Immigration and the Tech Industry: As a Labor Shortage Remedy, for Innovation, or for Cost Savings?

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Abstract: The two main reasons cited by the U.S. tech industry for hiring foreign workers—remedying labor shortages and hiring "the best and the brightest"—are not supported by the data, even after excluding the Indian IT service firms. Instead, the primary goals of employers in hiring the foreign workers are to reduce labor costs and to obtain "indentured" employees. Current immigration policy is causing an Internal Brain Drain in STEM.

Overview

An irony in the immigration debate in the United States is that most of the discussion is over two polar opposite ends of the labor market spectrum. On the one end are the unauthorized immigrants, typically low-skilled and with very limited education. On the other end are engineers, scientists and the like, all with at least bachelor's degrees and many with postgraduate degrees, hired by the tech industry. Proponents of expanding high end admissions often distance themselves from the low end, claiming the immigrants are needed to maintain American technological edge. Critics of the high-end policies, on the other hand, claim the two types of immigration have a key point of commonality—employers' desire to save on labor costs.

The tech employers' stated reasons for hiring the foreign workers are (1) that American college students either cannot or will not study science, technology, engineering and mathematics (STEM), and (2) that employers need to hire from abroad in order to have "the best and the brightest" workers, people who will produce the innovations necessary for the firms (and the U.S.) to maintain technological dominance.

Neither of these claims will be confirmed here upon close inspection of the data. Focusing on the former foreign students now working in the U.S.—exactly the group extolled by the industry as "the best and the brightest"—I find that relative to comparable U.S. natives, the immigrants tend to earn less,1 submit fewer patent applications and be less likely to be working in R&D positions This leaves cheap, immobile labor as the remaining explanatory factor for the popularity of the H-

1 The earnings analysis will be limited to former foreign students who now have green cards, so as to remove the exploitation issue.
1B program among employers.

A point rarely mentioned in the H-1B debate is the employers’ exploitation of the de facto indentured servitude of those being sponsored by their employers for green cards. Any H-1B worker has the legal right to switch employers, but this is unthinkable for most H-1Bs waiting for green cards (NRC, 2001). The foreign worker is thus often immobile, a highly attractive condition from the viewpoint of employers, who fear being left in the lurch in the midst of an urgent project. This means that many employers, especially in Silicon Valley, much prefer to hire foreign workers over similarly-qualified Americans.2

It is vital to keep in mind that the usage of the foreign workers as cheap labor is in most cases fully legal. Major legal loopholes enable the underpayment of foreign workers relative to comparable Americans.

The impacts of all this on American tech workers have been suppressed wage growth, greatly shortened careers, and most troubling from a national interest point of view, an internal brain drain, with many of America’s own best and brightest leaving STEM or avoiding entering it in the first place.

My main focus here is on computer science (CS) and electrical engineering (EE).

**Unwarranted Policymaker and Researcher Focus on the Indian IT Staffing Firms**

My analysis essentially excludes workers in the the Indian IT staffing firms (ITSFs) that hire H-1Bs and rent them to other companies. (Here the term “Indian” will be shorthand for “Indian and Indian-American.”) It is common among analysts of the H-1B workforce to refer to the market as segmented, making the assumption that the mainstream U.S. firms use the H-1B visa properly while the Indian firms abuse it.

This claim eventually made its way into Congress. During a controversial speech in the Senate in 2010, Senator Charles Schumer claimed that the majority of employers who use H-1B for cheap labor were the ITSFs. The Indian community took offense and accused him of scapegoating (Cha, 2010). The claim that the ITSFs are the main abusers of H-1B was also mentioned a number of times at a 2011 workshop attended by leading government policymakers (Hamuttal, 2011).

The analysis here will effectively exclude the ITSFs, focusing specifically on mainstream U.S. firms. It will be shown that abuse is commonplace among the mainstream U.S. firms as well. Policy singling out the ITSFs is thus not warranted.

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2 In this article I generally use American to mean U.S. citizens and permanent residents, but will restrict the term to natives in my analyses of the NSCG data.
To be sure, the ITSFs do differ from the mainstream U.S. companies in various ways. Compared to the mainstream firms, they tend to hire the lower-quality (e.g. lesser-educated) workers; their preferential hiring of foreign workers over Americans is more overt; and they are more prone to violate wage laws.

Yet those differences do not change the fact that the mainstream firms broadly abuse the foreign worker programs too. Hiring a higher-quality worker at, say, 20% below market is equally egregious as hiring a lower-quality worker at that discount rate. Furthermore, only 12% of the H-1Bs are employed by ITSFs, so the mainstream employer hiring of the foreign workers causes the worse overall adverse impact on American workers.

The NSCG and the PERM data analyzed here essentially exclude the ITSFs. With NSCG I limit the analysis to those who entered the U.S. as foreign students, which is almost never the case for NSCG workers. The PERM data involve green cards, and the Indian IT staffing firms almost never sponsor their foreign workers for green cards (Hira, 2007).

**Visa Types**

The foreign group of interest here, former foreign students now working in the U.S., typically follow this visa path: They enter the U.S. on an F-1 student visa; after graduation they work for a U.S. employer, holding the H-1B work visa sponsored by the employer (possibly first making use of the Optional Practical Training provision in F-1); then they are sponsored by the employer for U.S. permanent residency, i.e. a green card.

**Demographics**

In general, the H-1Bs are much younger than their coworkers, tending to be in the 20s or early 30s. This is clear in the case of the former foreign students, but it is also true broadly. The data in the 2003 National Survey of College Graduates indicate a mode of about 29 for the H-1Bs, versus about 42 for the American tech workers. See also (GAO, 2011).

