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U.S. High-Skill Immigration

John Bound
University of Michigan

Sarah Turner
University of Virginia

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Immigration in the U.S. is characterized by "twin peaks" (Johnson and Slaughter, 2001): disproportionately high concentrations of immigrants among very low-skill and very high-skill workers. Tabulations from the 2009-2011 American Community Survey show that more than 45% of workers with less than a high school degree and more than 33% of workers at the PhD level were born outside the United States (Table 1). This distribution is a recent change. In 1990, immigrants comprised only 22% of workers with less than a high school degree and 20% of doctorate-holding workers.

Table 1. Fraction foreign-born and employed by education level

	< High School	HS and Some College	BA	Master's	Professional	Doctoral
A – Percent Foreign by Education Level						
1990	22.2	7.0	8.6	10.7	12.3	20.1
2000	37.6	10.0	11.7	14.8	17.9	28.8
2009-2011	45.2	13.4	15.3	19.3	19.7	33.7
B - Percent Foreign by Education Level - Employed Individuals						
1990	24.6	6.6	7.9	9.8	11.3	19.5
2000	39.3	8.8	10.4	13.4	15.5	27.9
2009-2011	55.7	13.4	14.0	18.0	18.4	33.2
C - Percent Employed by Education Level						
1990	58.7	79.2	87.5	91.2	92.8	94.8
2000	53.9	77.0	85.5	89.0	89.3	91.9
2009-2011	54.3	73.3	83.9	87.9	89.8	92.5

Samples: Census 1990, 2000, and ACS 2009-2011 combined
Restriction: 25-54 years old, non imputed data on age, education level and immigrant status
Foreign definition: Naturalized or non-citizen

Researchers and policy-makers have focused on the incidence of low-skill immigration, particularly among undocumented workers, and the impact of this immigration on labor force outcomes for workers with minimal levels of education (Borjas, 1987; Borjas, 2003; Card, 2005; Card, 2009). However, research on the growth of high-skill immigration and the changing pathways to entry in the U.S. labor market has been more limited.[1]

[1] That is not to say the topic has been completely unaddressed. Recent work by Kerr and Lincoln (2010) and Orrenius and Zavodny (2010) and others has expanded research in this area.

From a purely theoretical perspective, the underlying economic model of immigration suggests some similarities between high-skill and low-skill immigration. The most basic economic arguments suggest that both high-skill and low-skill immigrants (1) impart benefits to employers, to owners of other inputs used in production such as capital, and to consumers, and (2) impose some costs on workers who are close substitutes (Borjas, 1999). The groups potentially in competition with high-skill versus low-skill immigrants are quite different – workers trained in science and engineering, on the one hand, and workers with low levels of education, on the other. Their potential employers are quite different as well. These differences contribute to the current lack of consensus on immigration reform.

The welfare effects of high-skill immigration are perceived to be positive in two regards. First, it is likely that high-skill immigrants make substantial tax payments at the local and federal level, creating a fiscal surplus rather than imposing a burden on public services (which often is associated with low-skill immigration – Camarota, 2004). Second, high-skill immigrants contribute to the generation of knowledge and productivity through patenting and innovation (Kerr and Lincoln 2010). The costs and benefits to training foreign-born students at U.S. universities are difficult to quantify, depending on the extent of public subsidies to universities, the stay-rate of foreign-born degree recipients in the U.S., and the magnitude of potentially crowding out degree attainment by native citizens in science and engineering fields.

This analysis documents changing patterns in the educational and labor force trajectories of college-educated immigrants.[2] A central theme in our analysis is that immigration policy combines with supply and demand to determine the representation of high-skill immigrants in

[2] In this paper, our use of the terms "immigrant" and "immigration" includes anyone designated as foreign born in counts such as the Census. We are unable to distinguish between immigrants who intend to stay in the U.S. and those in the U.S. on a temporary basis. In government statistics that distinguish foreign born by type of visa, those with temporary visas are described as "non-residents" rather than immigrants.

the U.S. population. Changes in both the U.S. and abroad have affected how immigration has impacted U.S. labor markets. For example, the dramatic expansion of post-secondary attainment abroad has led to changes in the skills that immigrants bring with them to the U.S., and many high-skill immigrants enter the U.S. labor market by way of U.S. colleges and universities. Because the vast majority of high-skill immigrants are employed in the formal sector, the availability of work visas, primarily the H-1B classification, and the opportunities for post-secondary study in the U.S. through F visas have substantial implications for entry and continued residence of high-skill workers from abroad.

Our analysis begins by presenting basic information on trends in immigration of high-skill workers derived from Census enumerations and the American Community Survey (ACS). We examine educational attainment, occupation, industry, earnings, citizenship, country of birth, and year of immigration. While we will make some use of the Census enumerations before 1990, we will focus on more recent patterns**.** Even with the large sample sizes of the Census and ACS, we face limitations in the possible level of disaggregation. For example, outcomes for small countries of origin, very specialized subfields, and narrow geographic areas are subject to substantial sampling variation. We complement these data with the National Survey of College Graduates (NSCG's 1993 and 2003 cohorts), which provide additional information on educational and labor market experiences for college graduates.[3]

In the next section, we present broad trends in immigration by skill level (using education as the indicator of skill), highlighting the very different origins of high-skill vs. low-skill

[3] Beyond the standard publicly available micro data, we access a range of supplementary sources to complete the portrait of high-skill workers in science and engineering fields. Data from the Survey of Earned Doctorates (SED), which is essentially a census of doctorate recipients of U.S. universities maintained by the National Science Foundation, provide indicators of doctorate production by university, field of study, age and country of citizenship over the last nearly four decades. The SED provides an explicit picture of the total PhD output of U.S. universities, as well as the transition to initial employment.

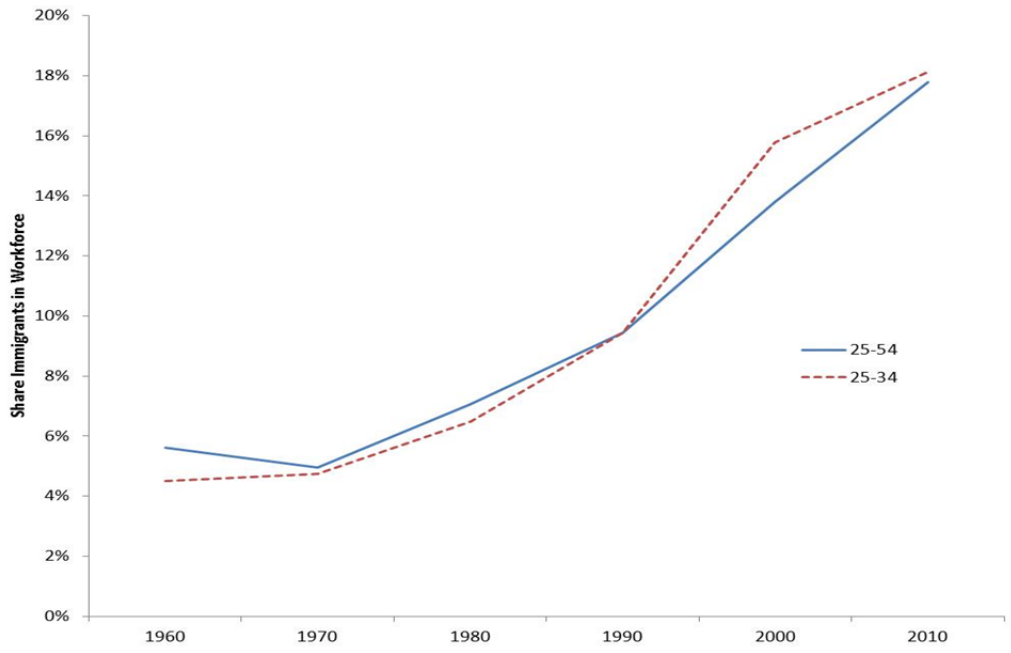
immigrants. We then place high skill immigration in the context of changes in the U.S. labor market, emphasizing the role of immigration in accommodating "demand shocks" in science and engineering fields. We examine the pathways to the U.S. labor market, identifying country-specific trends and the role of visa policy. Finally we address the demographic characteristics and family circumstances of high-skill immigrants and modes of entry into the U.S.

Volume of Immigration

Overall Trends in Immigration by Skill Level

From 1960 to 2010, the overall share of foreign born among the working-age U.S. population increased from 7% to 17.3% (Figure 1), with 75% of this growth occurring in the last two decades. Growth among younger age groups (ages 25-34) was somewhat more pronounced in recent years.

Figure 1. Share of Immigrants in the U.S. Workforce by Age



Source: Census 1960-2000 and ACS 2010
Data are limited to individuals with positive hours in the prior year.

Table 1 shows that from 1990 to 2011 increases in immigration have occurred at every level of education, and panel 1B shows that these increases have been even more marked among the employed. For workers with less than a high school degree, the immigrant share more than doubled from 25% to 56% in this period. In the middle education groups, the immigrant share increased from 7% to 13% for high school graduates (HS) and those with some college (SC).

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Samples: Census 1990, 2000, and ACS 2009-2011 combined
Restriction: 25-54 years old, non imputed data on age, education level and immigrant status
Foreign definition: Naturalized or non-citizen

Among the college educated, immigrant share increased from 8% to 14% for college graduates (BA), from 10% to 18% for master degree holders (MA), from 11% to 18% for professional degree holders, and from 19% to 33% for PhDs. Table 2 presents these data from a different angle, showing a much higher fraction of workers with less than a high school education among foreignborn (26.3%) than native born (6.9%). On the other end of the education spectrum, foreign-born workers are also more concentrated at the masters level and

above, comprising more than twice the share of workers with a PhD (though only 2% achieve this education level).

