Finishing Degrees and Finding Jobs:

U.S. Higher Education and the Flow of Foreign IT Workers

John Bound
University of Michigan and NBER

Murat Demirci
University of Virginia

Gaurav Khanna
University of Michigan

Sarah Turner
University of Virginia and NBER

ABSTRACT

The rising importance of Information Technology (IT) occupations in the U.S. economy has been accompanied by an expansion in the representation of high-skill foreign-born workers in this area. To illustrate, the share foreign born in this occupation increased from about 15.5% to about 31.5% between 1993 and 2010, with the increased representation of foreign-born particularly marked among those younger than 45. This analysis focuses on understanding the role that U.S. higher education and immigration policy play in this transformation. Degree receipt from U.S. colleges and universities is an important pathway to participation in the U.S. labor market in IT fields, with foreign born workers with U.S. degree credentials particularly likely to persist in the U.S. For many workers from abroad, including countries like India and China where wages in IT fields lag those in the U.S., there is a substantial return to finding employment in the U.S. even as temporary work visa policies may limit entry. Limits on temporary work visas, which are particularly binding for those educated abroad, likely increase the attractiveness degree attainment from U.S. colleges and universities as pathway to explore opportunities in the U.S labor market in IT and other occupations.

1. Introduction

The "internet boom" of the late 1990s combined with the ongoing technological innovation has brought about a dramatic increase over the last two decades in high-skill workers in information technology (IT) occupations. Broadly encompassing programmers, computer scientists and electrical engineers, the number of workers in IT occupations has expanded by more than 1.2 million, or more than 112% between 1993 and 2010 (Table 1).[1] In turn, sectors served by these workers have responded to dramatic increases in internet commerce and the rise of technology firms like Google, Yahoo, and Amazon, as well as the continued prosperity of firms like Microsoft and IBM.

One of the distinguishing features of the internet tech-boom initiated in the late 1990s has been the extent to which foreign-born workers have been part of the supply response. Among IT workers with at least a Bachelor's degree, foreign born workers have grown from about 16% of the IT workforce in 1993 to nearly 32% in 2010 (Table 1). The immigration of high-skill workers from abroad in IT fields in recent decades has generated a much different labor market response to demand shocks than would have occurred in the 1970s or in an environment with more restrictive immigration policies (Bound, Braga, Golden, Turner 2013). This analysis focuses on understanding the role that U.S. higher education and immigration policy play in this transformation.

Basic economics motivates the consideration of U.S. higher education, combined with immigration policy, in understanding the determinants of immigration in the high skill labor

[1] More concretely, we include the following occupations in IT field: computer and information scientists, computer network architects, computer support specialists, computer system analysts, database administrators, information security analysts, network and computer system administrators, software developers, web developers, other computer information science, computer engineers, electrical and electronic engineers, computer and information system managers, and computer programmers from the occupation list of the National Survey of College Graduates.

market. To the extent that the U.S. labor market provides a substantial premia relative to countries like China and India (Clemens, 2013) in IT occupations, high-skill workers have a strong incentive to immigrate. Yet, limits in the availability of temporary H-1B visas which require employer sponsorship may limit direct flows from foreign countries to the U.S. labor market. Because the number of foreign students who can enroll in U.S. higher education is limited by the higher education market (capacity to pay and supply) not visa policy, foreign students have incentives to pursue degrees in the U.S. both to acquire skills and to improve the potential likelihood of finding a job in the U.S. labor market. In effect, many foreign students may find a high rate of return to investment in U.S. degree programs.

This analysis demonstrates that degree receipt from U.S. colleges and universities is an important pathway to participation in the U.S. labor market in IT fields, with foreign born workers with U.S. degree credentials particularly likely to persist in the U.S. For many workers from abroad, including countries like India and China where wages in IT fields lag those in the U.S., there is a substantial return to finding employment in the U.S. even as temporary work visa policies may limit entry. Limits on temporary work visas, which are particularly binding for those educated abroad, likely increase the attractiveness degree attainment from U.S. colleges and universities as pathway to explore opportunities in the U.S labor market in IT and other occupations.

Our analysis in this paper begins by presenting a descriptive picture of the level and changes in educational attainment of foreign-born and natives working in the IT fields. Notably, foreign-born IT workers are more likely to hold advanced degrees than their U.S. born peers and a significant avenue for the flow of foreign born workers is among individuals who receive their highest degrees from U.S. institutions. The next section reviews the institutional parameters that

determine entry to the U.S. for high-skill workers, with particular attention to the mechanism of student visas. Then, we examine the growth in enrollment and degrees awarded to temporary residents by U.S. universities. An important finding is that, in the most recent two decade, degree receipt at U.S. institutions among foreign students, particularly at the Master's level, has been particularly responsive to labor market conditions. In the final section, we provide an examination of how the location of degree receipt affects persistence in the U.S. labor market and earnings of foreign born workers. For those in IT occupations, there is considerable variation by country of origin in the extent to which there is a labor market penalty or premium for foreign degree receipt; at the extremes, workers from China paying a penalty and those from European countries receive a premium.

2. Descriptive Backdrop: The Changing Composition of IT Workers

No matter what source of national data we employ, the rise in the total of number of IT workers and the increased representation of foreign-born workers is unambiguous over the last two decades. This finding is clear in the Current Population Survey, the American Community Survey (ACS), the Decennial Census enumerations and the periodic National Survey of College Graduates (NSCG: 1993, 2003, 2010), which includes detailed information on the location, year and field of post-secondary attainment.[2]

[2] The National Survey of College Graduates (NSCG) draws on the Census and ACS for the sampling frame. While the advantage of this survey for the analytics that follow is that we are able to identify whether an individual's post-secondary degrees were obtained in the U.S. or abroad, a disadvantage is that the NSCG will underrepresent college-educated workers residing in the U.S. for short periods of time and those leaving the country owing to the expiration of work visas.

Broad Trends

A point of departure for this analysis is the dramatic rise in the number of college educated workers employed in the IT sector: rising from 1.1 million in 1993 to nearly 2 million in 2003, with a more incremental rise to 2.4 million in 2010, respectively, which account for 0.4% of the total U.S. population in 1993, 0.7% in 2003, and 0.8% in 2010 (Table 1). Indeed, it is this first interval that is often referred to as an era of the "internet boom." While more than half (54%) of this increase is accounted for by the growth in U.S. born IT workers, about 575,000 of the IT workers added between 1993 and 2010 were born abroad. In turn, the share foreign born in this occupation increased from about 15.5% to about 31.5%, with the increased representation of foreign-born particularly marked among those younger than 45.

While it is widely regarded that a college-degree is a prerequisite to employment in high-skill IT fields, native-born and foreign-born workers differ somewhat in the extent to which they hold post-baccalaureate credentials. For U.S. born IT workers, nearly 75% hold a Bachelor's degree as their highest credential, while among foreign born workers less than 50% have the Bachelor's degree as their terminal degree, as nearly 44% hold a Master's and more than 6% hold PhDs (Table 2). Notably, foreign-born IT workers are more likely to hold advanced degrees than the broader group of college-educated foreign born workers in the U.S. economy while among native-born workers, IT workers are less likely to hold advanced degrees than the overall pool of college educated workers (Table 2, compare Panels A and B). Indeed, this "educational differential" is particularly noteworthy among the younger cohorts in recent years (Figure 1).

Location of Degrees among Foreign Born

For foreign-born IT workers a key question is the "source" of their human capital: were they educated entirely abroad, did they come to the U.S. for their entire post-secondary experience or did they come to the U.S. only for graduate school? Location of post-secondary degree attainment may affect the quality of the educational experience and, in turn, expected wages. While there is a wide distribution of university quality in the U.S., there is no question that the U.S. holds a comparative global advantage in university research education in the sciences, with U.S. universities often dominating global rankings. Yet, with more than 3000 post-secondary institutions in the U.S. there is substantial variation in resources per student across institutions and it is very difficult to assess accurately differences in quality of undergraduate or sub-doctorate graduate programs across countries.

In turn, degree attainment in the U.S. may provide the advantage of potentially easier access to U.S. employment options, as firms have less uncertainty about worker skills when they are well-acquainted with their educational institutions or it is relatively straightforward to interview candidates on site. U.S. employment is attractive to many immigrants, especially from developing countries like India and China, where the same skills will receive higher wages in the U.S. (Clemens, Montenegro and Pritchett 2008; Clemens, 2013).

Consistent with the proposition that the U.S. has a relative advantage in the production of advanced degrees (Bound, Turner and Walsh, 2009; Bird and Turner, 2013),[3] we see that among foreign IT workers those with advanced degrees are appreciably more likely to have received their degrees from U.S. institutions than those with only a Bachelor's. For example, in the year 2010 among those between ages 25-34, 73% of Master's degree recipients and 95% of PhD

[3] Based on rankings of research universities, 6 of the top 10 universities and 15 of the top 30 universities are located in the U.S.

recipients received their highest degrees from a U.S. institution relative to about 52% of Bachelor's degree recipients in 2010 (Table 3). For those whose highest degree is a Bachelor's, there is a marked change over the last two decades in the receipt of degrees in the U.S., with the share holding a U.S. degree sliding from about 86% to 52%. As we discuss later in this analysis, there has been a marked changed in the pathway of entry among foreign IT workers, shifting from those arriving at very young ages – often with their parents – to individuals arriving either as students or as young workers.

Formal Post-Secondary Training of IT Workers

While it is natural to associate degrees in fields like Computer Science and Electrical Engineering with employment in IT occupations, the formal credentials of workers in these occupations are more diverse, particularly for natives. Indeed, for natives between the ages of 25 and 34, only about 37% of Bachelor's level workers and 43% of Master's level workers hold their highest degree in Computer Science; with an additional 18% at the Bachelor's and 22% at the Master's levels holding highest degrees in Engineering, leaving more than 45% of natives with degrees in other fields at the Bachelor's level and more than 35% at the Master's level in 2010 (Table 4, Panel B). A clear implication of this finding is that we may expect that "inflows" from other fields, in addition to net new degree receipt, is an important source of supply flows for the domestic market for IT professionals.

For foreign born IT workers, the concentration of formal training in Computer Science and Engineering is much more marked. At the Bachelor's level, more than 82% of the foreign born IT workers concentrated in either Computer Science or Engineering, while about 81% of foreign born Master's-level workers held these concentrations (Table 4 Panel B). This finding

reflects both the selection of high-skill immigrants, as computer sciences and engineering tools are likely to be among the most "portable" skills, and the observation that Science and Engineering (S&E) degree programs comprise a greater proportion of degree programs abroad than in the U.S. For example, while about half of first university degrees awarded in China are in S&E fields, only about 31% of first university degrees in the U.S. are in these fields (*Science and Engineering Indicators*, 2014; Appendix Table 2-37).[4]

One hypothesis is that U.S. firms may find it easier to evaluate non-degree credentials among natives than among foreign-born. As a result, degree receipt in computer science or engineering provides much more information about qualifications for science and engineering positions, particularly in the IT fields, for non-natives than for natives.

3. Policy and Institutional Context

The factors that determine the flow of high-skill workers to the U.S. labor market include the quality and quantity of educational institutions in the home country, opportunities for post-secondary study in the U.S., relative labor market opportunities, and U.S. visa policies. Indeed, U.S. visa policies may affect not just decision to participate in the U.S. labor market but also educational investments. Moreover, U.S. visa policies affect the type and duration of employment of high-skill foreign-born workers in the U.S.[5]

Until about 1990, the primary source of high-skill immigrants to the U.S. labor market was via permanent residency or "green card" provisions. Yet, in recent decades – avenues for

[4] S&E fields include physical and biological sciences, mathematics and computer sciences, agricultural sciences, social and behavioral sciences, and engineering in Science and Engineering Indicators, 2014.

[5] For jobs most likely to engage foreign-born workers, permanent residence status or appropriate visa permitting work are most likely required given the difficulty of formal sector transactions with undocumented workers. While nearly 75% of unauthorized immigrants (compared to about 26% of all immigrants) 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).

temporary residency of high-skill individuals from abroad – including both temporary work status (primarily H-1B) and student status (primarily F visas) – have become a significant component of the pathway to permanent residency of high-skill workers born abroad.[6]

Permanent Residents

Some degree of "preference" for high-skill immigrants has long been a part of U.S. immigration policy. The Displaced Persons Act of 1948 established a pathway to permanent residency for high-skill immigrants and 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**,** but reserved 50% of each nation's quota for high-skill immigrants.

