Senator Chuck Grassley
Questions for the Record
U.S. Senate Committee on the Judiciary
"Immigration Reforms Needed to Protect Skilled American Workers"

6. TO PROFESSOR HAL SALZMAN [NB: The first 1-2 paragraphs of each response provide the summary/overview, with additional detail and data following]

    - **April 1 is the opening day of the Fiscal Year 2016 H-1B filing season. Many believe that all 85,000 cap-subject H-1B visa slots will be allocated within days of the opening day of the H-1B filing season and that such demand for H-1B visa numbers means that the U.S. suffers from a shortage of tech workers able to fill those jobs. During the hearing you remarked that this phenomenon does not indicate a shortage of U.S. workers for those jobs so much as a shortage of *discounted* labor. Could you please expand on your answer?**

For the IT industry, the evidence is overwhelming that the H-1B program provides labor at a lower cost than companies would have to pay if hiring domestically. Matloff has shown H-1B workers earn less; my early research for the National Research Council (in 1999/2000) found firms were using the H-1B to lower labor costs (both directly and by the "chilling effect" on current workers who saw that H-1B labor supply could be increased (via Congress) to levels that allowed them to be replaced; and our current analysis finds that in IT occupations, the average H-1B wage is lower than the U.S. worker wage in the same occupations (see table below). Perhaps most compellingly, firms state this quite directly (see Testimony, p.13ff for full quotes and citations)—in 10-K and 20-F statements, firms state that if they are unable to obtain sufficient H-1B visas, the effect will be: *"...to replace existing offshore resources with local resources*, or hire additional local resources, potentially *at higher wages*."… "…cost of doing business would increase"….

Interestingly, none of the companies state that they would not be able to find a sufficient number of U.S. workers, just that it would increase costs.

The evidence suggests that the primary use of H-1B program is by offshoring companies and they would be limited in conducting work offshore without sufficient numbers of H-1B workers because of increased costs; the second use of H-1B and other guestworkers is for lower cost labor onshore. Both of these uses have the combined impact of constraining U.S. IT wages; as all studies have shown (even the Brookings study; see below), IT wages have stagnated since the dot-com bust, at about late 1990s levels. Thus the supply of H-1B workers is a direct need for offshore work and lower cost labor, and an additional effect of having a large supply of young, entry-level and early-career workers to replace domestic workers, older workers, and generally signal that positions can be easily filled and, through this labor market distortion, hold down average wages (i.e., by paying lower wages, replacing exiting workers directly and through moving the work offshore, and by replacing older workers with younger workers).

Table 1: U.S. and H-1B wages and workforce

	% Masters	Annual Average Salary	Number of Workers		
Domestic Workforce					
Computer scientists and systems analysts	25%	$79,895	234,239		
Computer programmers	21%	$79,185	225,292		
Average (combined occupations)	23%	$79,547	459,531		
H-1B workforce			**1st & 3rd Year Approvals**	**Estimated 6 Year Population**	**Est. Percent of Domestic IT Workforce**
Computer Sci/Systems Analyst & Programmers (combined)	45%	$75,873	78,113	195,283	42.5%

Source: DHS H-1B data; calculations by authors (Lowell and Salzman, forthcoming).

- **According to a 2012 publication by the U.S. Chamber of Commerce, the unemployment rate among petroleum engineers is 0.1 percent. Is the appropriate response to a low unemployment rate in a particular STEM field necessarily to increase levels of H-1B visas?**

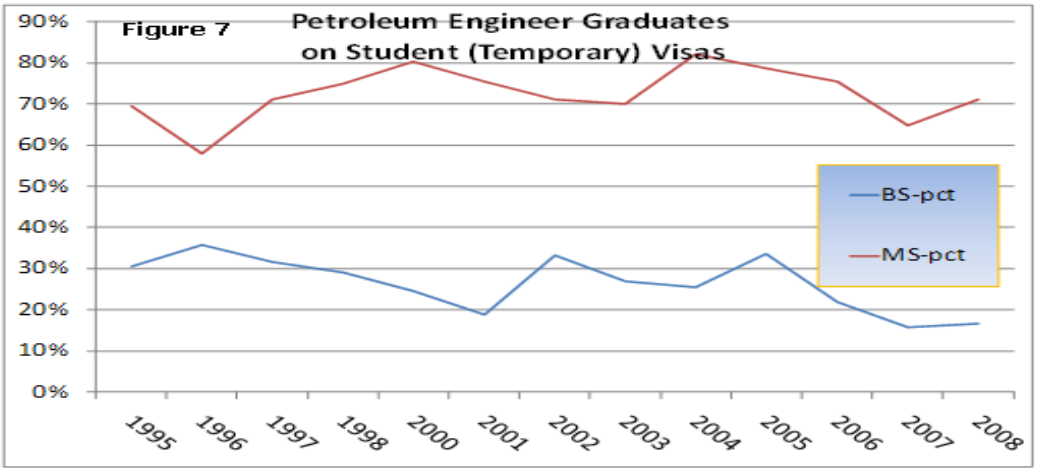
The case of petroleum engineers is, in fact, a case that shows effective market functioning and how it can adjust *without* a guestworker program; the case of petroleum engineers, showing the overwhelming response to increased salaries by U.S. students, suggests that the H-1B program is undermining the normal, and effective market functioning in other areas (where stated demand by employers has not led to wage increase but, instead, worsening job conditions –declines in salary, career stability, full time employment). Detail and analysis of petroleum engineers, below, is excerpted from our forthcoming book chapter, "Dynamics of Engineering Labor Markets: Petroleum Engineering Demand and Responsive Supply" (Lynn, Salzman, Kuehn, 2015).[1] Again, the "lessons learned" from the recent history of petroleum engineering demand is that wage increases lead to immediate and large increases in the supply of workers/college graduates without the need to supplement the workforce with guestworkers. In fact, the domestic student response—to enter petroleum engineering—has been so strong that many petroleum engineering programs are now concerned about a glut of graduates (see below).