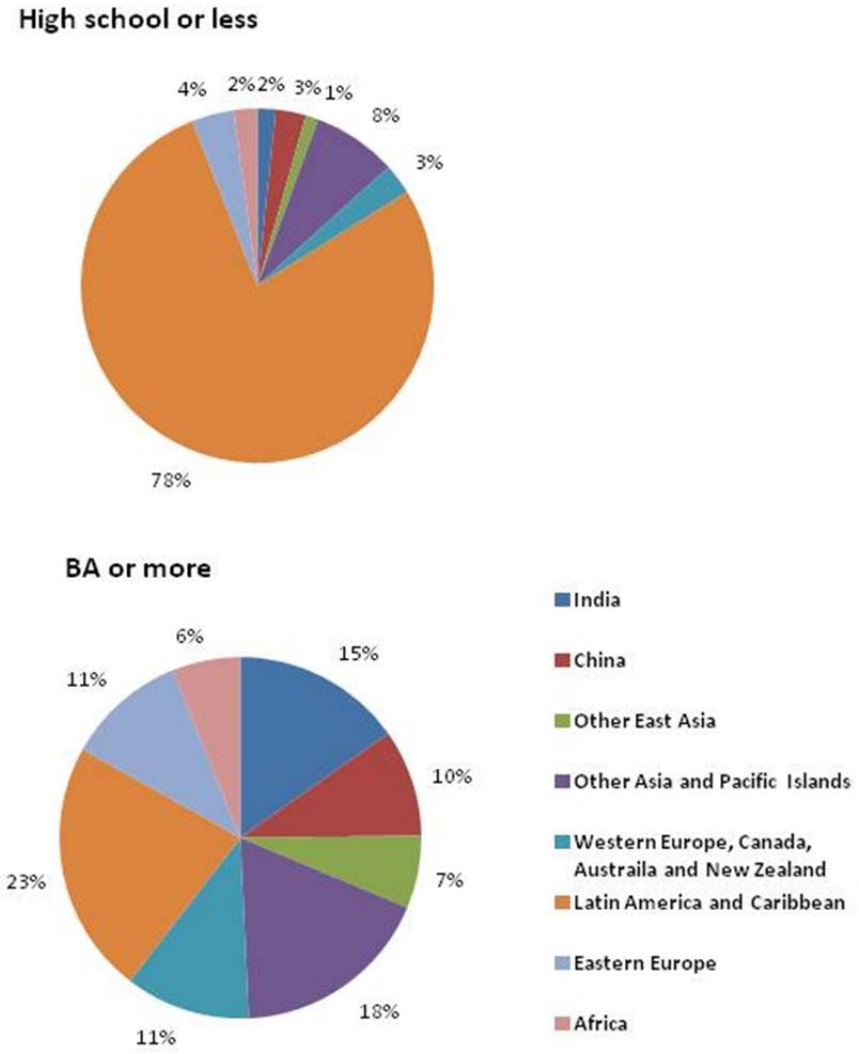
Table 2. Distribution of Education by Immigration Status Among Employed Workers

	1990		2000		2009-2011	
	American	Foreign	American	Foreign	American	Foreign
< High school	8.1%	26.5%	5.1%	23.9%	4.0%	23.9%
HS and some college	64.5%	46.1%	63.3%	44.4%	60.5%	44.1%
BA	18.0%	15.5%	21.0%	17.7%	23.5%	18.1%
Master's	6.4%	7.0%	7.4%	8.3%	8.7%	9.0%
Professional	2.2%	2.8%	2.4%	3.2%	2.3%	2.4%
Doctoral	0.9%	2.1%	0.9%	2.5%	1.1%	2.5%

Samples: Census 1990 and 2000, and ACS 2009-2011
Restriction: Employed 25-54 years old, non imputed data on age, education level and immigrant status
Foreign definition: Naturalized or non-citizen

These data indicate that immigrants are disproportionately found at the very low-skill and very high-skill levels. As shown in Figure 2, the geographic origins of these two types of immigrant workers are quite different. In 2010, about 78% of low-skill immigrants (high school or less) arrived in the U.S. from Latin American countries, while about half of high-skill immigrants (BA or higher) came from Asian countries. Although the distribution of countries of origin is more dispersed among high-skill than low-skill immigrants, representation shifted toward China and other Asian countries between 1990 and 2010. In 2010, about 15% of high-skill immigrants were from India, 10% from China, and about 25% from other Asian countries. These differences by country of origin are affected by the supply of potential immigrants at each education level and also by the cost of immigration. Latin America has a large supply of workers with low education who can relatively inexpensively travel to the U.S.; it is more difficult and costly for low-skill workers in Asia to manage the passage.

Figure 2: Geographic origins of immigrants by continent and education level in 2010
Source: ACS 2009-2011 combined samples



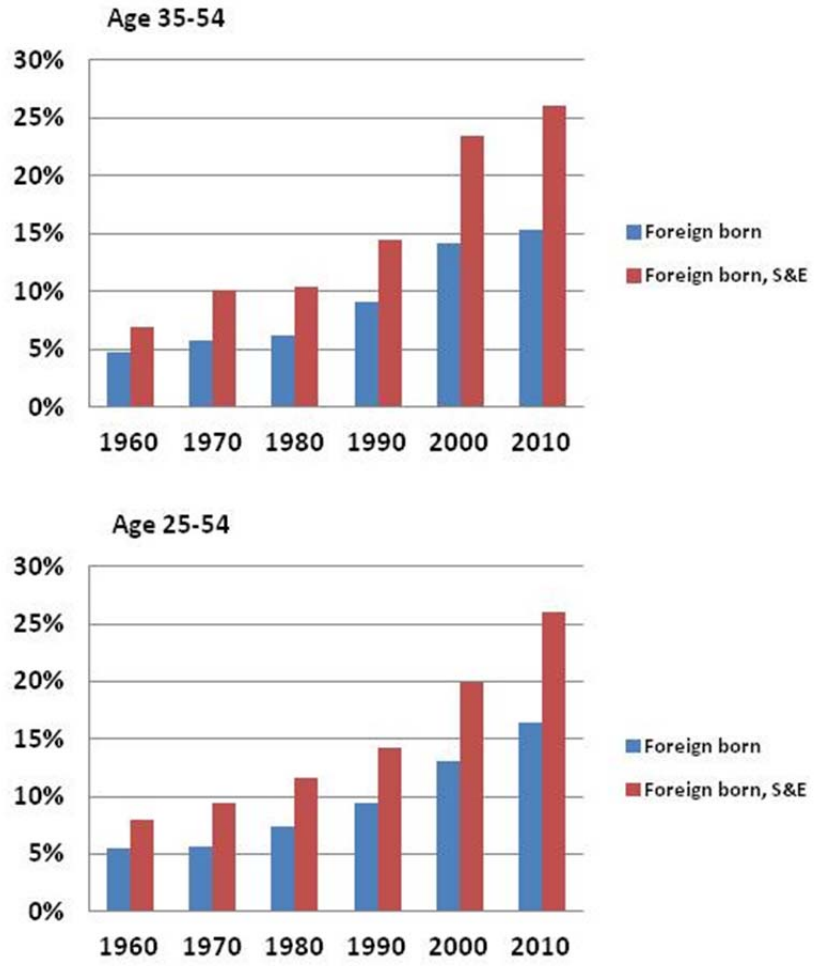
Fields of Concentration

High-skill immigrants to the U.S. tend to work in science and engineering (S&E) fields. The first panel of Figure 3 shows the share of immigrants among all college-graduate workers (in blue) compared to those in Science and Engineering fields (S&E, in red).[4] The immigrant share in S&E fields has increased markedly over the last two decades, from about 14% of working

[4] Science Definition: 1. Math, computer science and related (occ1990 codes: 64-68); 2. Natural and life science (occ1990 codes: 69-83); 3. Social science (occ1990 codes: 166-169); 4. Post-secondary teaching (occ1990 codes: 113-154). Engineering Definition: Engineers (occ1990 codes: 44-59).

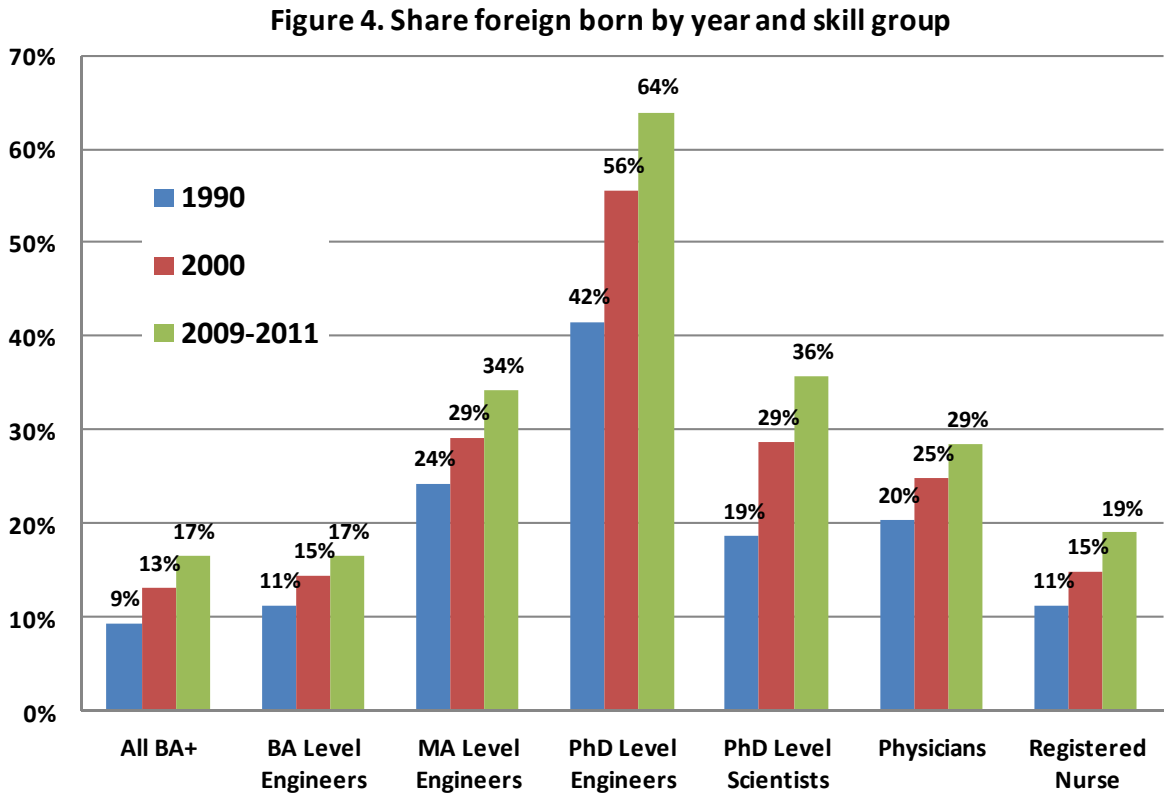
adults in 1990 to nearly 24% in 2010. Among younger U.S. workers (Panel B), the immigrant share in S&E fields was slightly higher from 1990 to 2010, rising from 15% to over 26%.

Figure 3. Foreign born among employed college graduates by year and Science/Engineering concentration (Source: Census 1960-2000and ACS 2001-2010)



Examination of the immigrant share by degree and occupational classifications shown in Figure 4 illustrates the significant and growing concentration of high-skill immigrants in all post-BA occupations, including BA-, MA-, and PhD-level engineering jobs, other PhD-level science jobs, and health professions. At the extreme, immigrants account for 64% of PhD-level

engineers in 2010, up from 42% in 1990. Immigrants are also overrepresented in health fields, comprising about 29% of physicians and 19% of nurses.[5]



Immigration and Visa Policies for High-Skill Workers

The dynamics of high-skill immigrant flows to the U.S. follow from the U.S. immigration policy. Visa policies determine when potential immigrants can enter the U.S. labor market and also influence whether they obtain education at home or abroad, how long they are likely to stay in the U.S., and whether they are able to attain permanent residency.

Most employers in the "formal" sector require citizenship, permanent residence, or an appropriate visa permitting work, and this requirement is most likely to be enforced for high-skill immigrants. While nearly 75% of unauthorized immigrants (compared to about 26% of all

[5] We are reluctant to over interpret the data for those in the 25-34 age range because degree receipt, particularly among native born, is likely to persist well in the 30s.

immigrants, as shown in Table 2) are estimated to hold a high school degree or less, only about 15% are estimated to hold a BA degree or higher (Passell and Cohn, 2010).[6]

The costs to a firm of hiring a foreign-born worker and the administrative restrictions and financial costs to a high-skill foreign-born worker of coming to the United States have varied markedly over time. They also differ by skill set and country of origin. The immigrant's access to the labor market may be permanent or temporary, depending on the time of entry, the country of origin, and the individual's expertise. Because these factors have such important impacts, we review them here in some detail.