Employment endorsement is one of the four avenues for permanent immigration identified by the Immigration and Nationality Act of 1965 (Hart-Celler Act), which replaced the quotas.[7] Employment-based immigration generally follows a transition from another visa type; indeed, in 2011, 90% of employment-based green cards are an "adjustment of status" rather than new entry (*Handbook of Immigration Statistics*, 2011). 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.[8] For an employment-based green card, an employer must certify that

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

[7] The four main avenues for permanent residency are: 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 immigration. Some high-skill immigrants are admitted as children via this channel, completing their pre-collegiate and post-secondary training in the U.S.

[8] 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).

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. Beyond employer certification, education and skills play a key role in determining preference groupings for permanent 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.[9] Note that in 2011 more than 66% of employment based green-cards meet the first two priorities, while more than 92% meet the first three.

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 March 2014, Indian professionals falling into the second priority category had waited since November of 2004, while those in the third priority had waited more than 10 years from September 2003.[11]

Constraints on employment-based permanent residency opportunities may have several behavioral implications. First, high skill foreign-born workers may face constraints in their

[9] Additional "priorities" include: Fourth priority is given to individuals who have specialized jobs such as physicians, religious workers, and international organization employees. Last priority goes to entrepreneurs who invest at least $500,000 to create and sustain at least 10 permanent jobs. See http://travel.state.gov/visa/immigrants/types/types_1323.html for details.

[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. (March 2014) Visa Bulletin for March 2014, Volume IX Number 66. Retrieved from http://travel.state.gov/content/visas/english/law-and-policy/bulletin/2014/visa-bulletin-for-march-2014.html

capacity to stay in the U.S. or to switch jobs. These constraints are most likely to bind for those from countries like India and China subject to the 7% rule and those with lower educational attainment or priority rankings. Lowell and Avato (2013) provide some evidence that those on temporary work visas tend to face substantial earnings penalties. Secondly, those with the highest returns to staying may make investments in advanced degrees in order to increase priority status for advanced degrees.

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 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 and 40.2% of the total group transitioning to legal permanent residency under CSPA held student visas (Orrenius, Zavodny, Kerr, 2012).[12] Notably, nearly all of these students would have been graduate students given the trivial number of undergraduate students from China enrolled at U.S. institutions in the 1980s.

Temporary Work and Student Visas

For potential IT and high-skill workers from abroad, there are two related pathways to entry for those who do not hold permanent residency. The direct path to employment as a temporary worker is through the H-1B program while an indirect path is through the U.S. higher

[12] A similar country specific program is the Soviet Scientists Immigration Act (1992) allowed permanent visa status to 750 scientists from the USSR and former Baltic states. Note that the Soviet Scientists Immigration Act is distinguished from the CSPA in that it applies mostly to those who have completed post-secondary education.

education system, involving the acquisition of a degree and then the "option" of persisting in the U.S. labor market with either a temporary or permanent visa allowing work. It is critical to understand both paths, as they represent the dominant pathway to entrance to the U.S. labor market among foreign born. Indeed, in 2010, temporary work visas (H-1B) accounted for about 39% of the first visa status of IT workers ages 25-34 and student visas (F) accounted for about 35% ,with these shares up markedly relatively to older cohorts where entry via permanent residency was far more common (Table 5 Panel B).

The H-1B: Temporary Work

The H-1 designation dates to the passage of the 1952 Immigration and Nationality Act and is intended to provide 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. While the Immigration and Naturalization Act of 1990 transformed the H-1 visa program to what is now known as the H-1B visa program which includes a "dual purpose provision", allowing workers to potentially transition to permanent residency.[13] H-1B visas are valid for three years with the potential for a three-year extension.[14] In addition, H-1B visas are

[13] By statute, H-1B visas are "… are reserved for high-skill workers, requiring that the employee be in a 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 …" While the H-1B is the most widely recognized temporary visa, there is a substantial portfolio of other temporary work visa options which can connect foreign-born high skill workers to the U.S. labor market. Appendix Table 1 of Bound and Turner (2013) summarizes these alternative types. 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. In addition, there is some evidence that research universities increasingly use the J-1 category for foreign post-docs and visiting research 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.

[14] 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.

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] 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. In 2012, about 45% of the initial H-1B visa beneficiaries adjusted their visa status to an H-1B from another visa classification (U.S. Citizenship and Immigration Services, 2013).

The annual number of H-1B visas is capped at 65,000, though visas issued to individuals employed at colleges and universities (e.g., researchers and faculty) or non-profit research organizations 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.[16] This cap has been binding every year since 2004. 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. It is notable that neither country-specific visa quota has been filled since inception: the total number of H-1B1 visas for both Chile and Singapore is less than 1,000.

The F Student Visa

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

[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] 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

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.[17] There is no cap on the number of F-1 visas issued; these are issued automatically with the certification of U.S. higher education institutions. As shown in Figure 2, 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 2).

What is important to recognize is that U.S. higher education and entry through the F program is a viable avenue to achieving access to the U.S. labor market. In addition to facilitating the direct adjustment to a permanent residency or an H-1B visa, U.S.-based

[17] 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." 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.

postsecondary education creates an alternative opportunity to engage in the U.S. labor market through the Optional Practical Training (OPT) program. The program extends the F visa status for one year with work permission in jobs related to a student's major area of study.

Unlike permanent residency cards and H-1B visas, there is no annual quota limiting the number of students who may participate in OPT. An international student who has attended a certified U.S. university on a full-time basis for at least one academic year becomes eligible for OPT.[18] In 2008, Congress revised the OPT program in two dimensions: by limiting the possible unemployed period to a maximum of 90 days, and by extending the duration of the visa from 12 to 29 months for those in eligible STEM fields.[19]

To find the transition rates of foreign students into U.S. labor market through the OPT program, we compare the number of OPT beneficiaries in a year to the number of foreign graduates of U.S. colleges in the previous year. From 1999 to 2009, this transition rate has been around 0.3, which implies that three tenths of students enter the U.S. labor market initially under the OPT status. Upon completing the duration of the OPT status, an F-1 student has a 60-day grace period to change the visa status.

4. U.S. Enrollment and Degree Attainment: Cyclicality and Foreign Expansion

The flow of foreign-born students to U.S. higher education institutions and – potentially – the U.S. labor market depends on both home-country circumstances and the supply side of the

[18] The mechanics of adjusting to OPT program are as follows: a foreign student who wishes to work in the U.S. labor market must apply to the Designated School Office of his/her school within the 60 days of graduation. Designated School Officials renews his/her Form I-20, by making appropriate notation in SEVIS, then send it out to the U.S. Citizenship and Immigration Services, with the application fee paid by the student. The amount is currently $380. When the Employment Authorization Document (Form I-765) is issued by USCIS, the student becomes eligible to work. For further details of the program, and its impact on the stay rate and labor market outcomes of foreign students, see Demirci (2013).

[19] A further administrative change extended the number of designated STEM programs from about 200 to nearly 400 in May 2011 and June 2012.

U.S. market. Demand for U.S. higher education depends on home-country economic conditions, availability of home country options, and potentially labor market opportunities in the U.S. Despite a substantial literature on high-skill immigration in the workforce, there is limited existing work on determinants of foreign student flows into the U.S. higher education system.

In considering the motivation for foreign born pursuing post-secondary education in the U.S., Rosenzweig (2006) proposes two models for foreign student mobility: a "constrained domestic schooling model", which leads to the hypothesis that foreign students seek education in the U.S. due to a dearth of home country options; and a "migration model", which points to the hypothesis that foreign students enroll in the U.S. to increase the probability that they will find employment in the U.S. when they graduate.[20] As we discuss later in this analysis, there is likely substantial interaction between visa policies providing access to the U.S. labor market and educational decisions. More restrictive H-1B visa policies may have two countervailing impacts: one the one hand, some students may be discouraged from U.S. study as the option value of gaining employment subsequent to graduation likely decreases[21] while for those with the weakest

[20] Using a cross-section of data, Rosenzweig finds that the number of foreign students is positively related to the number of universities in a home country, and negatively related to the home country "skill-price", the market wage for a given skill level. Rosenzweig concludes that the migration model is the correct model, meaning foreign students come to the U.S. for education for an option value to enter the U.S. labor market. However, Hwang (2009) uses a panel of data from an alternate source, and finds a positive relationship between a home country's skill-price and enrollment in the U.S. She also performs a survey of foreign students at Harvard, from which 35.8% respondents revealed that their primary reason for studying in the U.S. was a lack of high-quality options in their home country. In addition, only half of respondents expressed the desire to work in the U.S. after graduation, and only 22% wished to work in the U.S. long term. Rosenzweig and Hwang do not disaggregate foreign students into education levels, i.e. undergraduate versus graduate. Yet, as we discuss below, demand determinants are likely very different for undergraduate, Master's, professional, or doctorate level students.

[21] Kato and Sparber (2013) test how decreasing H-1B visa quotas for most countries in the mid-2000s affected foreign enrollment. They find that not only do smaller quotas decrease foreign enrollment, but these restrictions also decrease the average quality of foreign interested in applying to U.S. institutions. Kato and Sparber's results are consistent with the migration model proposed by Rosenzweig, as applicants become less likely to secure employment in the U.S. after graduation. However, their results may be confounded by the fact that the U.S. student visa program also suffered from additional restrictions and delays in the years following the 9/11 attacks in 2001. Kato and Sparber's results are also limited to the undergraduate level.

home country options the return to U.S. study may increase to the extent that the relative likelihood of employment with a U.S. degree, particularly at the advanced level, is quite high.

Over the last three decades, there have been substantial changes in not only the total number of students coming to the U.S. for post-secondary education, but also shifts in countries of origin and destination institutions. It is these shifts that have a fundamental impact on the flow of foreign-born degree recipients to the U.S. labor market. Two data sources tracking country and institutional outcomes are the primary sources for what is known about these trends. First, the U.S. Department of Education distinguishes enrollment and degrees conferred among temporary residents from U.S. citizens and permanent residents at the level of the institution, further disaggregating by level of enrollment and field of degrees. Secondly, the Institute of International Education (IIE) has conducted a survey of the internationally mobile student population since 1948, which provides counts of students by country of origin studying in the U.S. at the undergraduate and graduate levels.[22]

Overall Trend in Foreign Enrollment

Figure 3 shows total enrollment of graduate and undergraduate students from abroad at U.S. colleges and universities from 1954 to 2011.[23] Over the three decades since 1980, the average annual growth rate in foreign graduate enrollment has been somewhat greater at 1.9% per year than undergraduate enrollment, though since 2005 undergraduate enrollment has grown at annual pace of 4.6% compared to 2.5% for graduate enrollment. While foreign undergraduates represent a relatively small share of undergraduate enrollment (3.3% in our sample of 4-year public and private non-profit institutions 2011), foreign students are a much

[22] Unfortunately, data providing enrollment by country of origin at the institution level is not available.

[23] The year corresponds to the fall year of the academic year. For example, 1954 corresponds to the 1954/55 academic year.

larger share of enrollment in graduate programs. According to the National Science Foundation's (NSF) Survey of Earned Doctorates data, 29% of all doctorate degrees awarded in 2011 went to temporary visa holders, while 34% of doctorates in S&E fields and 56% of doctorates in engineering went to temporary residents (Science and Engineering Indicators, 2014).

In the most recent decade, the post 9/11 dip is clearly evident in the time trend, and would be more marked if we were able to disaggregate by new entrants. While it is often conjectured that more stringent visa requirements amid a perceived hostile environment stifled foreign enrollment after 9/11, there is some evidence that the decline started before 9/11 and largely reflects a response to contracting economic opportunities.[24] Still, in the period since the collapse of the financial markets in 2008, enrollment of foreign students in U.S. higher education has continued on an upward trajectory, rising 14.6% in the 2008-11 interval among undergraduates and 6% among graduate students. As we show below, persistent growth is driven by countries less affected by the recent financial crisis, such as China.

Trends by Country of Origin

The relatively steady increase in the number of students from abroad disguises substantial variation in region and country of origin. Both politics and economics play a role in who chooses to study in the U.S. The last two decades have brought about dramatic changes in the countries of origin, particularly among undergraduate students.

[24] Recessionary conditions which limited U.S. job opportunities and continued growth in higher education abroad placed downward pressure on demand for U.S. degree programs. Lowell and Khadka (2011) document the post 9/11 decline and find a 20% decrease in F visas issued between 2001 and 2002, a more modest decline in 2003, and then a period of rebound beginning in 2004. Lowell and Khadka emphasize that, consistent with retrenchment in temporary student enrollment in the mid-1980s, visa declines are most closely aligned with changes in economic conditions, rises in real tuition costs at U.S. universities, and eroding post-degree job prospects in the U.S.