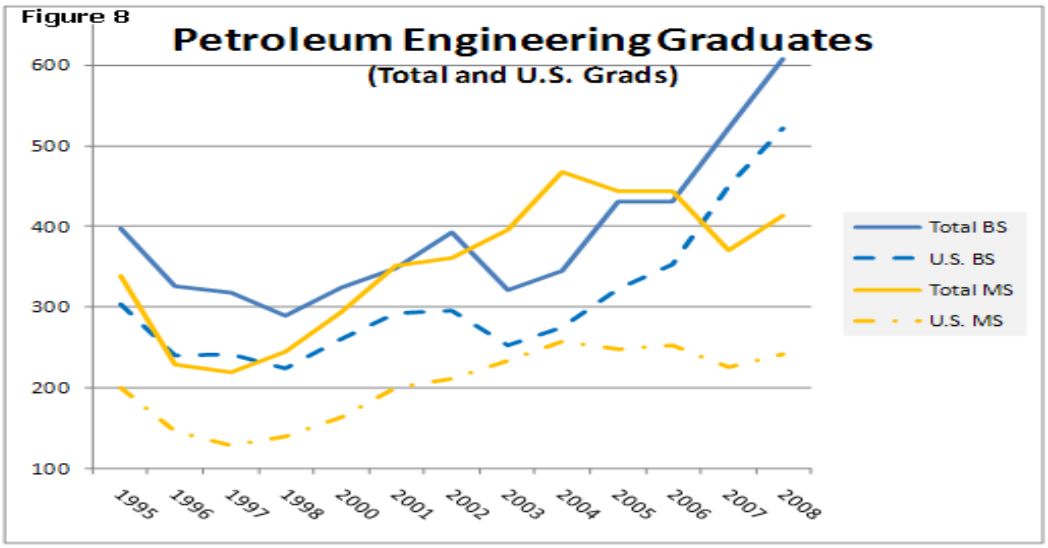
The increased hiring demand for petroleum engineers resulted from the confluence of several factors: (1) the "great crew change" of an older workforce reaching retirement age, and an industry in which there had not been much hiring for decades—a workforce where half of all geophysicists and engineers are expected to retire by 2018; (2) sharp increase in oil prices that made previously uneconomical exploration now profitable and thus additional engineers needed to explore and develop those oil fields; (3) technological advances that made previously inaccessible or uneconomical oil feasible to extract (e.g., tar sands).

In response to this and other market signals the number of new petroleum engineering degrees awarded by U.S. universities more than tripled (Rubin, 2010). In just the period from 2007-2008 to 2010-2011, U.S. university petroleum engineering departments increased the number of bachelor of science graduates from 444 to 891 and the number of doctoral graduates from 39 to 95. Texas A&M and Colorado School of Mines more than tripled their output of new graduates from 42 to 128 and 32 to 100, respectively. Reports from some petroleum engineering programs indicate an even greater increase in demand in subsequent years (TTU, 2010). As shown in the figures below (labeled Figures 7&8), the dramatic increase in petroleum engineering followed the steep rise in starting salaries, which in turn reflected an observable increase in industry demand. This would seem to be a clear textbook case of efficient and responsive market functioning. It suggests that normal market mechanisms, namely wage increases, can dramatically and quickly increase supply.

[1] *Forthcoming in*: in Freeman, R. and H. Salzman (eds.) *Engineering in a Global Economy* (forthcoming, 2015) NBER and University of Chicago Press.

Importantly, the increase in supply came from the domestic pool of students and not from foreign students (which declined as a share of the total number of graduates).





The following "Industry Alert" from the Society of Petroleum Engineers in 2010 summarizes some key trends [emphasis added]:

> Environmental and remediation companies of all sizes have a real opportunity to take steps in 2010 to address that shortage of engineering talent expected in the next decade, especially in the United States and Europe….*An increase in the number of graduates in petroleum engineering programs is creating* ***the largest pool in 20 years of young engineers*** *seeking entry into the oil and gas industry.*

Interestingly, this industry newsletter called on companies to continue hiring (in anticipation of future retirements and growth) even if they were meeting their immediate employment needs because "Scaling back on new graduate recruiting in 2010 could lead to a permanent loss of this talent from the industry, and chill the interest of future engineering students in pursuing careers in the oil and gas industry."

This strongly suggests that even in a peak demand year there was no serious shortage in the availability of new petroleum engineering graduates and that, indeed, there was some concern of future generations being turned away from the field if companies did not proactively hire more new graduates than were immediately needed.

The potential downside of large increases in the supply of engineers is suggested in a guest editorial written by the current department chair and a former department chair of the Petroleum Engineering Department at Texas A&M University. These authors note:

> Between fall 2011 and fall 2012, the number of freshmen in petroleum engineering programs in the United States grew from 1,388 to 2,153, a 55 percent increase in one year. The enrollment pressure we are experiencing at Texas A&M suggests that there will be another increase in freshman enrollment in 2013. We are rapidly heading toward having more than 2,000 bachelor of science degree petroleum engineering graduates per year in the United States. So far, essentially all of our graduates have been receiving job offers, *but there is concern that the job market may not grow as fast as enrollment and graduation rates.*

These authors note similarities with an earlier ramping up of the number of petroleum engineering students in the 1980s . They fear a potential collapse of the job market and suggest that more universities should manage "the unbounded growth in enrollment that is currently occurring." They note that the two departments that have historically been the largest in the United States, Texas A&M University and University of Texas at Austin, have indeed controlled their growth, but other departments have not, and have passed the two Texas schools in size of enrollments.

So is there an impending crisis demanding special measures to increase the number of graduating engineers in petroleum engineering? Employers continue to voice alarm, but some suggest that in the past such warnings were overstated. What then, does the case of petroleum engineers suggest about other fields of engineering? First, in petroleum engineering there seemed to be no serious difficulty in getting qualified students once students had a strong incentive to enter this field of engineering. The three chairs of leading petroleum engineering departments who responded to an e-mail survey sent out in March 2015 (surveys were sent to 10) indicated they had experienced no difficulty in recruiting students. Second, while the department chairs who responded to our survey complained of difficulties in recruiting as many qualified faculty as they would have liked, they were able to meet the increases in demand for qualified students, with no lowering of standards. U.S. universities seem to have been remarkably flexible. Indeed, two of the three department chairs expressed concern that universities had overbuilt their capacity in petroleum engineering, saying this was already happening. The other chair expressed confidence that the demand for petroleum engineers would continue growing so the increased capacity would be needed. Third, it is not clear nonmarket signals such as projections of demand by experts (U.S. Department of

Labor) or industry spokespeople (who may, after all, have a vested interest in talking up prospects for demand), have done any better in their predictions than the market.

