of, or disagree about, the positive impacts of immigration, including skilled immigration, for the host-countries. The disagreement focuses on whether skilled immigrants make meaningful contributions to the outcome of the host country through knowledge spillover, or whether they substitute or "crowd-out" host-country workers, while simultaneously being exploited by the employers. Some argue for the substitution or "crowding-out" effect (Borjas, 2005, 2007, 2009; Borjas and Doran, 2012; Kerr and Kerr, 2013; Borjas and Doran, 2015; Doran et al., 2016; and Borjas et al., 2017). Others find mixed effects, such as a positive impact for younger workers and negative impact on older workers, or no effect on wages but a negative effect on employment (Lowell, 2001; Watts, 2001; Zavodny, 2003; Kerr et al., 2015), while yet others either fail to find any effect, find a positive effect, or find that other factors, such as business cycles dominate the supply effect of immigration (D'Amuri et al., 2010 and Sana, 2010).

Despite this sizable literature on skilled immigration, firm-level analysis of skilled immigrant worker employment is scant. Most of the literature uses either country-level data or data for academic researchers / faculty members / doctoral students. Notable exceptions include Kerr and Lincoln (2010), Kerr et al. (2015), Doran et al. (2016), Ghosh et al. (2016), and Ashraf and Ray (2017), that use firm level data. Among these studies only the last two use a comprehensive sample that matches the immigrant dataset with the Compustat firm universe. Ghosh et al. (2016) study the impact of skilled immigrant hiring on a firm's revenue, profitability, growth, and productivity of workers. Ashraf and Ray (2017) measure the impact of skilled immigrant workers on innovation, specifically patents and patent citations, and analyze whether the policy decision made by U.S. firms to procure skilled labor in the international market is effective. Neither provides any answer to what makes U.S. firms decide on the policy to hire skilled immigrants in the first place.

We contribute to this literature by analyzing the trend in skilled immigrant hiring in the U.S., the educational attainment of such workers, and their age. Analyzing the age of skilled immigrant hiring helps us to understand whether the younger workers substituting the older is perverse and can occur within the skilled immigrant population as well. We are the first, to our knowledge, to analyze the determinants of skilled immigrant hiring, and the intensity of such hiring by U.S. firms, occupations where such hiring is most prevalent, and the characteristics

---

[1] Moser et al. (2014) find that émigrés encourage innovation by attracting new researchers in their fields, and not by increasing the productivity of the incumbent inventors.

of the firms and occupations where most such hiring takes place. We find that larger firms, firms that are high growth, that have low financial distress risk, and that make large investment in R&D are more likely to hire skilled immigrants. Collectively these suggest that firms that have more intangible assets, including those firms where innovative employees are the assets, are more likely to hire skilled immigrants.

We find no significant relation between a firm's profitability, nor how much it spends on sales, general and administrative (SG&A) expense on the choice to hire skilled immigrants. SG&A is a measure of organizational capital and a low level of SG&A suggests that a firm is underinvesting on the wages, education, and training of skilled or white-collar workers, and on information technology (IT). Thus, our tests are unable to provide a conclusive answer to the debate on whether skilled immigrants and host-country workers are substitutes or complements, but younger skilled immigrants are likely to be substituted for older skilled immigrants. We also find that firms that are more likely to hire skilled immigrant workers do not necessarily cut back on employee wages, education, and training.

Ottaviano et al. (2013) provide evidence that host-country, immigrant, and offshore workers are heterogeneous in terms of the skill-set required for complex tasks. Given availability of immigrant and offshore workers in the labor market, firms will employ these workers where they have comparative advantage (e.g. programming or call center), while host-country workers will specialize in skills where they have comparative advantage (e.g. communication, design, development, management). Because skills are closely tied to occupation, we analyze whether skilled immigrant workers are indeed preferred by firms for certain occupations. Consistent with the hypothesis of Ottaviano et al. (2013), we observe that skilled immigrant hiring is highly concentrated in three occupation categories: computer related occupations, occupations in engineering and architecture, and occupations in science and mathematics. Specifically, for science and mathematics occupations, there is a strong correlation between firm-level investment in research and development (R&D) and intensity of hiring skilled immigrant workers. An incremental increase of $85 million in R&D expenditure is associated with a 37% increase in the number of new skilled immigrant hired relative to other firms that hire skilled immigrants. In other words, hiring of skilled immigrants are correlated with firm-level capital investment in research and innovation.

2. Institutional Details

2.1 H-1B Program

The Immigration and Nationality Act or INA section 101 (a) (15) (H) governs the H-1B visa, and it allows US employers to employ skilled temporary foreign workers in specialty occupations. "Specialty occupation" is defined as an occupation that requires theoretical and practical application of a body of highly specialized knowledge in a field of human endeavor including but not limited to architecture, engineering, mathematics, physical sciences, social sciences, biotechnology, medicine and health, education, law, accounting, business specialties, theology, and the arts. The initial length of the employment can be for up to three years with a possibility of extension for another three years.

A U.S. employer must file an H-1B petition with the U.S. Citizenship and Immigration Services (USCIS) prior to employing an H-1B temporary worker. USCIS is responsible for evaluating an applicant's qualifications and approves or rejects the candidate.[2] For an

---

[2] Approval of an H-1B petition, however, does not imply obtaining the H-1B visa status by the worker. The

individual to qualify for H-1B status, a U.S. employer must offer a position that normally requires at least a U.S. Bachelor's degree or its foreign equivalent in a specific field. The employer must pay the H-1B worker the maximum of the actual wage level it pays to all other similarly qualified employees for the same job and the prevailing wage level, i.e. the average wage paid by all employers for similar positions in the same geographic area.[3] This ensures that the host-country labor force is not displaced or adversely affected by a foreign labor force and that H-1B foreign workers are not paid lower wages than the existing labor market rates, thereby preventing exploitation of H-1B workers.

2.2 H-1B Quota and Petition with USCIS

Until 1997, the H-1B cap was for 90,000 workers. In 1999, Congress passed a bill to temporarily increase the H-1B cap for five years. Under the American Competitiveness and Workforce Improvement Act in 1998, the cap increased to 115,000 workers in 1999 and for 2000, 2001, 2002 and 2003 the cap was for 195,000 workers. In 2004, the cap reverted back to 90,000 workers, when the temporary increase passed by Congress in 1999 expired. Since 2006, the basic quota was left at 65,000 but with an additional 20,000 visa exemptions for foreign workers with masters or higher degrees from U.S. universities. In addition, the exemption holds if the foreign worker is employed at institutions of higher education, affiliated nonprofit organization, and non-profit research or government organizations. For each FY, up to 1,400 and 5,400 H-1B visas are set aside for nationals of Chile and Singapore, respectively, according to a Free Trade Agreement. Unused visas in this category are made available to foreign workers from other countries in subsequent fiscal years. More than one U.S. employer may submit petitions for a foreign worker. Exemptions, rollovers from the Chile and Singapore quotas, and multiple petitions for the same individual can cause the number of approved H-1B petitions for initial employment to exceed the cap for a given fiscal year. Petitions approved in a given FY, reported in USCIS filings, are based on the number of approvals in that year regardless of when the petitions are filed. Therefore it is possible that in any given FY the number of petitions approved may exceed the number of petitions filed.

The H-1B cap applies only for petitions for initial employment that are filed for the first time H-1B workers. Transfers among the employers only count towards the quota when changing jobs from an employer exempt from the limits that is academia or research to one that is not exempt. Continued workers petitions are not subject to any annual quota numbers. The petitions for continuing employment are the filings for foreign workers who are already in the US and refer to extensions, sequential employment and concurrent employments. Extensions refer to petitions for H-1B workers to provide extension to work for up to 6 years beyond the initial 3-year period. Petitions for sequential employment are filings for workers transferring between H-1B employers within the 6-year period. Concurrent employment petitions refer to filings for H-1B workers intending to work simultaneously for a second employer.

The H-1B quota for any given year applies to the fiscal year beginning October 1 on the previous year. Employers can start filing H-1B visa applications to USCIS for prospective H-1B workers starting April 1st till the quota has been reached for the upcoming fiscal year. For

---

Department of State (DOS) plays an important role in the H-1B admission process.

[3] Wage is obtained by multiplying an employer's proposed wage rate times a wage multiplier, determined by the unit of pay for the proposed wage rate. For example if the worker's proposed wage rate unit is annual then the wage multiplier is 1, and if the proposed wage rate unit is monthly then the wage multiplier is 12. The variations of wage rate units are: annual, monthly, bi-weekly, weekly, and hourly.

example, for FY 2008 beginning on October 2007, the USCIS starts accepting petitions from April 1, 2007. In the early 1990s, when the quota was 90,000, the quota rarely reached its cap and H-1B visas were processed by USCIS on basis of first come first served. In the mid-1990s H-1B quota got filled up, causing petitions to be denied. However, during 2001 – 2003, it never reached its cap.

When the quota was decreased in 2004, it got filled up fairly quickly in the subsequent years. For example, for FY 2008, which began on October 2007, the 65,000 quota was reached before the end of the first day that the USCIS began accepting applications for that year, April 2, 2007. The final selection was done by lottery using computerized randomization of about 124,000 petitions that were received in the first two days, April 2 and 3, 2007. The 20,000 for higher education exemption quota was exhausted by April 30, 2006.