The computer-related workers—that is, software developers, database administrators and the like—predominate among H-1Bs. During 2000-2009, 46% of H-1Bs were in this category, far more than in the second-largest category, university employment at 7%. Electrical engineers formed only 4% of the H-1Bs.
Computer-related H-1Bs are predominantly from India, with Indian nationals forming 64.8% of the total in 2001. Those from China were a distant second at 8.2%, followed by Filipinos at 2.3% (Hoefer, 2001). For green card sponsorship, the PERM data show that in 2010, 52.5% of the applications were for Indian workers, while 5.9% were for Chinese.

Claims of a Tech Labor Shortage

Starting with its first big campaign to convince Congress to expand the H-1B and related programs in 1997, the tech industry has asserted a tech labor shortage. Yet, other than one survey conducted by the industry trade group ITAA (ITAA, 1997), no study has ever confirmed the shortage claims.

Lack of Indicators of a Shortage

Studies by the Department of Commerce, the university computer science consortium known as the Computing Research Association, the Urban Institute's Robert Lerman, and the National Research Council (congressionally commissioned study), all failed to confirm the ITAA claim of a tech labor shortage. (See (Matloff, 2003) for a survey of the studies.) Vivek Wadhwa, a former tech CEO who now writes about the tech industry, conducted his own survey in 2006 (Wadhwa, 2006), and found no evidence of a shortage. Wadhwa and his coauthors asked employers about their ability to hire the engineers they need. They found that acceptance rates of job offers were good, and that most job offers did not include bonuses. Wadhwa remarked that the industry’s claim of a “shortage” is actually “a shortage of engineers below market price that work day and night like slave labor” (Overby, 2007).

In 2011, wages of experienced workers in Silicon Valley had increased only 3% since 2009 (Carey, 2011). Interestingly, the online jobs board Dice.com gave anecdotal evidence of a shortage but then admitted that tech salaries had risen less than 1% in the past year. None of these figures indicates a shortage.

Claims of a Pipeline Shortage: Undergraduate Level

The industry has also claimed a pipeline shortage—first asserting that not enough American students majoring in STEM at the undergraduate level (ITAA, 1997), and later claiming that not enough earn PhDs. Let us examine these claims, looking first at bachelor's degrees.

Most industry claims are based on numbers of new graduates, which have little or no bearing on the actual demand. If the number of new CS graduates declines
from one year to the next, that doesn't imply that there is a "shortage" relative to the job market.

Moreover, most software developers come from educational backgrounds other than CS. A former researcher in the U.S. Department of Education found that large numbers of non-CS majors complete advanced courses in CS (Adelman, 1997). Most software developers actually do not have CS degrees (Lerman, 1998). Here is a similar analysis from the NSCG data, broken down by broad major categories:

<table>
<thead>
<tr>
<th>field</th>
<th>% of SEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>computer sci</td>
<td>40.2%</td>
</tr>
<tr>
<td>bio sci</td>
<td>2.3%</td>
</tr>
<tr>
<td>phys sci</td>
<td>3.6%</td>
</tr>
<tr>
<td>soc sci</td>
<td>4.8%</td>
</tr>
<tr>
<td>engineering</td>
<td>21.9%</td>
</tr>
<tr>
<td>health sci</td>
<td>5.6%</td>
</tr>
<tr>
<td>business</td>
<td>21.5%</td>
</tr>
</tbody>
</table>

So only 40.2% of those with Software Engineer, Programmer or Computer Scientist titles came to the profession from a CS degree, which here includes those in the less technical majors such as Information Science, not just Computer Science. Note too that this does not account for the many in the occupation who don't have a degree at all.3

The most direct way to determine whether there is a shortage of CS/EE graduates is to look for a rapid rise in wages, but there is none. For example, in 2011, starting salaries for new computer science graduates were up only 3% from the year before (NACE, 2011), certainly not indicative of a shortage.

The claim of a general STEM pipeline shortage has been refuted by studies showing that U.S. universities graduate more than enough STEM students each year to meet the demands of the economy (Lowell, 2007).

This point was put into sharper focus for CS/EE in 2011 testimony before the U.S. House Immigration Subcommittee, by Texas Instruments V.P. for HR Darla Whitaker (Whitaker, 2011). Ms. Whitaker stated that her firm does not sponsor workers holding only bachelor's degrees for H-1B visas, as the company has no shortage of American applicants.

Since TI has been one of the most vociferous in calling on Congress to increase H-1B cap, their statement, plus the statistical aspects discussed above, should settle the issue: There is no shortage of bachelor's-level STEM graduates in general and of CS/EE graduates in particular.

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3 Many big names in the industry have no degree, such as Bill Gates, Larry Ellison, Mark Zuckerberg and Linux inventor Linus Torvalds.
TI does claim a pipeline shortage at the postgraduate level, though, a claim I will discuss in the next section.\textsuperscript{4}

**Claims of a Pipeline Shortage: PhD Level**

The industry lobbyists often cite the fact that 50% or more of the STEM doctoral degrees at U.S. universities are awarded to foreign students. However, one cannot conclude from these numbers that there is a shortage of American doctoral students in these fields. On the contrary, there are strong indications that we have been overproducing PhDs in these fields.

These concerns began back in the mid-1990s, triggered by a Stanford study (Massy, 1995). Much controversy ensued, but it was clear that the critics mainly disliked the message, rather than disagreeing with it. For instance, the CEO of the then-hot tech firm Silicon Graphics, Forest Baskett, conceded that “…it is probably true that [his PhD workers] don’t have jobs that really require a PhD” (Lazowska, 1995).

It would be easy to dismiss the concerns at the time as being ill-timed Cassandra thinking just prior to the amazing Dot Com boom. However, the issue is just as valid today.