As oil prices sharply declined in 2014 and early 2015 there were increasing reports of job cuts, either those that had already occurred or those that were feared. In February 2015 Reuters stated that more than 100,000 layoffs worldwide had been reported in the oil industry. Halliburton had announced cuts of 8 percent of its global workforce and Schlumberger was planning to eliminate 7 percent of its workforce (Kemp 2015). Bloomberg (Shauk 2015) reported concerns of new petroleum engineering graduates about their job prospects commenting, "Six months ago, a degree in petroleum engineering was a ticket to a job with a six-figure salary. Now it's looking like a path to the unemployment office." The director of undergraduate advising for Texas A&M's Petroleum Engineering Department indicated that student were expressing "definite concern" about the job market.

- **According to the testimony provided by Mr. Johnson, the unemployment rates for some STEM occupations appear low. Do low unemployment rates indicate full employment in these fields?**

The unemployment rates are misleading because they do not indicate whether they are employed in their field (for those who sought employment in their field), or just employed in any job; further, the statistics cited often do not indicate whether they are employed full time or whether part time and/or contingent (contract, temporary) employment. All one can conclude is that STEM graduates are able to find some type of employment more successfully than the 83% of college graduates who are not STEM graduates, and more successful than the 90-92% of the overall workforce who are not STEM graduates. Moreover, at the highest levels of science, Ph.D. level scientists, employment prospects are very dismal, to the extent that the National Institutes of Health finds science careers have become "unattractive." [2] One news report finds: "A new report issued by the National Academy of Sciences and other groups recommend that universities and other institutions address it by reducing the number of postdocs they produce…The document also calls on universities to tell their graduate students about the state of the job market and help them train for, and enter, alternative careers in such areas as science writing, science policy and consulting."

The Federal Reserve of NY analyzed recent college graduate employment (for those with a four-year degree, ages 22-27) and found the employment status noted in the figure below, by degree field. Of recent engineering graduates, for example, 20 percent were in a job that did not require a bachelor's degree; the 75 percent employed in a job that required a bachelor's degree but they did not analyze whether it was an engineering job; for math and computers, 22% were in a job not requiring a bachelor's degree; in the sciences, 43% were in a job not requiring a bachelor's degree. Further analysis shows those who are "underemployed" working part time.

Another analysis that I conducted with colleagues was of one cohort of recent graduates in which they were asked whether they were employed in their field of study (this was restricted to just those employed). Figure below (and in my written testimony). Our analysis of a large, nationally representative survey of a recent college cohort by the National Center for Educational Statistics finds that only two-thirds of computer science graduates went into IT jobs in 2009 (that would include all IT jobs, not just those for formally defined "computer occupations"). Of those not landing an IT job, half said they found a better job elsewhere. Fully one-third reported there were no IT jobs available (although this was the year

[2] One recent news report says: "Despite all the seeming demand for experts in the sciences, cuts in research spending and belt-tightening at universities mean that only one in five Ph.D.s in science, engineering and health end up with faculty teaching or research positions within five years of completing their degrees, according to the National Science Foundation. …In the case of biology Ph.D.s like McDowell, only 1 in 10 will snag an academic job. Many of the rest are drifting into other fields. And critics say the squeeze may be affecting the quality of scientific research and the nation's international economic competitiveness….Biomedical postdocs — according to the National Institutes of Health, there may be as many as 68,000 of them — are clogging a job market that almost certainly can't absorb them all."
http://www.npr.org/blogs/ed/2015/02/27/388443923/a-glut-of-ph-d-s-means-long-odds-of-getting-jobs

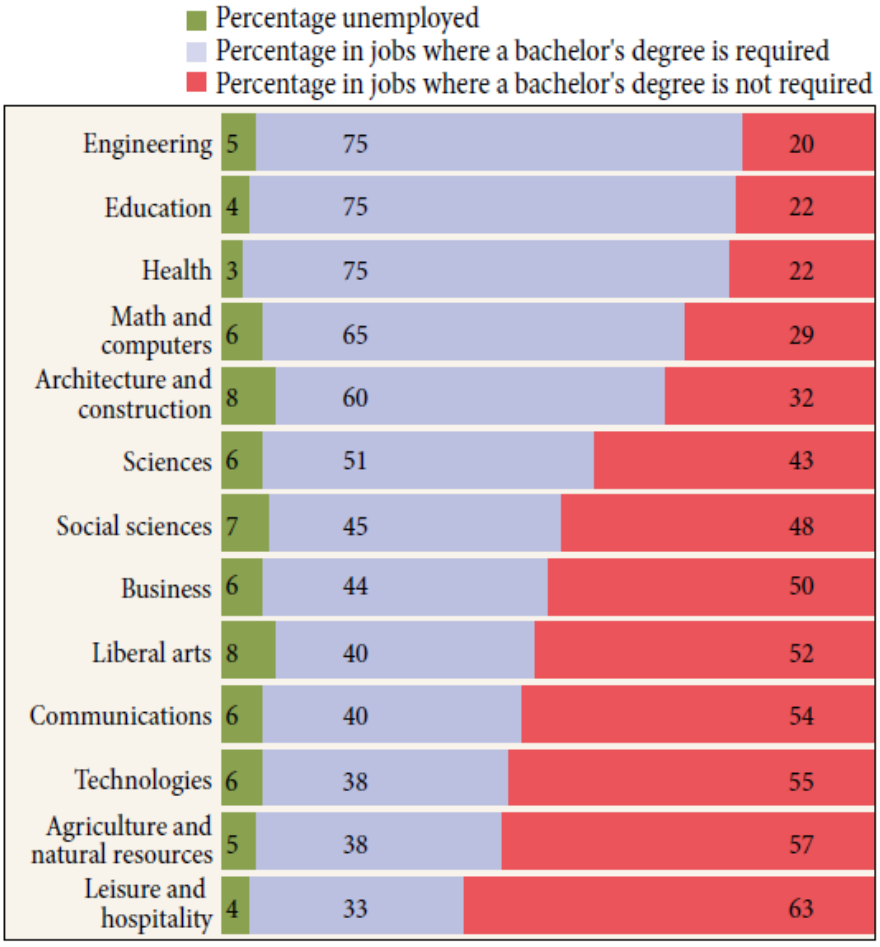
after the start of the Great Recession, this is only slightly lower than the historical trend; Salzman, et al., 2013).