Permanent Residents

The Displaced Persons Act of 1948 established a pathway to permanent residency for high-skill immigrants. This Act gave priority to displaced persons "possessing special educational, scientific and technological or professional qualifications" (Tichenor, 2012). The Immigration and Nationality Act of 1952 set national quotas[7], but reserved 50% of each nation's quota for high-skill immigrants.

The Immigration and Nationality Act of 1965 (Hart-Celler Act) replaced the quotas with a preference system tied to four main avenues for permanent residency: family reunification, employment, humanitarian/refugee interests and diversity (Martin, 2012). Family-based immigration is the largest channel for immigration. Immediate relatives (parents, spouses, minor children) are admitted without limit, while there is a cap of 480,000 for other family-based

[6] (Passell and Cohn, 2011) estimate more than 11 million unauthorized immigrants in the United States in 2010, up from 8.4 million in 2000 and down slightly from the peak of 12 million in 2007.

[7] National quotas on immigration were first imposed in 1921. Under the Immigration Restriction Act of 1921 quotas were set proportional to the number of individuals living in the U.S. as of 1990. The intent of this law was to restrict immigration flows from Eastern and Southern Europe. Earlier, during the latter part of the 19th century congress had enacted laws (e.g. the Page Act of 1975 and the Chinese Exclusion Act of 1982) putting restrictions on the immigration of Asians to the U.S.

immigration. We expect that some high-skill immigrants were admitted as children via this channel, completing their pre-collegiate and post-secondary training in the U.S.[8]

While family-based immigration of children and high-skill relatives often occurs directly from the country of origin, employment-based immigration generally follows a transition from another visa type. The capacity to enter the U.S. as a permanent resident through an employment-based green card is quite limited: only 140,000 such visas are offered each year.[9] For an employment-based green card, an employer must certify that s/he has not been able to hire a qualified citizen or permanent resident for the position and the employer must file an immigration petition (form I-140) on the employee's behalf.

Within the set of visas allocated for employment, preference groupings determine visa priority. The highest priority is reserved for those with extraordinary capabilities, including researchers, professors, and multinational executives. Next in line are aliens who have advanced degrees or whose ability benefits U.S. interests (e.g., physicians practicing in designated underserved areas). Third in priority are foreign born in three categories: skilled workers, college-educated professionals, and unskilled workers (see http://travel.state.gov/visa/immigrants/types/types_1323.html for details). Fourth priority is given to individuals who have specialized jobs such as physicians, religious workers, and international organization employees (this residual category includes many subgroups, such as 50 visas for former interpreters from Afghanistan or Iraq). Last priority goes to entrepreneurs who invest at

[8] Additional channels of immigration include the humanitarian/refugee provision (about 168,000) and diversity visa (about 50,000). The Diversity Immigrant Visa Program provides up to 55,000 diversity visas annually, drawn from random selection among all entries to persons who meet eligibility requirements from countries with low rates of immigration to the United States. (http://travel.state.gov/visa/immigrants/types/types_1322.html).

[9] Less than one-half of the employment based visas have gone to workers themselves, as this total includes dependents of these immigrants in the employment-based visa cap (Orrenius and Zavodny, 2010).

least $500,000 to create and sustain at least 10 permanent jobs. Table 3 shows transitions to legal permanent residency by immigration channel and preference category.

Table 3. Adjustedments to Legal Permanent Resident Status by Type and Class of Admission, 2002 and 2011

	2002			2011		
	In category of admission	Adjusted	% of all adjustments	In category of admission	Adjusted	% of all adjustments
Family-sponsored preferences	186,880	63,363	9.4%	234,931	28,346	4.9%
Immediate relatives of U.S. citizens	483,676	305,304	45.2%	453,158	243,174	41.9%
Employment-based preferences	173,777	133,755	19.8%	139,339	124,384	21.4%
First: Priority workers	34,168	24,587	3.6%	25,251	23,605	4.1%
Second: Professionals with advanced degrees or aliens of exceptional ability	44,316	38,993	5.8%	66,831	65,140	11.2%
Third: Skilled workers, professionals, and unskilled workers	88,002	64,554	9.6%	37,216	29,757	5.1%
Fourth: Certain special immigrants	7,149	5,530	0.8%	6,701	5,306	0.9%
Fifth: Employment creation (investors)	142	91	0.0%	3,340	576	0.1%
Diversity	42,820	1,986	0.3%	50,103	1,617	0.3%
Refugees	115,601	115,601	17.1%	113,045	113,045	19.5%
Other	56,602	55,058	8.2%	71,464	69,526	12.0%
Total	1,059,356	675,067	100.0%	1,062,040	580,092	100.0%

Source: Table 6, Handbook of Immigration Statistics, 2011
http://www.dhs.gov/yearbook-immigration-statistics-2011-1

Adding to the complexity of this system, visas for any given country are capped at 7% of the annual U.S. limit for family- and employment-based immigration. This rule, intended to allow immigration from a variety of places,[10] causes considerable lags for those coming from China, India, Mexico, and the Philippines who are not in the highest priority category. Martin (2012) notes that Indian professionals, entering under lower priorities, have had to wait between 5 and 10 years. In June 2013, Indian professionals falling into the second- or third-priority categories were granted visas after a wait of 9 to 10 years.[11]

[10] U.S. State Department. (May 2013) "The Operation of the Immigrant Numerical Control System." Retrieved from http://www.travel.state.gov/pdf/Immigrant%20Visa%20Control%20System_operation%20of.pdf

[11] U.S. State Department. (May 2013) Visa Bulletin for June 2013, Volume IX Number 57. Retrieved from http://www.travel.state.gov/visa/bulletin/bulletin_5953.html

In addition to these long-standing pathways to permanent residency for high-skill immigrants, Congress has on two occasions given special treatment to foreign groups that likely included a disproportionate share of high-skill immigrants. The Chinese Student Protection Act (1992) allowed Chinese nationals (including students) who were present in the U.S. at the time of the Tiananmen Square violence in 1989[12] to apply for legal permanent resident status. Of the nearly 50,000 individuals making the transition to legal permanent resident status under CSPA, at least 30,000 had initial visa classifications indicating high-skill characteristics (Orrenius, Zavodny, Kerr, 2012). Similarly (though more modestly), the Soviet Scientists Immigration Act (1992) allowed permanent visa status to 750 scientists from the USSR and former Baltic states.

While it is possible to enter the U.S. directly with permanent residency status, Lowell (2010) estimates that 90% of employment-based and 55% of family-based visa holders move up from temporary visa status or from family-sponsored preferences.[13]

Temporary Work Visas

Since passage of the 1952 Immigration and Nationality Act, the H-1 designation has provided an employment window for aliens of "distinguished merit and ability." The original expectation of the H-1 designation was that residency in the U.S. would be temporary, with this provision altered as part of policy reform in 1990.

The Immigration and Naturalization Act of 1990 transformed the H-1 visa program to what is now known as the H-1B visa program, along with the companion H-1A program for nurses.[14] H-1B visas are reserved for high-skill workers. They require that the employee be in a

[12] Slightly earlier in April 1990, an executive order deferred deportations and granted employment authorization to Chinese nationals who were in the U.S. at the time of the Tiananmen Square events (Orrenius, Zavodny, Kerr, 2012).

[13] Permanent residents may also become naturalized citizens; typically, permanent residents may apply for citizenship five years after attaining permanent residency.

[14] The H-1A visa category was created exclusively for temporary employment of foreign-born nurses under the 1989 Immigration Nursing Relief Act, which expired in 1995. In 1995, 7,261 nurses were admitted under this

specialty occupation, defined as one that requires "theoretical and practical application of a body of highly specialized knowledge and attainment of a bachelor's or higher, or its equivalent." By definition H-1B visas are limited to high-skill workers. In addition, H-1B visas are subject to a binding cap. H-1B visas are employer-specific and require the employer to post a substantial application fee and certify that the foreign employee will be paid the prevailing wage.[15] H-1B visas are valid for three years with the potential for a three-year extension.[16] Workers may enter the U.S. directly on an H-1B visa or may transfer to an H-1B from another visa classification such as an F student visa. H1-B visa holders may pursue permanent residency while working temporary jobs in the U.S.

Unlike the original H-1 visa, which did not have a cap, the Immigration Act of 1990 caps H-1B visas annually at 65,000, though visas issued to individuals at non-profit organizations such as colleges and universities (e.g., researchers and faculty) are exempt from the cap. During the early 1990s the cap was not reached, but the cap became binding in the mid-1990s and was subsequently raised to 115,000 in 1999 and then to 195,000 in 2001. This limit was maintained until 2004, when the H-1B cap reverted to 65,000 once again, although in the same year Congress authorized an extra 20,000 H-1B visas for foreign workers holding advanced degrees from U.S. universities through the Visa Reform Act.[17] This cap has been binding every year

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program. A second program, the H-1C visa program, was established through the Nursing Relief for Disadvantaged Areas Act of 1999 opened visa opportunities for those employed in designated "health professional shortage areas" serving a minimum share of Medicaid and Medicare patients; this program was ended in 2009. Nursing professionals continue to receive priority in green card applications as a field of national interest.

[15] The minimum application fees total $3575 in the most recent year and are somewhat larger for firms with more than 25 employees (an additional $750 per employee) and cases requesting expedited processing ($1225 per employee).

[16] In cases where an H-1B holder has applied for a "green card" or permanent residences status but has not achieved current priority date for processing, they may receive a three-year H-1B extension, following from the American Competitiveness in the Twenty-First Century Act of 2000.

[17] U.S. Government Accountability Office, "H-1B Visa Program: Reforms are Needed to Minimize the Risks and Costs of the Current Program," January, 2011: http://www.gao.gov/assets/320/314501.pdf

since 2004.[18] In addition, country-specific free trade agreements designate 1,400 H-1B1 visas for Chilean nationals and 5,400 H-1B1 visas for Singapore nationals. In 2000, Lindsay Lowell estimated the total number of individuals working on all H-1 visas in the U.S. to be close to half a million. Figure 5 shows trends regarding H-1 visas since 1975.

While the H-1B is the most widely recognized temporary visa, there is a substantial portfolio – a veritable alphabet soup – of other temporary work visa options which can connect foreign-born high skill workers to the U.S. labor market. Appendix Table 1 provides a brief summary of these alternative types. These categories include country-specific opportunities for temporary employment along with field-specific options.