A very illuminating example is the CIFellows program of the Computing Research Association, a consortium of the major computer science departments in North American universities. The CRA launched an initiative in 2009 to provide post doctoral employment for new computer science PhDs, to remedy the fact that these graduates were having severe problems finding jobs—termed "crisis conditions in the labor market for computing researchers" in the external report commissioned later by CRA to evaluate the program (SRI, 2010). Since CS had never been a field in which post doc work was common (CRA, 2011a), the advent of the CIFellows program starkly dramatized the poor job market for CS PhDs.

Recently the CRA announced it would probably not continue the project past the 2011-2012 academic year, as the economy has recovered. Yet the situation for CS PhDs is still not good. Indeed, the CRA CIFellows Web page\textsuperscript{5} lists numerous open post doc positions. Given that the CRA defines a post doc as "a person who has recently completed his or her doctoral degree but has not yet found a permanent position on a faculty, in a research laboratory, or in industry" (CRA, 2011a), the CRA’s listing of a plethora of open post doc jobs shows that the CRA

\textsuperscript{4} During the industry’s first big push for Congress to expand H-1B in 1998, Intel CEO Andy Grove made similar statements, as reported by the *Washington Post*, April 24, 1998: “I don't buy into the hyperventilated description of the technology worker shortage,” but followed by saying there was a shortage at the postgraduate level.

\textsuperscript{5} http://cifellows.org/opportunities/
in fact continues to believe we have a number of unemployed or underemployed
CS PhDs. In other words, CRA believes we have a surplus of PhDs after all.

CIFellow Cindy Bethel wrote in the CRA’s newsletter in the fall of 2011, “In 2009,
opportunities to find employment in computing research were extremely limited,
and unfortunately that situation has not improved much today...(Bethel, 2011)
Indeed, the external report commissioned by CRA stated, “Now that the
computing research field is maturing, it will not be as easy for the labor market
to absorb all newly-minted Ph.D.’s in computing research, and postdocs may help
to create equilibrium in the research labor market” (SRI, 2010). In other words,
the SRI reviewers believe that the job market for CS PhDs will be permanently
tough.

The Best and the Brightest?

I now turn to another question that arises frequently in discussions of H-1B: Do
the H-1Bs, especially those who first came to the U.S. as international students,
tend to be “the best and the brightest,” key to America’s ability to innovate? My
approach here consists of regression analyses on salary, patenting activity and
work in research and development (R&D).

In the three regression analyses, I look at the 2003 NSCG data, restricting to the
following groups. I cover every full-time, nonmanagerial, nonsales worker who
satisfies the following conditions:

• had his/her highest degree in the CS/EE field
• was working full time in a U.S. position in CS/EE as of 2003
• if foreign-born, originally entered the U.S. on a foreign student visa

In addition, to avoid complications involving the exploitation of H-1Bs, in the
case of my salary analyses I imposed an additional condition on the foreign-born:

• was a U.S. citizen (naturalized) or permanent resident as of 2003

Note that we thus are comparing U.S. natives to former foreign students now
working in the U.S. For simplicity, I will refer to the natives as “Americans,” but
it must be noted that many of the former students have naturalized and are now
Americans too.

Note also who is excluded. First, the analyses do not include those who entered
the U.S. on a work visa, so as to exclude the Indian IT staffing firms.

Also excluded are those who immigrated under family qualifications and the
like. Some researchers have found U.S. education to be an important variable, which may play a role in the American cultural propensity for innovation. Since family immigrants enter the U.S. at a variety of ages, the easiest way to account for the U.S. education variable is to restrict to U.S. natives.

Thus, although I generally include naturalized citizens and permanent residents when I refer to Americans in this article, in the following analyses of wages, patenting and R&D work in the NSCG data, I am comparing former foreign students now working in the U.S. to U.S. natives.

Unlike (Hunt 2011), who also used the NSCG data, I chose not to analyze entrepreneurship, as its value in assessing innovation is problematic. As will be shown later in this paper, immigration policy results in Americans being crowded out of the computer science and electrical engineering fields. Any study of immigrant entrepreneurship among the college educated must account for this, investigating whether the immigrants are more entrepreneurial on a per capita basis. If those crowding out the Americans are no more entrepreneurial than the Americans, then there is no net gain in entrepreneurship.

(Hunt, 2011) did find a higher per-capita level of entrepreneurship among the immigrants. However, one doesn’t know the kind of business involved. Berkeley researcher AnnaLee Saxenian found that 36% of the Chinese-immigrant owned firms are in the business of “computer wholesaling,” meaning that they are simply assemblers of commodity PCs, with no engineering or programming work being done (Saxenian, 1999). This certainly does not represent “best/brightest” innovation. And many Indian-owned tech firms are in the offshore outsourcing business, again not the type of entrepreneurship that is relevant here.

Publication counts confuse quantity with quality, and vary greatly from one research specialty to another, thus forming a poor measure (Patterson, 1999; Hamermesh, 2011). I thus did not include this variable in my analysis either.

Wage Analysis

I ran a regression analysis, in order to assess how salary is affected by age, education level, region and original F-1 status. The latter is an indicator variable regarding the type of visa a person first held upon entering the U.S., with the variable being equal to 1 if the person came here as a foreign student, 0 otherwise. Similarly, there is an indicator variable for having a master’s degree (without a PhD), one for a doctorate, one for working in a high cost-of-living region and ones indicating academic or government job. (Those with just a bachelor’s degree are indicated by the presence of 0 values in the master’s and PhD variables.)
The regression equation was

\[
\text{mean wage} = 
\beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 \text{MS} + \beta_4 \text{PhD} + \beta_5 \text{highCOL} + \beta_6 \text{origF1} + \beta_7 \text{acad} + \beta_8 \text{gov}
\]

Here are the results for CS:

<table>
<thead>
<tr>
<th>variable</th>
<th>coefficient</th>
<th>margin of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-18730.91</td>
<td>35517.8</td>
</tr>
<tr>
<td>age</td>
<td>4389.22</td>
<td>1724.64</td>
</tr>
<tr>
<td>age2</td>
<td>-46.91</td>
<td>20.44</td>
</tr>
<tr>
<td>Master's</td>
<td>6702.87</td>
<td>4061.24</td>
</tr>
<tr>
<td>PhD</td>
<td>28245.61</td>
<td>8872.46</td>
</tr>
<tr>
<td>former F-1</td>
<td>-5278.43</td>
<td>4894.7</td>
</tr>
<tr>
<td>high cost/living</td>
<td>9543.1</td>
<td>3550.42</td>
</tr>
<tr>
<td>academic</td>
<td>-29900.76</td>
<td>10193.52</td>
</tr>
<tr>
<td>government</td>
<td>-16047.47</td>
<td>6998.94</td>
</tr>
</tbody>
</table>

(I place regression coefficient values that are statistically significant at the 5% level in bold face. Rather than merely reporting the results of statistical significance tests, I also report margins of error, i.e. radii of approximate 95% confidence intervals for the coefficients. Confidence intervals yield more informative results (Freedman 1998; Kaye 2000).)

The estimated coefficient for the former foreign students, -5278.43, is negative and statistically significant. In other words, the former foreign students working in CS are earning significantly less than the Americans of the same age, education and so on.

The regression results for the EE case are as follows:

<table>
<thead>
<tr>
<th>variable</th>
<th>coefficient</th>
<th>margin of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-12320.07</td>
<td>31148.43</td>
</tr>
<tr>
<td>age</td>
<td>3632.59</td>
<td>1423.59</td>
</tr>
<tr>
<td>age2</td>
<td>-34.16</td>
<td>15.79</td>
</tr>
<tr>
<td>Master's</td>
<td>10338.16</td>
<td>4183.99</td>
</tr>
<tr>
<td>PhD</td>
<td>22671.42</td>
<td>7017.32</td>
</tr>
<tr>
<td>former F-1</td>
<td>684.82</td>
<td>5213.38</td>
</tr>
<tr>
<td>high cost/living</td>
<td>6543.49</td>
<td>3660.81</td>
</tr>
<tr>
<td>academic</td>
<td>-18721.15</td>
<td>12790.41</td>
</tr>
<tr>
<td>government</td>
<td>-1262.13</td>
<td>6266.94</td>
</tr>
</tbody>
</table>
Here the coefficient for former foreign student status was not significantly different from 0.

Looking at the two regression results, we see that no “best and brightest” trend was found for the former foreign students. On the contrary, in the CS case the former foreign students appear to be somewhat less talented on average than the Americans.

Salary and Language
(Hunt, 2011), in finding that Asian immigrant professionals earn less than their European immigrant peers, surmised that the difference was due poor English skills among the Asians. But this is probably not the cause.

The tech industry is famously meritocratic for engineering workers. Since work involves producing tangible products of direct, crucial value to the firms, all that matters to your employer is whether you successfully write the code or design the chips; if you do, you are rewarded, regardless of, say, poor grammar.

Professor Joyce Tang found that language skills were not a barrier to Asian immigrant engineers, even for those who wished to obtain academic positions (Tang 2000). My logistic regression analysis on the 2000 PUMS census data (not presented here) shows that among immigrant Chinese engineers and programmers, English skill has no statistically significant impact on the probability of earning a high salary, defined to be above $150,000.

Moreover, it must be noted that the numerically dominant H-1B group in the tech area is the Indians. They typically grow up with English, and often dazzle U.S. professors with language skills greatly exceeding those of American native students.

Patent Activity
There have been a number of recent studies on immigrant patenting in the tech area, several having attracted considerable attention (Wadhwa, 2007; Hunt, 2010; Kerr, 2010). However, they are not very useful in the present context, as their findings essentially boil down to stating, “Immigrants are numerous in the tech field, and thus they are also numerous in patent activities.”

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6 The situation is believed to differ in the case of management jobs.
None of these studies addresses the central question relevant here, which is whether the immigrant tech workers are more prone to patenting on a \textit{per capita} basis, especially after education and other variables are taken into account. This per-capita issue is crucial; are the immigrants of higher quality than those they are displacing?

Hunt’s second study (Hunt, 2009; Hunt, 2011) did address this question. In the working paper version (Hunt, 2009), she wrote, "After I control for field of study...and education...both main work visa groups and student/trainee visa holders have statistically significantly lower patenting probabilities than natives." In the final published version the data set coverage was somewhat different, but she still found no statistically significant difference between immigrants and natives.\footnote{(Hunt, 2009) was a working paper. During the journal review process, Hunt was asked to remove the H-1Bs and others holding work visas from her analysis, so the final published version (Hunt, 2011) excludes that group.}

As mentioned, though, Hunt cast quite a broad net, encompassing myriad fields and types of entry visas, in contrast to my narrow focus here on former foreign students in CS/EE. With that in mind we turn again to the NSCG data. We no longer restrict to U.S. citizens and permanent residents, but remove those in academia and government, where patenting rates are lower. Here is the regression analysis in the CS case, expressing mean number of patent applications filed in terms of age, education and original F-1 status:

<table>
<thead>
<tr>
<th>variable</th>
<th>coefficient</th>
<th>margin of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.18</td>
<td>0.60</td>
</tr>
<tr>
<td>age</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Master's</td>
<td>0.44</td>
<td>0.28</td>
</tr>
<tr>
<td>PhD</td>
<td>2.90</td>
<td>0.61</td>
</tr>
<tr>
<td>former F-1</td>
<td>-0.44</td>
<td>0.32</td>
</tr>
</tbody>
</table>

The coefficient for original foreign student status, -0.44, is significantly different from 0 at the 5% level. In other words, on average the former foreign students are producing about a half a patent fewer per person than are Americans of the same age and educational level.