Table 7 presents leading source countries for U.S. enrollment in 1993 and 2011 for undergraduate and graduate enrollment. Most recently, China leads the way with nearly 75,000 students enrolled as undergraduates, followed by South Korea (38,232) and Saudi Arabia (14,344). Including India, Canada, Vietnam, and Japan, the top 7 sending countries account for about 56% of total undergraduate foreign enrollment. This pattern of enrollment differs markedly from 1993, when Japan was the leading source country and China sent a much more modest number of students to study in the U.S. and did not crack the top 7 sending countries.

The bottom panel of Table 7 makes the same presentation for graduate enrollment. China, followed by India, has led the way sending students to the U.S. for more than two decades. Notably, these two countries have experienced appreciably growth over the 1993-2011 interval with U.S. graduate enrollment increasing by a factor of 2.4 for students from China and by a factor of 2.1 for students from India. We conjecture that the nature of Chinese and Indian enrollment at the graduate level has changed somewhat over time, shifting from enrollment nearly exclusively at the PhD level to enrollment dispersed between doctorate programs, Master's programs and professional studies. Participation among students from Taiwan in U.S. graduate education has actually dropped dramatically (from 24,623 to 13,629), potentially reflecting some maturation in the university structure in Taiwan.

Across countries, the trends in participation in U.S. higher education differ markedly, along with notable differences in the concentration of undergraduate and graduate students. Figure 4 presents time trends for selected countries. For some countries that are working up the development trajectory, such as China and India, there is some indication the growth in graduate education precedes growth in undergraduate education. We hypothesize that this occurs in part because U.S. institutions are able to offer substantial financial aid for graduate study, particularly

in PhD science programs. Yet, as we discuss in detail below, doctorate education is a relatively small component in graduate education. For affluent western economies with well-developed home country education systems such as Germany and Canada, undergraduate and graduate enrollment are near the same scale and exhibit modest variation over our period of analysis.

In understanding the demand for enrollment at different levels of U.S. education, it is important to consider the barriers created by cost of attendance -- not only may institutions require payment of tuition and fees but demonstration of capacity to meet costs of attendance is a requirement for the F visa. For temporary residents considering study in the United States, the barriers to studying at the undergraduate level may be prohibitive in the absence of generous home country support or affluent parents.[25] At the doctorate level, the availability of substantial financial aid in the form of teaching assistantships and research assistantships may reduce the financial barriers to attendance, providing opportunities for many foreign students who are from modest economic circumstances. Programs at the Master's level may provide an important intermediate ground: because the term of study is shorter, the required funding is more modest. Overall, the data from Institute of International Education (IIE) shows that among undergraduate students, 81.6% of foreign students finance their studies through "personal and family funds."[26] When we focus on doctorate students in the sciences, the distribution of funding sources is dramatically different, only about 5% of foreign students relying on "own" sources as their primary support mechanism in graduate school in recent years.

[25] To be sure, a small number of the "super-elite" colleges and universities in the U.S. are able to offer need-blind admission and full financial aid to international undergraduate students; these institutions include, MIT, Harvard, Princeton, Dartmouth, Williams, and Middlebury, with most of these institutions opening aid to international students around the year 2000. See http://www.edupass.org/finaid/undergraduate.phtml for a list of universities that offer significant financial aid (both need-based and merit, but not athletic) to international students.

[26] *Open Doors 2007* "Table 15 International Students by Primary Source of Funding 2005/06 & 2006/07."

Degrees Conferred: Trends by Field for U.S. and Foreign Students

Examining degree outcomes beyond enrollment provides a stronger indication of the skills that foreign-born and native students bring to the labor market – either in the U.S. or in a global setting. As is well-known, foreign-born are more likely than their native counterparts to choose science and engineering fields and, in turn, foreign born represent a substantial share of graduate enrollment in IT-feeder fields like engineering and computer science.

In the research literature on science and engineering labor markets, there is a long-standing reference to the adjustment of choice of major to changes in labor market conditions. A classic set of papers, including Freeman (1971, 1975, 1976) and Ryoo and Rosen (2004), models student enrollment as functions of their expectations of future earnings. These "closed economy" modeling approaches, in which the labor supply adjustments in a particular occupation are achieved by the transfer of workers from another occupation, and by the entrance of new workers from the domestic educational pipeline, were quite successful in predicting the supply–response in choice of major to demand shocks in S&E fields. Examining the response in Bachelor's degrees to "IT Booms", Bound, Braga, Golden and Turner (2013) are able to identify cycles that respond to demand with an approximately four-year lag, producing "peaks" in 1986 and 2003. They suggest that the adjustment in domestic undergraduate degrees to demand shocks is somewhat more muted in the more recent period, owing to the flow of foreign-born high skill workers into the IT labor pool.[27] Yet, as the U.S. higher education market is unquestionably "international" – particularly at the graduate level – an open question concerns the cyclicality of the foreign student enrollment.

[27] Between 1975 and the local peak in 1986, CS and Electrical Engineering (EE) undergraduate degrees increased by 446%, from 15,285 to 68,307 based on data from the Department of Education's annual "Earned Degrees Conferred Surveys". Then, from 1995 to 2004, degree awards increased by a more modest – though still appreciable – 186%, from 42,348 to 78,747.

Figure 5 focuses on the fields of Computer Science (CS) and Engineering and shows the trends over time in degrees awarded at the Bachelor's, Master's and PhD level. A first point of observation is that at the graduate level (Master's and PhD degrees) more than 40% of degrees are awarded to temporary residents today, demonstrating a substantial increase since the mid-1980s. In contrast, degrees awarded to temporary residents remain a fairly modest share of Bachelor's degrees in these fields.

A key point to note is the marked increase in the number of Master's degrees awarded to temporary residents since the mid-1990s, particularly in IT-related fields. The number of Master's degrees in CS awarded to foreign-born increased from 5,007 in 1995 to 12,087 in 2012, while the number of Master's degrees in engineering to temporary students increase from 9,699 to 17,583. CS and engineering are notable in that this increase in Master's degrees in these fields accounts for 37% of the total increase in Master's degrees awarded in this period and dwarfs the increase in the number of PhD and Bachelor's degrees awarded to temporary residents over this period.[28] The importance of Master's degrees awarded from U.S. institutions to IT workers is also apparent in Table 6 which shows an estimated 122,619 Master's degree recipients from U.S. universities with student visas as their first visa status relative to about 30,802 Bachelor's recipients.

A second point to note from Figure 5 is that the share of temporary residents in each degree category appears to demonstrate more cyclicality than the total level of degrees awarded. To wit, the share of Master's degrees awarded to temporary residents decreases by 15% from

[28] While the number of Master's degrees in all fields to temporary students increased from 48,756 to 89,145; the number of Master's degrees in CS and engineering increased from 14,711 to 29,670. Thus the increase in CS and engineering, in the amount of 14,959, accounts for 37% of the total increase in Master's degrees. On the other hand, PhD degrees to temporary residents in CS and engineering increased by 2,728, and BA degrees increased by 2,886. Both of these figures are substantially smaller than the increase in Master's degrees.

0.446 to 0.377 in CS and by 10% from 0.416 to 0.376 in engineering between 2001 and 2007, before then rebounding as the market has picked up in recent years.

An examination of the institutional sources of Master's degrees awarded to temporary residents in CS provides some insight into the nature of adjustment in the U.S. higher education institutions. First, there is substantial concentration of foreign students in a relatively modest number of programs with 10 institutions awarding nearly 25% of the Master's-level degrees awarded to temporary residents. In examining the list of institutions awarding the bulk of these degrees, the heterogeneity in rankings is noteworthy. Only one university (Carnegie Mellon) ranked in the top-5 by U.S. News[29] as a graduate program in computer science is among the top-5 institutions in terms of the number of degrees awarded to temporary residents. Institutions awarding large numbers of Master's-level degrees in CS to temporary residents include: Carnegie Mellon University (464), Illinois Institute of Technology (397), University of Southern California (377), Columbia University in the City of New York (292) and University of Texas at Dallas (214). This list represents considerable heterogeneity in institutional ranking as well as the mix of public and private control, suggesting that it may be difficult to make strong statements about the qualitative characteristics of U.S. degree receipt relative to foreign country options in IT preparatory fields.

5. Foreign Born Degree Recipients and the U.S. Labor Market

Evaluating the impact of U.S. post-secondary degree acquisition on the U.S. labor market depends markedly on whether U.S. education – particularly among temporary visa recipients –

[29] See: http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/computer-science-rankings The most highly ranked programs in computer science are: Carnegie Mellon University, Massachusetts Institute of Technology, Stanford University, University of California—Berkeley, and University of Illinois—Urbana-Champaign.

leads to long term participation in the U.S. labor market. Our evidence, presented in more detail below, makes two striking points: First, "stay rates" for degree recipients are extraordinarily high and, by implication, much higher than for other temporary visa recipients. Secondly, not only do we observe marked differences in the flows across countries into U.S. degree programs (as discussed in the prior section) but these cross-country differences imply marked differences across countries in pathways to entrance and labor market performance.

Coming and Going

Unfortunately, we have limited information available to observe the numbers of transitions from F visas to a permanent residency or an H-1B visa. In 2000, the most recent year when the DHS releases the transition tables, 16,161 international students adjusted their visa status to a permanent residency from student visas, which make up about 16% of the total number of international students graduating in 1999 (Yearbook of Immigration Statistics, 2001).[30] Using administrative data, Lowell and Avato (2013) estimate that approximately 31,000 H-1Bs were awarded to foreign students in 2003, representing about four-tenths of the prior year's graduating class of Master's degree and PhD holders and about 90% of foreign graduates in science and engineering.

As a proxy for the transition to H-1B visa, we use the ratio of initial H-1B beneficiaries, who have been in the U.S. under another visa classification, to the number of international graduates of U.S. universities. Our calculation implies that, on average, about a half of each class changes visa status to H-1B from 1999 to 2009 (Figure 6).

[30] This measure includes all types of transitions to permanent residency including those based on family green cards.

For doctorate recipients, administrative data merges provide a much better measure of stay rates: tabulations done by the Social Security Administration for Michael Finn (2012) link the NSF's Survey of Earned Doctorates (SED), a census of those receiving PhDs from U.S. institutions, 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 STEM fields and have been trending up. They also vary by country of origin, strength of U.S. ties, and the academic ability of the doctorate recipients. 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.[31] To illustrate, Grogger and Hanson (2013) show that the foreign PhD students with a stronger U.S. ties and academic ability, indicated by fellowship receipt, are more likely to stay in the US.

An implication, then, is that entry on a temporary student visa is likely to be a strong proxy for persistence in the U.S. labor market. Without identifying causality, it is useful to consider the multiple mechanisms through which a U.S. education leads to labor market persistence. First, self-selection may play an important role: individuals with the most to gain from access to the U.S. labor market may be the most likely to invest in U.S. higher education,

[31] However, for a number of other countries like Japan, South Korea, and Taiwan, Finn finds 5-year stay rates under 50%. An inference following Bound, Turner, Walsh (2009) is that persistence rates reflect market forces, not just 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.

which comes at a non-trivial cost of both tuition and forgone earnings. Second, U.S. higher education experiences may produce skills that are more highly valued by U.S. firms than those available abroad – one might think that some types of degree programs are not available in many countries or they are of a quality that is not comparable to U.S. institutions. Finally, it is possible that the U.S. higher education credentials may serve a screening function – helping firms to identify high-skill candidates when the costs of identifying candidates from a vast country like China are likely to be prohibitive.

One implication is that we expect – and find – considerable cross-country variation in U.S. degree receipt and, in turn, the likelihood that foreign-born use the U.S. education market as a pathway to enter the U.S. labor market. Table 8 presents data from the National Survey of College Graduates by broad geographic area, distinguishing Europe, Canada, India and China as places of origin. A first point of note is that workers from China, followed by India, are the "most educated" in terms of degree attainment. Overall, in 2010 68% of Chinese workers and 81% in the IT sector hold advanced degrees and, among those from India, 56% of workers hold advanced degrees both in the IT sector and overall. Comparable numbers for immigrants from Europe or Canada are appreciably lower (Table 8).

Workers from China are also distinguished by the extent to which the U.S. education market is the source of individuals' highest degree. As shown in the right side of Table 8, among Master's degree recipients from China more than 80% received their highest degree from a U.S. institution. In contrast, among European workers with advanced degrees, the share drawing from the U.S. education market is much more modest, with 27% of those with a Master's and 36% of those with a PhD holding U.S. degrees. That U.S. post-secondary degree receipt is a pathway to entry is validated by review of the data on visa at entry by country of origin. Overall, about 55%

(and about 64% of those who did not enter on a permanent visa) of those now employed from China entered on a temporary student visa (authors' tabulations from NSCG:2010).