What these analyses suggest is that those who get a STEM degree do better in the job market than those who do not have STEM degrees, but does not indicate anything whatsoever about demand for STEM workers by the STEM industries. Further, and importantly, the selectivity of STEM degree holders further limits any inferences about STEM worker demand. STEM graduates are approximately 17% of current college graduates and have a more demanding program of study than many other fields. Comparisons of a selective group of 17% of the college graduate population could just reflect that selectivity rather than characteristics of a STEM degree, per se.

In the workforce, STEM workers are approximately 5% to 8% of the workforce and comparisons of this select group, mostly college educated, with the other 95% of the workforce (which includes Wal-mart and other low-paid workers), of whom approximately only 35% have a college degree, overwhelmingly reflects selectivity.

Chart 7

Employment Outcomes for Recent College Graduates by Major, 2009-11



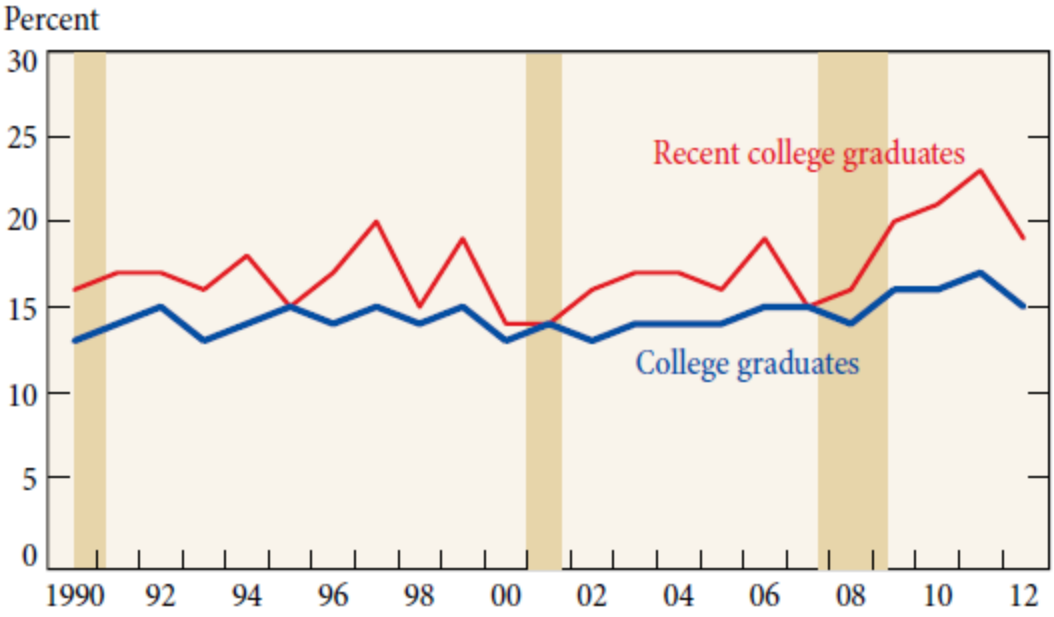
Sources: U.S. Census Bureau, American Community Survey; U.S. Department of Labor, O*NET.

Notes: *Recent college graduates* are those aged 22 to 27 with a bachelor's degree or higher. All figures exclude those currently enrolled in school. Because of rounding, figures in each bar may not sum to 100.

FROM: "Are Recent College Graduates Finding Good Jobs?"
Jaison R. Abel, Richard Deitz, and Yaqin Su
Federal Reserve Bank of New York, *Current Issues in Economics and Finance* v.20:1, 2014

