

Immigration and the tech industry: As a labour 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--remediating labour shortages and hiring "the best and the brightest"--are investigated, using data on wages, patents, R&D work, as well as previous research and industry statements. The analysis shows that the claims of shortage and outstanding talent are not supported by the data, even after excluding the Indian IT service firms. Instead, it is shown that the primary goals of employers in hiring foreign workers are to reduce labour costs and to obtain "indentured" employees. Current immigration policy is causing an 'Internal Brain Drain' in STEM.

Keywords: H-1B, green card, prevailing wage, best and brightest

Introduction

An irony in the U.S. immigration debate is that most of the discussion concerns opposite ends of the labour market spectrum. On one end are the unauthorized immigrants, typically low-skilled and with very limited education. On the other end are engineers, scientists and the like, with at least bachelor's degrees and often postgraduate degrees, hired by the tech industry and sponsored for H-1B work visas.

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

Neither of these claims will be confirmed here. Focusing on the former foreign students now working in the US--exactly the group extolled by the industry as "the best and the brightest"--I find that relative to comparable US natives, the immigrants tend to earn less, submit fewer patent applications and be less likely to be working in R&D positions. This leaves cheap, immobile labour as the remaining explanatory factor for the popularity of the H-1B program among employers, and this will be demonstrated.

A point rarely mentioned in the H-1B debate is the exploitation of the *de facto* indentured servitude of those being sponsored by employers for green cards (US permanent residency). Though any H-1B worker has the legal right to switch employers, this is unthinkable for most H-1Bs waiting for green cards (NRC, 2001, Swaim, 2012). The foreign worker is thus often immobile,

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a highly attractive condition for employers, who fear being left in the lurch in the midst of an urgent project. This means that many tech employers much prefer to hire foreign workers over similarly-qualified Americans.¹

It should be noted that the usage of the foreign workers as cheap labour is in most cases fully legal. Major legal loopholes enable the underpayment of foreign workers relative to comparable Americans.

The impacts on American tech workers have been suppressed wage growth, reduced job opportunities, 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 the computer science (CS) and electrical engineering (EE) fields, as these form the bulk of the foreign STEM workers. The primary data sets used are from the US government: the 2003 National Survey of College Graduates (NSCG), and PERM, consisting of employer-sponsored green card applications.

My analysis essentially excludes workers in the Indian/Indian-American IT staffing firms (ITSFs) that hire H-1Bs and rent them to other companies. It is common among analysts of the H-1B workforce to refer to the market as *segmented*, making the assumption that the mainstream US firms use the H-1B visa properly while the Indian firms abuse it. This view is incorrect.

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 violating 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. Moreover, the mainstream firms also abuse the green card process, making them actually worse than the ITSFs.

My data sets here essentially exclude the ITSFs. With the NSCG data I limit the analysis to those who entered the US as foreign students, which is almost never the case for ITSF workers. The PERM data involve green cards, and the Indian IT staffing firms almost never sponsor their foreign workers for green cards (Hira, 2010). Thus this paper's conclusions -that the H-1B and green card programs are widely abused for cheap, immobile labour-apply to the mainstream firms.

In general, the H-1Bs are much younger than their co-workers, in their 20s or early 30s. The NSCG data indicate a mode of about 29 for the H-1Bs, versus about 42 for the American tech workers (See also GAO, 2011, Figure 16).

The computer-related workers—that is, software developers, database ad-

¹ In this article I generally use *American* to mean US citizens and permanent residents, but will restrict the term to natives in my analyses of the NSCG wage data.

ministrators 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.

Lack of indicators of a shortage

Starting with its first big campaign to convince Congress to expand the H-1B in 1997, the tech industry has asserted a tech labour shortage. Yet, other than one survey conducted by the industry trade group ITAA (ITAA, 1997), no study has ever confirmed the shortage claims (See Matloff, 2003 for a survey of the studies conducted around that time).

Vivek Wadhwa, a former tech CEO who now writes about the tech industry, conducted his own survey and found no evidence of a shortage. He 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% during 2009-2010 (Dice, 2011). Costa (2012) found that wages in computer and mathematical occupations have been increasing only 0.5% per year since 2000. 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 are 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, with 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 (Lerman, 1998). Here is an analysis of software engineers from the NSCG data, broken down by broad major categories:

Table 1. Major field, software engineers

Computer science	40.20%
Bio science	2.30%
Physical science	3.60%
Social science	4.80%
Engineering	21.90%
Health science	5.60%
Business	21.50%

Source: National Survey of College Graduates, 2003.