Valuing Skills: Differences by Degree Location

How country of origin and location of post-secondary education correspond to earnings in the U.S. labor market provides information to explain the incentives for immigration and degree completion in the U.S. We continue to focus on those employed in the IT sector because this set of occupations encompass well-defined skills subject to broadly similar demand shocks, even as the overall labor market for college educated workers provides a point of comparison.

Our focus is to consider the earnings for those born abroad relative to natives with the same degree qualifications and the differences associated with the location of highest degree (U.S. vs abroad) and timing of U.S. entry, distinguishing between those entering as young children and those entering as adults. We employ both the NSCG ((1993, 2003 and 2010), which has the advantage of precisely measured location and timing of degrees, and the American Community Survey (ACS), which provides more limited education coverage but a much larger sample. Across the board, those foreign-born individuals who arrive in the U.S. at relatively young ages earn a labor market premium to those arriving at older ages, on the order of 0.17-0.18 log points, while also garnering a premium relative to natives among IT workers.[32] The interpretation of this effect includes the potential for substantial assimilation and the likely selection by family circumstances.

Focusing on the wage differentials for those arriving after the elementary-secondary years, we are interested in whether those who completed all of their post-secondary training

[32] The same broad pattern holds for all college educated workers. We report parallel regressions for all workers in the Appendix.

abroad earn more (or less) than their foreign-born peers completing their highest degree in the states. The sign and magnitude of this coefficient is indicative of several factors:

- The relative "quality" of U.S. versus foreign post-secondary options. While it is widely acknowledged that the U.S. universities represent a disproportionate share of the most highly-ranked options at the doctorate level, the extent to which undergraduate or Master's preparation abroad differs from the U.S. is far from clear.
- If foreigners graduating from U.S. institutions are in a better position to search for jobs than are those living abroad, this advantage is likely to show up both in terms of increase employment prospects and higher wages.
- Individuals entering the U.S. labor market directly may be "selected" differently than those continuing on from the post-secondary system, as the former group may be required to be particularly distinguished in order to gain appointments in the U.S.

While we are unable to distinguish these effects empirically, we are able to provide an estimate of the net effect.

For IT workers, foreign-born individuals educated abroad earn – on average – a modest premium in recent years over those receiving their highest degree in the U.S. The magnitude of this effect differs somewhat over samples and time. First, in the NSCG which necessarily requires three years of residence in the U.S. by sample construction, the effect goes from being -0.0607 (in logs, with the negative indicating foreign-born with a highest degree from abroad earn less than those foreign born with a degree from the states) to positive effects of 0.0622 and 0.0956 in 2003 and 2010, respectively. Examining the ACS over the last decade, we find a differential between foreign and U.S. educated of -0.009489 for the 2001-2010 period and 0.02419 for the most recent three years. In effect, these effects tend to either suggest no

difference or a modest positive advantage to foreign-born educated abroad in the U.S. labor market. To the extent that these effects shift over time – from a disadvantage for foreign study to an advantage – it may be that the composition of foreign-born IT professionals by country of origin changes somewhat over this period, along with the relative quality of degree receipt in the U.S. and abroad.

It is worth noting that these results for the IT sector are notably somewhat different than those that are found in the labor market at large for foreign born workers where both parallel regressions and evidence from prior research (e.g. Zeng and Xie, 2004) tend to find a substantial premium for U.S. relative to foreign post-secondary education. Indeed, we find an overall penalty for foreign education of nearly -.233 in the most recent NSCG and about -.172 log points in the ACS over the most recent decade.

Several related hypotheses may explain the difference between IT and non-IT fields in the "return" to a U.S. degree. First, as has been noted by Hunt (2013) and others, the returns to English language fluency which may be a product of a U.S. post-secondary experience may be smaller in IT than in other fields. As already noted, a substantial share of foreign degrees are awarded in CS and engineering, which likely include preparation much-valued in the IT sector.[33] The implication, then, is that foreign born with U.S. degrees "outperform" not only other immigrants with degrees from abroad but also U.S. residents. Either selection on innate skills or the relatively high quality of post-secondary education received by U.S. trained immigrants may "explain" this result.[34]

[33] Using the NSCG allows for the observation of field of study in addition to location of degree. As shown in the additional rows of Table 9A (and Appendix Table 11), the estimated effects of the "location" of degree receipt change only modestly with the inclusion of field of study and occupation fixed effects.

[34] It is noteworthy that even as the Table 9A results include fixed effects for occupation (Columns 3,6, and 9), when we limit the analysis to those in the IT profession we see a decided change in the interaction between "Foreign Born" and "Foreign Degree Receipt", with this coefficient ceasing to be negative and significant after 1993. As we discuss in the next paragraph, two factors are at play: first, location of degree may matter less in IT

To interpret our basic result -- a modest benefit for preparation abroad for foreign-born employed in the IT sector relative to a substantial penalty for foreign post-secondary completion in non-IT fields – consider the potential role of country-specific factors in determining these estimates. Not only do training options for IT professionals differ across countries, but so too do employment options. Using data from the NSCG (Table 10) and the ASC (Table 12), we present results that disaggregate the foreign-born place of education effect by country of origin. What is striking is that foreign-born IT-workers educated in European countries and Canada appear to be benefiting by degrees from abroad, while those from China face a disadvantage. For those from India, place of post-secondary training has virtually no effect for the foreign born.

Because the Asian countries – particularly China and India – represent a "big part of the story" of the IT labor market over the last several decades it is striking that the penalty for foreign education is dramatically attenuated in the IT sector relative to all high skill workers (see Tables 10 A &B). One might ask why, then, do students from countries like India and China continue to pursue degrees in the U.S. given the relatively high out-of-pocket costs. One explanation is that while U.S. degrees do not provide a strong wage advantage, they do provide access to the U.S. labor market which is facilitated by the U.S. visa system: The OPT programs provides an extended window of opportunity to look for jobs while the extension of additional H-1B visas for advanced degree recipients provides a specific motivation to attain a degree in the U.S.

6. Concluding thoughts and Implications for Policy

---

fields than in other occupations and, secondly, the composition of foreign-born IT professionals by country of origin changes somewhat over this period.

The key takeaway from this analysis is that U.S. higher education institutions and U.S. immigration policy both play a critical role in determining the flow of high skill immigrants to the U.S. labor market, particularly among countries with the least developed higher education systems. About 9.5% of the current high-skill labor force is comprised of those entering the U.S. on student visas and then transitioning to temporary or permanent work visas. In occupations like IT, the share is yet higher at 15.7%. Focusing on just those workers under the age of 35, the role of U.S higher education as a pathway to the labor market is yet magnified with 16.7% of all high-skill workers and 26.4% of IT workers following this pathway (authors' tabulations from NSCG:2010). Among those not arriving at young ages on permanent visas, the share of IT workers receiving their highest degree from U.S. institutions is yet higher.

For workers in the IT sector, there is a much more modest premium to U.S. degree receipt than for all high-skill workers and this differential varies by country of origin. There is considerable variation by country of origin in the extent to which there is a labor market penalty or premium for foreign degree receipt; at the extremes, workers from China paying a penalty and those from European countries receive a premium. Such differences likely reflect the combination of differences across countries in the quality of home-country university options and home-country labor market opportunities which affect selection into the U.S. labor market. Because student visas are not subject to a numerical cap and foreign-born who receive U.S. degrees are advantaged in the award of temporary work visas, a further incentive to study in the U.S. is the likely improvement in employment prospects in the U.S. labor market.

A clear implication from this analysis is that post-secondary policies that affect opportunities for study in the U.S. will have a substantial effect on the flow of high-skill workers to the U.S. labor market. Changing the direct cost of U.S. higher education or visa policies

affecting foreign students may have large impacts on the supply of high skill immigrants. In turn, without the supply elasticity demonstrated by the fairly dramatic expansion of U.S. graduate programs – particularly in science and engineering – to meet foreign demand, it is likely that the level and composition of high-skill immigration would be much different.

Changes in U.S. higher education could have very dramatic effects on the flow of high-skill foreign born workers to the U.S. economy. On the one hand, the expansion of opportunities for graduate study – particularly at the Master's level – in courses of study that employ some technology to reduce costs may further increase supply opportunities. On the other hand, continued fiscal contractions, particularly at public universities, may force the shuttering of doctorate programs which would narrow a channel of entry for foreign graduate students.

Of course, the demand side of foreign flows to the U.S. higher education market also merits attention in projecting forward. Two factors may serve to reduce demand for post-secondary study in the U.S. First, to the extent that countries rapidly climbing the development ladder expand university capacity, demand for U.S degree programs from abroad may decline. In turn, changes in domestic labor markets that narrow or close the difference in expected earnings between the U.S. and abroad would also dampen demand from abroad for U.S. higher education. Particularly at the graduate level, where students from abroad are a large constituency, a large decline in the demand for U.S. degree programs from abroad would have a substantial effect on the U.S. market for higher education.

References

Bird, Kelli and Sarah Turner (2014) "College in the States: Foreign Student Demand and Higher Education Supply in the U.S." unpublished working paper.

Blanchard, E., J. Bound, and S. E. Turner (2009). "Opening (and closing) doors: Country-specific shocks in U.S. doctoral education." In *Doctoral education and the faculty of the future,* edited by R. G. Ehrenberg and C. V. Kuh, pp. 224-248. Ithaca: Cornell University Press.

Borjas, G. J. (2004). "Do foreign students crows out native students from graduate programs?" NBER Working Paper 10349.

Bound, J. and S. Turner (2013). "U.S. High-Skill Immigration."

Bound, J., S. Turner and P. Walsh (2009). "Internationalization of U.S. doctorate education." In *Science and engineering careers in the United States: analysis of markets and employment,* edited by R. B. Freeman and D. L. Goroff. Chicago: University of Chicago Press.

Bound, John; Breno Braga, Joe Golden and Sarah Turner. (2013). "Pathways to Adjustment: The Case of Information Technology Workers" *American Economic Review Papers and Proceedings*,103(3): 203-207

Clemens, Michael; Claudio Montenegro and Lant Pritchett. (2008). "The Place Premium: Wage Differences for Identical Workers across the U.S. Border," Working Papers 148, Center for Global Development

Clemens, Michael A. (2013). "Why Do Programmers Earn More in Houston Than Hyderabad? Evidence from Randomized Processing of US Visas." *American Economic Review, Papers & Proceedings*, 103(3): 198-202.

Demirci, M. (2013) "Foreign Science and Engineering Majors and the U.S. Labor Market: The Extension of the Optional Practical Training Visa", Unpublished Manuscript.

Farrar, L. (2012). "Smaller U.S. Colleges Try to Crack Chinese Market." *New York Times*, December 14, 2012.

Freeman, Richard. (2010). What Does Global Expansion of Higher Education Mean for the United States? In *American Universities in a Global Market*, ed. C. Clotfelter. NBER, University of Chicago Press, pp. 373-404.

Grogger, J. and G. H. Hanson (2013). "Attracting talent: Location choices of foreign-born PhDs in the US. No. w18780. National Bureau of Economic Research, 2013.

Hunt, J. (2011). "Which Immigrants are most Innovative and Entrepreneurial? Distinctions by Entry Visa", Journal of Labor Economics 29:3, 417-457.

Hwang, J. E. (2009). "MIT or Tsinghua? A panel data analysis of the determinants of domestic higher education and international student mobility." Department of Economics, Harvard College.

Institute of International Education (2012) "Open Doors Data: 2000-2012", available at http://www.iie.org/en/Research-and-Publications/Open-Doors.

Johnson, J. (2011). "Chinese students enroll in record numbers at U.S. colleges." *The Washington Post*, 11/14/2011.

Kato, T. and C. Sparber (2013). "Quotas and quality: The effect of H-1B visa restrictions on the pool of prospective undergraduate students from abroad." *The Review of Economics and Statistics*, March 2013, 95(1): 109-126.

Kerr, W. R. (2013). "U.S. High-Skilled Immigration, Innovation, and Entrepreneurship: Empirical Approaches and Evidence." Harvard Business School Working Paper Number 14-017.

Lowell, Lindsay. (2010). "A Long View of America's Immigration Policy and the Supply of Foreign-Born STEM Workers in the United States." *American Behavioral Scientist* 53: 1029-1044.

Lowell, B. L. and J. Avato (2013). "The Wages of Skilled Temporary Migrants: Effects of Visa Pathways and Job Portability." *International Migration*.