The following year, on April 8, 2008, the USCIS announced that the quota had been reached for FY 2009. After the financial crisis of 2008, it took longer to fill the quota. It took almost nine and 10 months, respectively, to reach the quota for FY 2010 and 2011. The quota started to fill up quickly again after the U.S. economy recovered. For example, on April 7, 2014, the USCIS announced that it has received about 172,500 H-1B petitions including petitions filed for the advanced degree exemption for FY 2015. The USCIS selected petitions by a computerized lottery on April 10, 2014, to meet the 65,000 basic cap and 20,000 advanced degree exemption cap. The advanced degree petitions were randomly selected first and the petitions that were not selected at the first stage were included in the random selection process with the base category limit of 65,000. USCIS rejected all remaining petitions that were not randomly selected, returned the petitions, and refunded the filing fees.[4]

3. Data

3.1 Characteristics of Specialty Occupation

For each fiscal year the USCIS provides characteristics of specialty occupation workers (H-1B), which are available in the Department of Homeland Security USCIS website.[5] The tables with the characteristics of specialty occupation workers reported are generated from the USCIS service center electronic data files. The data provide the number of petitions received and approved by the USCIS for each fiscal year for initial and continuing workers. It also reports number of petitions approved by country of birth, age at time of approval, level of education of beneficiaries for both initial and continuing workers. The data categorizes jobs into major occupation groups and reports the number of petitions approved and annual compensation for each category for all, initial and continuing workers.

Annual compensation is based on full-time employment for 12 months even if the beneficiary was employed for less than 12 months and is equal to the cash compensation the employer agreed to pay to the H-1B worker at the time when application was filed, excluding any non-cash compensation and benefits such as health insurance and transportation. The file also reports number of petitions approved for detailed occupation and industry category based on the North American Industry Classification System (NAICS).

---

[4] Source: Factiva and USCIS news release http://www.uscis.gov/news/uscis-reaches-fy-2015-h-1b-cap-0. The advanced-degree petitions were randomly selected first, and petitions that were not selected in this category were included in the random selection process for the 65,000 petitions in the base category.
[5] Source: http://www.uscis.gov/tools/reports-studies/reports-and-studies

3.2. Hypotheses:

Our primary hypotheses (stated as alternatives) are the following:

H1: There is a strong negative relation between a firm's profitability and the probability of a firm hiring H-1B workers.

H2: There is either a strong negative or positive relation between the Sales, General, and Administrative (SG&A) expense and the probability of a firm hiring H-1B workers.

H3: There is no relation between the research and development expense (R&D) and the probability of a firm hiring H-1B workers.

H4: There is no relation between a firm's leverage and the probability of a firm hiring H-1B workers.

If we believe in the argument made by various labor organizations, including the AFL-CIO (Watts, 2001) and the Tech Industry Workers' Association, that skilled immigrant workers are hired because of lower wages and displacement of higher cost host-country workers, then we expect a negative relation between a firm's profitability and the probability of hiring immigrant workers. This is because less profitable firms are more likely to be under pressure to reduce labor costs. If the causality, however, goes in the other direction, hiring of skilled immigrant workers at a lower wage might have contributed to the higher profitability.

By the same logic, the relation between SG&A and the probability of hiring H-1B workers would be negative if the motive for hiring skilled immigrants is to bring the high labor cost down, if the immigrants are lower cost substitutes for the host-country workers, and the cost reduction has been accomplished. On the other hand, if these workers are complements, then firms that hire skilled immigrant workers are also more likely to invest in education and training of their existing workforce, including the workforce from the host-country. In such cases, we expect to observe a positive relation. A counterargument could be made that the firms that have high current SG&A relative to the firms that do not hire skilled immigrant workers have started hiring skilled immigrant workers as a lower cost alternative to host-country workers, and hence this relation should be positive. In other words, a positive relation might require further analysis.

If there is a relation between hiring skilled immigrant workers and innovation, as argued by Ashraf and Ray (2017), we expect the relation between R&D expense and the probability of skilled immigrant hiring to be positive.

Finally, if skilled immigrant workers are hired because of their intellectual capital, and skilled workers are part of the intangible assets of a firm and not simply a cheap source of labor, these assets would likely lose value when a firm faces high financial distress risk. Because of the agency problem associated with debt (Jensen and Meckling, 1976), we expect the relation between leverage and the probability of hiring skilled immigrant workers to be negative.

Our core specification for testing these hypotheses takes the following form:

$$LCA_i^* = \mu_0 + \mu_1 \cdot SG\&A_i + \mu_2 \cdot ROA_i + \mu_3 \cdot R\&D_i + \mu_4 \cdot Leverage_i + \mu_5 \cdot X_I + \omega_i \quad (1)$$

where,

$$LCA_i = 1 \quad if \quad LCA_i^* > 0$$

and

$$LCA_i = 0 \quad if \quad LCA_i^* \leq 0$$

$$LCA_i = 1 \quad \text{if the i}^{th} \text{ firm hires skilled immigrant workers}$$

Other explanatory variables and how these have been constructed are provided in the Appendix Table A.1.

4. Results

4.1 Time Series Trend in H-1B Petition Filing and Approval Rate

During 2001–2011, an annual average of 120,000 initial employment petitions to hire new H-1B workers were filed. This includes H-1B workers hired by non-profit employers exempt from the quota. The annual average number of petitions filed for continued employment was 150,000 during that period.

Figure 1 shows the trend in the annual number of H-1B petitions filed for initial and continued employment from 2001 to 2011.
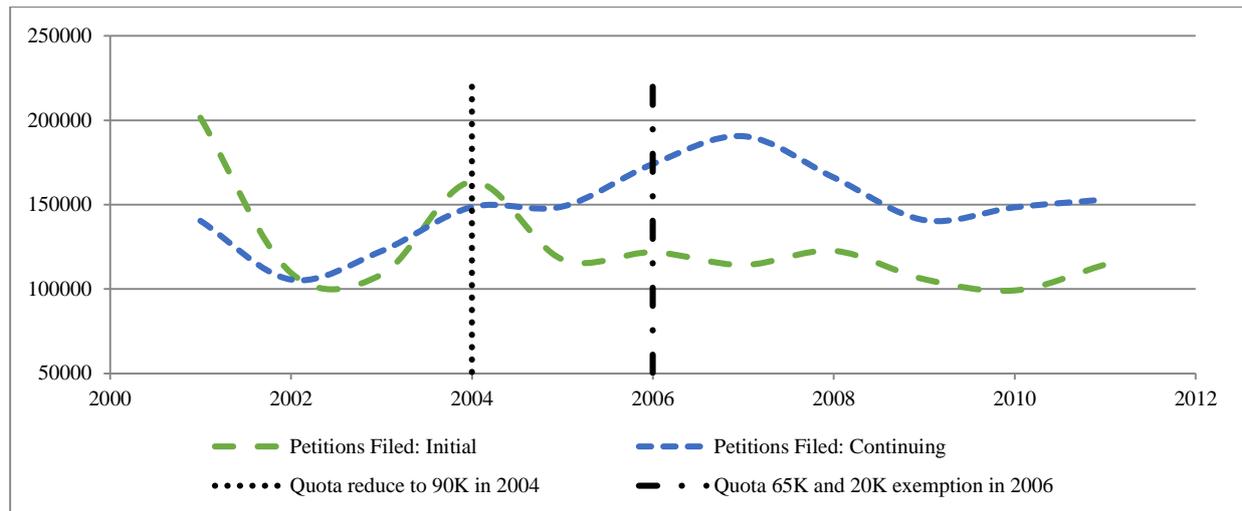

Figure 1. Number of Petitions Filed for Initial Employment and Continuing Employment for H-1B Workers This figure displays the number of petitions filed for initial and continuing employment for H-1B workers for the period 2001 to 2011.

Figure 2 shows the trend in the approval rate for the H-1B petitions filed for initial and continued employment category during the same period. The initial (continuing) employment approval rate is obtained by dividing the number of petitions approved for initial (continuing) employment by the total number of petitions filed for initial (continuing) employment for a given FY. The approval rate for both initial and continuing employment is above 100% in some years for the reasons explained in the previous section. On average, 90% (95%) of the H-1B petitions filed for initial (continuing) employment were approved during 2001–2011. In FY 2004, the year the H-1B quota reverted to 90,000, only 80% of the petitions filed for initial employment were approved, while the approval rate for continued employment was 106%.