On the other hand, in EE the former foreign students’ patenting activity is not significantly different from the Americans:
In summary, the former CS students apply for somewhat fewer patents than do their American peers, while in EE the foreign and American groups have about the same mean numbers of patents.

Again, the data certainly do not show a “best and brightest” tendency among the former foreign students.

**R&D Work**

Presumably much (though by no means all) of the innovation in the tech industry comes from those working in research and development (R&D) positions. It is thus of interest to investigate the proportions of U.S. versus immigrant workers who hold such jobs. Fortunately, the NSCG data include a variable for this status.

Here I used a logistic regression model for the probability of working in R&D, with the following results for CS:

<table>
<thead>
<tr>
<th>variable</th>
<th>coefficient</th>
<th>margin of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>1.03</td>
<td>2.72</td>
</tr>
<tr>
<td>age</td>
<td>0.02</td>
<td>0.13</td>
</tr>
<tr>
<td>age2</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Master's</td>
<td>0.46</td>
<td>0.33</td>
</tr>
<tr>
<td>PhD</td>
<td>2.32</td>
<td>1.23</td>
</tr>
<tr>
<td>former F-1</td>
<td>-0.66</td>
<td>0.37</td>
</tr>
</tbody>
</table>

The former foreign students in CS are significantly less likely to be working in R&D than the Americans.

Here are the results for EE:
variable coefficient margin of error
const \[8.14\] 6.12
age -0.27 0.29
age2 0.00 0.00
Master's \[1.14\] 0.79
PhD \[2.17\] 1.58
former F-1 \[-1.36\] 0.77

Here again, the former foreign students are less likely than comparable Americans to be working in research and development.

So we find that under this measure the former foreign students are on average less innovative than the Americans.

H-1Bs As Cheap Labor: Overview

In this section, it will be confirmed that the use of foreign tech workers for cheap labor pervades the industry.

There are (at least) two ways that employers save money via the H-1B program:

- Type I savings: Paying H-1Bs less than comparable U.S. citizens and permanent residents.
- Type II savings: Hiring younger H-1Bs in lieu of older Americans over age 35.

I first cover the Type I case. In the following, the reader should keep in mind two central points to be demonstrated here:

(a) Most employers who use H-1Bs for cheap labor do so in full compliance with the law, through the use of loopholes. The problem lies not in fraud or violation of the law, but in the law itself.

(b) Use of H-1B to reduce labor costs pervades the entire tech industry, including the mainstream U.S. firms. It is not limited to the Indian-owned IT staffing firms.

Cheap Labor Issue: Type I

Here I investigate the Type I salary savings issue: Do the foreign tech workers get lower wages on average than do comparable American peers?
Previous Research on Type I Wage Savings

My research for CS/EE estimates the underpayment at 15-20 percent (Matloff, 2003). A study of earlier data even calculated the pay gap for engineering to be 33 percent (Ong, 1997).

The congressionally-commissioned National Research Council study (NRC, 2001) is noteworthy in that it included an employer survey. Based on a survey of a cross section of employers, it found that the H-1Bs “received lower wages, less senior job titles, smaller signing bonuses, and smaller pay and compensation increases than would be typical for the work they actually did.”

Hunt, analyzing all college graduates, with no restriction on field, found that the group of interest here—those who first arrived as foreign graduate students—were making significantly less than comparable natives (Hunt 2009). On the other hand, Lofstrom and Hayes (Lofstrom, 2012) concluded that the H-1Bs are at least as well paid as the Americans, and Mithas and Lucas (Mithas 2010) found that foreign IT workers are actually paid 2.3 percent more.

A key aspect of these studies is the data set. Mithas and Lucas, for example, based their analysis on a reader survey of a magazine for IT managers, not mainstream engineers and programmers. Also, the average age in their sample was about a decade older than among H-1Bs in general, thus raising further questions of the relevance of the data to the general H-1B issue. Hunt’s data set is extremely broad, with unknown consequences to the analyses.

In attempting to determine whether H-1Bs are paid less than comparable Americans, the key word is comparable. Employers say they hire the H-1Bs because the foreign workers have some special quality, such as experience in "hot" technological skills, possession of a rare degree or special brilliance. Special qualities command premium wages on the open market. Thus if there were no exploitation of the foreign workers, average salaries would be substantially higher for the foreign workers than for the Americans. Thus any study, such that of (Lofstrom, 2012) or (Mithas, 2010), that finds that the foreign workers have about the same average wage as the Americans actually demonstrates exploitation.

The Legal Prevailing Wage Is Typically Below the Market Wage

Both H-1B visa and green card sponsorship require the employer to pay the prevailing wage, the average salary for similar workers in the given job. A key

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8 The researcher who conducted the survey described the firms surveyed as a “cross-section, from the major [mainstream firms]...names you'd recognize, and a few smaller companies and body shops, and also companies in India” (Salzman, 2012).
9 See earlier comment on the difference between (Hunt, 2009) and (Hunt, 2011).
10 The employer is required to pay the higher of the prevailing wage and the actual wage. The latter is
point in the analysis here will be that the prevailing wage, as legally defined, is typically well below what the given worker's qualifications would command in the open market. This enables employers to legally underpay the foreign workers.\textsuperscript{11}

The industry lobbyists have cited numerous employer claims that the H-1Bs are hired for their special skill sets (McGee, 2004) (Alvares, 1998) (AILA, 1998) (Cooper, 2011).

The CEO of Meebo has often been outspoken in support of the H-1B program, claiming he cannot find qualified U.S. workers. A typical Meebo job ad in 2011\textsuperscript{12} required experience in JavaScript, and the ad listed as "plusses" DOM, CSS, semantic HTML, YUI, Dojo and JQuery. This listing of multiple skills requirements (or "plusses") is typical of job ads in the industry.