Lowell, B. L. and P. Khadka (2011). "Trends in foreign-student admissions to the United States: Policy and competitive effects" in B. R. Chiswick, *High-Skilled Immigration in a Globalized Labor Market*, Washington DC: American Enterprise Institute, 83-108.

Martin, Susan. (2012). "Labor Migration to the United States: Challenges and Opportunities" Paper Draft Paper presented at 2012 Mortimer Caplin Conference on the World Economy: Resources and Scholarship, Miller Center.

National Science Board. (2014). Science and Engineering Indicators 2014. Arlington VA: National Science Foundation (NSB 14-01).

Orrenius, Pia and Madeline Zavodny. (2010). Beside the Golden Door. Washington DC: AEI.

Orrenius, Pia; Madeline Zavodny and Emily Kerr. (2012). "Chinese Immigrants in the U.S. Labor Market: Effects of Post-Tianamen Immigration Policy." IZA DP No 6287., [Retrieved from: http://www.iza.org/en/webcontent/publications/papers/viewAbstract?dp_id=6287]

Passel, J. and D. Cohn. (2011). "Unauthorized Immigrant Population: National and State Trends, 2010." Washington, D.C. Pew Hispanic Center. [Retrieved from:

http://www.pewhispanic.org/2011/02/01/unauthorized-immigrant-population-brnational-and-state-trends-2010/]

Peri, G. (2009). "The Determinants and Effects of Highly-Skilled Labor Movements: Evidence from OECD Countries 1980-2005", CEPR Report.

Rosenzweig, M. R. (2006). "Global Wage Differences and International Student Flows." *Brookings Trade Forum,* pp. 57-86.

Ryoo, Jaewoo, and Sherwin Rosen. (2004). "The Engineering Labor Market." *Journal of Political Economy* 112, no. 1(2): S110-40.

Tichenor, Daniel. (2013). "High-Skilled Immigration Reform in Historical Context: New Opportunities and Enduring Constraints" Paper presented at 2012 Mortimer Caplin Conference on the World Economy: Resources and Scholarship, Miller Center. [Retrieved from: http://web1.millercenter.org/conferences/caplin/2012_caplinBackgroundPaper.pdf]

U.S. Citizenship and Immigration Services (2013) "Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2000-2012", available at http://www.uscis.gov/tools/reports-studies/reports-and-studies.

Table 1: Representation of foreign-born among IT Workers (by year and age-group)

Panel A: All Workers

	1993	2003	2010	Total
Native	23,784,160	31,992,012	37,422,597	93,198,770
Foreign Born	2,437,745	4,864,934	6,943,759	14,246,438
Total	26,221,905	36,856,946	44,366,356	107,445,208
% Foreign Born, by Age group				
25 to 34	9%	14%	15%	
35 to 44	10%	16%	20%	
45 to 54	10%	12%	16%	
above 54	8%	11%	12%	
Total	9%	13%	16%	

Panel B: IT Workers

	1993	2003	2010	Total
Native	943,192	1,476,963	1,627,328	4,047,483
Foreign Born	174,204	540,480	749,613	1,464,297
Total	1,117,396	2,017,443	2,376,941	5,511,780
% Foreign Born, by Age group				
25 to 34	16%	34%	35%	
35 to 44	17%	29%	37%	
45 to 54	14%	19%	27%	
above 54	13%	16%	19%	
Total	16%	27%	32%	

Source: National Survey of College Graduates (NSCG) -1993, 2003 and 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 2. Distribution of Foreign Born and US natives by Highest Degree achieved and year

Panel A: All Workers

	Natives			
	1993	**2003**	**2010**	**1993-2010**
Bachelor's	15,526,091	20,556,119	23,871,814	59,954,023
Percentage of total	65	64	64	64
Master's	5,822,671	8,402,498	10,214,300	24,439,469
Percentage of total	24	26	27	26
PhD	812,200	1,050,539	1,122,285	2,985,024
Percentage of total	3	3	3	3
Professional Degrees	1,623,199	1,982,857	2,214,199	5,820,254
Percentage of total	7	6	6	6
Total	23,784,160	31,992,012	37,422,597	93,198,770
	100	100	100	100

	Foreign Born			
	1993	**2003**	**2010**	**1993-2010**
Bachelor's	1,394,163	2,767,936	4,046,264	8,208,363
Percentage of total	57	57	58	58
Master's	618,548	1,362,724	1,970,894	3,952,166
Percentage of total	25	28	28	28
PhD	207,833	379,256	528,096	1,115,184
Percentage of total	9	8	8	8
Professional Degrees	217,201	355,019	398,506	970,726
Percentage of total	9	7	6	7
Total	2,437,745	4,864,934	6,943,759	14,246,438
	100	100	100	100

Panel B: IT Workers

	Natives			
	1993	**2003**	**2010**	**1993-2010**
Bachelor's	694,431	1,077,515	1,236,683	3,008,628
Percentage of total	74	73	76	74
Master's	223,737	361,020	358,024	942,780
Percentage of total	24	24	22	23
PhD	22,052	32,541	27,390	81,983
Percentage of total	2	2	2	2
Professional Degrees	2,973	5,887	5,231	14,091
Percentage of total	0	0	0	0
Total	943,192	1,476,963	1,627,328	4,047,483
	100	100	100	100

	Foreign Born			
	1993	**2003**	**2010**	**1993-2010**
Bachelor's	92,767	265,431	374,171	732,370
Percentage of total	53	49	50	50
Master's	68,359	239,426	330,448	638,233
Percentage of total	39	44	44	44
PhD	12,786	34,636	44,638	92,061
Percentage of total	7	6	6	6
Professional Degrees	292	987	355	1,634
Percentage of total	0	0	0	0
Total	174,204	540,480	749,613	1,464,297
	100	100	100	100

Source: National Survey of College Graduates (NSCG) -1993, 2003 and 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 3. Location of Highest Degree by Age and Year

Panel A: All Workers				**Panel B: IT Workers**			
Percentage of Degrees earned in U.S.				**Percentage of Degrees earned in U.S.**			
Bachelor's Highest degree				***Bachelor's Highest degree***			
	1993	**2003**	**2010**		**1993**	**2003**	**2010**
25 to 34	74%	61%	59%	**25 to 34**	86%	50%	52%
35 to 44	53%	54%	45%	**35 to 44**	62%	57%	41%
45 to 54	41%	43%	47%	**45 to 54**	56%	56%	50%
above 54	42%	37%	33%	**above 54**	47%	48%	63%
Master's Highest degree				***Master's Highest degree***			
	1993	**2003**	**2010**		**1993**	**2003**	**2010**
25 to 34	87%	78%	69%	**25 to 34**	92%	72%	73%
35 to 44	77%	73%	69%	**35 to 44**	82%	74%	60%
45 to 54	75%	70%	67%	**45 to 54**	78%	74%	79%
above 54	70%	70%	64%	**above 54**	74%	62%	66%
PhD Highest degree				***PhD Highest degree***			
	1993	**2003**	**2010**		**1993**	**2003**	**2010**
25 to 34	76%	81%	77%	**25 to 34**	83%	85%	95%
35 to 44	73%	67%	62%	**35 to 44**	85%	69%	78%
45 to 54	74%	65%	59%	**45 to 54**	84%	63%	63%
above 54	60%	62%	60%	**above 54**	68%	61%	67%
Professional Highest degree				***Professional Highest degree***			
	1993	**2003**	**2010**		**1993**	**2003**	**2010**
25 to 34	65%	80%	68%	**25 to 34**	100%	0%	0%
35 to 44	52%	54%	49%	**35 to 44**	0%	0%	100%
45 to 54	32%	44%	46%	**45 to 54**	100%	0%	100%
above 54	34%	29%	29%	**above 54**	0%	57%	0%

Source: National Survey of College Graduates (NSCG) -1993, 2003 and 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 4. Distribution of Bachelor's degree and Master's degree workers by Field of Highest Degree

Panel A: All Workers

Bachelor's Highest Degree, Foreign Born

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	10%	13%	5%	5%	3%	2%	11%	11%	16%	11%		12%	56%	46%
35 to 44	6%	10%	5%	5%	3%	1%	11%	12%	14%	15%		14%	61%	43%
45 to 54	3%	8%	5%	4%	4%	3%	9%	13%	14%	15%		16%	66%	42%
above 54	2%	4%	4%	5%	4%	3%	9%	9%	19%	17%		15%	61%	48%

Bachelor's Highest Degree, Native

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	5%	4%	4%	6%	2%	1%	11%	15%	8%	6%		7%	70%	61%
35 to 44	3%	5%	6%	4%	2%	1%	12%	14%	6%	6%		8%	71%	62%
45 to 54	3%	5%	4%	4%	2%	2%	12%	11%	7%	7%		9%	71%	60%
above 54	2%	3%	4%	5%	4%	2%	10%	14%	13%	6%		10%	68%	60%

Master's Highest Degree, Foreign Born

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	13%	14%	5%	5%	3%	2%	7%	7%	26%	19%		11%	47%	42%
35 to 44	10%	18%	3%	4%	3%	2%	9%	8%	17%	14%		7%	57%	48%
45 to 54	6%	13%	4%	3%	4%	3%	9%	6%	18%	16%		11%	59%	47%
above 54	3%	7%	3%	3%	3%	3%	10%	10%	18%	14%		11%	63%	53%

Master's Highest Degree, Native

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	4%	3%	3%	2%	2%	1%	7%	7%	8%	4%		12%	75%	72%
35 to 44	3%	4%	3%	2%	2%	1%	7%	6%	5%	4%		11%	80%	72%
45 to 54	3%	4%	2%	2%	2%	1%	8%	7%	4%	5%		11%	81%	71%
above 54	2%	3%	2%	2%	2%	1%	7%	7%	5%	3%		9%	81%	73%

Panel B: IT Workers

Bachelor's Highest Degree, Foreign Born

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	31%	55%	1%	1%	1%	2%	4%	3%	43%	27%	0%	6%	19%	6%
35 to 44	28%	38%	3%	0%	2%	3%	4%	3%	39%	36%	0%	7%	25%	12%
45 to 54	19%	34%	3%	2%	3%	5%	3%	2%	43%	37%	0%	6%	30%	13%
above 54	8%	19%	0%	2%	9%	2%	6%	2%	48%	46%	0%	5%	29%	23%

Bachelor's Highest Degree, Native

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	35%	37%	1%	2%	2%	1%	4%	8%	29%	18%	0%	4%	30%	31%
35 to 44	23%	32%	3%	1%	4%	2%	7%	8%	25%	17%	0%	4%	37%	36%
45 to 54	19%	38%	2%	2%	4%	2%	8%	5%	25%	22%	0%	7%	41%	24%
above 54	9%	22%	0%	4%	6%	3%	5%	14%	47%	18%	0%	7%	32%	32%

Master's Highest Degree, Foreign Born

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	32%	41%	0%	1%	1%	1%	2%	0%	49%	40%	0%	7%	16%	10%
35 to 44	41%	44%	0%	1%	1%	2%	1%	2%	37%	25%	0%	6%	19%	19%
45 to 54	23%	45%	2%	1%	4%	1%	1%	1%	43%	29%	0%	3%	27%	21%
above 54	23%	32%	0%	1%	5%	3%	3%	0%	41%	39%	0%	14%	28%	12%

Master's Highest Degree, Native

	Computer/Math		Life Sciences		Physical Sciences		Social Sciences		Engineering		S&E Related		Non S&E Fields	
Age group	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**	**1993**	**2010**
25 to 34	28%	43%	1%	1%	1%	2%	3%	2%	40%	22%	0%	4%	27%	27%
35 to 44	26%	28%	1%	1%	4%	0%	3%	3%	29%	24%	0%	4%	37%	39%
45 to 54	22%	26%	0%	0%	4%	2%	6%	3%	22%	30%	0%	4%	45%	35%
above 54	17%	27%	0%	3%	7%	3%	2%	5%	32%	18%	0%	4%	43%	40%

Source: National Survey of College Graduates (NSCG) -1993, 2003 and 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 5. First Visa Status

Panel A: All Workers

	Permanent Resident Visa		Temporary Work Visa		Temporary Student/Training		Dependent Visa		Other Temp Visa	
Age group	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**
25 to 34	41%	36%	14%	14%	24%	27%	15%	19%	5%	4%
35 to 44	38%	33%	13%	22%	26%	21%	13%	17%	9%	7%
45 to 54	46%	35%	12%	16%	23%	25%	9%	11%	10%	12%
above 54	52%	49%	8%	11%	23%	19%	7%	7%	10%	14%

Panel B: IT Workers

	Permanent Resident Visa		Temporary Work Visa		Temporary Student/Training		Dependent Visa		Other Temp Visa	
Age group	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**
25 to 34	25%	16%	32%	39%	30%	35%	11%	9%	2%	1%
35 to 44	29%	22%	23%	46%	32%	23%	9%	7%	7%	3%
45 to 54	34%	28%	13%	23%	34%	36%	8%	7%	11%	6%
above 54	40%	34%	14%	12%	37%	30%	3%	6%	6%	19%

Source: National Survey of College Graduates (NSCG) - 2003 and 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

First-Visa status not available for the 1993 survey.