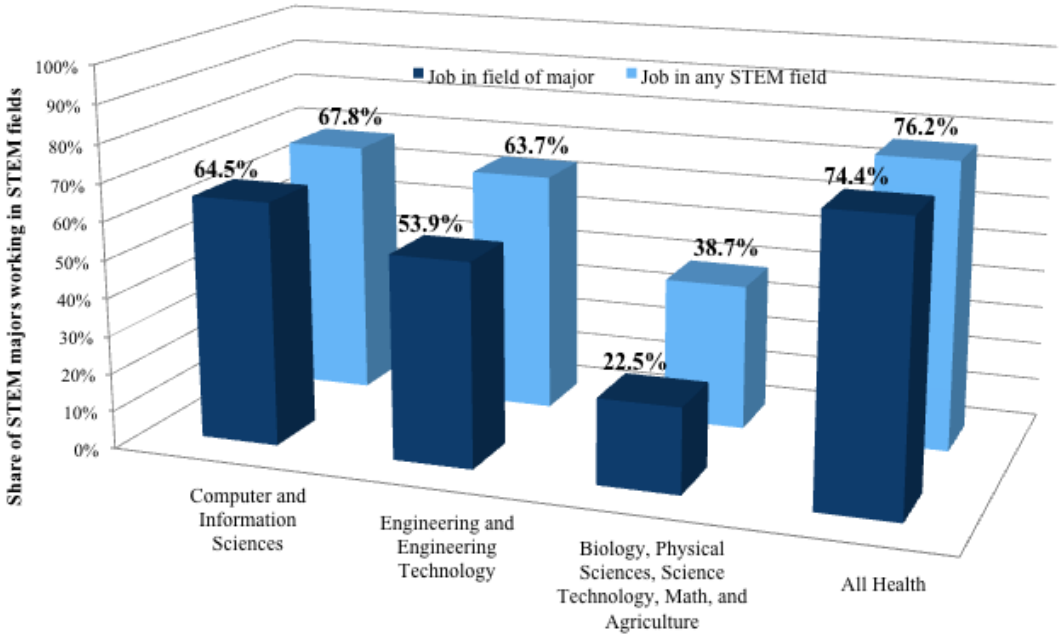
Chart 6

Share of Underemployed Graduates Working Part-Time



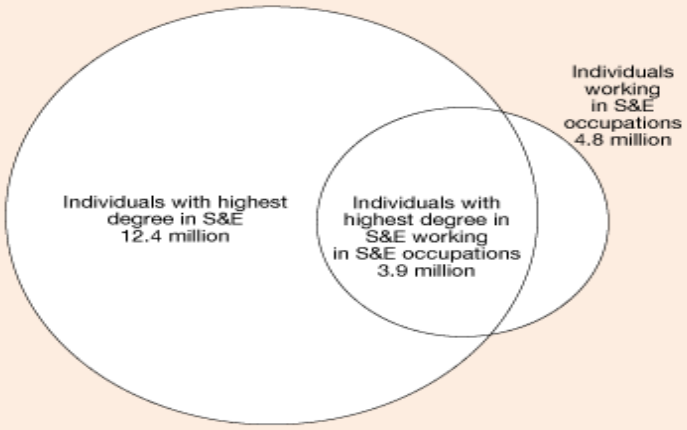
Sources: U.S. Census Bureau and U.S. Bureau of Labor Statistics, Current Population Survey, March Supplement; U.S. Department of Labor, O*NET.

Notes: *College graduates* are those aged 22 to 65 with a bachelor's degree or higher; *recent college graduates* are those aged 22 to 27 with a bachelor's degree or higher. All figures exclude those currently enrolled in school. Shaded areas indicate periods designated recessions by the National Bureau of Economic Research. Shaded areas indicate periods designated recessions by the National Bureau of Economic Research.



Source: National Center for Education Statistics. (2013). 2003–2004 Baccalaureate and Beyond Survey (B&B) [Restricted data file]. Washington, DC: U.S. Department of Education; tabulations by authors.

Figure 3-10
Intersection of highest degree in S&E and S&E occupation: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

Science and Engineering Indicators 2010

- **Could you explain the ways by which you understand firms use the H-1B and L-1 programs to facilitate the offshoring of US jobs and describe the impacts on the U.S. workforce and economy of such offshoring?**

The use of guestworkers is required to support offshore IT development because a portion of the project team (often estimated as about one-third of the entire project team) is dedicated to managing the customer account in the United States, to do requirements analysis, quality assurance, implementation, and liaise with the offshore team. Without this onshore team, it would be nearly impossible for a company to do offshore development. It is thus not the case, as often asserted, that without guestworkers firms would move their work offshore. It is, in fact, quite the opposite: without guestworkers, conducting work offshore would be much more difficult and the cost savings would be substantially reduced. This finding is based partly on fieldwork (Salzman, 2000; Salzman and Biswas, 2001), but also comes directly from the statements of offshoring companies in their U.S. Security and Exchange Commission (SEC) filings (10-K and 20-F forms) (see Testimony, p.13ff for discussion and quotes).

The effect on the U.S. workforce is evident in both wage levels (as noted above) and reduction in the number of jobs available to U.S. workers, and particularly in its impact on workers over the age of 35 who, it appears, are more susceptible to being replaced. The firms themselves state these impacts by noting that reductions in guestworkers would require them to hire more U.S. workers—conversely, the availability of guestworkers reduces the demand for U.S. workers.

The offshoring firms (both U.S. and Indian) are quite explicit about the need for H-1B and L-1 guestworkers to conduct offshore software development. From the firm's 10-K and 20-F SEC filings about impact of reductions in the supply of guestworkers:
"Any restriction on ability to deploy trained offshore resources at client locations may require Infosys *to replace existing offshore resources with local resources,* or hire additional local resources, potentially *at higher wages*." [emphasis added] the "…majority of professionals in the U.S. hold H-1B visas or L-1 visas; *ability of our technology professionals to engage in work-related activity abroad depends on ability to obtain the visas and permits*."[emphasis added]; another states: it would affect their "…ability to compete for and provide services to clients in U.S." because they might not be able to "…continue to be able to obtain any or a sufficient number of H-1B and L-1 visas for our onsite employees on the same timeframe as we currently maintain." Accenture states that if it is "…unable to deploy needed talent because of increased regulation of immigration or work visas, including limitations placed on number of visas granted, limitations on type of work performed or location in which work can be performed, and new or higher minimum salary requirements, could be more difficult to staff employees on client engagements and increase costs." Worth noting is that the problem appears to be one of costs and difficulty in offshore staff working in the U.S., but not a potential "shortage" of workers. Cognizant states that any reduction in guestworkers would have the effect that the "…*cost of doing business in the U.S. would increase*...[and would]… *impair ability to staff projects with professionals who are not citizens of the country where the work is to be performed*."

- **During the hearing we heard about an American Enterprise Institute study (Madeline Zovodny, "Immigration and American Jobs") that concludes that each H-1B creates 1.83 additional jobs for Americans. There was also reference to a 2008 National Foundation for American Policy study that concluded that each H-1B worker creates 5 new jobs (see http://www.nfap.com/pdf/080311h1b.pdf). Are you familiar with the studies in question? Do you agree with the studies' conclusions?**

  - **Does the AEI study or any other similar study you know of measure the job-creating powers of *American* workers?**

First, the paper assumes that temporary migrant workers are somehow more productive than other workers, but it provides no empirical facts to back that up. We know, for example, that foreign workers are not more likely to patent than natives (Hunt, Matloff); and that recently hired H-1Bs earn less than natives (Lowell, Matloff). The facts on entrepreneurship are also controversial and, regardless, apply to a sliver of the potential foreign-born population and even fewer H-1Bs (Hart). There really is no agreed-upon or compelling evidence of greater individual productivity so no causal mechanism for Zavodny's finding (Matloff). Along these lines, see this analysis using good data and statistics that supports the contention of no H-1B advantage:

http://www.aei.org/publication/high-skill-immigrants-without-advanced-degree-actually-create-jobs/

http://www.nber.org/papers/w20668

Second, the paper is internally inconsistent in a couple of ways. Along the lines of differential productivity, it finds that H-2B migrants in low-wage industries generate the greatest employment boost (p.4, 464 vs 162 jobs). How is it possible that a tiny number of (65k) low-wage seasonal workers in a handful of states generate the biggest effect? If its true then, rather than H-1Bs, it would suggest increases of H-2Bs would be better for the U.S. economy (or require H-1Bs to be certified for seasonal jobs). Along the lines of missing variables, the paper finds a positive employment boost in pre-recession (2000-2007) but not when including post great recession (2000-2010) years. As the paper argues, it's plausible that native employment gains waned during the great recession, but why would the foreign born effect zero out? For policymakers, the putative evidence clearly indicates that admitting increased number of foreign workers during a recession is not supported by this analysis.