The pattern reversed in 2007. During the economic crisis of 2008 to 2010, the approval rate declined for both types of petitions, but it declined first and recovered last for the initial employment petitions, and the rate of decline was also higher for this category. Therefore, when the H-1B visa cap is low and during a period of economic crisis, employers face more risk in filing petitions for initial employment than for continued employment. A higher rate of denied petitions can reduce the ability of H-1B dependent firms to screen and replace incumbent H-1B workers who have demonstrated sub-par performance with talent from the non-incumbent pool.
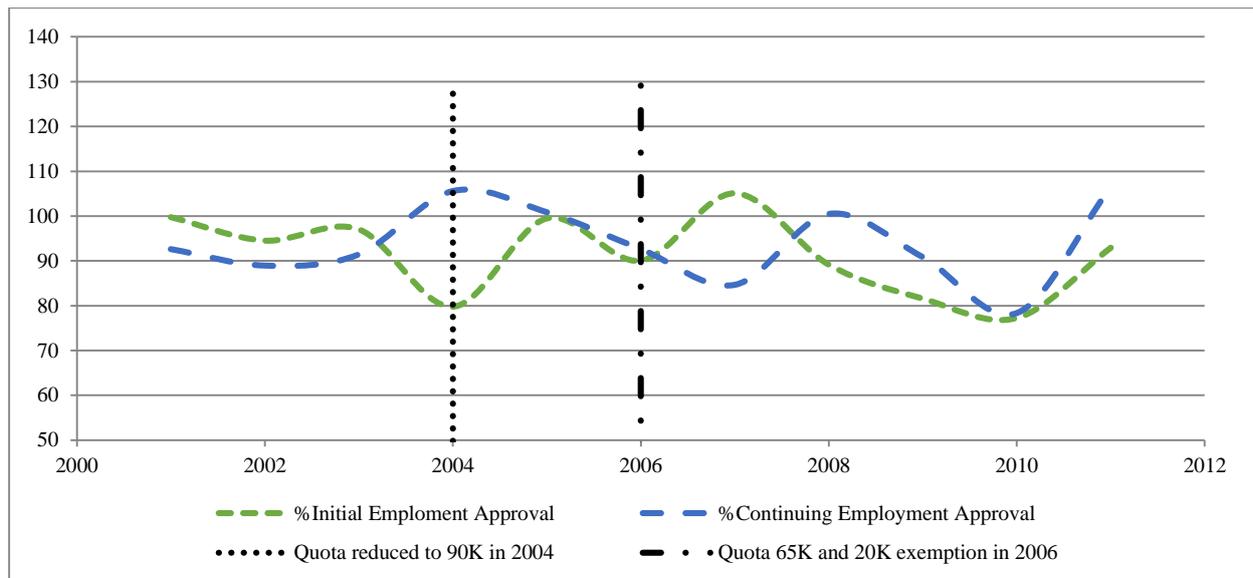
Figure 2. Approval Rate for H-1B Petitions Filed for Initial and Continuing Employment

This figure displays the approval rate for H-1B petitions filed for initial and continuing employment for the period 2001 to 2011. The percentage of initial (continuing) employment approval is obtained by dividing the number of petitions approved for initial (continuing) employment by the total number of petitions filed for initial (continuing) employment for a given fiscal year.

Until 2003, the number of petitions filed in the initial employment category was the same or slightly higher than the number of petitions filed for continued employment, as shown in Figure 1. In 2001, 60% of all the petitions approved belonged to the initial employment category, and the remaining 40% belonged to the continuing employment category as shown in Figure 3. Between 2002 and 2004, the rate of approval for petitions filed for initial employment declined, and that for continuing employment increased. After 2004, when the cap was reduced, the rate of petition approval for continuing employment started increasing and reached a steady state of 60% of all petitions filed in 2006, the year the basic quota was reduced to 65,000. Employers would eventually begin to file about 40,000 (35%) more petitions each year in the continuing employment category, not subject to quota, than in the initial employment category, which is subject to quota. These numbers also point to a higher retention rate of the known incumbent talent pool by the H-1B-dependent firms. This change suggests that the reduction in the H-1B quota might have imposed a binding constraint on employers in their practice of H-1B worker hiring and retention. Given the supply shortage in the non-incumbent H-1B worker pool, if the H-1B-dependent firms were forced to hire a higher fraction of their human capital from the known incumbent talent pool, then Tervio (2008) predicts a lower average level of future talent and output.
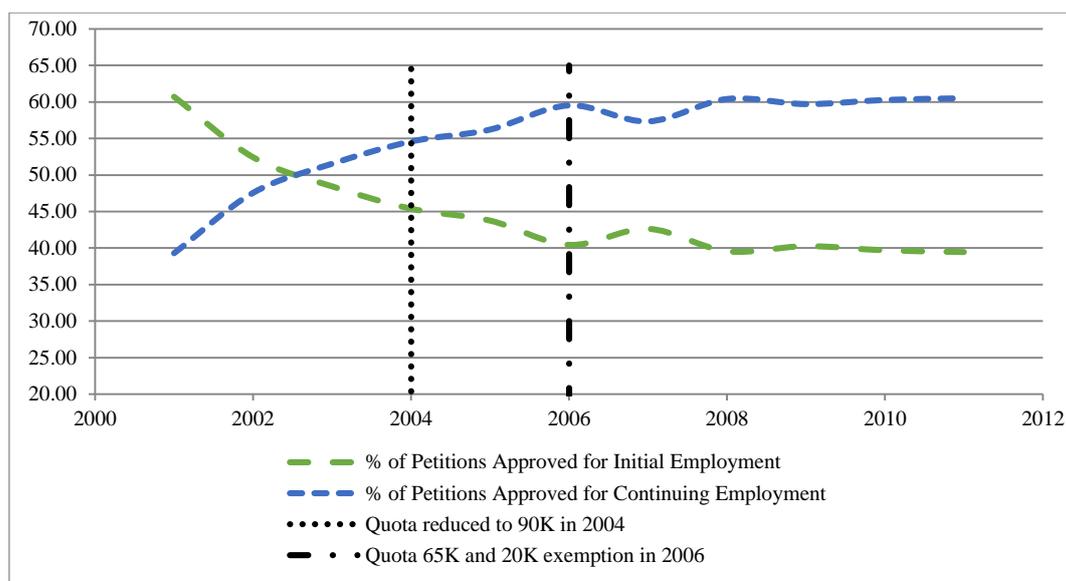
Figure 3. Relative Number of H-1B Petitions Approved for Initial and Continuing Employment Category
This figure shows the relative number of H-1B petitions approved for initial and continuing employment for fiscal years 2001–2011. The percentage of petitions approved for initial (continuing) employment is obtained by dividing the number of approved petitions for initial (continuing) employment by the total number of approved petitions, which is the sum of approved petitions for initial and continuing employment.

How did the 2004 immigration policy shock impact the hiring practices of U.S. employers? In Table 2 (shown later on page 25), we present a more formal analysis by comparing the non-parametric difference of means for skilled worker employment before and after the policy shock.

Before the shock 52% (48%) of the petitions filed were in the initial (continuing) employment category (Panel A of Table 2). After the shock it changed to 43% (57%). Thus, there was a statistically significant difference of 9% (-9%) for between the pre- and post- shock period for hiring in the initial (continuing) category. The overall approval rate also declined for all type of petitions – by 2% – from 94% before the shock to 92% after. But, more importantly, before the shock, the approval rate for initial (continuing) petitions was 97% (91%); after the shock it became 89% (95%). Hence, after the shock, at the margin, employers were better off filing petitions in the continuing employment category than in the initial employment category for two reasons. The first is that the continuing category was not subject to the cap, and the second is that the rejection rate by the USCIS for the initial employment category increased by more than 250% – from 3% rejection rate before the shock to 11% after the shock.

4.2 Skilled Immigrant Worker Educational Attainment and Age

About 46% of the skilled immigrant workers have a bachelors' degree, another 37% a masters' degree, and 16% a professional degree (for e.g. in business, law, medicine etc.) or a PhD as shown in Panel A of Table 1. This distribution holds for both the initial and the continued employment category in the pooled sample. However, when we break down the data on annual basis, a different pattern emerges.

Table 1. Summary Statistics of H-1B Petitions

The table presents summary statistics of H-1B petitions from the USCIS filings of Characteristics of Specialty Occupation Workers that are available in the Department of Homeland Security website for the fiscal year 2001 – 2011. All variables are defined in Appendix I. The table shows mean, median, maximum, minimum, and standard deviation of petition filing and approval rates by degree and age-cohort of the beneficiaries. In each fiscal year Characteristics filings report the number of petition filing and approval rates for all, initial and continuing employment. It also reports petitions approved by academic degree and age-cohort of beneficiaries for all, initial and continuing employment. Panel A reports the summary statistics of petition approval rate by degree and panel B reports the summary statistics of petition- approval rate by age-cohort.

Panel A: Educational Attainment of the Beneficiaries						
	Obs.	Mean	Median	Maximum	Minimum	Standard Deviation
% Bachelor approved all	11	46.09	45	57	41	4.93
% Masters approved all	11	36.73	39	42	30	4.43
% PhD and professional approved all	11	16.18	16	19	10	2.36
% Bachelor approved initial	11	45.59	43.7	58	40.7	5.00
% Masters approved initial	11	36.04	38	42.4	29.1	4.87
% PhD and professional approved initial	11	17.01	16.2	20.3	10.4	2.88
% Bachelor approved continuing	11	46.48	46.5	54.7	39.9	4.95
% Masters approved continuing	11	37.26	37.3	43.6	31.9	4.36
% PhD and professional approved continuing	11	15.32	15.9	17.5	10.4	1.94

Panel B: Age Cohort of Beneficiaries						
	Obs.	Mean	Median	Maximum	Minimum	Standard Deviation
% Age 25-29 all	11	34.55	33.9	41.9	32.1	2.62
% Age 30-34 all	11	31.75	32.3	34.8	25.8	2.65
% Age 35-39 all	11	15.15	15.3	16.4	12	1.18
% Age above 40 all	11	11.29	11.6	12.8	8.7	1.25
% Age 25-29 initial	11	41.23	42.4	46.1	33.7	3.57
% Age 30-34 initial	11	24.95	25.4	26.1	22	1.24
% Age 35-39 initial	11	10.84	10.2	14.3	9.1	1.64
% Age above 40 initial	11	8.72	8.4	14	6.2	2.55
% Age 25-29 continuing	11	29.91	27.5	41.9	25.9	5.19
% Age 30-34 continuing	11	37.06	37.9	40.8	31.5	2.91
% Age 35-39 continuing	11	18.34	19.3	19.9	13.9	1.89
% Age above 40 continuing	11	13.07	13.2	15.9	9	1.98