Table 6. First Visa Status by Highest Degree (2010 survey)

Panel A: All Workers

Bachelor's Highest Degree

	Location of Highest Degree		
	Abroad	**US**	**Total**
Permanent Resident Visa	772,412	850,052	1,622,464
Percentage of total	35	59	45
Temporary Work Visa	599,500	35,604	635,104
Percentage of total	27	2	17
Temporary Student/Training	181,701	262,412	444,113
Percentage of total	8	18	12
Dependent Visa	335,297	204,367	539,663
Percentage of total	15	14	15
Other Temp Visa	300,842	93,183	394,024
Percentage of total	14	6	11
Total	2,189,752	1,445,617	3,635,368
	100	100	100

Master's Highest Degree

	Location of Highest Degree		
	Abroad	**US**	**Total**
Permanent Resident Visa	171,686	358,184	529,870
Percentage of total	27	32	30
Temporary Work Visa	207,964	61,751	269,715
Percentage of total	33	6	15
Temporary Student/Training	68,443	520,075	588,518
Percentage of total	11	47	34
Dependent Visa	86,683	127,957	214,640
Percentage of total	14	12	12
Other Temp Visa	102,883	42,209	145,092
Percentage of total	16	4	8
Total	637,658	1,110,177	1,747,835
	100	100	100

Panel B: IT Workers

Bachelor's Highest Degree

	Location of Highest Degree		
	Abroad	**US**	**Total**
Permanent Resident Visa	30,595	75,265	105,860
Percentage of total	16	52	31
Temporary Work Visa	132,600	12,744	145,344
Percentage of total	68	9	43
Temporary Student/Training	11,901	30,802	42,703
Percentage of total	6	21	13
Dependent Visa	9,696	15,106	24,801
Percentage of total	5	11	7
Other Temp Visa	8,873	9,493	18,365
Percentage of total	5	7	5
Total	193,664	143,409	337,073
	100	100	100

Master's Highest Degree

	Location of Highest Degree		
	Abroad	**US**	**Total**
Permanent Resident Visa	12,052	29,724	41,776
	12	15	14
Temporary Work Visa	68,301	22,003	90,303
	67	11	30
Temporary Student/Training	9,778	122,619	132,397
	10	63	44
Dependent Visa	7,707	16,656	24,363
	8	9	8
Other Temp Visa	4,522	4,351	8,873
	4	2	3
Total	102,359	195,352	297,711
	100	100	100

Source: National Survey of College Graduates (NSCG) – 2010

Panel A: Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 7. Leading Countries of Origin for U.S. Enrollment, 1993 and 2011

Undergraduate Enrollment					
2011			1993		
1	China	74,516	1	Japan	31,960
2	South Korea	38,232	2	Canada	13,149
3	Saudi Arabia	14,344	3	South Korea	12,521
4	India	13,509	4	Malaysia	11,289
5	Canada	12,866	5	Taiwan	11,067
6	Vietnam	11,244	6	Hong Kong	10,427
7	Japan	9,359	7	Indonesia	7,982
Leading Country Total		174,070			98,395
Top 7 as % of total		56.27%			46.10%
TOTAL		309,342			213,610
Graduate Enrollment					
2011			1993		
1	China	88,429	1	China	36,370
2	India	59,014	2	India	27,533
3	South Korea	21,260	3	Taiwan	24,623
4	Taiwan	12,007	4	South Korea	15,785
5	Canada	11,190	5	Canada	8,455
6	Turkey	6,198	6	Japan	7,755
7	Saudi Arabia	6,133	7	Thailand	5,621
Leading Country Total		204,231			126,142
Top 7 as % of total		67.98%			62.70%
TOTAL		300,430			201,030

Source: IIE Open Doors

Table 8: Distribution of Highest-Degrees achieved, and its location by Country of Birth

	Degree distribution				% Highest Degrees from US		
	Bachelor's	Master's	PhD	Prof	Bachelor's	Master's	PhD
				Europe			
All Workers							
1993	54%	27%	10%	8%	70%	68%	55%
2003	53%	30%	10%	7%	62%	61%	47%
2010	53%	30%	12%	5%	56%	50%	49%
IT workers							
1993	58%	35%	7%	0%	71%	58%	44%
2003	53%	38%	9%	0%	59%	49%	46%
2010	54%	38%	8%	0%	46%	27%	36%
				Canada			
All Workers							
1993	58%	23%	8%	11%	75%	82%	81%
2003	61%	22%	8%	10%	60%	77%	65%
2010	60%	23%	7%	10%	51%	74%	59%
IT workers							
1993	75%	20%	5%	0%	78%	70%	79%
2003	80%	16%	3%	1%	42%	57%	76%
2010	64%	22%	13%	1%	45%	69%	100%
				India			
All Workers							
1993	37%	37%	13%	13%	23%	69%	69%
2003	44%	41%	8%	7%	21%	57%	67%
2010	44%	42%	7%	7%	19%	58%	70%
IT workers							
1993	26%	62%	12%	0%	37%	84%	83%
2003	41%	55%	4%	0%	14%	60%	66%
2010	44%	54%	2%	0%	17%	62%	78%
				China			
All Workers							
1993	43%	34%	17%	5%	43%	86%	88%
2003	30%	43%	22%	4%	43%	84%	77%
2010	32%	37%	27%	5%	47%	83%	70%
IT workers							
1993	30%	54%	16%	0%	67%	97%	94%
2003	19%	65%	16%	0%	45%	88%	79%
2010	19%	58%	23%	0%	50%	86%	79%

Source: National Survey of College Graduates (NSCG) – 1993, 2003 and 2010

All workers: Sample restricted to all full-time college-educated workers, that are 25 years or older.
IT workers: Sample restricted to those working in the IT industry or related occupations, and are 25 years or older

Table 9A: Coefficient on Foreign Born and Educated Abroad for Various Specifications, All workers

	NSCG			Census-ACS			
Specification	1993	2003	2010	1990	2000	2001-2010	2008-2010
Base Specification (see footnote)	-0.0858***	-0.191***	-0.223***	-0.0444***	-0.137***	-0.173***	-0.172***
	(0.0107)	(0.0204)	(0.0470)	(0.0087)	(0.0059)	(0.0066)	(0.0088)
Base Specification with field of study dummies	-0.0698***	-0.192***	-0.225***				
	(0.0107)	(0.0203)	(0.0459)				
Base Specification with field of study and occupation dummies	-0.0605***	-0.178***	-0.211***				
	(0.0104)	(0.0198)	(0.0441)				

Source: National Survey of College Graduates (1993, 2003 and 2010); Census (1990 and 2000) and ACS (2001 to 2010)
Note: Weighted regressions for all college-educated full-time workers.
The Census/ACS does not report location of institution for degrees. Based on age of immigration and educational qualifications, and comparing it to the NSCG tabulations, it was estimated whether the individual obtained their degree from inside or outside the US. The ACS regressions are estimated separately for each yer, the average coefficient values are reported for the period of interest in this table. See Appendix for the full set of estimation results.
The base specification includes a constant, dummy variables for foreign born, foreign born and immigrated after 18, highest degree levels, sex, and age groups.

Table 9B: Coefficient on Foreign Born and Educated Abroad for Various Specifications, IT workers

	NSCG			Census-ACS			
Specification	1993	2003	2010	1990	2000	2001-2010	2008-2010
Base Specification (see footnote)	-0.0607**	0.0622**	0.0956*	0.0128	-0.0610***	-0.0095	0.0242
	(0.0253)	(0.0276)	(0.0518)	(0.0194)	(0.0117)	(0.0123)	(0.0202)
Base Specification with field of study dummies	-0.0506**	0.0593**	0.0878*				
	(0.0248)	(0.0277)	(0.0513)				

Source: National Survey of College Graduates (1993, 2003 and 2010); Census (1990 and 2000) and ACS (2001 to 2010)
Note: Weighted regressions for IT workers (Computer or Information Scientists; and Electrical or Computer Hardware Engineers) The Census/ACS does not report location of institution for degrees. Based on age of immigration and educational qualifications, and comparing it to the NSCG tabulations, it was estimated whether the individual obtained their degree from inside or outside the US. The ACS regressions are estimated separately for each yer, the average coefficient values are reported for the period of interest in this table. See Appendix for the full set of estimation results. The base specification includes a constant, dummy variables for foreign born, foreign born and immigrated after 18, highest degree levels, sex, and age groups.

Table 10A: Coefficient on Country of Birth and Educated Abroad for Various Specifications, All workers

	NSCG			Census-ACS			
Country	1993	2003	2010	1990	2000	2001-2010	2008-2010
			Base Specification (see footnote)				
China	-0.270***	-0.174**	-0.459***	-0.232***	-0.237***	-0.242***	-0.225***
	(0.0462)	(0.0761)	(0.1230)	(0.0175)	(0.0123)	(0.01058)	(0.0153)
India	-0.181***	-0.281***	-0.380***	-0.168***	-0.224***	-0.138***	-0.119***
	(0.0278)	(0.0468)	(0.1030)	(0.0185)	(0.0115)	(0.0124)	(0.0191)
Europe	0.0754***	0.00937	-0.031	0.0163	-0.0422***	-0.056***	-0.038***
	(0.0216)	(0.0432)	(0.0796)	(0.0115)	(0.0093)	(0.0078)	(0.0111)
Canada	0.376***	0.447***	0.316	0.106***	0.186***	0.133***	0.134***
	(0.0503)	(0.0965)	(0.2800)	(0.0235)	(0.0192)	(0.0148)	(0.0217)
Others	-0.0911***	-0.289***	-0.251***	-0.0642***	-0.154***	-0.230***	-0.237***
	(0.0176)	(0.0315)	(0.0716)	(0.0087)	(0.0065)	(0.0057)	(0.0078)
			Base Specification with field of study				
China	-0.250***	-0.146*	-0.430***				
	(0.0464)	(0.0759)	(0.1300)				
India	-0.148***	-0.248***	-0.349***				
	(0.0277)	(0.0458)	(0.0964)				
Europe	0.0489**	-0.0235	-0.0546				
	(0.0217)	(0.0433)	(0.0812)				
Canada	0.350***	0.418***	0.252				
	(0.0497)	(0.0975)	(0.2690)				
Others	-0.0827***	-0.287***	-0.232***				
	(0.0175)	(0.0317)	(0.0709)				

Source: National Survey of College Graduates (1993, 2003 and 2010); Census (1990 and 2000) and ACS (2001 to 2010)
Note: Weighted regressions for all college-educated full-time workers.
The Census/ACS does not report location of institution for degrees. Based on age of immigration and educational qualifications, and comparing it to the NSCG tabulations, it was estimated whether the individual obtained their degree from inside or outside the US. The ACS regressions are estimated separately for each year, the average coefficient values are reported for the period of interest in this table. See Appendix for the full set of estimation results.
The base specification includes a constant, dummy variables for foreign born, foreign born and immigrated after 18, highest degree levels, sex, and age groups.