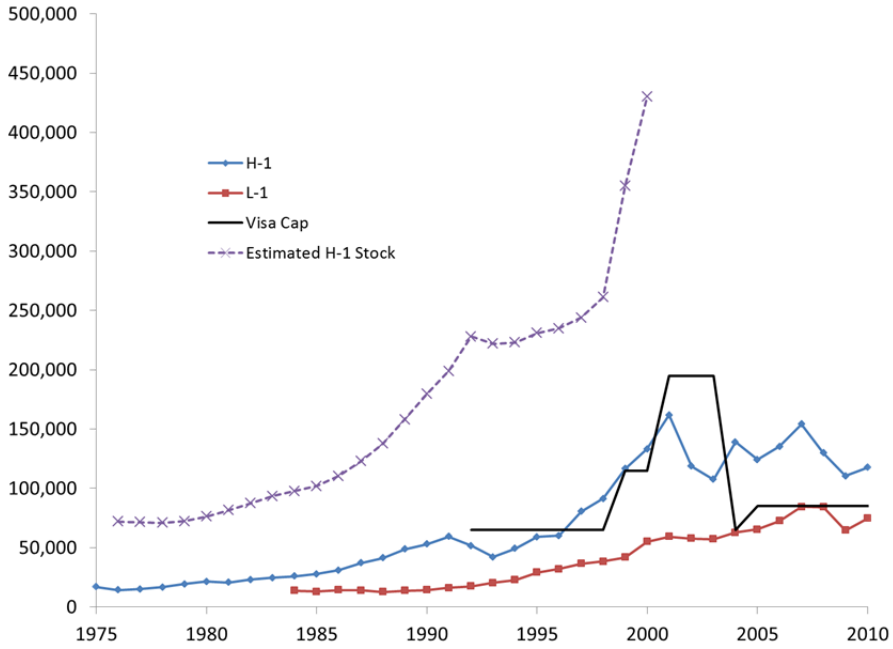
Other temporary visa categories include the L-1 visa for Intracompany Transfers, the O-1 visa for "Workers with Extraordinary Ability or Achievement," the TN visa for NAFTA Professional Workers, and the E-1 visa for Treaty Traders and Treaty Investors. Behind H-1B issuances, L-1 Intracompany Transfer visas are the most issued of the other temporary worker visa categories. As shown in Figure 5, the number of L-1s issued climbed from 14,342 in 1990 to 84,532 in 2007), and then decreased to 70,728 in 2011.[19] At the introduction of the O-1 visa in 1992, 462 were issued, a number that rose to 9,368 in 2009 and declined to 8,828 in 2011.[20] The number of E-1 Treaty Traders visas issued fell from 20,100 in 1989 to 6,807 in 2011.

[18] Ibid

[19] H-1 visas include H-1A (nursing) and H-1B visas after 1990; in addition to the stated visa cap, H visas assigned to those employed by academic institutions are exempt from the cap and, beginning in 2004, an additional 20,000 H-1B visas were offered to foreign graduates of U.S. universities. Figure 5 data from 1972-1980 are from Lowell (2000). For 1987 and later, data are from the Bureau of Consular Affairs, available at http://travel.state.gov/visa/statistics/nivstats/nivstats_4582.html. Estimates of the H-1 visa stock are from Lowell (2000).

[20] See Department of State, Nonimmigrant Visa Statistics, http://travel.state.gov/visa/statistics/nivstats/nivstats_4582.html .

Figure 5. Trends in the Flow and Stock of Skill-Based Visas



Other visa categories, although not officially categorized as "temporary worker" visas, allow non-immigrants to enter the work force. For example, the J-1 Exchange Visitor visa, issued to non-immigrant individuals participating in Department of State-approved cultural exchange programs, allows some visa holders to work during their time in this country.[21] The number of Exchange Visitor visas issued is typically more than double that of H-1B workers, but since not all J-1 visa holders are authorized to work, it is difficult to compare the two types. Over the past two decades, the number of J-1 visas issued has risen fairly steadily from 146,549 in 1990 to 324,294 in 2011.

The limits on and costs of the H-1B work visas provide incentives for firms and employers to use other visa options to employ high-skill workers. There is some evidence that research universities increasingly use the J-1 category for foreign post-docs and visiting research

[21] USCIS web page on the J-1 Exchange Visitors visa: http://www.uscis.gov/portal/site/uscis/menuitem.eb1d4c2a3e5b9ac89243c6a7543f6d1a/?vgnextoid=b69c83453d4a3210VgnVCM100000b92ca60aRCRD&vgnextchannel=b69c83453d4a3210VgnVCM100000b92ca60aRCRD

scientists rather than the more costly H-1B visa. While occupational categories typically using J-1 visas include physicians, (including medical residents), teachers, and visiting scholars, the largest single group of J-1 visa recipients is foreign nationals traveling to the U.S. for summer work or travel – comprising 31% of the 2012 total.[22] Historically, Europe has been the largest sourcecountry for J-1 visas (representing 52% of visas issued in 2012), though the number of J-1 visitors from Asian countries has increased in the past decade.

Student Visas

Unlike H-1B employment visas, which are subject to a numerical cap and require a costly petition from an employer, there is effectively no limit on visas for postsecondary study in the U.S. Demand for U.S. higher education among foreign students is driven by two main aims: to acquire skills and training that may be in short supply in their home countries or to obtain work in the U.S. Employment prospects for foreign-born individuals with a degree from a U.S. institution may be considerable better than for foreign degree-holding individuals. . These students face relatively modest barriers to connecting with U.S. firms. Compared to foreign-degree holding students, U.S. employers may favor U.S. degree recipients because they may be better able to assess degree quality.

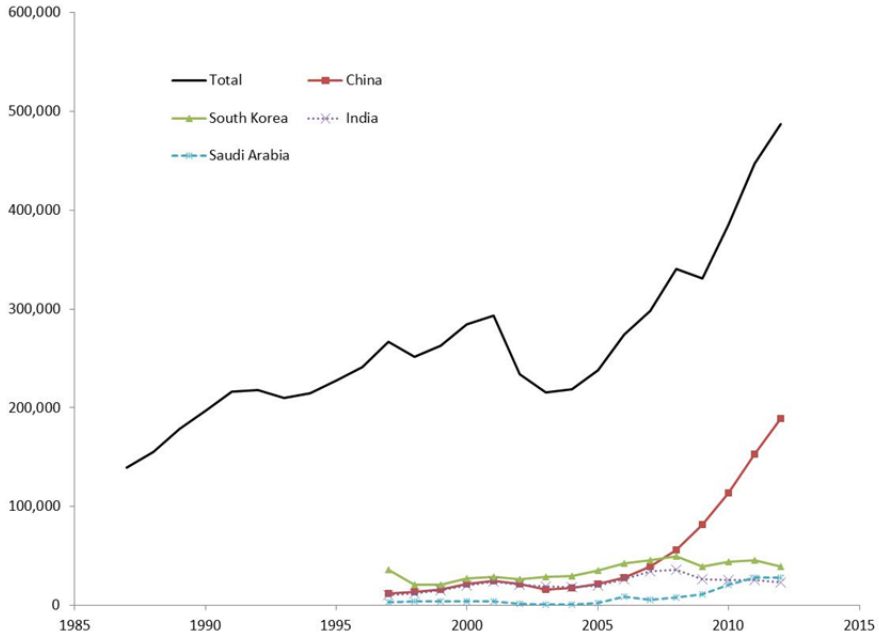
To enroll in a U.S. degree program, a student needs a visa, the prerequisite skills, and the capacity to finance the course of study. For most degree programs, the F-1 visa, or full-time student visa, is the primary vehicle for entry.[23] There is no cap on the number of F-1 visas issued;

[22] U.S. State Department. (May 2013) J-1 Visa Facts and Figures. http://j1visa.state.gov/basics/facts-and-figures/

[23] The mechanics of receiving an F visa are as follows. Foreign students who wish to study in the United States must first apply to and be accepted by a Student and Exchange Visitors Program (SEVP)-certified school. The school them provides the form Form I-20A-B, Certificate of Eligibility for Nonimmigrant (F-1) Student Status-For Academic and Language Students. The student's information given on this form is recorded in the SEVIS database. After submitting the I-20 form, students are required to submit the SEVIS I-901 fee. For F-1 visas, this amount is currently $200 (U.S. Immigration and Customs Enforcement (ICE) Website, "Fact Sheet: I-901 SEVIS Fee for F, M and J Nonimmigrant Students and Exchange Visitors."

these are issued automatically with the certification of U.S. higher education institutions. As shown in Figure 6, the number of annual F-1 visas rose by nearly 60% from 241,003 in 1996, to 385,210 in 2010, with a non-trivial decline following both the contraction in the IT sector and the events of 9/11, which generated greater administrative hurdles. Students from Asia contribute the majority of students on F-1 visas, with the number from China increasing very dramatically over the last decade (Figure 6).

Figure 6: Trends in Student Visas



Source: Department of State, "Nonimmigrant Visa Issuances by Visa Class and by Nationality " and "Nonimmigrant Visas by Individual Class of Admission"; see http://travel.state.gov/visa/statistics/nivstats/nivstats_4582.html

Foreign students studying at U.S. institutions while on an F-type visa may seek another type of visa (such as an H-1B). Additionally, the student can extend the F visa for one year through participation in Optional Practical Training (OPT) related to a student's major area of

http://www.ice.gov/sevis/factsheet/090104_fs.htm). After receiving the SEVIS I-901 receipt, the student can apply for a visa at any US Embassy. To maintain the F visa, an individual must refrain from unauthorized employment and maintain a full course load.

study. In 2008, Congress extended the duration of OPT from 12 to 29 months for those in STEM fields.[24]

Labor Market Determinants of High-Skill Immigration

Besides these institutional policies, the flow of foreign-born professionals is determined by economic conditions. Changes in the supply of high-skilled workers from abroad, changes in demand for skilled labor in the U.S., and the availability of temporary and permanent visas all impact the level of immigration, as well as the earnings of immigrants and non-immigrants.

Demand-side determinants of high-skill immigration

One of the most notable features in the U.S. economy over the last three decades is the increase in the earnings premium to college graduates (Goldin and Katz, 2008). Demand for college-educated workers has grown at a far greater pace than changes in supply. The expansion of computer use in the workplace and of skill-intensive jobs in manufacturing and other industries has increased demand for workers in computer science and engineering occupations (Autor, Katz, and Krueger, 1998; Katz and Murphy, 1992; Acemoglu and Autor, 2011).

The economy has also seen unambiguous and differentiated demand shocks in specific science disciplines that have affected both labor and college enrollment. In terms of the physical sciences, defense investments and federal funding spiked in the 1980s, reversed in the 1990s, and then rebounded in recent years. In the life sciences, the National Institutes of Health budget doubled between the late 1990s and 2000. For computer sciences, the high-tech market has expanded and contracted over the past two decades –including precipitous decline following the dot.com bubble of the late 1990s.

[24] A further administrative change extended the number of designated STEM programs from about 90 to nearly 400 in June 2012.

Yet the college-educated professionals in science and engineering fields have not received disproportionate wage gains over this period (Katz and Autor, 1999; Card and DiNardo, 2002). Figure 7, which illustrates trends since 1970 in earnings for BA holders in some S&E occupations, shows that real wages have fluctuated over the period, but in 2010 were about at the same level as in 1973. Not surprisingly, PhDs in these fields earned more than BA degree recipients, as shown in Figure 8. In 1974, median earnings for PhDs in math and computer science and in physical sciences who were in the first ten years of their careers matched the 85th percentile of all BAs in the first ten years of their careers. PhDs in the biological sciences matched at the 81st percentile. In the second panel of Figure 8 we compare the evolution of the median earnings of PhD scientists and engineers to the earnings of BAs at the 85th percentile (which represents the baseline point of comparison at the start of the period) and at the 81st, and 92nd percentiles of the BA earnings distributions. As the figure shows, in all four cases, relative earnings fell. The relative fall was the least for those with math and computer science PhDs (roughly 10%) and the most for those in the biological sciences (roughly 33%).