In 2001 almost 60% of the skilled immigrant workers hired for the initial employment category had a bachelors' degree, 30% had a masters' degree and the rest had a professional or a PhD degree, as shown in Figure 4. Beginning in 2004, the year of the immigration policy shock, there is a steady decline (increase) in the proportion of skilled immigrant workers hired that had a bachelors' (master's degree), as shown in Figure 4. This suggests that the reduction of quota posed a binding constraint in skilled immigrant hiring, and the 20,000 exemptions on the hiring of workers with a U.S. masters' degree has eased this constraint to an extent and simultaneously increased the share of skilled workers with a masters' degree. From 2005 onward, the bachelors' and a masters' degree holders constitute 40% each of all skilled immigrant workers. A similar pattern is observed for the continued employment category as shown in Figure 5. Between 2001 and 2003, just over 60% (30%) of all skilled immigrant

workers hired in this category had a bachelors' (masters') degree. After 2004, there is a decline (increase) in hiring of workers with a bachelors' (masters') degree in this category. If the relative proportion of skilled workers with a masters' degree increase in the initial employment category cohorts, then they are likely to increase in the continued hiring category as well, holding all else constant. Hiring of skilled workers with a PhD and a professional and degree are relatively constant during this period for both category of workers at just over 10% and 5%, respectively.
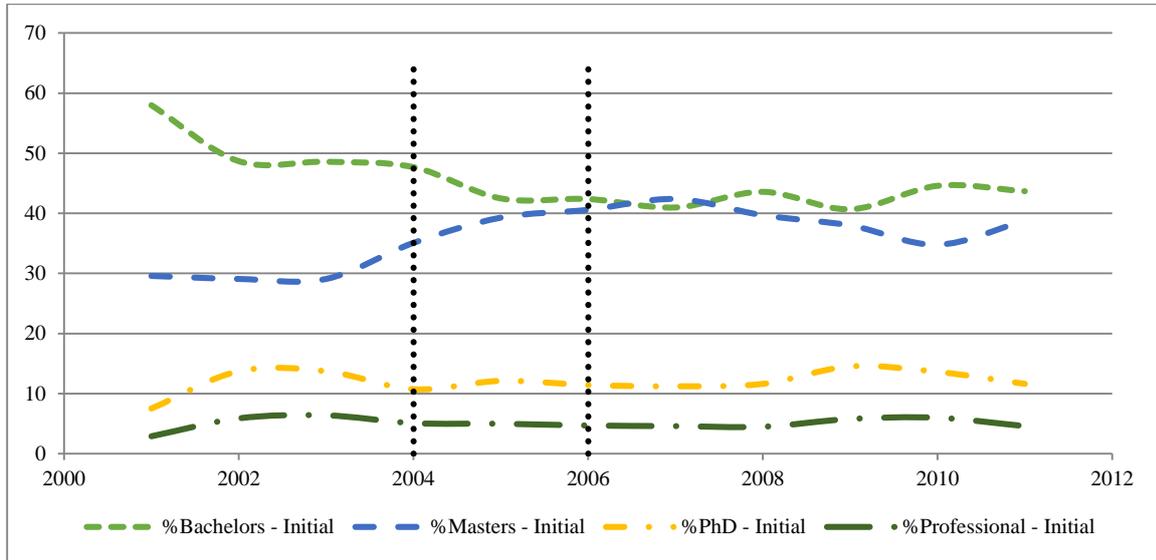

Figure 4. Percentage of Petitions Approved for Initial Employment Clustered by Level of Education of the H-1B Applicants: 2001– 2011
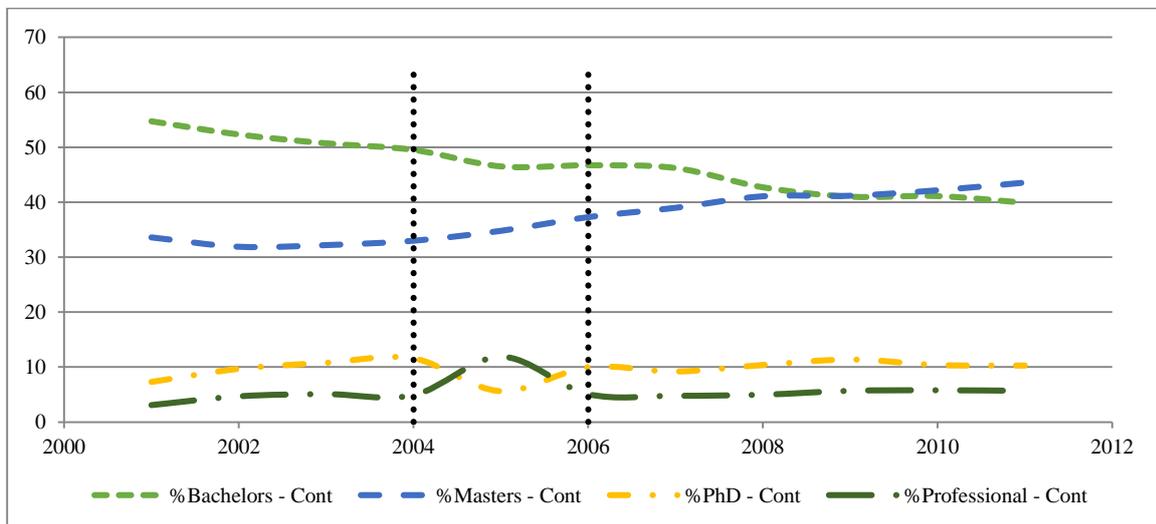

Figure 5. Percentage of Petitions Approved for Continuing Employment Clustered by Level of Education of the H-1B Applicants: 2000 –2011

Overall, while the proportion of petitions approved for H-1B workers with a master's degree increased after 2004, it declined for workers with a bachelor's degree. The shift in hiring policy appears permanent. The trend to hire a higher proportion of immigrant workers with a

master's degree in the initial employment category is mechanical owing to the 20,000 quota for advanced-degree holders from U.S. institutions. The shift in the continued employment category can also be explained in the following manner. If more of the non-incumbent skilled workers are being hired to fill the 20,000 additional quota, and the constraint on hiring non-incumbent skilled immigrants resulted in a higher retention rate for the workers in the continued employment category, then the compounding effect of both these factors over time will result in a permanent shift toward hiring a higher proportion of skilled immigrant workers with a master's degree.

These graphical relations are more formally tested and results presented in Panel A of Table 2. Before the immigration policy shock 52% (31%) of all skilled immigrants hired had a bachelors' (masters') degree but after the shock 44% (39%). Thus, the fraction of skilled workers with a bachelors' degree declined by a statistically significant 16% and there was a 25% increase in the fraction of workers with a masters' degree. The proportion of skilled immigrant workers in a professional and a PhD degree also increased moderately, from 15% to 17%, a 10% increase. A consequence of hiring more workers with an advance degree would be an upward shift in age.

About 35% of the petitions filed are for the age group 25-29, 32% are for the age group 30-34, and another 15% and 11% are for the age group 35-39, and 40 and above, respectively (Panel B of Table 1). If we partition the data in the initial and the continuing employment category, these numbers, however, look very different. In the initial employment category almost 42% of the skilled immigrant workers are in the youngest age group, 25% and 11% are in the age group of 30-34 and 35-39, and the remaining 9% are in the oldest age group. Mechanically, we would expect a lower fraction of immigrant workers in the youngest age group for the continuing employment category because these petitions are being filed when the skilled immigrant workers have already worked for their H1-B employers for almost three years, and many of those who were in the youngest cohort at the time of initial employment might have transitioned to a higher age cohort. Therefore, we know that 30% of the skilled immigrant workers hired under the continuing employment category were younger than 27 at the time of their initial employment. At the continuing category, 37% and 18% of the skilled workers are in the age group of 30-34 and 35-39, respectively, and another 13% are at least 37 years old at the time of their initial employment.

Did the change in immigration policy result is a shift in the characteristics of the skilled immigrant workers? On the one hand, if the immigration policy shock had resulted in hiring more skilled immigrants with advanced degree because of the additional 20,000 quota, all else being equal, we would expect the average age of skilled immigrants hires to increase. On the other hand, we also expect employers to become more selective in their hiring practice when faced with a supply shock and to hire younger workers. Which of these two effects would dominate is an empirical question.

Figure 6A shows the age cohort of the skilled immigrants when they were hired initially. The share of skilled immigrants hired in the youngest age cohort (25-29 years) increased at the expense of the oldest two cohorts while it did not change for the second oldest cohort (30-34 years). The reverse happened for the skilled immigrant hiring in the continuing category as shown in Figure 6B. This is consistent with the findings by Watts (2001) that there may be a shortage of labor in the area of latest computer programming and software. Hiring skilled immigrant workers in the youngest age cohort is a low cost mechanism to ensure that these workers have the latest knowledge of the field. This also suggests that the substitution or the

crowding-out effect for older workers are not unique for the host-country workers (Kerr et al., 2015) and is also prevalent among the skilled immigrants.

Table 2. H-1B petitions characteristics before and after 2004

Panel A compares the petition filing and approval rate for initial and continuing employment before and after 2004. Panel A also reports the mean approval rates categorized by the academic degree and age-cohort of the beneficiaries before and after 2004. Panel B compares the approval rates for the initial and continuing employment categories based on academic degree and age-cohort of the beneficiaries before and after 2004.