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 an extensive study 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). She 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. TI does claim a pipeline shortage at the postgraduate level, though, a claim I will discuss in the next section.²

Claims of a pipeline shortage: PhD level

Advocates of expansive foreign tech worker programs often cite the fact that 50% or more of CS/EE doctoral degrees at US universities are awarded to foreign students (Wildavsky, 2010).³ However, one cannot conclude that there is a shortage of American doctoral students in these fields. On the contrary, there are strong indications of *overproduction* of PhDs.

These concerns began back in the mid-1990s, triggered by a Stanford study (Massy, 1995), and 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 severe problems these graduates were having finding jobs (SRI, 2010). Since CS had never been a field in which post doc work was common (CRA, 2011), 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. Yet the situation for CS PhDs is still not good. 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

² 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.

³ The numbers at the undergraduate level are much smaller. For example, 7.0% of the bachelor's degrees in 2010-2011 were awarded to foreign students (Zweben, 2012, Table 5).

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 "matured" job market for CS PhDs will be permanently tough.

A 2012 by the government National Science Foundation found a similarly grim situation for engineering in general, as summarized in (Benderly, 2012): "Long recognized as a form of disguised unemployment, postdocs were now the first post-degree positions for 41% of new Ph.D. engineers, more than doubling from 18.9% a decade before."

The best and the brightest?

I now turn to a question that arises frequently in discussions of H-1B: Do the H-1Bs, especially those who first came to the US as international students, tend to be "the best and the brightest," key to America's ability to innovate? I assess this via regression analyses on salary, patenting activity and work in research and development (R&D).⁴

In the three regression analyses, I look at the 2003 NSCG data, restricting to the following groups. I cover every full-time, non-managerial, non-sales worker whose highest degree is in CS/EE and who was working in the field at the time. I restrict attention to US natives and those who originally entered the U.S. on a foreign student visa. In addition, to avoid complications involving the wage exploitation of H-1Bs, in the case of my salary analyses I imposed an additional condition on the foreign-born: Was a US citizen (naturalized) or permanent resident as of 2003.

Wage analysis

I ran a regression analysis of wage against 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 US, 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.⁵

The regression equation was

mean wage =

$$\beta_0 + \beta_1 \text{ age} + \beta_2 \text{ age}^2 + \beta_3 \text{ MS} + \beta_4 \text{ PhD} + \beta_5 \text{ highCOL} + \beta_6 \text{ origF1} + \beta_7 \text{ acad} + \beta_8 \text{ gov}$$

⁴ See Matloff (2013), where I also investigate selectivity of graduate institution, finding that the average ranking of the doctoral institutions of the foreign students in computer science is lower than that of the Americans. See similar results for the sciences in (Bound *et al.*, 2006:77).

⁵ Those with just a bachelor's degree are indicated by the presence of 0 values in the master's and PhD variables.

Table 2. Wage regression analysis

	Computer Science	Electrical Engineering
Constant	-18,731	-12,320
	35,518	31,148
Age	1,725	3,633
	(1,725)	1,425
Age squared	-47	-34
	20	16
Master's	6,703	10,338
	4,061	4,184
PhD	28,246	22,671
	8,872	7,017
Former foreign student (F-1)	-5,278	685
	4,895	5,213
High Cost-of-living	9,543	6,543
	3,550	3,661
Academic	-29,901	-18,721
	10,194	12,790
Government	-16,047	-1,262
	6,999	6,267

Note: 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.

216

correction: first 1725 should be 4389

The estimated coefficient for the former foreign students, -5278.43, is negative and statistically significant. Thus, the former foreign students working in CS are earning significantly less than the Americans of the same age, education and so on. In the EE case, the coefficient for former foreign student status was not significantly different from 0.

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 for the wage difference found in the CS case above.

The tech industry is famously meritocratic for non-management 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.

Tang (2000) found that language skills were not a barrier to Asian immigrant engineers relative to Caucasian immigrants, even for those who wished to obtain academic positions (p.96). She also cited evidence that the group of interest here, those who first come to the US as foreign students, attain sufficient proficiency in English during their years as students in American schools (p.64).