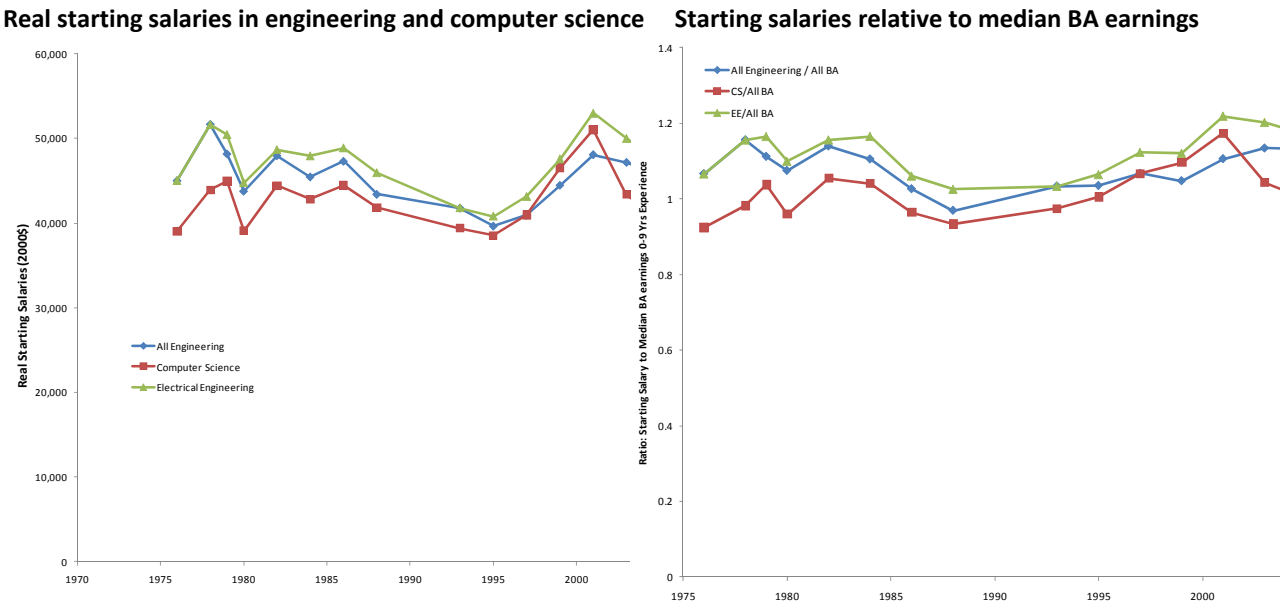
Taking a close look at the IT sector, Bound, Braga, Golden and Turner (2013) compare labor market adjustments to demand shocks generated by technological changes, first during the adoption of microprocessor technology in the late 1970s, and then during the internet boom in the late 1990s. Entry-level wages of those with a BA in computer science (CS) or electrical engineering (EE) relative to all BAs were greater in the 1970s and 1980s than in the 1990s and beyond.[25] It is plausible that this relative decline in wages is linked to increases in high-skill

[25] Measured at the peaks in each technology boom, the ratio of median earnings of CS graduates to all BA recipients was 1.78 in 1979 and 1.54 in 2001.

immigration during this period. Notably, the share of H-1B visa holders employed in IT fields rose from 11% in 1989 to more than 60% in 1999. [26]

In short, while S&E wage trends show short-term response to specific changes in demand, the growing demand for high-skilled workers in these fields has been accommodated. We believe high-skill immigration is one factor contributing to the economy's adjustment to S&E labor demand shocks.

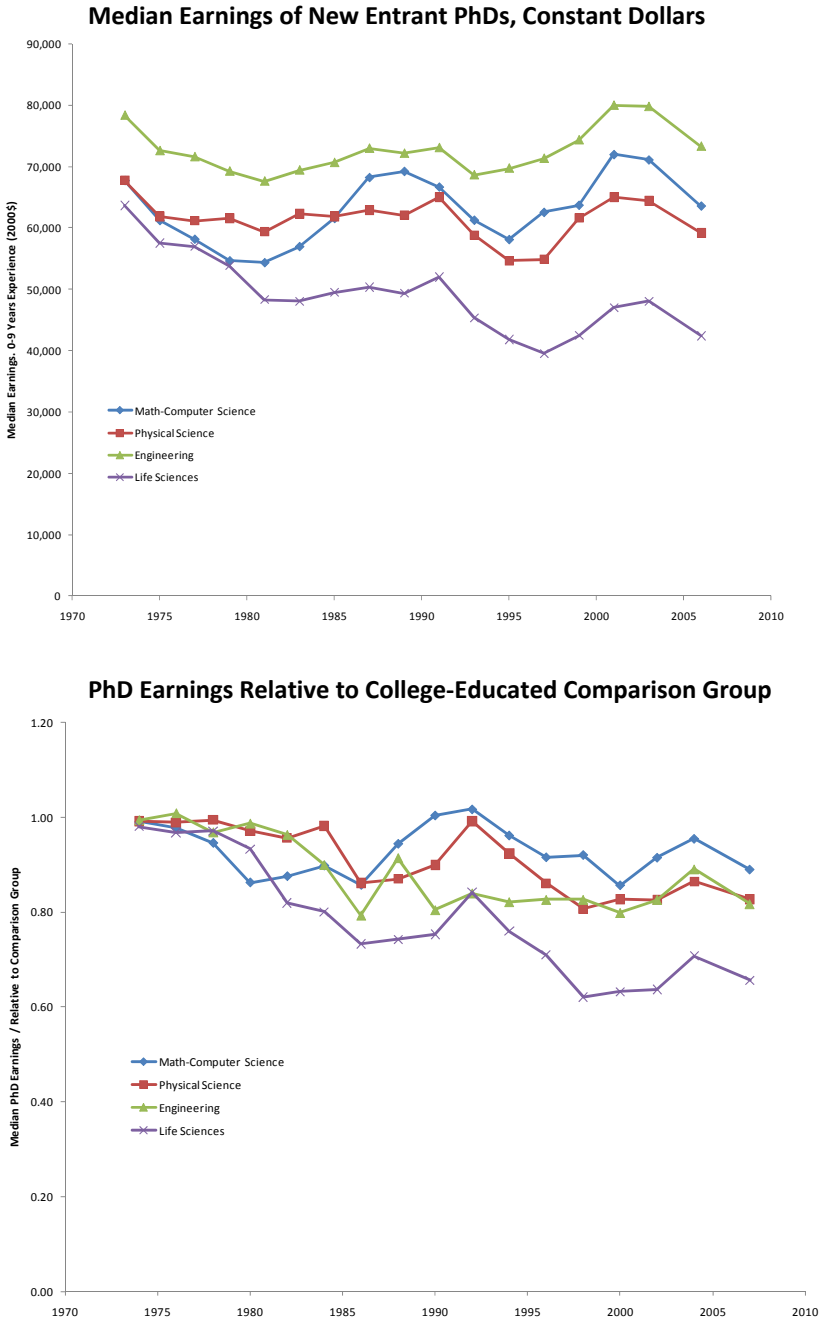
Figure 7: Trends in Wages for BA-level Scientists and Engineers, Levels and Relative to All BA Recipients



Source: New Entrants Surveys (NES) 1976-1988 and Survey of Recent College Graduates (1992-2006), limited to individuals working full-time.

[26] See Bound, Braga, and Golden (2013) with data from GAO (1992) and INS (2000). Note, as well, that India is the country which shows the largest growth in H visas issued in the 1990s, rising from 2,250 in 1990 to 16,485 in 1995 to 61,530 in 2000 (see U.S. State Department's *Annual Reports of the Visa Office*, *Yearbook of Immigration Statistics* and http://www.travel.state.gov/pdf/MultiYearTableXVI.pdf).

Figure 8: PhD Earnings in Levels and Relative to BA Comparison, Science and Engineering Fields, 0-9 Years of Experience (Men)



Source: Data on median earnings of doctorate recipients by field are for "new entrants" (0-9 years of experience) from the *Survey of Doctorate Recipients* and include only men. Panel B presents PhD earnings relative to a comparison group defined as the matching percentile from the *Current Population Survey* of the overall BA wage distribution observed in the baseline year (1974) for men with 0-9 years of experience; these matched percentiles are the 85th for Math-CS, the 85th for Physical Sciences, the 92nd for Engineers, and the 81st for the Life Sciences.

Supply of High-Skill Potential Immigrants

Growth in post-secondary enrollment in countries outside the U.S. has been extraordinary in the last three decades, increasing from 55.3 million to 141.5 million, with enrollment growth concentrated in developing countries and especially in Asia (Freeman, 2010, Table 1).

These marked increases in secondary and post-secondary educational attainment abroad increase the pool of potential high-skill immigrants to the U.S. Table 4 presents some illustrative country-specific trends across Asia, North America, and Europe. In China, growth in post-secondary enrollment has been astounding, increasing from barely a million students in 1980 to nearly 29 million students in 2009. In India, post-secondary enrollment increased from about 3.2 million in 1980 to about 18.6 million students in 2009. Together, the combination of extraordinary rates of growth and large population bases has dramatically expanded the global supply of college-educated workers.

Changes in post-secondary enrollment have translated to changes in degree receipt at the BA, MA, and PhD levels. A significant distinction between the U.S. and many Asian countries is in the proportion of college degrees awarded in science and engineering fields. Of the BA-level degrees awarded in 2006, nearly 53% of those in China and more than 40% of those in South Korea and Taiwan were in S&E fields, compared to only about 32% of those in the U.S. Asian countries such as China, India, and South Korea have also invested in the production of advanced degrees, breaking the near-monopoly previously held by the U.S, the U.K., Germany, and Japan.

Table 4. Tertiary Enrollment by Year, Selected Countries

	1980	1985	1990	1995	2000	2005	2009	% Change 1985-2009	% Change 1995-2009
Australia	323,716	370,048	485,075	964,998	845,132	1,024,589	1,199,845	224%	24%
Brazil	1,409,243	...	1,540,080	...	2,781,328	4,572,297	6,115,138	.	.
China	1,019,950	2,746,124	3,924,546	5,278,935	7,364,111	20,601,219	29,295,841	967%	455%
France	1,060,412	1,255,538	1,587,202	2,072,552	2,015,344	2,187,383	2,172,855	73%	5%
India	3,278,793	4,271,618	4,780,181	4,932,669	9,404,460	11,777,296	18,648,923	337%	278%
Indonesia	...	980,162	1,515,689	2,229,796	...	3,660,270	4,859,409	396%	118%
Israel	97,624	...	122,568	182,836	255,891	310,937	342,707	.	87%
Republic of Korea	538,726	1,345,114	1,630,374	2,065,579	3,003,498	3,210,184	3,219,216	139%	56%
United Kingdom	795,985	1,006,969	1,177,792	1,813,280	2,024,138	2,287,541	2,415,222	140%	33%
USA	11,569,899	12,241,940	13,538,000	14,278,799	13,202,880	17,272,044	19,102,814	56%	34%
Viet Nam	133,558	...	185,788	203,300	732,187	1,354,543	1,774,321	.	773%

Source: UNESCO Accessed 2/24/2012

The rapid expansion in the number of college-educated workers abroad not only dramatically increases the potential pool of high-skill workers who may seek to join the U.S. labor force, it may also increase demand for advanced degree programs offered in the U.S. These trends reinforce our view that immigration likely explains much of the labor market adjustment to demand shocks.