Panel A: H-1B Petition Characteristics: Before and After 2004			
	Before	After	p-Value for Difference
	Mean	Mean	
Petitions filing and approvals			
% Petitions filed initial	52.27	42.91	0.00
% Petitions filed continuing	47.73	57.09	0.00
% Petitions approved	94.23	92.18	0.03
% Petitions approved initial	53.87	41.41	0.00
% Petitions approved continuing	46.13	58.59	0.00
% Initial filed approved	97.11	89.42	0.00
% Continuing filed approved	91.01	94.99	0.00
Beneficiaries degree			
% Bachelor approved	52.33	43.75	0.00
% Masters approved	30.67	39	0.00
% PhD and professional approved	15	16.63	0.00
Beneficiaries age			
% Age 25-29	37.2	33.56	0.00
% Age 30-34	28.5	32.97	0.00
% Age 35-39	14.17	15.52	0.00
% Age above 40	11.37	11.26	0.59

| Panel B: Difference between Initial and Continuing Beneficiaries: Before and After 2004								
	Mean				p-Value for Difference			
	Before		After		Initial vs. Continuing		Before vs. After Shock	
	Initial	Continuing	Initial	Continuing	Before	After	Initial	Continuing
Beneficiaries degree								
% Bachelor approved	51.77	52.57	43.27	44.2	0.23	0.00	0.00	0.00
% Masters approved	29.27	32.57	38.59	39.02	0.00	0.23	0.00	0.00
% PhD and professional approved	16.7	13.57	17.12	15.97	0.00	0.00	0.34	0.00
Beneficiaries age								
% Age 25-29	37.23	37.30	42.73	27.14	0.92	0.00	0.00	0.00
% Age 30-34	24.43	33.27	25.15	38.49	0.00	0.00	0.00	0.00
% Age 35-39	12.73	15.73	10.12	19.32	0.00	0.00	0.00	0.00
% Age above 40	11.77	11.07	7.57	13.83	0.08	0.00	0.00	0.00
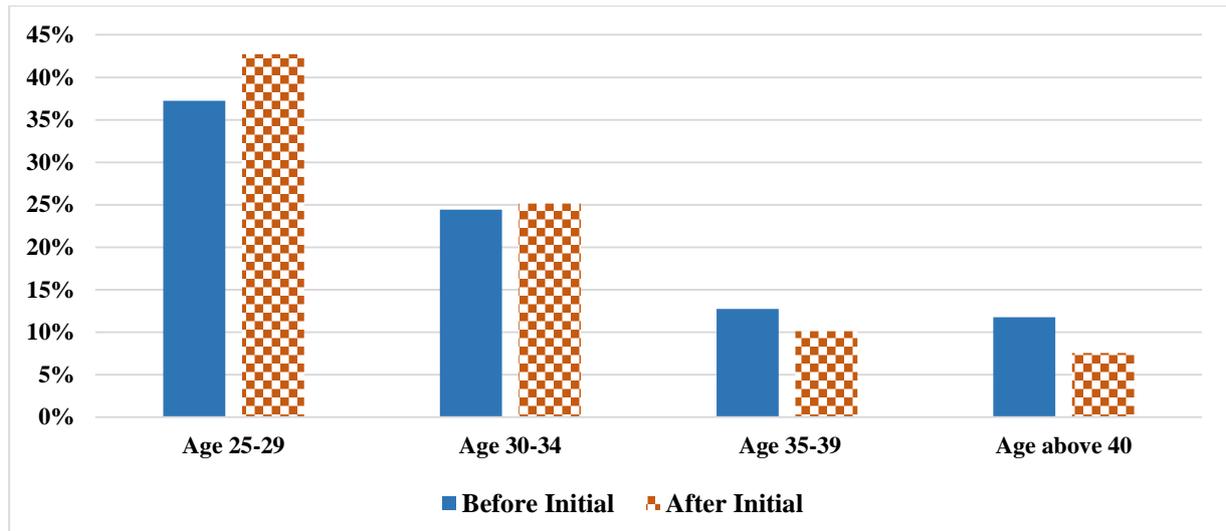
Figure 6A. Age Cohort of Skilled Immigrant Workers Hired for the Initial Filing Category
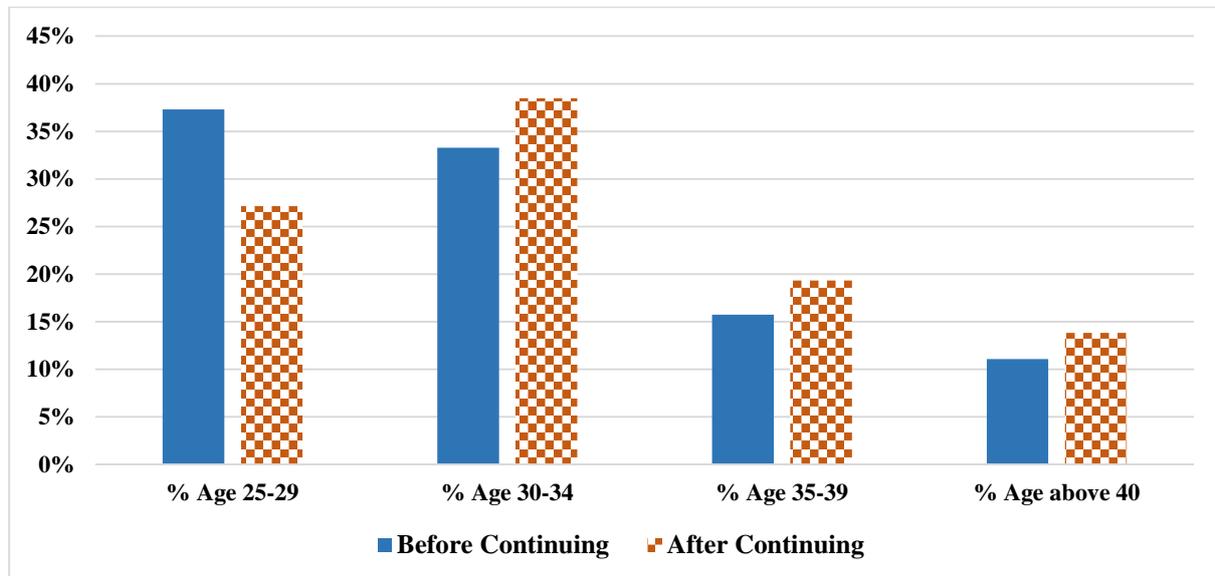

Figure 6B. Age Cohort of Skilled Immigrant Workers Hired for the Continuous Filing Category

Why are these effects observed for the skilled workers hired in the initial category but not in the continuing category? There may not have been very many skilled immigrants that have earned a bachelors, perhaps participated in the labor market in the country of origin and/or earned a master's degree in the U.S., worked on H-1B visa for three years and still are 29 or younger. In addition, given a greater share of skilled immigrants hired after the shock have a masters' degree, that would tend to push the average age of the two youngest cohorts up at the time of the initial hiring and this effect would likely carry over for the skilled immigrants hired in the continued category also after the policy shock.

Hence, we test these relations more formally in Panel A of Table 2. Before the shock 37% (29%) of all skilled immigrant workers hired were in the 25-29 (30-34) year old age group, but after the shock it was 34% (33%). Thus there was a 10% decline in the proportion of youngest

cohort of workers hired and a 13% increase in the proportion of workers hired in the second oldest age cohort. The impact on the third oldest age cohort is also similar – a 10% increase in the proportion of workers hired in this group – but the effect is negligible for the oldest age cohort, both economically and statistically.

More importantly, before the shock 37% of initial skilled immigrant workers hired were in 25-29 year old age group, but after the shock it became 43%. Thus, there was a 16% increase in hiring workers in the youngest age cohort in the initial employment category, and a 21% and 36% decline, respectively, for the two oldest ago cohorts in this category. The second youngest age category also saw a small 3% increase in relative hiring.

Before the policy shock 37% (33%) of immigrant workers in the continued employment category were in the 25-29 (30-34) year-old age cohort, but after the shock 27% (38%) belonged to this group. This suggests a 27% decline (16% increase) after the shock. The two oldest age cohorts also saw a 23% - 25% increase in their relative share of employment in the continued employment category. Overall, the upward shift for younger cohort of workers in the initial employment category and the upward shift for older cohorts for the continued employment category seen in Figure 6 are confirmed by more formal tests.

4.3 Occupational Specialization among Skilled Immigrant Workers

A total of 1.3 million skilled immigrants were hired in the computer related occupations during our sample period. This is the largest occupation category for skilled immigarnts. Computer related occupations consists of the following job codes, for e.g. Software Engineer, Programmer, Application Developer, Computer System Analyst, Application/System Architect. These results are consistent with the conjecture in Ottaviano et al. (2013) about occupational specialization among immigrant-, host-country- and offshore- workers based on skills. Other large categories of employment for skilled immigrant workers are education, administrative specialization, medicine and health, architecture, engineering, and survey.

Before the immigration policy shock, about 36% (55%) of initial (continuing) petitions filed were for computer related occupations, but after the policy shock it became 46% (47%), as shown in Table 3. This implies that employers want to hire a certain number of new skilled immigrants in computer related occupations and because of the quota shock, they could hire fewer absolute number of workers in the occupation, but among all workers hired, the relative share of this occupation increased. Before the policy shock the retention rate was higher in this occupation, but after the shock, the retention rate declined for skilled immigrant workers in these occupations. One conjecture is that given the hiring constrained, employers want to hire workers already trained in the latest development in the field and apply a finer filter to screen the workers before contract renewal instead of training existing workers through a continuing education program. The reverse is observed for occupations in Life Science, Medicine, Social Sciences, Mathematics, Professional and Technical occupations and in education. In these fields, on-the job experience accumulated by the workers that have spent three years on the job seem to outweigh the benefit of training or education in the latest developments in the field. The relative share of the skilled immigrant worker hiring in the remaining major occupations are not as significant economically (Table 3).