In the open market, employers would have to pay a premium for these rare technological skills. For example:

<table>
<thead>
<tr>
<th>skill</th>
<th>premium</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>various</td>
<td>16-24%</td>
<td>1998</td>
</tr>
<tr>
<td>SOA</td>
<td>37%</td>
<td>2010</td>
</tr>
<tr>
<td>iPhone/Android</td>
<td>20%</td>
<td>2011</td>
</tr>
<tr>
<td>Ruby</td>
<td>up to 70%</td>
<td>2011</td>
</tr>
<tr>
<td>cloud</td>
<td>25%</td>
<td>2012</td>
</tr>
</tbody>
</table>

(See Matloff, 2003), (Drapier, 2011), (Darrow, 2012), (McKendrick, 2011).)

Yet these premiums for a hot skill are not factored into the prevailing wage. Since hot skills command a wage premium in the open market, the result is that the legal prevailing wage is typically less than what the given worker could earn on the open market.

Here is how it works. To begin with, the statute defines prevailing wage in terms of the \textit{job}, not the \textit{worker}. If experience with Android programming, say, is merely a "plus" rather than a requirement, the prevailing wage does not account for Android—and the employer can hire a foreign Android programmer for the price of a generic one. Recalling the long list of "plusses" in the sample Meebo ad described earlier, which is typical, it is clear that employers can reap major cost savings through this loophole.

Even more important is the database used to determine prevailing wage. The Department of Labor (DOL) offers employers two options—either use a private

\textsuperscript{11} This point is key. Though many articles in the popular press cite sensational DOL investigations of fraud, it is rare. Instead, legal underpayment of the foreign workers is widespread, enabled by loopholes discussed here.

\textsuperscript{12} http://www.meebo.com/jobs/openings/javascript/ Meebo was acquired by Google in 2012.
salary survey, or utilize DOL's automated system, the Online Wage Library (OWL), based on DOL's Occupational Employment Statistics (OES) database. Though an employer can do better (in the sense of obtaining a lower prevailing wage) with a private survey, most choose the DOL system instead, as DOL considers it “safe harbor,” i.e. automatic acceptance. Thus, let’s focus on OWL here, examining the procedure.

The employer who wishes to sponsor a foreign worker for an H-1B visa logs on to the DOL Web page (http://www.flcdatacenter.com), where he is asked the job's occupation category, experience level (I through IV) and geographical location. The employer is not asked whether the worker has any specific skill, say in Android programming. Thus the prevailing wage requirement allows employers to legally underpay their H-1B workers. The law regarding prevailing wage for green cards is basically the same as for H-1B,13 so again, the employer can hire, say, a foreign Android programmer for the price of a generic programmer.

The same analysis can be made for the other reasons claimed by the industry for hiring the foreign workers, say that people of outstanding talent are being hired: The prevailing wage simply is the wage of the average worker. In other words, the employer of the foreign worker gets a special-value worker for the price of an average one, thus less than what he would need to pay a similar special-value American. This point will be central in the analyses below.

Let us conservatively take 20% as a typical wage premium for special skills in the above table, and thus take 20% as our reference number for the amount by which legal prevailing wage is below market level.

The fact that the legally required wage is below the real market wage has been occasionally recognized by government. An employer survey conducted by the GAO (GAO, 2003) found that some employers readily admitted to paying H-1Bs less than comparable Americans, but noted that they were nevertheless paying the legally required wage, thereby illustrating that the latter is indeed below the market wage. Representative Zoe Lofgren has remarked that the Department of Labor, in response to a query from her, reported that the average wage for computer systems analysts in her district was $92,000, while the legal prevailing wage was $52,000 (Thibodeau, 2011).

13 The case of a green card application does have one additional aspect. The employer goes through OWL as with H-1B, but he must state in the application whether there are any “special skills” needed for the job. Here, the DOL adjudicator may adjust upward the experience level, level I, II, III or IV, that the employer has stated for the job (Durham, 2012). However, this refers to something like foreign language requirements, not the platform skills such as Android. For instance, the case study of (Goldblum, 2006), presented in a professional seminar for immigration lawyers, lists as requirements for a particular job experience with specific computer operating systems, certain network technologies and so on, but lists None in the Special Skills section of the application, and does not factor those computer skills into the prevailing wage.
Analysis Based on the Below-Market Nature of the Prevailing Wage

As shown earlier, the legally required prevailing wage is typically well below the true market wage, with 20% being a conservative estimate of the degree of underpayment. Here I will use this fact to present further evidence that the foreign workers are paid less than comparable Americans.

I looked at the PERM data, 2005-2011, consisting of records of all employer-based applications for worker green cards. For each worker I calculated the wage ratio (WR), meaning the ratio of their salary to the prevailing wage. Since the latter is below market level, a value of WR near 1.00 indicates underpayment of the worker. Note that by law, DOL will not approve any application for which WR is below 1.00.¹⁴

Here are the WR values for occupations of interest:

<table>
<thead>
<tr>
<th>job title</th>
<th>median WR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>1.00</td>
</tr>
<tr>
<td>EE</td>
<td>1.00</td>
</tr>
<tr>
<td>CS</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Thus most foreign workers were being paid at or near the prevailing wage. Since that latter value is low, we see that most foreign workers are paid less than comparable Americans.