- **During the hearing there was discussion of a 2013 article by the Brookings Institution ("H-1B Visas and the STEM Shortage") that stated that "H-1B workers are paid more than U.S. native-born workers with a bachelor's degree generally ($76,356 versus $67,301 in 2010) and even within the same occupation and industry for workers with similar experience." Do you agree with the conclusions in that Brookings article?**

The Brookings data when read carefully (a) supports our (Salzman, Kuehn, Lowell, 2013) and other analyzes of trends showing IT wages have been flat and no evidence of labor shortages, and (b) the Brookings analysis of H-1B earnings is flawed and appropriate comparisons of H-1Bs vs full-time year-round domestic workers finds no H-1B earning advantage and, in fact, in IT the average H-1B workers earns $3,674, or 5 percent, *less* per year than a U.S. worker in the same occupation. A careful reading of the Brookings analysis and corrected analyses of their data do not support their conclusions.

That is, *the Brookings paper shows that wages are essentially flat since the industry recovery following the dot-com crash;* a finding consistent with our findings and those of nearly every study of wage trends in the IT sector (see my written testimony, and Salzman, et al., 2013, for additional salary analyses by occupation, by industry, by region).

The Brookings paper also notes that "Even among H-1B visas requests, many require only an Associate's degree, meaning that the current U.S. workforce could be trained to do these jobs at relatively little cost" (p.2), and that these workers are not supplied by the H-1B or most other high-skill guestworker programs. We would point out that each year there are 64,341 students who earn an associate degree or certificate in IT in 2012, far exceeding the expected growth of 44,600 new IT workers with less than a bachelor's degree for work in the computer occupations (many of whom do not require an associate degree or certificate). Importantly, the Brookings analysis about the nature of the demand – for less than bachelor's degree level -- also supports our analysis that the "talent" demand for highly skilled and educated workers is far less than overall net hiring needs, about a quarter of overall demand is for those holding a computer science degree.

THUS, the Brookings paper findings would appear to make a strong case that the IT industry—the dominant industry supplied by the H-1B and other guestworker programs—exhibit low levels of demand as indicated by the flat wages that are still below their early 2000s peak and that demand for high-skill is a small fraction of the overall hiring needs.

The Brookings study is deeply flawed. Beyond the basic errors, such as those in their regression, among others (see Matloff critique; Matloff and Hira have discussed these errors), there are two serious errors that undermine any analytic value the analysis might have.

First, let me point out two findings in the Brookings study:

(1) Wage changes in the "computer and mathematical occupations" –which includes the occupation with the highest concentration of H-1B workers (computer occupations; unclear why they didn't limit their analysis to just computer occupations since the mathematical occupations are for actuaries and operations research analysts, among other non-IT occupations)), are the occupations of most relevance (as discussed in my testimony and in Salzman, et al., 2013).

As noted in my written testimony, and Salzman, et al., (2013), the "great crew change" in IT occurred during the recovery after the dot-com crash; it was in this period, 2004-2006, that there appeared to be significant substitution of guestworkers for U.S. workers, in part because of increased offshoring (see answer above about function of guestworkers for offshoring).

THUS, the key question is: *What occurred in wage growth in the occupations with the highest concentration of guestworkers when the IT industry recovered from the dot-com crash?*

--No other industry (at least not yet) is asking for guestworker supply equal to 65% to 150% of their stated net hiring needs. No one is arguing that demand for high-skill talent is zero; only that any conceivable skill demand is modest compared to the supply available in the U.S. and thus, unless there is compelling evidence to the contrary, high-skill guestworker flows should be minor in any given industry. In industries with minor guestworker supply –as appears to be the case in many if not most industries— the impact of guestworkers on wages would also be expected to be correspondingly small.

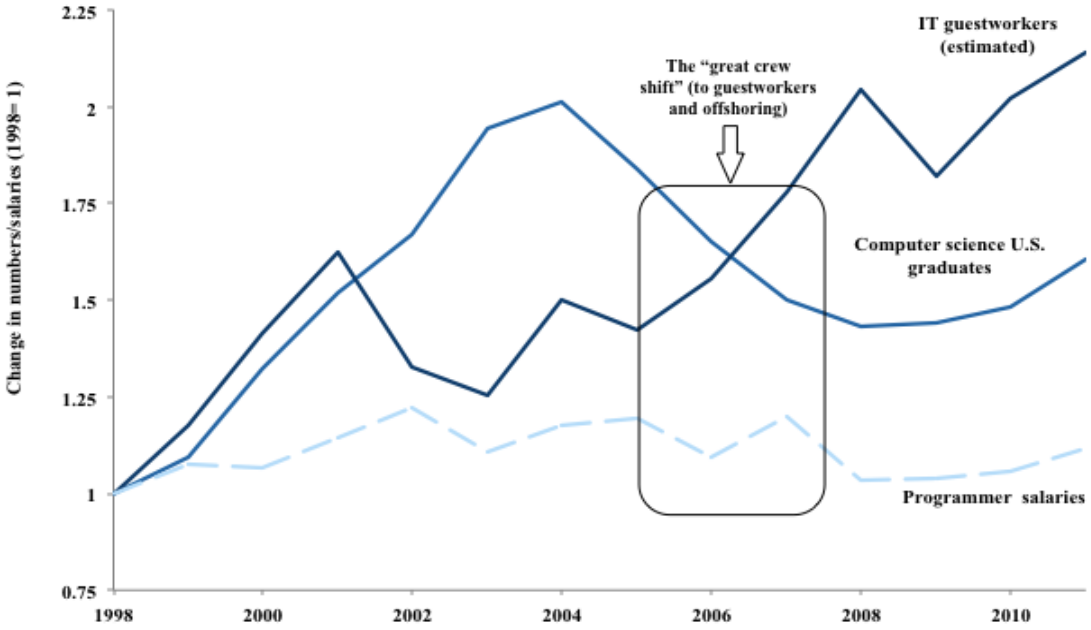
THUS, the specific industry and occupations of interest are the computer occupations in the IT industry which account for the predominant share of guestworker demand and supply.