Table 3. Petitions Approval and Change in Compensation for Major Occupation Groups: Before and After 2004

This table displays percentage of petitions approved for all, initial, and continuing employment before and after the year 2004 for major occupation categories. USICIS filings of Characteristics of Specialty Occupation Workers report petitions approval rates for 17 major occupation categories for all, initial and continuing employment. On the basis of these 17 major groups we construct 6 groups. Major categories in USCIS with more than 10 percent approval rate over all categories on average are maintained as single group and they are: Computers, Architecture and Engineering, Education, Administrative Specialist. With less than 10 percent approval rate on average, we collapse the USCIS major categories into two groups: Life Science, Medicine, Science & Technology and Law, Arts & Entertainment. %Petitions Approved All for a job category is the number of petitions approved for that occupation group divided by the total number of petitions approved for all occupation categories with known job codes for a given fiscal year.   %Petitions Approved Initial for a job category is the number of initial petitions approved for that occupation group divided by the total number of initial petitions approved for all occupation categories with known job codes for a given fiscal year. %Petitions Approved Continuing for a job category is the number of continuing petitions approved for that occupation group divided by the total number of continuing petitions approved for all occupation categories with known job codes for a given fiscal year.

| | %Petitions Approved | | | | | |
| | All | | Initial | | Continuing | |
	Before	After	Before	After	Before	After
Computer-Related Occupations	44.93	46.91	35.98	46.36	54.58	47.24
Occupations in Architecture, Engineering, and Surveying	12.51	11.36	12.93	10.59	11.96	11.93
Occupations in Education	8.96	10.11	11.29	10.75	6.50	9.74
Occupations in Administrative Specializations	9.55	9.06	11.52	9.32	7.44	8.88
Life Science, Medicine, Social Sciences, Mathematics, Professional and Technical	20.50	19.64	23.83	19.69	16.96	19.63
Occupations in Law, Arts and Entertainment	3.54	2.91	4.44	3.29	2.55	2.65

At the firm level, about 55% of all the skilled immigrant workers hired are in computer-related occupations, 25% in science (including social science), mathematics, and other technical profession, 12% in engineering and architecture, another 6% in occupations with administrative specialization and about 2% in law, arts, and entertainment (Panel A of Table 4). Thus, the demand for the first two occupations are higher at the firm-level than the aggregate demand of these occupations in the U.S., and the demand is lower for the rest of the major occupational categories.   This is particularly true for educational occupation, demand for which comes almost exclusively from the non-profit sector.

Table 4. Distribution of Occupations in LCA Filings for Compustat Matched H-1B Firms

The table provides distributions of occupations according to the LCA Filings by H-1B firms in the Compustat universe for the period 2002-2011. Panel A represents within sample variation in LCA filings for various occupations and Panel B represents across firms variation in LCA filings for various occupations. For example, *Computer-Related Occupations (%)* in Panel A is the percentage of LCA applications by an H-1B firm in computer related occupations. *Computer-Related Occupations (%)* in Panel B is the number of LCA applications by an H-1B firm in a given year for computer related occupations relative to total number of LCA applications for those occupations among the sample firms. Others are defined similarly.

Panel A					
	Mean	Median	Maximum	Minimum	Standard Deviation
Distributions of Occupations in LCA Filings					
Computer-Related Occupations (%)	55.12	57.14	100.00	0.00	34.16
Occupations in Architecture, Engineering, and Surveying (%)	12.15	0.00	100.00	0.00	23.07
Life Science, Medicine, Social Sciences, Mathematics, Professional and Technical (%)	25.02	13.82	100.00	0.00	27.29
Occupations in Education (%)	0.03	0.00	6.89	0.00	0.27
Occupations in Administrative Specializations (%)	5.88	0.54	100.00	0.00	10.84
Occupations in Law, Arts and Entertainment (%)	1.64	0.00	91.30	0.00	8.07

Panel B					
	Mean	Median	Maximum	Minimum	Standard Deviation
Distributions of Occupations in LCA Filings					
Computer-Related Occupations (%)	0.36	0.10	19.48	0.00	1.23
Occupations in Architecture, Engineering, and Surveying (%)	0.38	0.01	27.98	0.00	1.42
Life Science, Medicine, Social Sciences, Mathematics, Professional and Technical (%)	0.37	0.10	11.93	0.00	0.91

A distribution of the intensity of hiring workers at the firm level in the top three occupation categories is provided in Panel B of Table 4. This suggests that on average a firm hired just over one third of one percent of skilled immigrant supply and it would take almost 300 such firms to employ all skilled immigrants in each of these three occupation categories. The largest employer in computer related occupations, however, hired 19% of the available supply of skilled immigrants for these occupations. The corresponding numbers for the architecture, engineering, and survey and life science, medicine, social science related occupations were 28% and 12% respectively.

4.4 Characteristic of Firms that Hire Skilled Immigrant Workers

Firms in the Compustat universe that hire skilled immigrant workers are significantly larger with a mean (median) size of 16.2 (2.6) billion dollars in asset compared to 3.2 (0.2) billion dollars for the firms that do not hire skilled immigrant workers, as shown in Table 5. The mean (median) revenue for the firms with skilled immigrant employees are 8.3 (2.0) billion dollars relative to 1.3 (0.08) billion dollars for the firms without such employees. The mean (median) employer with skilled immigrant workers have 33,000 (9,000) employees on payroll relative to 5,000 (400) employees for those without. Mean (median) market value of equity is also higher for the firms that hire skilled immigrant workers at 10.0 (3.2) billion dollars relative to 1.4 (0.1) billion dollars for firms that do not hire skilled immigrants. Thus, on average

the firms that hire skilled immigrant workers are much larger in size.

Firms that hire skilled immigrant workers are expected to have a lower leverage, and hence lower risk of financial distress, an important consideration where employees' skills and talents are critical assets for a firm's success. The mean (median) leverage are 0.20 (0.15) and 0.37 (0.17) for firms that hire skilled immigrant workers and those that do not hire such workers, respectively. Thus, the leverage for employers that do not hire skilled immigrants is highly skewed and is driven by a few firms with very high leverage, and this gets reflected in the much higher standard deviation of leverage for these firms. Yet, these firms are also less profitable than those that hire skilled immigrants. The mean (median) return on investments or ROAs are 11% (11%) and -28% (6%) for firms that hire skilled immigrant workers and those that do not hire such workers, respectively. Once again, the data for the latter group are highly skewed, and a few firms with very large negative ROA are contributing to the mean negative ROA value for the firms that do not hire skilled immigrants.

Table 5. Summary Statistics of H-1B and Non-H-1B firms from Compustat Universe: 2002-2011

The table provides summary statistics of H-1B and non-H-1B firms from Compustat universe for the period 2002-2011. A sample firm is identified as an H-1B firm if it files one or more LCA with the DOL in any of the sample years 2002-2011. H-1B firm is then matched with Compustat data by firm name to create the Compustat matched H-1B sample. The remaining firms in the Compustat universe are identified as non-H-1B firms. The total number of H-1B firm (firm-year) is 659 (5,764) and non-H-1B firm (firm-year) is 17,361 (105,982). All variables are winsorized at the 1st and 99th percentile levels and expressed in 2001 dollars.

	Mean		Median		Standard Deviation	
	H-1B (N=5,764)	Non H-1B (N=105,982)	H-1B	Non H-1B	H-1B	Non H-1B
Firm Characteristics						
Assets ($mill)	16,219	3,245	2,567	176	32,742	13,780
Sales ($mill)	8,258	1,348	2,029	78	12,502	4,819
Number of employees (Thousands)	33.37	5.24	8.95	0.38	55.06	16.81
Tobin's Q	2.20	4.58	1.71	1.38	2.39	14.98
ROA	0.11	-0.28	0.11	0.06	0.33	1.68
Leverage	0.20	0.37	0.15	0.17	0.29	0.89
Market-to-Book	3.19	2.24	2.48	1.56	6.04	8.47
R&D	129.96	12.93	28.52	0.00	195.61	61.13
R&D/Asset	0.055	0.054	0.02	0.00	0.09	0.17
SG&A	1,480.87	202.34	433.08	18.77	2,253	800
SG&A/Sales	0.41	0.89	0.30	0.27	1.04	3.06
Market Value of Equity	10,067.34	1,359.72	3,234.22	110.42	14,201	5,042

A higher market-to-book ratio for firms that hire skilled immigrants – a mean (median) of 3.2 (2.5) vs. 2.2 (1.6) for the firms without skilled immigrant workers suggest that the former have more intangible asset, potentially higher information asymmetry, and potentially high growth. Surprisingly, the median Tobin's q for the firms that hire skilled immigrants is higher at 1.7 relative to 1.4 those that do not hire such workers, but the opposite effect is observed for the average, 2.2 and 4.6 respectively. This indicates that the distribution for Tobin's q for the firms that do not hire skilled immigrant workers is also highly skewed with a very high standard deviation.

Firms that hire skilled immigrant workers spend a mean (median) of $ 130 (29) million in research and development or R&D on average, while those such expenditures are 13 (0) million

dollars for the firms that do not hire skilled immigrants. When the R&D expense is normalized by total assets as a measure of firm size, we observe that both groups spend similar amount on average, 5.5% of total asset on R&D.