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 US professors with language skills greatly exceeding those of American native students.⁶

Patent activity

There have been a number of recent studies on immigrant patenting in the tech area, notably 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."⁷

None of these studies addresses the central question here, which is whether the immigrant tech workers are more prone to patenting on a *per capita* basis, 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 and 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.⁸

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. In the following I make those restrictions, but no longer restrict to U.S. citizens and permanent residents. I remove those in academia and government, where patenting rates are lower. Here is the regression analysis, expressing mean number of patent applications filed in terms of age, education and original F-1 status:

⁶ Hunt herself, in a more recent paper that investigates the language issue more directly, also finds that language has little impact on non-management tech workers (Hunt, 2012).

⁷ Some of these studies also find an association between foreign-worker patents and American-worker ones.

⁸ Hunt (2009) was a working paper. The final published version (Hunt, 2011) excludes H-1Bs and others holding work visas.

Table 3. Patent rates

	Computer Science	Electrical engineering
Constant	0.18 0.60	0.57 0.91
Age	0.00 0.01	0.00 0.20
Master's	0.44 0.28	0.20 0.47
PhD	2.90 0.61	2.98 0.76
Former foreign student	-0.44 0.32	-0.05 0.56

The coefficient for original foreign student status in the CS case, -0.44, is significant at the 5% level. On the other hand, in EE the former foreign students' patenting activity is not significantly different from the Americans. In other words, 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.

Research and development work

Much (though by no means all) of the innovation in the tech industry comes from those working in research and development (R&D) positions. I thus investigated the proportions of US versus immigrant workers who hold such jobs. Here I used a logistic regression model for the probability of working in R&D, with the following results:

Table 4. Rates of research and development work

	Computer science	Electrical engineering
constant	1.03 -2.72	8.14 6.12
Age	0.02 0.13	-0.27 0.29
Age2	0.00 0.00	0.00 0.00
Master's	0.46 0.33	1.14 0.79
PhD	2.32 1.23	2.17 1.58
Former F-1	-0.66 0.37	-1.36 0.77

The former foreign students in CS are significantly less likely to be working in R&D than the Americans. In the EE case, 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 labour: Overview

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).

Cheap labour issue: Type I

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

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

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

219

A number of studies have addressed the Type I wage savings issue, with mixed results. Work finding that the H-1Bs are underpaid includes Matloff (2003), Hunt (2009) and NRC (2001: 175).⁹ This is countered by, for example, Mithas (2010) and Lofstrom (2012), both of which found that the H-1Bs are paid at least as much as comparable Americans, or even slightly more. The key word here is *comparable*. Mithas (2010) is problematic in that it relied on data involving foreign workers who were outside the mainstream, in that they tended to be managers and/or of older ages. Lofstrom (2012) did not account for special technical skill sets, which command a premium wage in the open market; such data is not available, but lack of it produces a bias favouring the foreign workers. My analysis below will have this point as motivation.

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 workers in a given job, in a given locale

⁹ NRC raised the question as to whether their survey, conducted by Hal Salzman, had been "representative." However, Salzman states, "we covered everyone--most names you'd recognize and covered most all segments that I can think of" (Salzman, 2012).

and having a given level of experience.¹⁰ A key point is that the legal prevailing wage does not take into account special technical skills or other special qualifications, and is thus typically well below what the given worker's qualifications would command in the open market. This enables employers to legally underpay the foreign workers.

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). For instance, a 2011 job ad for Meebo required experience in JavaScript, and 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 (Table 5) (See Matloff, 2003, Drapier, 2011, Darrow, 2012, McKendrick, 2011). Yet these premiums are not factored into the legal prevailing wage, rendering the latter typically being below market wage.

Table 5. Salary premiums

skill	premium	year
various	16-24%	1998
SOA	37.00%	2010
iPhone/Android	20.00%	2011
Ruby	up to 70%	2011
cloud	25.00%	2012

If, say, experience with Android programming 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. Moreover, the Department of Labor (DOL) does not include skill sets in its Online Wage Library (OWL), used by most employers to determine prevailing wage.

This 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, so again, the employer can hire, say, a foreign Android programmer for the price of a generic programmer.