The basic supply-demand model suggests that while immigration brings gains in output, the availability of foreign high-skill workers will lower wages and crowd out U.S.-born workers as long as the demand for labor slopes down (Borjas, 2003). However, direct evidence on the magnitude of such crowd-out is difficult to obtain and research on this question has often found no effects. For example, Kerr and Lincoln (2010) find that variation in immigrant flows at the local level related to national changes in H-1B flows do not appear to depress native wages or employment, which would imply a very large elasticity of demand. A central challenge to interpretation of the evidence is that changes in supply and demand for workers may occur concurrently, complicating the capacity to infer the net effect of immigration on wages.

Pathways to Entry

We now trace the pathways to immigrant entry to the U.S. labor market and the persistence of high-skill foreign-born workers in this market. Of particular interest is the timing of immigrant entry in relation to educational attainment and the role of colleges and universities in giving immigrants access to the U.S. labor market. There is potentially a large intergenerational component to immigration if today's high-skill immigrants arrived as young children. Further, immigration may interact with educational attainment because many immigrants enter the U.S. as students and then enter the labor force.

Our analysis covers the immigrants currently in the country. It would be preferable to provide more detail about the retention rates or likelihood of becoming permanent residents or naturalized citizens among all foreign-born students entering the U.S. on either work or student visas. Such information is not available.

Age and Education Level at Immigration

The age distribution at entry to the U.S. of older working age immigrants (35-54) provides an indicator of their pathway to entry (we omit younger persons in this table because a large share of them are still students). Among these immigrants at every educational level, more than half did not arrive in the U.S. until they were at least 25 years old (Table 5). This share is highest (rising to about two-thirds) among professional and PhD recipients, suggesting that many of the latter entered the U.S. via graduate training or a high-skill job. Few of these older working-age immigrants arrived in the U.S. between the ages of 18 and 21, the typical age of undergraduate enrollment.[27] Low-skill immigrants are the group most likely to enter the U.S.

[27] Very recent evidence suggests an increase in the number of foreign students pursuing U.S. undergraduate degrees, though it is too early to predict whether these students will stay in the U.S. (Bird and Turner, 2012).

between the ages of 18 and 21 (about 18.1%). (We suspect 18% is an underestimate because this group is likely to enter and then return to their home countries.)

Table 5. Distribution Age of Entry among Immigrants

Age at Entry	< High School	HS and Some College	BA	Master's	Professional	Doctoral
0-17	18%	26%	21%	18%	19%	10%
18-21	18%	14%	10%	10%	6%	8%
22-24	13%	12%	12%	14%	9%	14%
25-34	32%	31%	36%	38%	43%	45%
35+	20%	17%	21%	20%	24%	23%

Sample: Census 2000
Restriction: Foreign 35-54 years old, non-imputed data on age, education level and immigrant status

For high-skill immigrants, we can examine the interplay between the timing of educational attainment and arrival in the U.S. using the National Survey of College Graduates (1993, 2003). This survey provides detailed information for high-skill immigrants who were in the U.S. for both the decennial census years (1990 and 2000) and the point of observation three years later. (A disadvantage is that it is a follow-up three years after the initial survey; hence, it omits the non-immigrant foreign-born who stay in the U.S. only a short time.)

A very high proportion of immigrants, particularly those with advanced degrees, received their highest credential in the U.S. not their home country. Table 6 presents data on the location of highest degree among immigrants with BAs, MAs, and PhDs working in S&E occupations in 2003. For those with graduate degrees, a strikingly high proportion received this degree in the U.S., with these shares somewhat higher among those employed in engineering and computer science fields. At the MA level, nearly 45% of engineers and 50% of those in computer science received their MA in the U.S. after completing prior studies abroad. At the PhD level, more than 60% of engineers and computer scientists studied abroad and then received a U.S. PhD.

Table 6. Location of Degrees by Occupation

	American HS	HS Abroad and American BA	HS and BA Abroad
All BA	30%	15%	55%
Engineers, BA	30%	22%	48%
Computer Science and Math, BA	31%	16%	53%
RN, Pharmacists, Dietitian	29%	17%	55%
Diagnosing and Treating Health	44%	12%	44%

	American HS	HS Abroad American BA	HS and BA Abroad and American Highest Degree	HS, BA, and Highest Degree Abroad
All MA	24%	18%	35%	23%
Engineers, MA	19%	19%	45%	17%
Computer Science and Math, MA	13%	12%	51%	24%
All Phd	12%	13%	47%	28%
Engineers & Scientists, PhD	11%	10%	51%	29%
Engineers, PhD	9%	8%	63%	20%
Computer Science and Math, PhD	6%	7%	62%	25%

Source: NSCG 2003
Foreign Definition - Citizenship Status
Restrictions: Foreigners with available information about the location of degree

While U.S. higher education remains an important gateway to immigrant labor market participation in engineering and computer science fields, there has been a modest increase in the share of high-skill immigrants who received all of their education abroad. In particular, between 1993 and 2003 (not shown here) the share of computer science immigrants educated entirely abroad increased from 36% to 52% at the BA level, from 11% to 24% at the MA level, and from 17.6% to 24.7% at the PhD level. We hypothesize that this shift may reflect the increased demand in computer science over this period, the growth of international networks linking U.S. employers and potential immigrants, and the expanded capacity of foreign tertiary education to award degrees in high demand areas.

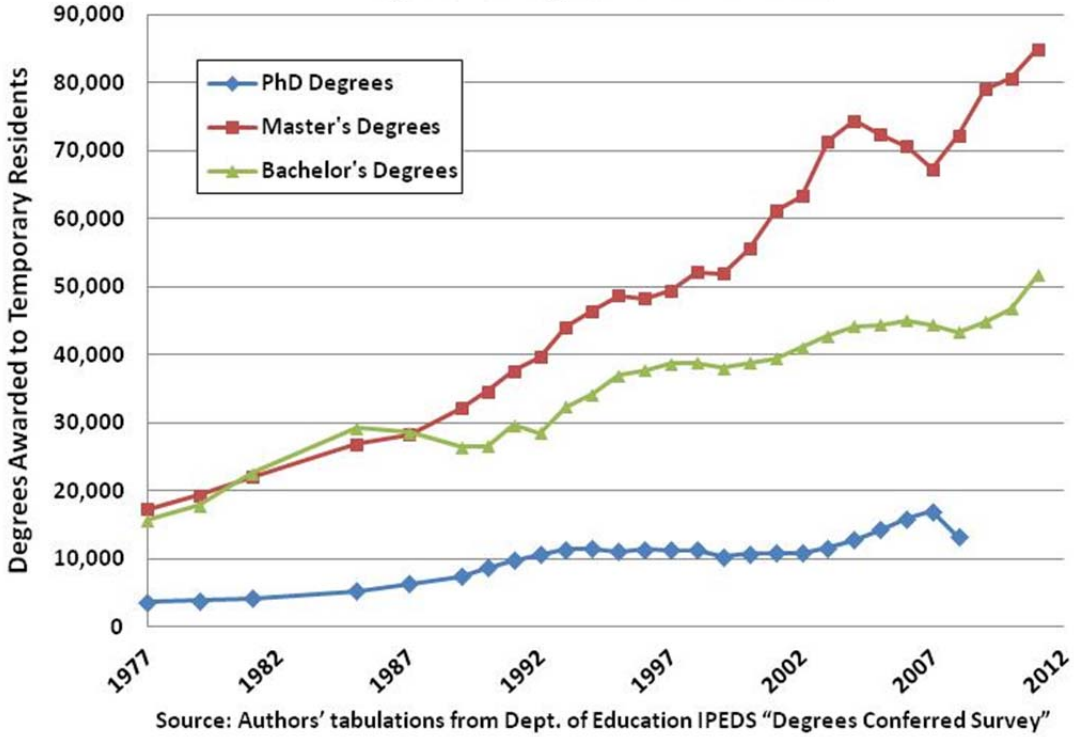
U.S. Higher Education and Foreign Degree Attainment

Demand for U.S. higher education among foreign students reflects both their desire to acquire skills and training that may be in short supply in home countries and an option on employment in the U.S. labor market. As noted above, foreign-born recipients of U.S. degrees hold an advantage over those holding only foreign degrees. The impact on demand for higher education at both the undergraduate and graduate levels in the U.S. is substantial. U.S. institutions have (at least in recent history) held a strong advantage in degree production at the highest levels. Thus, even as countries expand the capacity of post-secondary institutions, it is unlikely that growth will be in degree programs that can compete with the most highly ranked programs in the U.S. Rozenzweig (2006) examines the extent to which home-country degree production is a substitute or a complement for foreign-degree production. He finds that in emerging economies, an increase in a country's post-secondary enrollment will increase the pool of students seeking to study abroad.

The capacity to finance study in the U.S. is likely to be a primary determinant of foreign demand. U.S. undergraduate institutions rarely provide need-based financial aid at the undergraduate level, making four years of either private or out-of-state public tuition out of reach for all but the most affluent foreign students. At the other extreme, PhD programs can often provide financial aid through TA, RA, and fellowship support. Less than 5% of foreign students support themselves as self-pay (Blanchard, Bound and Turner, 2009). In the middle ground, MA programs are more likely to be an option than BA programs given their shorter duration, and some foreign students will gain admittance to PhD programs with full financial aid, only to depart with an MA degree.

Hence three factors explain the large number of foreign students enrolled in U.S. graduate programs and the high immigrant representation among post-baccalaureate degree recipients: 1) Substitutes for U.S. graduate education and elite undergraduate education are not likely to be available in their home countries; 2) Advanced degree attainment increases the likelihood that a firm can satisfy H-1B requirements; 3) Foreign-born are more likely to be able to finance graduate study than undergraduate attainment because MA programs are of short duration and PhD programs often provide financial aid.

Figure 9. Trends in Degrees Awarded to Temporary Residents by U.S. Colleges and Universities



Source: Authors' tabulations from Dept. of Education IPEDS "Degrees Conferred Survey"

Figure 9 plots the number of degrees awarded to foreign students by education level from 1977 to 2011. The number of BA degrees awarded to temporary residents increased by 328%, from 15,744 to 51,703, during this 34-year period. The increases in MA and PhD degrees awarded to temporary residents were evern more dramatic, with the number of MAs rising by a factor of 4.8, and PhD degrees by a factor of 4.7. The increase in MA degrees includes those

earned as part of a path to a PhD degree as well as terminal MA degrees. We suspect that terminal MA degrees in which students pay full tuition have increased as a share of all MA degrees in recent years.