We expect the firms that hire skilled immigrant workers to spend more on selling, general, and administrative expense, or SG&A, because the revenue generated by these firms are much higher.   In addition, SG&A is also a measure of organization capital (Li et al., 2017), a large part of which consists of expenses related to labor and information technology expense, such as white collar worker wages, training, consulting, and information technology expenses. The mean (median) SG&A is 1.5 (0.4) billion dollars for these firms compared to 0.2(0.02) billion dollars for firms that do not hire skilled immigrants.

4.5 Determinants of Skilled Worker Employment at the Firm and Occupation Level – Multivariate Analysis

Large firms with high research and development intensity tend to hire skilled immigrant workers. One standard deviation (16 billion dollars) increase in assets is associated with a 48% higher probability that a firm hires an H-1B worker, as shown in Table 6.   It is not surprising that large firms are more likely to hire H-1B workers because the fixed costs (e.g. legal, documentation, advertisement fees etc.) associated with hiring such workers get distributed over a larger payroll and these costs do not add significantly to the operating leverage for large firms.   An increase in the number of employees by one standard deviation (23,000 employees) is associated with a 97% increase in the probability of the firm hiring an H-1B worker.   As the number of employees is correlated with firm size, this is a reasonable finding.

In contrast, one standard deviation (84 million dollars) increase in R&D expense, – which has the best explanatory power for hiring skilled immigrants – is associated with a 198% higher probability that a firm hires an H-1B worker.   This is also consistent with our expectations. Those firms that make a large capital investment in research and innovation are also more likely to hire highly skilled employees regardless of their country of origin.   Thus, we are able to reject the alternative hypothesis that there is no relation between a firm's investment in R&D and its choice to hire skilled immigrant workers.

Surprisingly, we observe no relation between a firm's normalized SG&A and its choice to hire skilled immigrants. Thus, we are unable to answer whether skilled immigrants are substitutes or complements to the host-country workers using this measure.   We also observe a weak positive relation between a firm's profitability and its choice of hiring skilled immigrant workers.   Economically, a one standard deviation or 168% increase ROA is associated with 34% higher probability of an employer hiring skilled immigrant workers.   Taken together, results from the SG&A and ROA effects are inconclusive on whether high-skilled immigrants "crowd-out" or substitute host-country workers or complements them and the debate continues.

One standard deviation (14.5) increase in Tobin's q is associated with a 58% higher probability of an employer hiring skilled immigrant workers.   Tobin's q is a measure of long-term growth for a firm.   We expect innovative firms that make large investment in financial and human capital are likely to have high growth and profitability.   Another proxy for long-term growth is the market-to-book ratio.   We observe a 13% higher probability of a firm hiring skilled immigrant workers when the market-to-book ratio increases by one standard deviation (8.3).

Finally, one standard deviation (84%) increase in leverage is associated with a 74% decline in probability of hiring skilled immigrant workers.   When the most important assets of a firm

are intangibles such as patents, employees, in process R&D etc., – as opposed to physical assets – firms are less likely to be highly levered because of the high cost of financial distress. Thus, we are also able to reject our alternative hypothesis that leverage or potential risk of financial distress has no impact on a firm's choice of hiring skilled immigrant workers. In addition, USCIS asks for employers to provide evidence of financial ability to pay wages to the skilled immigrant workers, which may be difficult to demonstrate for a highly levered firm.

Table 6. Characteristics of H-1B Firms: Logistic Regression

The dependent variable *H-1B Firm* takes the value equal to 1 if a firm is an H-1B dependent firm, that is it submits LCA filings to the DOL any year from 2002 to 2011, and 0 otherwise. The regression models include year dummies. The values reported here are odds ratio; the *t*-statistics are reported in parentheses and are based on robust standard errors clustered at the firm level. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)
Ln(asset)	1.442***	1.173***
	(16.30)	(2.89)
Ln(R&D)	1.396***	1.448***
	(14.63)	(11.66)
Ln(Employee)		1.310***
		(5.46)
SG&A/Sales		0.990
		(-0.76)
Tobin's Q		1.040***
		(7.27)
ROA		1.208*
		(1.65)
Leverage		0.149***
		(-4.82)
Market-to-Book		1.016***
		(3.05)
Constant	0.005***	0.020***
	(-39.03)	(-13.61)
Observations	73,787	44,144
Year Dummies	Yes	Yes
Pseudo R-squared	0.225	0.269

What determines the intensity of hiring skilled immigrants? Size is the largest factor associated with this choice. Among the firms that hire skilled immigrants, one standard deviation increase in firm size (33 billion dollars) is associated with 376% increase in the number of skilled immigrants that are hired as shown in Panel A of Table 7. Adding R&D expense to the regression has no effect – either economic or statistical – and does not improve the explanatory power. This is expected because the specifications have firm- and year- fixed-effects. Because R&D investment is a sticky variable that does not change much over time or across the firms, we do not expect this variable to be of any significance. On the other hand, size contributes to about 13% of the overall explanatory power.

If we perform the analysis with the industry fixed-effect instead of the firm-fixed effect, the results are very similar as shown in Panel B of Table 7. Among the firms that hire skilled immigrants, one standard deviation increase in firm size (33 billion dollars) is associated with 305% increase in the number of skilled immigrants. The R-square of the regression, however,

drops to 0.29, or by 30% and the constants become significant. In addition, if we now drop firm size, the R-square further declines to 0.07, a 75% decline and clearly this is not a very well specified model.   In the absence of firm- fixed-effect and firm size, R&D becomes a significant variable in explaining the intensity of a firm hiring skilled immigrant workers because R&D is likely to be correlated with firm size within a specific industry.

Table 7. Relation between Firm Size and Number of LCA Applications
The table presents the relation between number of H-1B LCA applications and firm size. Panel A includes firm- and year- fixed-effects and Panel B includes industry- and year-fixed effects. All variables are winsorized at the 1st and 99th percentile levels and expressed in 2001 dollars. Values of *t*-statistics are reported in parentheses and are based on robust standard errors clustered at the firm (industry) level in Panel A (Panel B). ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Panel A		
	(4)	(5)	(6)
Ln(asset)	0.380***		0.380***
	(7.54)		(7.53)
Ln(R&D)		0.005	-0.001
		(0.54)	(-0.08)
Constant	0.281	3.23***	0.282
	(0.70)	(45.16)	(0.70)
Observations	2,323	2,324	2,323
R-squared	0.42	0.37	0.42
Number of Firms	592	593	592
Year F.E.	Yes	Yes	Yes
Firm F.E.	Yes	Yes	Yes

	Panel B		
	(1)	(2)	(3)
Ln(asset)	0.317***		0.319***
	(7.82)		(7.91)
Ln(R&D)		0.088***	-0.004
		(5.33)	(-0.31)
Constant	0.989***	3.306***	0.987***
	(2.75)	(36.93)	(2.75)
Observations	2,268	2,268	2,268
R-squared	0.29	0.07	0.29
Number of Firms	156	156	156
Year F.E.	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes

What influences skilled immigrant hiring at the occupation level? Among the firms that hire skilled immigrants, one standard deviation increase in firm size (33 billion dollars) is associated with 56% increase in the number of skilled immigrants hired in computer-related occupations, as shown in Table 8. We also observe a 43% increase in skilled immigrant hiring in occupations in engineering and architecture for the same increase in firm size. The most robust statistical relationship is observed in life science, medicine, social sciences, mathematics, professional, and other technical occupations, where a 33 billion dollars increase in size is associated with a 40% increase in hiring of immigrants with these specific skills. For occupations in science and mathematics, one standard deviation increase in R&D (85 million dollars) is associated with a 37% increase in skilled immigrant worker hiring and for these

occupations the impact of R&D expense is considerable in both the explanatory power and the numbers of workers hired. R&D has the weakest effect on the computer related occupations.

Table 8. H-1B Firms and LCA Applications in Different Occupations

The dependent variable *Occupations in Computer-Related (%)* in models 1, 2, and 3 is the number of LCA applications filed by an H-1B firm in a given year for computer related occupations relative to total number of LCA applications for those occupations among the sample firms. The dependent variable *Occupations in Engineering and Architecture (%)* in models 4, 5, and 6 is defined as above for engineering, architecture or surveying related occupations. The dependent variable *Occupations in Science and Mathematics (%)* in models 7, 8, and 9 is defined as above in life science, medicine, social sciences, mathematics, professional and technical related occupations. All models include year and industry fixed effects. All variables are winsorized at the 1st and 99th percentile levels and expressed in 2001 dollars. Values of *t*-statistics are reported in parentheses and are based on robust standard errors clustered at the industry level. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Occupations in Computer-Related (%)			Occupations in Engineering and Architecture (%)			Occupations in Science and Mathematics (%)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(Asset)	0.161**		0.153*	0.150*		0.124*	0.116***		0.101***
	(2.03)		(1.78)	(1.99)		(1.85)	(4.99)		(4.83)
Ln(R&D)		0.063***	0.013		0.083**	0.043		0.056***	0.023*
		(3.52)	(0.82)		(2.02)	(1.55)		(3.92)	(1.93)
Constant	-0.520	0.578***	-0.509	-0.328	0.592***	-0.290	-0.308	0.433**	-0.288
	(-0.92)	(8.63)	(-0.89)	(-0.57)	(3.26)	(-0.51)	(-1.13)	(2.49)	(-1.12)
Observations	2,303	2,304	2,303	2,303	2,304	2,303	2,303	2,304	2,303
R-squared	0.06	0.03	0.06	0.05	0.04	0.06	0.10	0.06	0.10
Number of Industry	52	52	52	52	52	52	52	52	52
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5. Conclusions

There is an ongoing debate on the current U.S. immigration policy, including policy for skilled worker immigration. We contribute to this literature by establishing how the skilled worker employment has changed in the U.S. in terms of worker characteristics such as age, educational attainment, and skill or occupation since the immigration policy change of 2004. We establish the nature of the firms that are more likely to hire skilled immigrants, the intensity of skilled immigrant hiring, and the occupations where the skilled immigrant workers are most in demand. We find that larger firms that invest heavily in R&D and that have high growth are more likely to hire skilled immigrants. Consistent with theory, these firms also have lower financial distress risk. The intensity of skilled immigrant hiring increases in firm size. Most of the demand for skilled immigrants is in computer-related occupations, in science and mathematics, and in engineering and architecture. We are not able to eliminate either of the hypotheses regarding skilled immigrants acting as substitutes or complements for the host-country workers. Younger skilled immigrants, however, may be substitutes for their older counterparts, i.e. older skilled immigrants. Skilled immigrants also seem to be correlated with firm-level capital investment in research and innovation for occupations related to science and mathematics.