In terms of the IT industry, then, the Brookings study shows the same salary outcomes as our and other studies. The Brookings paper, page 8/Figure 2, shows that "computer and math occupations" salaries rise steadily leading to the peak of the dot-com bubble then show either stasis, or perhaps secular decline, with small annual variation of 1 to 2 percent—in 6 of the 8 years following the peak in 2003, annual salaries were below the 2003 peak. [3]

If we examine programmer salaries – the occupational group in which guestworkers are most concentrated and for which we have a long time series (the combined "computer occupations and mathematical occupations" was created in 2002 and, as far as we know from our discussions with BLS, there is no way to construct a comparable occupational group before 2002), salaries have remained at, or below, their late 1990s level except for the brief dot-com boom period.

Figure 1: Change in Programmer Salaries and in Numbers of U.S. STEM-related Graduates and IT Guestworkers, 1998-2011

[3] All the year-to-year salary variance is within two percentage points (note the scale on the left –it's between about 1.06 and 1.085) between the crash and today. (We don't know how Brookings authors did their analysis prior to 2002 since, as far as we know, that occupational grouping wasn't available before 2002, as we note in our paper). Fluctuations of 1-2%, given the extent to which it bounces up/down, are essentially flat (given margin of error, unlikely the 1% change in a given year is meaningful).



That is, *the Brookings paper shows that wages are essentially flat since the industry recovery following the dot-com crash;* a finding consistent with our findings and those of nearly every study of wage trends in the IT sector (see above Figure 1; my written testimony, and Salzman, et al., 2013, for additional salary analyses by occupation, by industry, by region).

(2) The Brookings paper also notes that "Even among H-1B visas requests, many require only an Associate's degree, meaning that the current U.S. workforce could be trained to do these jobs at relatively little cost" (p.2), and that these workers are not supplied by the H-1B or most other high-skill guestworker programs. We would point out that each year there are 64,341 students who earn an associate degree or certificate in IT in 2012, far exceeding the expected growth of 44,600 new IT workers with less than a bachelor's degree for work in the computer occupations (many of whom do not require an associate degree or certificate). *Importantly,* the Brookings analysis about the nature of the demand – for less than bachelor's degree level -- also supports our analysis that the "talent" demand for highly skilled and educated workers is far less than overall net hiring needs, about a quarter of overall demand is for those holding a computer science degree.

THUS, the Brookings paper findings would appear to make a strong case that the IT industry—the dominant industry supplied by the H-1B and other guestworker programs—exhibits low levels of demand as indicated by the flat wages that are still below their early 2000s peak and that demand for high-skill is a small fraction of the overall hiring needs.

In terms of the analysis of H-1B wages in the Brookings paper, there are two fundamental flaws: sample definition in defining a comparison group and the construction of their datasets.

(1) Comparison groups: "Native" as compared to H-1B worker. The relevant analysis is one that examines the real world characteristics of the labor market and hiring decisions of employers, and of course the legal regulations that divide the labor market into two segments, domestic/U.S. vs. guestworker (there is no legal or practical IT labor market distinction between immigrant and native). In the IT market in particular, employers are not differentiating between "native" and immigrant (among other reasons, many tech managers are immigrants themselves) but, rather, between hiring from the domestic labor pool and the guestworker labor pool; the latter is a labor force that is available, and for whom conditions of work are quite different from the domestic labor force (requiring a work visa, etc.).

The relevant comparison groups are the domestic laborforce (citizen and permanent resident; native and immigrant) and guestworkers. Findings about natives vs. guestworkers might be relevant for some theoretical or academic exercise but not relevant to the policy question of the relationship of guestworker wages and domestic workforce wages and employment.

(2) The most serious of the analytic flaws in the Brookings study is how they constructed the two datasets for comparison.

What are the relevant data?

The data source for analysis of the H-1B workforce is the DHS dataset of approved petitions. These are the *prospective, employer-reported* annual wages the employer intended to offer a worker hired on an H-1B visa. That is, the wages listed in the data base are what the employer reports as the *intend wage* they will offer a worker hired on an H-1B visa should DHS approve the visa petition. Importantly, these are not necessarily the actual annual wages that are paid to a worker; there is no *ex post* verification of the reported wages and, it is estimated, perhaps 20 percent of the approved petitions are never filled with an actual hire. Also important to note is that the law exempts any labor attestation if the salary is above $60,000.

The comparison group, of native U.S. workers, is constructed from the American Community Survey. These data are from a survey of households and thus are the reported wages of individual *workers* for the *preceding* year. That is, these data reflect the *actual wages* that an individual worker reports having received for the prior year. These are subject to reporting biases and other limitations, but are clearly a very different data source from the employer-reported, prospective wages for an intended hire.

Reanalysis of H-1B and U.S. Worker Wage levels

In a current analysis (Lowell and Salzman), we first constructed two datasets that addressed the biases and anomalies to the extent possible (e.g., an inherent limitation that can not be addressed with these data are that H-1B data are prospective, employer reported wages –i.e., of what employers report to DHS on an application as the wage they intend to pay a worker whereas the U.S. worker data are individual workers reporting the actual income they received for the prior year). We correct for apparent errors in the Brooking analysis and construct both data sets to be comparable.

When comparing the two groups, as shown in Table below, the average H-1B workers earns $3,674, or 5 percent, less per year than a U.S. worker in the same occupations. There is substantial average wage savings gain by using H-1B workers, which we estimate now comprise over 40 percent of the current, total workforce in these occupations (the data on the U.S. workforce provides detailed occupational

breakouts but the H-1B data combine these two computer occupations). What is remarkable is that these workforce averages, which are for *all* workers in these occupations with a bachelor's degree or higher, are lower for the H-1B workforce yet the H-1B workforce is a workforce comprised of nearly twice the proportion of workers with a master's degree. *That is*, despite a workforce composed of a substantially greater number of workers with a postgraduate degree (nearly twice the proportion of the domestic workforce), their average wages are *lower*. In a preliminary analysis of wages and education, Lowell and Salzman (in preparation) find that, as would be expected in the labor market, U.S. workers with a master's degree receive higher wages than those with a bachelor's degree, and it is a wage premium that increases among older workers with a master's degree. However, in the H-1B workforce there is, on average, no wage premium for a master's degree. That is, for most H-1B workers with a master's degree, they do not earn more than an H-1B worker with a bachelor's degree.