The same applies to 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, so the employer of the foreign worker can get a special-value worker for the price of an average one. The foreign worker's salary is then less than what the employer would

¹⁰ The employer is required to pay the higher of the prevailing wage and the *actual wage*. The latter is defined to be the mean salary the employer pays other similar workers. The legal requirements for actual wage have many loopholes, but it won't be relevant to the analysis here, which will show that most employers pay many of their foreign workers at or near the prevailing wage.

need to pay a similar special-value American.

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 queried the DOL, finding that the average wage for computer systems analysts in her district was \$92,000, while the legal prevailing wage was \$52,000 (Thibodeau, 2011).

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

Analysis based on the below-market nature of the prevailing wage

The above points regarding the legal prevailing wage requirement show that employers can legally under pay their foreign workers; the question then is whether many of them actually do so. The answer will be that in fact the vast majority of foreign workers are underpaid.

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), the ratio of salary to 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. Table 6 presents the WR values for software engineers, electrical engineers and computer scientists.

Table 6. Overall WR values

job title	median WR
SE	1.00
EE	1.00
CS	1.05

Table 7. WR values, by firm

firm	median WR	% < 1.05
Microsoft	1.13	21.7%
Cisco	1.04	53.7%
Google	1.17	22.4%
Qualcomm	1.00	87.4%
Oracle	1.16	26.0%
Motorola	1.00	98.1%
Intel	1.10	38.2%
eBay	1.02	64.2%
HP	1.04	52.6%

We see that most foreign workers were being paid at or near the prevailing

wage. Since that latter value is below market wage, we see that most foreign workers are paid less than comparable Americans. Table 7 presents a WR analysis by firm, for the firms with the most applications for green cards.

Though some firms here do move away from the 1.00 level, none of the medians reaches 1.20, the conservative level we set earlier for experience in a specialized skill. All in fact are paying substantial proportions of their foreign workers at or near the prevailing wage, thus well below market. 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.

US 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. 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 their 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 labour 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 bar-

rel," 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 labour 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 US universities. This would reduce the period of *de facto* indentured servitude, thus ameliorating the Type I salary savings problem.

But this 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, making 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 in Table 8 (Matloff, 2006).

Table 8. Wage premium, experienced workers

group	25 th percentile	median	90 th percentile
new grads	\$45,000	\$50,664	\$61,500
all workers	\$65,070	\$82,120	\$120,410

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. Matloff (2003) presents extensive evidence to the contrary. 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 a number of times on this point, that skills is not the central issue, 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).

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 are eager to exploit the immobility of the workers*. Indeed, for many firms, *the immobility is even more attractive than the cheap-labour aspect* (though often the two aspects are related).

Such exploitation is pitched by immigration attorneys to employers. For example, lawyer David Swaim advises employers that the "handcuffed" nature of green card sponsors 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, 2012:3).

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 similarly-qualified American.

224

Impact of tech immigration on the US

The foreign worker programs are causing an internal brain drain from technology fields in the US. The impact is particularly acute on those who are older—which in this H-1B era for 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 "Asked for experience preference, corporate hiring managers most frequently say IT pros with two to five years in the workforce, followed by those with six to 10 years' experience."

The nexus of this to the influx of foreign workers, especially the former foreign students, was cited explicitly by a Berkeley research team (Brown *et al* 1998; emphasis added): "...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".

Later related work (Brown and Linden 2009) showed that the lifetime earnings premium from an advanced degree is negative for natives (due to lost

income while in graduate school) but positive for the immigrants (due to access to the US labour market), thus providing a disincentive for the natives to pursue graduate work (pp.131-132). As the authors point out, "...most [semiconductor companies] want to hire only MS (or PhD) engineers for design...and of course the companies would prefer that the graduate premiums stay low" (p.121). This preference is then satisfied by hiring large numbers of foreign engineers.

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 US students. This displacement of Americans at the PhD level was actually projected (if not planned for) by the Policy Research and Analysis division of the National Science Foundation: "A growing influx of foreign PhDs into US labour 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 acquiring a PhD may actually be negative" (Weinstein, 1998)

The PERM data indicate that Microsoft pays its entry-level 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, 2011).

Kerr (2013) aimed to quantify the impact of foreign STEM workers on Americans. They found that "A one SD [standard deviation] increase in abnormally high immigrant hiring [by a firm] at the time of a STEM worker's departure is associated with a 0.16... decline in log annualized wage." This amounts to a 17% drop in original wage.

Though my focus here has been on CS/EE, one should note the 2012 report by the US government National Institutes of Health (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 labour, 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.

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