Our findings should be interpreted with caution. What we document here are correlation and not causal relations. It's quite possible that choice regarding some of our outcome variables are jointly determined with the choice of hiring skilled immigrant workers, and in some cases,

such as Tobin's q and SG&A, the direction of causality might even be reversed. Our contribution is to establish that a relation exists that is consistent with some of the existing corporate finance theories and economic intuition, and we leave the specific channels through which these relations are established for future researchers to explore in greater detail.

References

Ashraf, Rasha, and Rina Ray, 2017, "Human Capital, Skilled Immigrants, and Innovation," University of Colorado Denver working paper.

Borjas, George J., 2005, "The Labor-Market Impact of High-Skill Immigration." *The American Economic Review Papers and Proceedings*, 95, 56-60.

Borjas, George J., 2007, "Do Foreign Students Crowd Out Native Students from Graduate Programs," in *Science and the University*, edited by Ronald G. Ehrenberg and Paula E. Stephan, University of Wisconsin Press.

Borjas, George J., 2009, "Immigration in High-Skill Labor Markets: The Impact of Foreign Students on the Earnings of Doctorates," in *Science and Engineering Careers in the United States*, edited by Richard B. Freeman and Daniel L. Goroff, University of Chicago Press.

Borjas, George J. and Kirk B. Doran, 2012, "The Collapse of the Soviet Union and the Productivity of American Mathematicians", *Quarterly Journal of Economics*, 127, 1143-1203.

Borjas, George J. and Kirk B. Doran, "Cognitive Mobility: Labor Market Responses to Supply Shocks in the Space of Ideas," *Journal of Labor Economics*, 33, S109-S145.

Borjas, George J., Kirk B. Doran, and Ying Shen, 2017, "Ethnic Complementarities after the Opening of China: How Chinese Graduate Students Affected the Productivity of Their Advisors", *Journal of Human Resources (forthcoming)*.

D'Amuri, Francesco, Gianmarco I.P. Ottaviano, and Giovanni Peri, 2010, The Labor Market Impact of Immigration in Western Germany in the 1990s, *European Economic Review*, 54, 550-570.

Doran, Kirk, Alexander Gelber, and Adam Isen, 2016, The Effects of High-Skilled Immigration Policy on Firms: Evidence from H-1B Visa Lotteries, UC Berkeley working paper.

Ghosh, Anirban, Anna M. Mayda, and Francesc Ortega, 2016, The Impact of Skilled Foreign Workers on Firms: an Investigation of Public Traded U.S. Firms, CUNY Working Paper (2016).

Hornung, Erik, 2014, Immigration and the diffusion of technology: The Huguenot Diaspora in Prussia, *American Economic Review* 104, 84-122.

Hunt, Jennifer and Marjolaine Gauthier-Loiselle, 2010, How Much Does Immigration Boost Innovation?, *American Economic Journal: Macroeconomics* 2, 31-56.

Michael C. Jensen, William H. Meckling, 1976, "Theory of the firm: Managerial behavior, agency costs and ownership structure", *Journal of Financial Economics*, 3, 305-360.

Li, Kai, Buhui Qiu, and Rui Shen, 2017, Organization Capital and Mergers and Acquisitions, *Journal of Financial and Quantitative Analysis* forthcoming.

Kerr, Sari P. and William R. Kerr, 2013, Immigration and Employer Transitions for STEM Workers, *The American Economic Review: Papers and Proceedings,* 103, 193-197

Kerr, Sari P., William R. Kerr, and William F. Lincoln, 2015, Skilled Immigration and the Employment Structure of U.S. Firms, *Journal of Labor Economics* 33, 109-145.

Kerr, William R. and William F. Lincoln, 2010, The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention, *Journal of Labor Economics* 28, 473-508.

Lowell, B. Lindsay. 2001. "Skilled Temporary and Permanent Immigrants in the United States." *Population Research and Policy Review*, 20, 33-58.

Moser, Petra, Alessandra Voena, and Fabian Waldinger, 2014, German Jewish Emigres and U.S. Invention, *American Economic Review* 104, 3222-3255.

Ottaviano, Gianmarco I. P., Giovanni Peri, and Greg C. Wright, 2013, Immigration, Offshoring, and American Jobs, *American Economic Review* 103, 1925-1959.

Peri, Giovanni, Kevin Shih, and Chad Sparber, 2015, STEM Workers, H-1B Visas, and Productivity in U.S. Cities, *Journal of Labor Economics* 33, S225-S255.

Peri, Giovanni, Kevin Shih, and Chad Sparber, 2015, "The Effects of Foreign Skilled Workers on Natives: Evidence from the H-1B Visa Lottery." UC Davis Working Paper.

Sana, Mariano. 2010. "Immigrants and Natives in U.S. Science and Engineering Occupations, 1994-2006." *Demography*, 47, 801-820.

Tervio, Marko, 2008, The Difference that CEOs Make: An Assignment Model Approach, *American Economic Review* 98, 642-668.

Watts, Julie R. 2001. "The H-1B visa: Free Market Solutions for Business and Labor." *Population Research and Policy Review*, 20, 143-156.

Zavodny, Madeline. 2003. "The H-1B Program and Its Effects on Information Technology Workers." *Federal Reserve Bank of Atlanta Economic Review*, 88, 33-43.

Appendix Table A.1: Variable Definitions:

Variable	Source	Definition
Petitions filing and approvals		
% Petitions filed initial	USCIS	Number of petitions filed for initial employment divided by total number of petitions filed for a given fiscal year
% Petitions filed continuing	USCIS	Number of petitions filed for continuing employment divided by total number of petitions filed for a given fiscal year
% Petitions approved	USCIS	Total number of petitions approved divided by the total number of petitions filed for a given fiscal year
% Petitions approved initial	USCIS	Number of petitions approved for initial employment divided by total number of petitions approved for a given fiscal year
% Petitions approved continuing	USCIS	Number of petitions approved for continuing employment divided by total number of petitions approved for a given fiscal year
% Initial filed approved	USCIS	Number of petitions approved for initial employment divided by the total number of petitions filed for initial employment for a given fiscal year
% Continuing filed approved	USCIS	Number of petitions approved for continuing employment divided by the total number of petitions filed for continuing employment for a given fiscal year
Beneficiaries degree		
% Bachelors' approved	USCIS	Number of petitions approved with a Bachelors' degree divided by the total number of petitions approved
% Masters' approved	USCIS	Number of petitions approved with a Masters' degree divided by the total number of petitions approved
% PhD and professional approved	USCIS	Number of petitions approved with PhD or Professional degree divided by the total number of petitions approved
Types of petitions		
Initial employment	USCIS	Petitions for initial employment are filed for the first time H-1B workers.
Continuing employment	USCIS	The petitions for continuing employment are the filings for foreign workers who are already in the US and refer to extensions, sequential employment and concurrent employments. Extensions refer to petitions for H-1B workers to provide extension to work for up to 6 years beyond the initial 3-year period. Petitions for sequential employment are filings for workers transferring between H-1B employers within the 6-year period. Concurrent employment petitions refer to filings for H-1B workers intending to work simultaneously for a second employer.
Beneficiaries age		
% Age 25-29	USCIS	Number of beneficiaries with age between 25 and 29 divided by total number beneficiaries with approved petitions for a given fiscal year
% Age 30-34	USCIS	Number of beneficiaries with age between 30 and 34 divided by total number beneficiaries with approved petitions for a given fiscal year
% Age 35-39	USCIS	Number of beneficiaries with age between 35 and 39 divided by total number beneficiaries with approved petitions for a given fiscal year
% Age above 40	USCIS	Number of beneficiaries with age above 40 divided by total number beneficiaries with approved petitions for a given fiscal year
Firm Characteristics		
Firm size	Compustat	Asset (AT)
Tobin's Q	Compustat	Sum of total assets plus market value of equity minus book value of equity divided by total assets [Compustat (AT + CSHO x PRCC_F - CEQ) / AT)].
Market-to-book	Compustat	(CSHO*PRCC_F)/ CEQ
ROA	Compustat	Earnings before interest and taxes divided by total assets (Compustat EBIT / AT)
Leverage	Compustat	Total debt, defined as debt in current liabilities plus long-term debt, divided by total assets [(DLC + DLTT) / AT].
R&D	Compustat	R&D expenses divided by total assets (XRD / AT).
SG&A	Compustat	Selling and General Administrative Expense (XSGA)
Employee	Compustat	Number of people employed by the company and its consolidated subsidiaries in thousands. (EMP)