Here is a WR analysis by firm, for the firms with the most applications for green cards:

<table>
<thead>
<tr>
<th>group</th>
<th>median WR</th>
<th>&quot;% &lt; 1.05&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft</td>
<td>1.13</td>
<td>21.7%</td>
</tr>
<tr>
<td>Cisco</td>
<td>1.04</td>
<td>53.7%</td>
</tr>
<tr>
<td>Google</td>
<td>1.17</td>
<td>22.4%</td>
</tr>
<tr>
<td>Qualcomm</td>
<td>1.00</td>
<td>87.4%</td>
</tr>
<tr>
<td>Oracle</td>
<td>1.16</td>
<td>26.0%</td>
</tr>
<tr>
<td>Motorola</td>
<td>1.00</td>
<td>98.1%</td>
</tr>
<tr>
<td>Intel</td>
<td>1.10</td>
<td>38.2%</td>
</tr>
<tr>
<td>eBay</td>
<td>1.02</td>
<td>64.2%</td>
</tr>
<tr>
<td>HP</td>
<td>1.04</td>
<td>52.6%</td>
</tr>
</tbody>
</table>

Though some firms here do move away from the 1.00 level, none of the medians

¹⁴ Up through 2004, it was permissible to have WR as low as 0.95.
reaches 1.20, the conservative level we set earlier for the wage premium for experience in a specialized skill. All in fact are paying substantial proportions of their foreign workers at or near the prevailing wage, which is well below market. Actually, the median values should be much higher than 1.20 for Google, Microsoft and Intel, all firms with extremely rigorous interviewing procedures that result in hiring top talent. In a meeting with researchers, for example, Google stated that it hires only the top 0.1% of talent (CIIP, 2012). The average software engineer salary in California for even the top 10% has a WR value of approximately 1.53, and the value for the top 0.1% would be even larger than that. Yet the median WR at Google was only 1.17.

Once again, note that the PERM data involves the mainstream firms, not the ITSFs.

Analysis Based on Economic Principles: Nonmonetary Compensation

Foreign workers have a lower reservation wage in economics terms—they are willing to work for lower pay than what comparable Americans would earn, as they typically derive nonmonetary compensation special to them. U.S permanent resident status, i.e. a green card, is a form of highly-valued nonmonetary compensation for the foreign workers. If the employer is sponsoring the worker for a green card, the worker may work for less. And even those who do not stay permanently will have valuable American work experience when they return home.

These considerations result in a lowered reservation wage, so the foreign worker may earn less than his American peer even at the time of hire.

Even Mithas and Lucas, cited above as finding that the H-1Bs are paid slightly more than Americans, recognize this basic point:

Possession of a green card provides greater bargaining power...for an IT professional compared to someone with a[n H-1B] work visa because...employers typically hold work visas, which makes it difficult for an IT professional to easily change his or her employer...

And indeed the authors found that workers with green cards earned more than H-1Bs.

Analysis Based on Economic Principles: Limitation of Mobility

H-1Bs who are being sponsored for green cards are essentially immobile, unable to allow other employers to compete for her services. During the lengthy period of the green card process, often five years or more, the worker dare not switch to...
another employer, as it would entail starting the green card process again. Thus she will not have other employers offering her better deals (NRC, 2001) (Wadhwa, 2012), wages that equally-qualified Americans could obtain. Basic economic theory then implies that the foreign workers, not being free agents in the labor market, will on average not get the best salary deal. In other words, they will on average be paid less than comparable Americans.

These points were confirmed and quantified in (Mukhopadhyay, 2012). The authors compared immigrants to immigrants (in general, not just in STEM), a very direct approach. They found that “acquisition of an employer-sponsored green card leads to an [average] annual wage gain of about $11,860.” The lead author explained the cause of the deficit in a press interview (Wharton, 2012):

"Employers know they have these workers over a barrel," Mukhopadhyay said. "They aren't going to demand a raise during those six years, even if they deserve it, and they aren't going to move on to another company, because they know doing those things will jeopardize their chances of getting their green cards in time."

As noted, the Indian IT staffing firms only rarely sponsor their foreign workers for green cards, so the Mukhopadhyay analysis effectively excludes them.

Cheap Labor Issue: Type II
As seen above, employers do tend to pay H-1Bs lower wages than they pay comparable Americans. Since this is due largely to the mobility limitations discussed earlier, many well-meaning reformers have proposed as a remedy awarding automatic green cards to newly-graduated foreign students who earn STEM degrees at U.S. universities. This would reduce the period of de facto indentured servitude, thus ameliorating the Type I salary savings problem.

But this thinking overlooks the central issue, which is that Type II savings—hiring younger, thus cheaper foreign workers in lieu of older (age 35+), thus more expensive Americans—is a primary reason why employers hire foreign workers. As seen below, Type II is where the major cost savings occur, and as noted earlier, the H-1Bs tend to be markedly younger than their American colleagues. This makes the H-1Bs cheaper. The proposals for permanent resident status would be thus just as harmful to older American workers as is the H-1B work visa, because the vast majority of new foreign graduates are young.

To see the scale involved, consider a comparison of wage distributions among new computer graduates and all software engineers, as of 2005, shown below (Matloff, 2006).
Thus the potential for labor cost reduction via H-1B is even greater for Type II than for Type I.

The industry lobbyists acknowledge that the H-1Bs tend to be younger, but claim that that is because only new graduates have the latest skills, which older workers could acquire only after undergoing training. Yet there have been a number of instances in which U.S. firms such as Pfizer, Nielsen, Wachovia, and the Bank of America have reportedly laid off American tech workers, replacing them with foreign workers, and forcing the Americans to train their foreign replacements (Hira, 2010). Clearly it was the foreign workers that lacked the skill set, not the Americans.

The industry’s own lobbying report used to convince Congress to expand the H-1B program in 1998 (ITAA, 1997) unwittingly showed that the skills issue is merely a pretext to avoid hiring the older, i.e. more expensive workers. Allowing an American IT worker to acquire new skills makes him a flight risk:

“You take a $45,000 asset, spend some time and money training him, and suddenly he’s turned into an $80,000 asset,” says Mary Kay Cosmetics CIO Trey Bradley).