Country of Origin and Degree Attainment

We now examine the relationship between country of origin, degree level, and occupational specialization. Table 7 shows the five largest source countries for immigrants ages 25-54, by

Table 7. Occupational Specialization by Country of Origin

All BA (no MA, PhD)		BA, Engineers		BA, Comp and Math	
Philippines	11%	Vietnam	12%	India	25%
India	9%	India	10%	Philippines	7%
Mexico	8%	Philippines	8%	Vietnam	6%
Korea	5%	Mexico	5%	China	4%
Vietnam	4%	China	5%	Korea	3%
MA, Engineers		**MA, Comp and Math**		**PhD, Eng. And Science**	
India	27%	India	38%	China	23%
China	13%	China	13%	India	12%
Taiwan	5%	Taiwan	5%	Korea	5%
Vietnam	4%	Germany	3%	Canada	4%
Iran	3%	Pakistan	2%	Germany	4%
Registered Nurses		**Physicians**			
Philippines	31%	India	20%		
India	6%	China	5%		
Canada	4%	Pakistan	5%		
Jamaica	4%	Philippines	5%		
Nigeria	4%	Canada	4%		

Source: ACS 2009-2011
Restrictions: 25-54 years old, born abroad, worked positive hours in the during the previous year.

education level and field, in 2009-2011. As shown nearly 23% of science and engineering PhDs were from China, 31% of nurses were from the Philippines, and almost 40% of MA degree recipients working in math and computer science were from India. The rise in the representation

of immigrants from China is noteworthy. In each field the share of immigrants from China in 2010 is more than twice the level observed in 1990 (not shown).

To examine the link between visa status on entry to the U.S. and current visa status, we look to the National Survey of College Graduates (2003), which includes foreign-born individuals in the U.S. as of the 2000 census. In effect, these estimates are conditional on retention in the U.S. for three years. The proportion of the current immigrant population entering on student visas varies with education and specialization (see Appendix Table 2). Among foreign-born workers in engineering and computer science, about 30% of those with BA or MA degrees entered the U.S. on student visas, while more than 70% of those with PhD degrees did. In contrast, immigrants in nursing are much more likely to enter directly as permanent residents than on student visas. Temporary work visas are the entry pathway for 17% of BA- and MA-degreed engineers and 26% of BA- and MA-degreed computer science professionals, while only 9% of doctorate- level scientists and engineers use this path.

For immigrants entering the U.S. via temporary visas, the likelihood of becoming naturalized citizens or gaining a green card is high. More than 72% of science and engineering PhDs entering on temporary visas transitioned to permanent residency or citizenship. Among engineers and computer scientists at the BA or MA level, those entering on student visas are somewhat more likely to hold permanent residency or citizenship than those entering on temporary work visas.

Persistence and Stay Rates

Understanding what fraction of those entering the U.S. on temporary visa arrangements remain in the U.S. and what fraction eventually return home is of considerable interest from both the social science and policy perspective. One often hears concern that after training the world's

best and brightest, we do not let them stay here. Indeed, high-skilled immigrants usually enter the U.S. under visas that are explicitly temporary – the F, J, H and L visas – though in the case of the F and the H visas, individuals are not prohibited from moving directly from their temporary status to the status of a permanent resident. In theory, it should be possible to follow legal immigrants from their initial entry into the U.S. through the visa system and through possible exit using administrative data; to determine what fraction of those who enter the U.S. on student visas eventually end up with either a work visa or a green card, and what fraction of those who enter on H-1Bs eventually end up with a green card. However, such data are not publicly available and**,** as far as we know, individuals within the government with access to these data have not integrated administrative information in this way.

The best information we have on persistence comes from tabulations done by the Social Security Administration for Michael Finn. Finn (2012) uses NSF's Survey of Earned Doctorates (SED), a census of those receiving PhDs from U.S. institutions, to identify recent PhDs. He then sends this information to the Social Security Administration to identify which of the foreign-born on temporary or permanent visas at the time they received their PhD continue to work in the U.S. at intervals of one, two, five, and ten years after degree receipt. Finn estimates that, as of 2009, 64% of those receiving their PhDs five years earlier continued to live in the U.S., while 66% of those who received their PhD ten years earlier did so.

Stay rates for doctorate recipients tend to be somewhat higher in science, technology, engineering, and mathematics (STEM) fields and have been trending up. They also vary by country of origin. Focusing on just those with temporary visas receiving PhDs in STEM fields, Finn finds that 89% of those from China and 79% from India remain in the U.S. five years after receiving their PhD. In contrast, he finds five-year stay rates for those from Japan, South Korea,

and Taiwan are all under 50%. More generally, those from Latin American, Canada, and Western Europe have below average (62%) five-year stay rates. These patterns, while not definitive, suggest that persistence rates reflect market forces, not only visa availability. Doctorate recipients from high-income countries with well-established universities may face better home-country options than those from low-income countries. As a result, those from Western Europe and Canada may not choose to stay permanently in the U.S. unless they obtain employment in top research universities or labs (Bound, Turner, Walsh, 2009).

In closely related work, Grogger and Hanson (2013) use the data within the SED on intentions to stay in the U.S. to study patterns across individual characteristics, countries and decades. Historically, the SED data on intentions closely tracks the data on actual stay patterns calculated by Finn. Grogger and Hanson (2013) find that over the period 1960 to 2008, the likelihood of reporting intentions to stay in the U.S. was high among science and engineering PhDs (77% planned to stay),and among students with stronger academic ability as measured by parental educational attainment and success in obtaining graduate fellowships. Students were less likely to report an intention to say if they came from high-income countries or countries which recently democratized. They also find that foreign PhDs were more likely to intend to stay in the U.S. during periods of strong U.S. GDP growth.

Researchers have used various indirect approaches to estimate persistence rates. One method is to construct synthetic cohorts of foreigners using repeated cross-sectional data. For example, one can use the 1990 and 2000 U.S. census enumerations and the 2010 ACS to identify the foreign born who immigrated to the U.S. between 1985 and 1990 and who were 25-29 years old as of 1990, 35-39 in 2000, and 45-49 in 2010. Comparisons of the size of these three populations gives an estimate of net 10- and 20-year persistence rates. We have done this kind

of calculation, restricting ourselves to individuals identified as having at least a BA degree. Of course, someone without a BA degree in 1990 might have one in 2000, but restricting our attention to those age 25 and above should minimize this issue. Strikingly, this method yields estimates of 10- and 20-year net persistence rates of very close to 100%.[28]

The 1993 National Survey of College Graduates (NSCG) allows us to calculate three-year stay rates. The sampling frame for the 1993 NSCG was drawn from the 1990 census. It is possible to link the sampling frame to the 1993 NSCG and then calculate loss to followup. Not all of such loss will have been due to emigration, but a comparison between the foreign and U.S.-born can give a crude estimate of the fraction who left. Recall, the sampling frame for the 1993 NSCG was those with a Bachelor's degree in 1990. We calculated loss to follow-up separately for those who were minors when they immigrated, who were 18-24, and who were 25 or older. The fractions lost to follow up were 19% of those who immigrated as minors, 25% of those who immigrated when they were 18-24, and 28% of those who immigrated after they were 25. These fractions represent upper bounds on three-year emigration rates. For the same sample period, 16% of the U.S.-born were lost to follow up, suggesting that many of the immigrants lost to follow up may not have emigrated. Indeed, the difference-in-difference estimate suggests that very few of those who arrived as minors subsequently emigrated, but that roughly 10% of those who immigrated as adults did. The implied stay rate is substantially higher than the 49% two-year stay-rate Finn calculated for the 1989 PhD cohort.

In another study, Lindsay Lowell (2010) used administrative data to calculate emigration among those who initially obtained an H-1B visa between 1992 and 1996. Aggregating across these five years, he estimates that just over 50% of these awarded H-1Bs ultimately emigrated.

[28] Freeman (2010) estimates that among foreign-born, BA recipients from U.S. universities, stay rates are exceedingly high. He estimates that about 550,000 non-citizens and nonpermanent residents obtained S&E degrees in the U.S. between 1960 and 2003, while the stock of U.S. educated S&E BA recipients in 2003 was about 723,000.

Socio-demographic Outcomes

Possibly related to retention is immigrant assimilation, the extent to which these individuals have similar location choices and family outcomes as natives.

Geography

In the U.S., some states (largely those in North East) have relatively high concentrations of college-educated workers, which can be attributed to the structure of local industry as well as relatively widespread availability of college and university opportunities**.** Indeed, we expect location choices of native born to adjust relatively rapidly to changes in product demand. To the extent that high-skill immigration responds to demand shocks in the labor market, we would expect the distribution of immigrants to approach the distribution of those born in the U.S. Alternatively, if immigrant networks are an important draw, we might expect to see a very different concentration of natives and foreign-born by state for different levels of education.

Table 8 shows the concentration ratio (CR5, or percent who live in the most common five states) and the index of dissimilarity[29] to describe the distribution of natives and immigrants by state for different levels of S&E education, and for RNs and MDs. As the table indicates, less well-educated immigrants and immigrant RNs are much more highly concentrated in a small set of states (notably California) than are their native-born counterparts. While the better-educated immigrants are also more concentrated than are their native-born counterparts, the differences are much less dramatic for these groups, while indices of dissimilarity fall by roughly 50%.

[29] Index of dissimilarity is defined as $\frac{1}{2}\sum_{i=1}^{50}|f_i - a_i|$ where i is a state index, f_i is the share of foreigners and a_i is the share of Americans in state i.

Table 8. Measures of population distribution across states			
	Concentration Index (CR5)		Index of dissimilarity
	American	Foreigner	American vs. Foreigner
Education			
Less than HS	0.32	0.64	0.39
HS and Some College	0.32	0.61	0.35
BA	0.33	0.6	0.29
Master's	0.34	0.53	0.23
PhD	0.34	0.46	0.17
Science/Engineering degree			
BA	0.3	0.57	0.31
Master's	0.32	0.5	0.21
PhD	0.33	0.45	0.16
Profession			
Registered Nurses	0.29	0.63	0.41
Physicians	0.33	0.46	0.19

Sample: ACS 2009-2011 combined
Restriction: 25-54 years old, non-imputed data on age, education level and immigrant status. Foreign definition: Naturalized or non-citizen

Marriage and Family Formation

Immigrants are much more likely to be married than non-immigrants at low levels of educational attainment but not at high levels (see Appendix Table 3). Most married immigrants select spouses from their country of birth. This pattern is somewhat more dramatic for the least well educated (roughly three quarters marry someone from their country of birth), but is true across all education groups.

Among high-skill workers, foreign-born men are only slightly more likely than native-born men to be married, while foreign-born women are 7 to 9 percentage points more likely to be married than native-born women. High-skill men are more likely than high-skill women to have the same country of origin as their spouses.

There is a high degree of intergenerational transmission of educational attainment. There is substantial evidence that the children of college-educated parents are much more likely to be college-educated than are children of those without a college education. The same is true of the

children of those with advanced degrees. Thus, it seems likely that were we able to identify not only first-, but second-generation immigrants using census data, we would find an even greater over-representation of immigrants amongst the highly skilled.

Thoughts ahead and conclusion

The evidence presented in this chapter highlights the importance of the growing the high-skill immigrant population in the U.S. Both visa policies and labor market incentives shape the pattern of immigration. Without question, gains in educational attainment abroad at both secondary and post-secondary levels have dramatically increased the potential supply of high-skill immigrants to the U.S. Furthermore, the concentration of foreign students in science and engineering serves to further alter relative supplies. In turn, increased demand for S&E skills in the U.S. economy in recent decades appears to have been accommodated in part by expansion in labor supplies through the entry of foreign-born high-skill workers (Bound, Braga, Golden and Turner, 2013).