Table 10B: Coefficient on Country of Birth and Educated Abroad for Various Specifications, IT workers

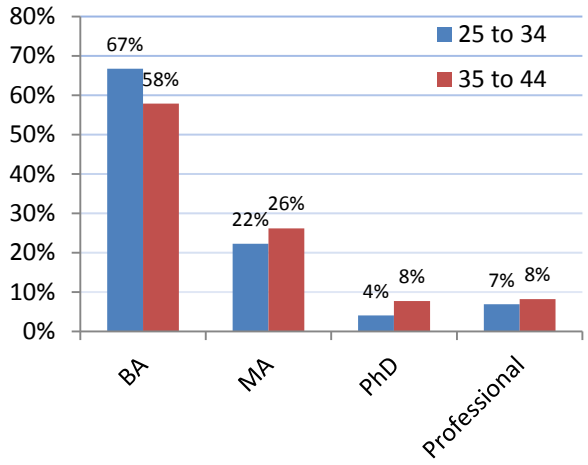
	NSCG			Census-ACS			
Country	1993	2003	2010	1990	2000	2001-2010	2008-2010
			Base Specification (see footnote)				
China	-0.0417	-0.039	-0.137	-0.0902***	-0.137***	-0.048	-0.076
	(0.0879)	(0.0779)	(0.2180)	(0.0315)	(0.0197)	(0.0187)	(0.0259)
India	-0.0717	-0.025	-0.0372	-0.0152	-0.0603***	0.006	0.018
	(0.0663)	(0.0475)	(0.0704)	(0.0331)	(0.0175)	(0.0236)	(0.0349)
Europe	0.0693*	0.173***	0.174**	0.0189	-0.00029	-0.013	0.000
	(0.0402)	(0.0604)	(0.0681)	(0.0305)	(0.0222)	(0.0188)	(0.0298)
Canada	0.222	-0.108	0.0947	0.076	0.202***	0.08	0.134**
	(0.1580)	(0.1420)	(0.1190)	(0.0661)	(0.0530)	(0.0369)	(0.0643)
Others	-0.0672	0.0626	0.113	0.0528**	-0.0709***	-0.026	-0.026
	(0.0467)	(0.0646)	(0.0857)	(0.0213)	(0.0176)	(0.0140)	(0.0216)
			Base Specification with field of study				
China	-0.0316	-0.0186	-0.123				
	(0.0895)	(0.0733)	(0.1940)				
India	-0.0757	-0.038	-0.0179				
	(0.0656)	(0.0486)	(0.0713)				
Europe	0.0598	0.148**	0.185***				
	(0.0394)	(0.0602)	(0.0697)				
Canada	0.192	-0.128	0.119				
	(0.1490)	(0.1320)	(0.1240)				
Others	-0.0574	0.0628	0.107				
	(0.0467)	(0.0652)	(0.0872)				

Source: National Survey of College Graduates (1993, 2003 and 2010); Census (1990 and 2000) and ACS (2001 to 2010)
Note: Weighted regressions for IT workers (Computer or Information Scientists; and Electrical or Computer Hardware Engineers)
The Census/ACS does not report location of institution for degrees. Based on age of immigration and educational qualifications, and comparing it to the NSCG tabulations, it was estimated whether the individual obtained their degree from inside or outside the US. The ACS regressions are estimated separately for each yer, the average coefficient values are reported for the period of interest in this table. See Appendix for the full set of estimation results.
The base specification includes a constant, dummy variables for foreign born, foreign born and immigrated after 18, highest degree levels, sex, and age groups.

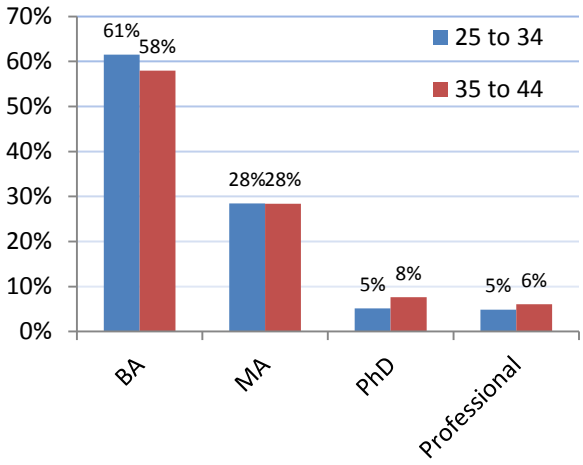
Figure 1. Distribution of workers by Highest Degree and Age Group, 1993 and 2010

Panel A: All Workers

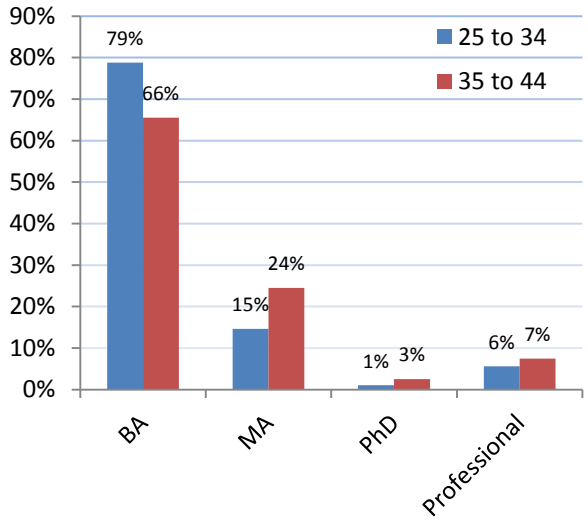
Foreign Born 1993



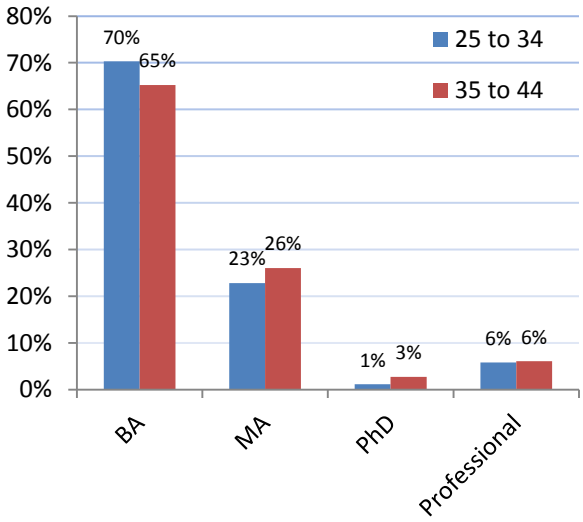
Foreign Born 2010



Native Born 1993



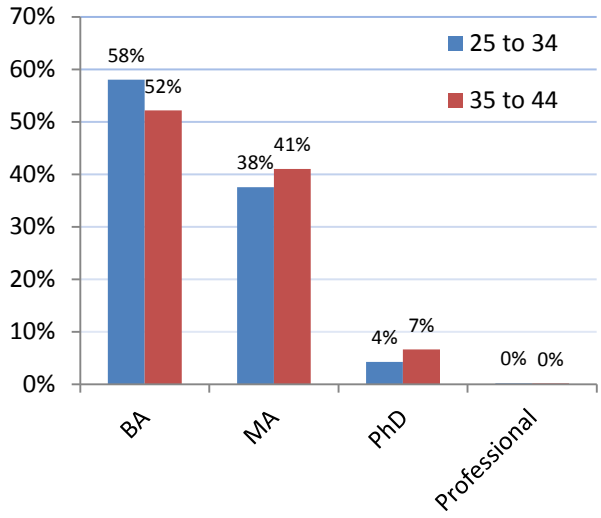
Native Born 2010



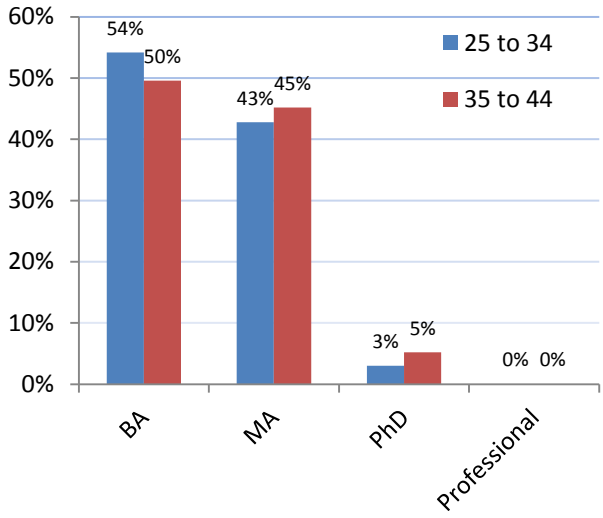
Source: National Survey of College Graduates (NSCG) – 1993 and 2010
Sample restricted to all full-time college-educated workers, that are 25 years or older.

Panel B: IT Workers

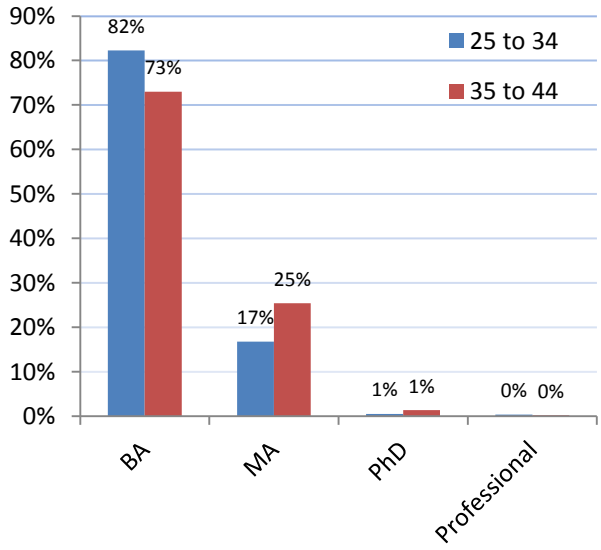
Foreign Born 1993



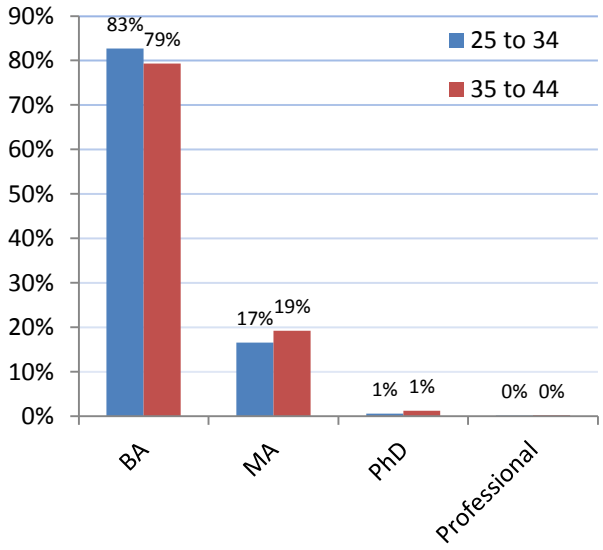
Foreign Born 2010



Native Born 1993

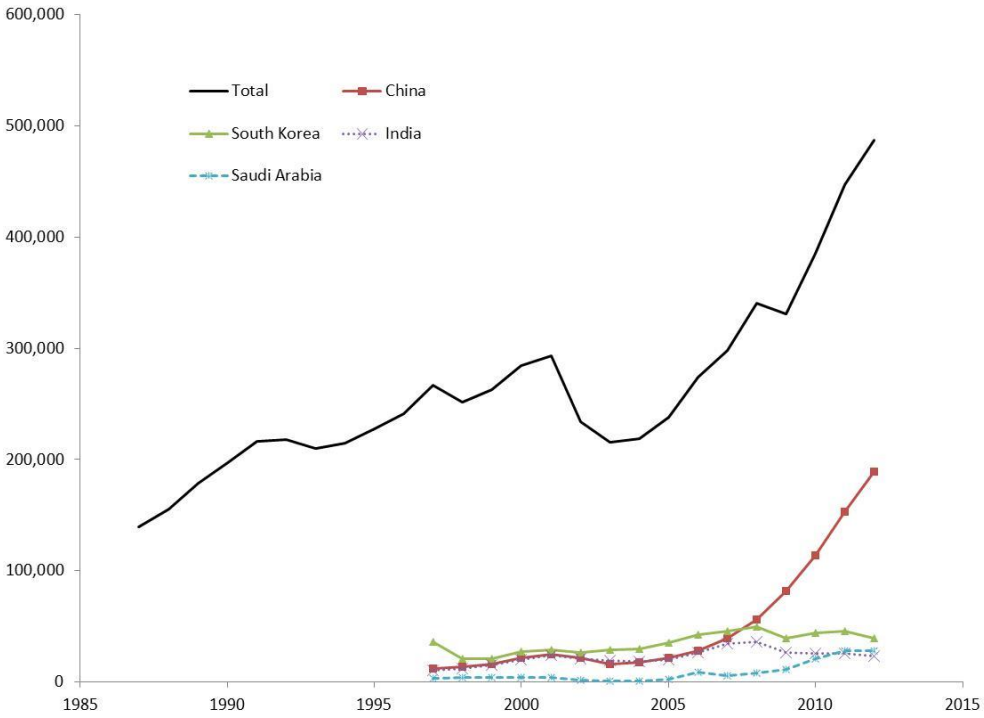


Native Born 2010



Source: National Survey of College Graduates (NSCG) – 1993 and 2010
Sample restricted to those working in the IT industry or related occupations, and are 25 years or older.