In other words, the real issue is not acquiring the skills, but that workers possessing the skills are more expensive. Obviously Bradley did not want to pay that higher price, and the ITAA message here is that the H-1B program provides a cheap alternative.

Former tech CEO (and current supporter of foreign worker programs) Vivek Wadhwa has spoken on this point, that skills is not the central issue, a number of times, saying for example,

...even if the [older] $120,000 programmer gets the right skills, companies would rather hire the younger [i.e. cheaper] workers. That’s really what’s behind this (Lehrer 2009).

Back in 1998 Congress, accepting the industry’s claim that older tech workers’ employment difficulties are due to lack of newer skills, added a user fee that employers of H-1Bs must pay, to go into a retraining fund. This failed to reduce H-1B usage (Vaas 2000), not surprising in light of the Wadhwa remark above--a
retrained expensive older programmer would still be an expensive older programmer.

The skills issue is treated in detail in (Matloff, 2003; Matloff, 2006).

**De Facto Indentured Servitude of the Foreign Workers**

As pointed out earlier, the H-Bs are often *de facto* indentured servants, especially if they are being sponsored for green cards. A point that seldom arises in the foreign worker debate is that *many employers exploit the immobility of the workers.* Indeed, for many firms, the immobility is even more attractive than the cheap-labor aspect (though often the two aspects are related).

The *de facto* indentured servitude of the H-1Bs is of tremendous value to many employers in Silicon Valley. If a worker leaves his employer is in the middle of a big, urgent project, the employer loses plenty.

Such exploitation is pitched by immigration attorneys to employers as an attraction of green card sponsorship. For example, lawyer David Swaim, whose online biography notes that he "created the immigration procedures at dozens of companies such as Texas Instruments..." (Swaim, 2012a), advises employers that the "handcuffed" nature of green card sponsees is a huge win for the employer:

> By far the most important advantage of [green card sponsorship] is the fact that the employee is tied to a particular position with one company and must remain with the company in most cases for more than four years...(Swaim, 2012b).

That "most important advantage" puts American job applicants at a substantial disadvantage. The employer has a big incentive to hire a foreign worker in lieu of a similar American.

**Impact of Tech Immigration on the U.S.**

All parties in the foreign tech worker debate, including me, agree that the nation benefits greatly from the immigration of "the best and the brightest.” These workers are extraordinarily productive and creative, making outsized contributions. The immigration of such outstanding talents should be
encouraged and facilitated.\textsuperscript{16} However, as shown earlier, the high tech immigrants are not typically of this caliber.

Thus the foreign worker programs are directly and indirectly displacing Americans. In other words, these programs are causing an \textit{internal brain drain} from technology fields in the U.S.

The impact is particularly acute on those who are older—which in the tech field, means over age 35. Employers prefer to hire the younger, thus cheaper, H-1Bs instead of the older, thus more expensive, Americans. Microsoft admits that “the vast majority of Microsoft hires are young, but that is because older workers tend to go into more senior jobs and there are fewer of those positions to begin with” (emphasis added) (Wadhwa 2008). A Network World article (Bednarz, 2012) reports that "corporate hiring managers most frequently say IT pros with two to five years in the workforce, followed by those with six to 10 years [of] experience." Two to ten years of experience typically corresponds to ages 24 through 35.

The adverse impact of the foreign influx on American engineers was cited explicitly by a Berkeley research team (emphasis added):

\textit{...high-tech engineers and managers have experienced lower wage growth than their counterparts nationally... Why hasn’t the growth of high-tech wages kept up?...Foreign students are an important part of the story...Approximately one-half of engineering PhDs and one-third of engineering MSs were granted to foreign-born students in the mid-1990s (Brown 1998; Brown 2009).}

Why are such large proportions of U.S. STEM postgraduate degrees earned by international students? The influx from abroad has hindered salary growth at that level, hence making pursuit of graduate degrees unattractive to U.S. students. This displacement of Americans at the PhD level was actually projected by the Policy Research and Analysis division of the National Science Foundation (Weinstein 1998).

Note carefully that the PRA projected that the resulting stagnant salaries for PhDs would drive the American students away:

\textit{A growing influx of foreign PhDs into U.S. labor markets will hold down the level of PhD salaries...[The Americans] will select alternative career paths...by choosing to acquire a "professional" degree in business or law, or by switching into management as rapidly as possible after gaining employment in private industry...[as] the effective premium for

\textsuperscript{16} I have proposed that any foreign national with a legitimate job offer at a salary above the 90th percentile for his occupation (and region, education etc.) be granted an automatic, quick green card.
acquiring a PhD may actually be negative.

The PERM data indicate that Microsoft pays its financial analysts and lawyers much more than it pays its engineers. Young people see these market signals and respond accordingly. Anthony Carnevale of Georgetown University has pointed out, "If you're a high math student in America, from a purely economic point of view, it's crazy to go into STEM" (Light, 2012).

Though my focus here has been on CS/EE, an even starker illustration of the problem was seen in a 2012 report to the National Institutes of Health, the main U.S. government funder of research in the life sciences (NIH, 2012). It was found that those hoping for a research career must undergo years of low-paid post doctoral work, during which time they have no idea as to whether they will ultimately be able to secure a career in the field. The report found this to be due to a huge surplus of labor, and it specifically cited the large number of foreign workers (about 60% of all post docs) as a major contributor to the problem. The report also stated that a result is the loss of many of the nation's top talents from STEM research--the internal brain drain.

The internal brain drain is perhaps the most acute of the negative impacts of current policy, from a national interest point of view.

References
Cooper, 2011. Testimony of Bo Cooper, partner, Berry, Appleman and Leiden, to the House Immigration Subcommittee, March 31, 2011.