The substantial representation of foreign-born workers in the U.S. S&E workforce and the growth in the global pool of workers with S&E training underscores the need to move away from "closed economy" models of high-skill labor markets in the U.S. Yet the process of adjustment to any change in technology or policy affecting the demand and supply for high-skilled workers from abroad is likely to be complex, with effects extending far beyond metrics of U.S. wages and employment. For example:

- Education and career decisions of U.S. natives are likely highly intertwined with patterns of high-skill immigration.
- Incentives for the foreign-born to study in the U.S. are closely coupled with potential labor force participation in the U.S. Universities may actively recruit foreign students to fill doctorate programs and to provide additional tuition revenue at the undergraduate

level, while preference for H-1B visas and opportunities for Optional Practical Training via the F visa may increase foreign student demand for U.S. programs.

- High-skill workers from abroad may impact innovation and science in the U.S. economy and, as such, the full welfare implications of immigration are not captured in analyses of employment and earnings.

- The flow of high-skill foreign-born workers to the U.S. also has substantial effects on source countries, raising questions about the level of wages and employment abroad in the absence of flows to the U.S.[30]

The long wait times for green cards and the quick exhaustion of caps for H-1Bs and other temporary visas imply that policy has generated disequilibrium conditions in the flow of high-skill workers to the U.S. labor market. Available evidence suggests that skilled workers from low-income countries gain substantially from migration to the U.S. (Clemens, 2013), resulting in excess demand for employment visas, both permanent and temporary. In addition, the counterfactual to reductions in the flow of high-skill foreign-born workers to the U.S. economy need not be greater employment of natives: firms may respond to limitations in the supply of high-skill workers by off-shoring.[31] Changes in U.S. policy with respect to the availability and cost of visas for education and employment could greatly affect high-skill immigration and retention.

While employment-based immigration and temporary work opportunities for high-skill workers are a widely discussed policy topic, the unavailability of relevant data remains a huge constraint in the capacity for research to inform public policy. Neither survey data nor administrative data currently accessible to researchers provide the information needed to measure employment and earnings by visa status, analyze transitions among different visa

[30] One example to this end is that changes in opportunities for nurses in the U.S. as the demand for nursing evaporated with the Great Recession have created a "glut" of trained nurses in the Philippines with attendant effects on this economy.

[31] See Feenstra (2009) for a discussion of offshoring in the presence of a highly elastic demand schedule for native workers.

classifications, or examine the timing and location of post-secondary investments in U.S. universities among foreign born. Available longitudinal surveys with information on immigrants (including the New Immigrant Survey) are often limited to immigrants with permanent visas or those who have substantial persistence in the U.S. Because of the retrospective frame of these surveys and the selection built into them, researchers are unable to make substantial progress in understanding the determinants of retention in the U.S. (as well as return migration) or the wage/employment changes that come with the transition to permanent residency.

Measures of persistence in the U.S. labor market, along with educational investments and the associated transitions from temporary visa classifications to permanent residency, are critical indicators of the welfare benefits and costs of high-skill immigration. However without better indicators of outcomes for temporary visa recipients, including those with short employment spells, and transition from student visas to work and other visas, it is difficult to measure the overall welfare benefits and costs of high skill immigration. To a large degree, constraints in access to administrative data that would inform these questions are organizational and bureaucratic, not technical. In effect, the government collects the relevant data but does not have a mechanism to provide access to researchers.

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APPENDICES

Appendix table 1: Descriptions of temporary visas

Visa Type:	Description	Countries of Eligibility	Duration of Visa
H1B, Temporary workers in specialty occupations	Requires the theoretical and practical application of a body of highly specialized knowledge requiring completion of a specific course of higher education. Capped at 65,000. This category also includes fashion models and Government-to-Government research and development, or co-production projects administered by the Department of Defense.	All Countries	3 Years, with 3 Year possible extension
O1, Workers with extraordinary ability or achievement	To qualify for an O-1 visa, the beneficiary must demonstrate extraordinary ability by sustained national or international acclaim and must be coming temporarily to the United States to continue work in the area of extraordinary ability. Extraordinary ability in the fields of science, education, business or athletics means a level of expertise indicating that the person is one of the small percentage who has risen to the very top of the field of endeavor. Extraordinary ability in the field of arts means distinction.	All Countries	Up to 3 Years, with 1 Year incremental extensions approved by USCIS
TN, North American Free Trade Agreement (NAFTA) professional workers	The North American Free Trade Agreement (NAFTA) created special economic and trade relationships for the United States, Canada and Mexico. The TN nonimmigrant classification permits qualified Canadian and Mexican citizens to seek temporary entry into the United States to engage in business activities at a professional level. Among the types of professionals who are eligible to seek admission as TN nonimmigrants are accountants, engineers, lawyers, pharmacists, scientists, and teachers.	Citizens of Canada and Mexico	Up to 3 Years
L1, Intracompany transferees	L1A: Enables a U.S. employer to transfer an executive or manager from one of its affiliated foreign offices to one of its offices in the United States. This classification also enables a foreign company which does not yet have an affiliated U.S. office to send an executive or manager to the United States with the purpose of establishing one. L1B: Enables a U.S. employer to transfer a professional employee with specialized knowledge relating to the organization's interests from one of its affiliated foreign offices to one of its offices in the United States. This classification also enables a foreign company which does not yet have an affiliated U.S. office to send a specialized knowledge employee to the United States to help establish one.	All Countries	Those entering the United States to establish a new office will be allowed to stay 1 year. All others given maximum stay of 3 years. Can request 2 year increment extensions. Max 7 years total
E1, Treaty traders and their spouses and children	Allows a national of a treaty country (a country with which the United States maintains a treaty of commerce and navigation) to be admitted to the United States solely to engage in international trade on his or her own behalf. Certain employees of such a person or of a qualifying organization may also be eligible for this classification.	U.S. Treaty Countries: list here: http://travel.state.gov/visa/fees/fees_3726.html	2 year max initial stay +2 year approved increments. No limit on total stay.
J1, Exchange visitors	Authorized for those who intend to participate in an approved program for the purpose of teaching, instructing or lecturing, studying, observing, conducting research, consulting, demonstrating special skills, receiving training, or to receive graduate medical education or training. J-1 nonimmigrants are therefore sponsored by an exchange program that is designated as such by the U.S. Department of State.	All Countries	Duration of the Exchange Program + 30 day grace period

Source: Description for H-1B, O-1, TN, L-1, E-1, E-2, K1, K3, V1 and V3 Visa Categories are from the Visa specific pages on the USCIS website: http://www.uscis.gov/portal/site/uscis. Description for J1 and J2 Visa types from the U.S. Department of State Exchange Visitor Program Website: http://j1visa.state.gov/

Appendix Table 2. Entry Visa Status and Current Visa Status (age 25-54)
Source: NSCG 2003

Entry visa status	Share of total	Current Visa Status: Naturalized	Permanent resident	Temporary work visa	Student visa	Temporary other visa
All entrants						
Permanent resident	44.4%	78.9%	20.8%	0.0%	0.0%	0.2%
Temporary work visa	13.1%	26.2%	49.0%	22.5%	0.2%	2.1%
Student visa	20.2%	51.4%	33.0%	11.8%	1.3%	2.5%
Temporary other visa	22.2%	60.5%	29.8%	4.7%	0.2%	4.8%
BA and MA, No PhD, Engineers						
Permanent resident	39.7%	88.0%	12.0%	0.0%	0.0%	0.0%
Temporary work visa	17.3%	15.1%	41.5%	39.7%	0.0%	3.7%
Student visa	30.3%	54.8%	28.4%	14.3%	1.3%	1.3%
Temporary other visa	12.6%	69.0%	20.5%	9.3%	0.0%	1.2%
BA and MA, No PhD, CS and Math Scientists						
Permanent resident	29.1%	81.1%	18.5%	0.1%	0.2%	0.0%
Temporary work visa	25.6%	10.7%	53.9%	32.8%	0.0%	2.5%
Student visa	29.5%	40.4%	37.0%	21.3%	0.3%	0.9%
Temporary other visa	15.9%	58.5%	34.2%	6.1%	0.0%	1.1%
PhD all fields						
Permanent resident	12.1%	75.8%	23.3%	0.9%	0.0%	0.0%
Temporary work visa	9.3%	24.5%	55.3%	18.9%	0.0%	1.4%
Student visa	67.3%	42.3%	34.2%	18.0%	3.5%	2.1%
Temporary other visa	11.3%	58.5%	31.3%	6.1%	1.3%	2.7%
PhD, , Engineers and Scientists						
Permanent resident	10.3%	78.7%	19.9%	1.4%	0.0%	0.0%
Temporary work visa	8.8%	22.5%	58.9%	16.6%	0.0%	2.0%
Student visa	71.1%	37.7%	36.0%	21.2%	3.5%	1.6%
Temporary other visa	9.8%	58.8%	29.4%	9.8%	1.1%	1.0%
RN, Pharmacists, Dietitian						
Permanent resident	46.3%	84.8%	15.2%	0.0%	0.0%	0.0%
Temporary work visa	27.3%	56.6%	32.4%	11.1%	0.0%	0.0%
Student visa	12.6%	81.8%	16.7%	1.5%	0.0%	0.0%
Temporary other visa	13.8%	72.1%	27.9%	0.0%	0.0%	0.0%
Diagnosing and Treating Health						
Permanent resident	43.5%	88.3%	11.7%	0.0%	0.0%	0.0%
Temporary work visa	7.4%	32.5%	51.1%	15.6%	0.0%	0.8%
Student visa	28.6%	59.1%	20.9%	16.9%	2.0%	1.0%
Temporary other visa	20.5%	79.2%	10.9%	6.4%	1.8%	1.6%
BA and MA, No PhD						
Permanent resident	35.3%	67.9%	31.5%	0.1%	0.0%	0.4%
Temporary work visa	17.5%	23.5%	50.6%	23.5%	0.2%	2.2%
Student visa	25.7%	49.3%	33.8%	12.7%	1.5%	2.7%
Temporary other visa	21.4%	48.5%	37.7%	6.5%	0.4%	7.0%
BA and MA, No PhD, Engineers						
Permanent resident	28.6%	80.9%	19.1%	0.0%	0.0%	0.0%
Temporary work visa	22.3%	10.3%	43.6%	42.2%	0.0%	3.9%
Student visa	37.8%	53.2%	29.9%	14.0%	1.4%	1.4%
Temporary other visa	11.3%	58.7%	25.6%	13.8%	0.0%	1.8%
BA and MA, No PhD, CS and Math Scientists						
Permanent resident	17.9%	65.8%	33.5%	0.3%	0.5%	0.0%
Temporary work visa	32.3%	9.7%	54.6%	33.2%	0.0%	2.6%
Student visa	36.1%	38.9%	37.7%	22.1%	0.3%	0.9%
Temporary other visa	13.6%	44.2%	45.7%	8.3%	0.0%	1.7%

Appendix Table 3. Marital status by Citizenship				
	American Men	Foreign Men	American Women	Foreign Women
Less than high school				
Not married	65%	42%	65%	39%
Married to native	31%	7%	30%	7%
Married to immigrant, same country	0%	44%	0%	47%
country	4%	7%	6%	7%
Total	4,392,020	2,893,602	3,196,957	2,466,476
High school and some college				
Not married	50%	41%	48%	38%
Married to native	44%	13%	45%	16%
Married to immigrant, same country	0%	38%	0%	37%
country	6%	8%	6%	8%
Total	27,451,324	3,315,555	27,045,605	3,423,455