Figure 2. 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

Figure 3: Overall trend in foreign enrollment by education level, 1954-2011

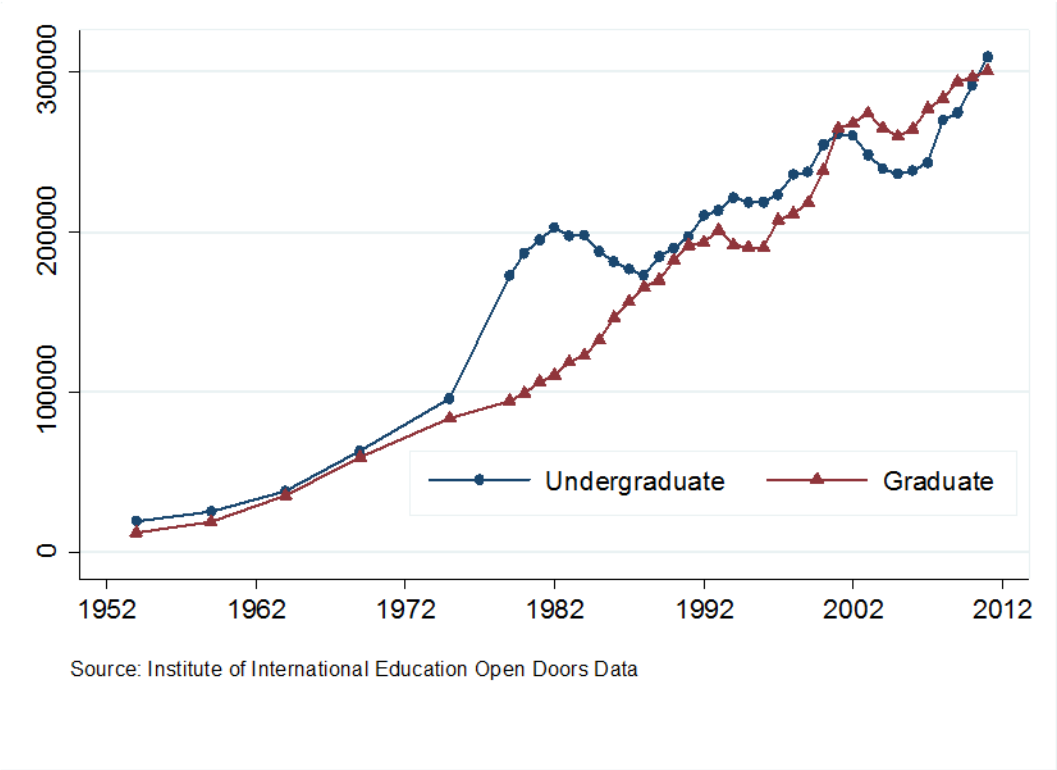
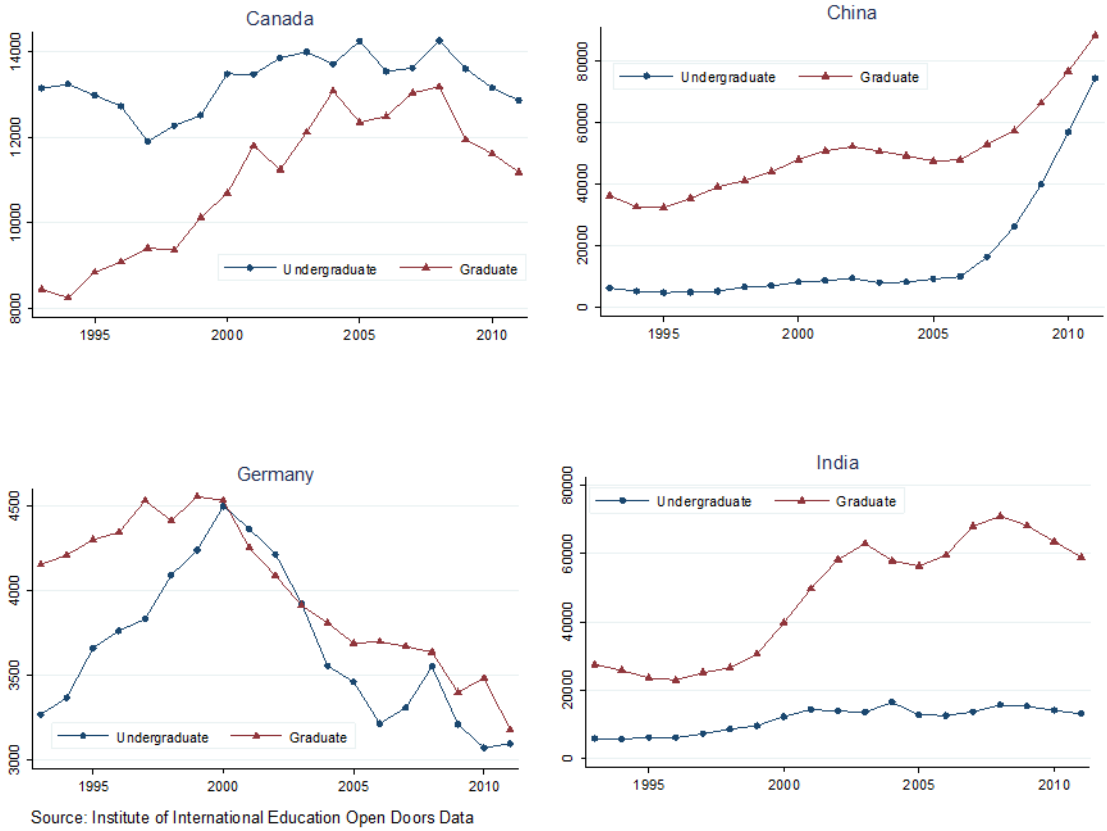


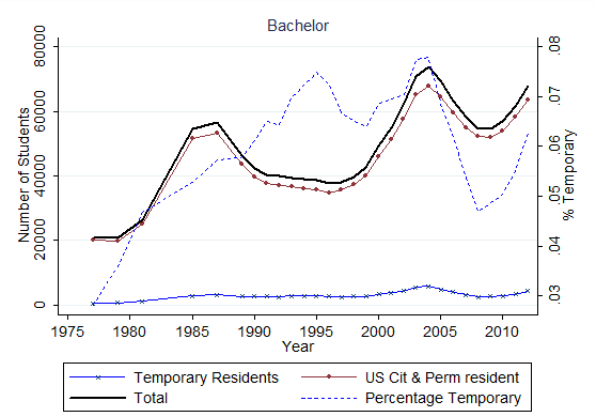
Figure 4: Foreign enrollment trends by major countries of origin, 1993-2011



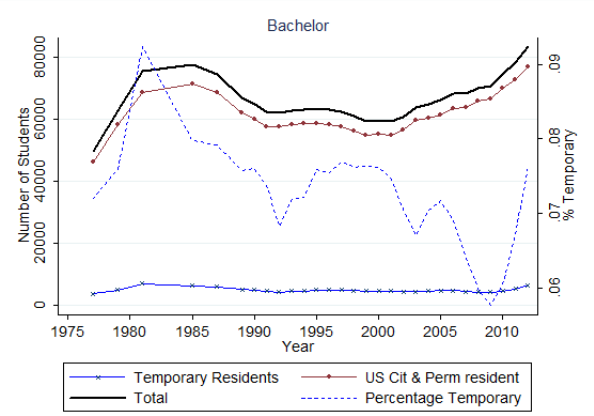
Source: IIE Open Doors Data

Figure 5. Degrees Conferred by Field and Level (Source: IPEDS Completion Surveys by race)

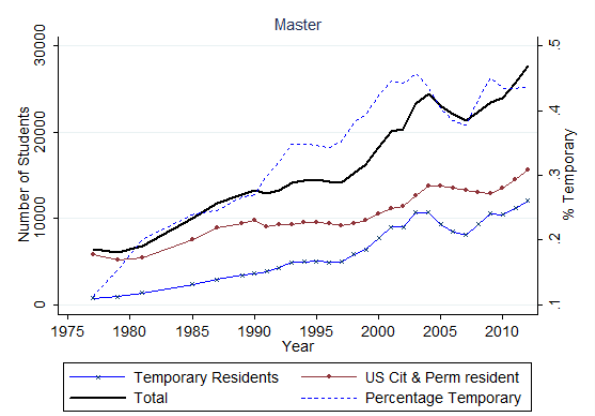
Computer Science



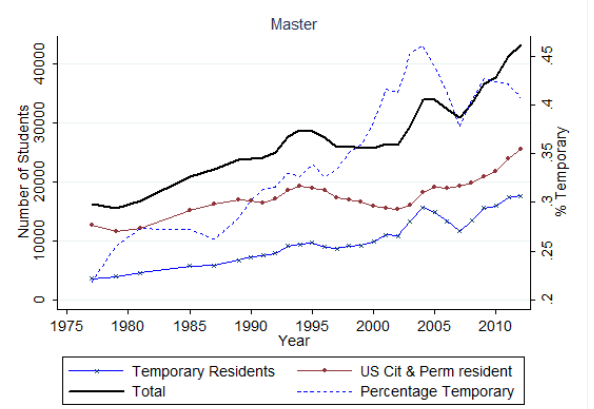
Engineering



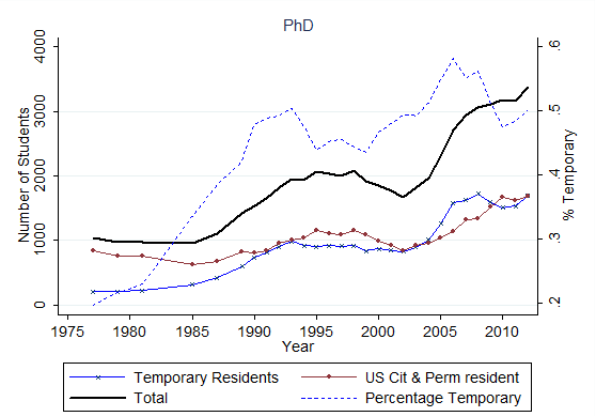
Computer Science



Engineering



Computer Science



Engineering

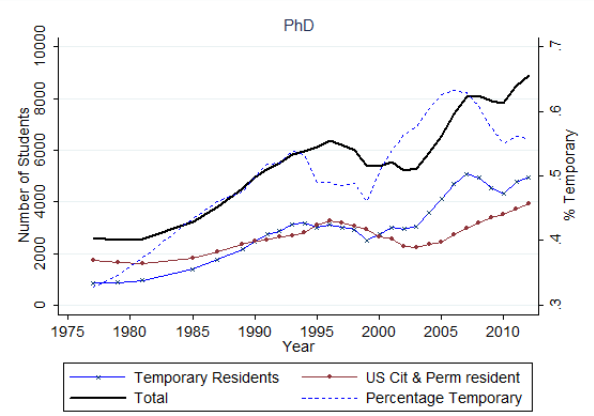
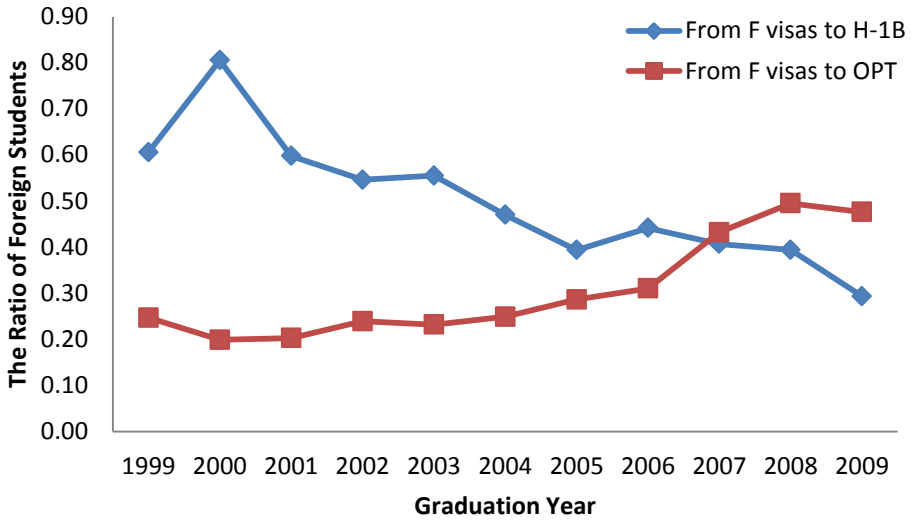


Figure 6: Transition from Student Visas to Temporary Work Visas



Source: 2000-2010 Characteristics of H-1B Specialty Workers Reports of the USCIS, and 2000-2010 Open Doors Report of the Institute of International Education. The transition rate from F visas to an H-1B visa (OPT) in a particular class of graduation is proxied by the ratio of initial H-1B petitions by aliens in the U.S. (OPT beneficiaries) in the following year of graduation to the number of foreign graduates of U.S. universities.