Table 1: U.S. and H-1B wages and workforce

	% Masters	Annual Average Salary	Number of Workers		
Domestic Workforce					
Computer scientists and systems analysts	25%	$79,895	234,239		
Computer programmers	21%	$79,185	225,292		
Average (combined occupations)	23%	$79,547	459,531		
H-1B workforce			**1st & 3rd Year Approvals**	**Estimated 6 Year Population**	**Est. Percent of Domestic IT Workforce**
Computer Sci/Systems Analyst & Programmers (combined)	45%	$75,873	78,113	195,283	42.5%

Source: DHS H-1B data; calculations by authors (Lowell and Salzman, forthcoming).

- **The employment projections made by the Bureau of Labor Statistics are often used to predict shortfalls in the future domestic supply of STEM workers. Could you explain whether these projections show a shortfall?**

The BLS states that its projections of demand do not address the issue of supply. In general, the presumption is that the labor market will respond to demand and, in fact, that is one use of the BLS projections by career counselors, educators and students to identify areas of future employment opportunity. Presumably the goal of such projections is to support a market response to demand that does not require extraordinary government intervention.

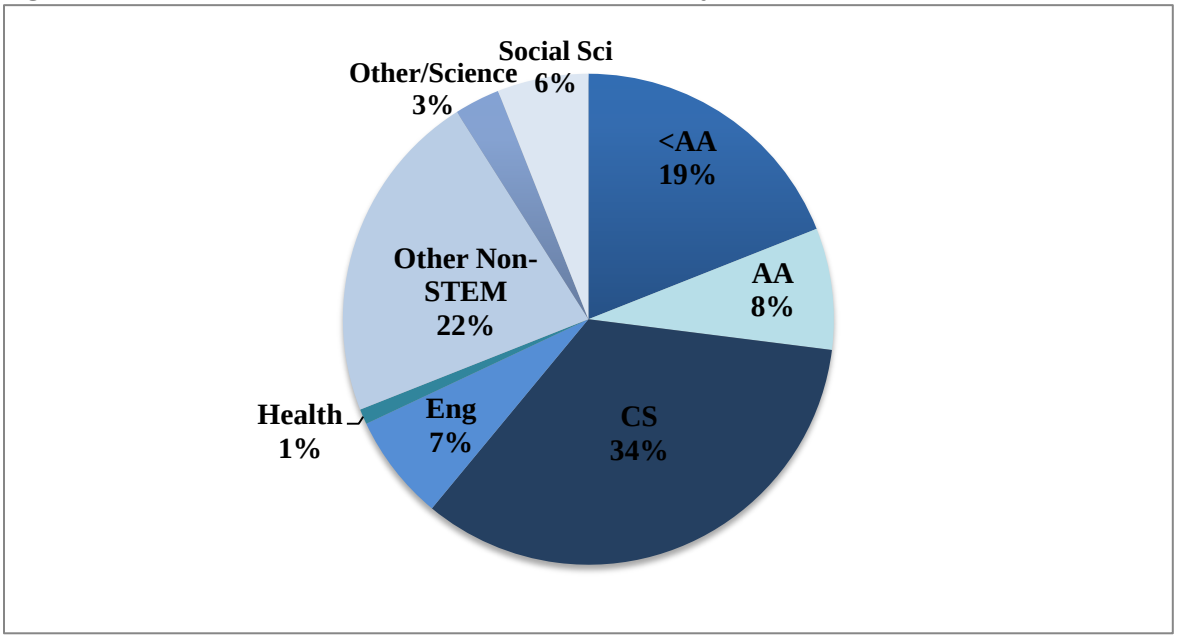
Current graduation rates indicate that projected employment demand specifically for computer science (CS) graduates can be met by about half of the current supply of 65,000 to 70,000 CS graduates (with at least a bachelor's degree) each year, and the balance of demand can be met by those graduating with a range of other degrees, as is the historical pattern. Outside of IT, study after study of science careers consistently finds there is a glut of Ph.D. life scientists resulting in poor employment prospects for new graduates and postdoctoral scientists (e.g., Teitelbaum 2008, 2014; Stephan, 2012; Freeman, 2004; NIH, 2012). The National Institutes of Health (NIH) has developed a program to help new biomedical Ph.D.s find alternative careers in the face of "unattractive" job prospects in the field, where less than a quarter of Ph.D. graduates will find a career research and teaching position (NIH, 2012). Overall, in the science fields, there are twice as many university graduates at the bachelor's degree level than the number who enter into a science occupation every year. Similarly, engineering schools graduate 50 percent more graduates than find jobs in engineering each year; the one engineering area where there has been a shortage, petroleum engineering, is the exception that proves the rule (see discussion of petroleum engineers).

As to whether the BLS projections indicate a shortfall -- According to the Bureau of Labor Statistics (BLS) projections for IT job growth, which is comprised of replacements (for those leaving the workforce because of retirements and job separations—layoffs and quits) and growth of the workforce, the IT industry needs approximately 124,000 new workers each year. Daniel Costa conducted a detailed study of these computer science shortage claims by Microsoft and other companies and shows the evidence does not support these claims because, among other reasons, "[i]t is a well-known fact that computer science graduates are not the only source of new hires in computing….less than one-fourth to less than one-half of workers in computing occupations have a computer science degree" (Costa, 2012). In fact, of those currently in computer occupations, only 14 percent hold a computer science degree and another 4 percent have electrical engineering degrees. Since that reflects the education level of the entire current IT workforce of all ages, it could understate the current cohort education levels.

Examining recent cohorts of all new entrants into IT occupations who have a postsecondary education, we find 34 percent have a bachelor's or master's computer science degree (See Figure below); of just the

pool of four-year college graduates entering computer occupations, 46 percent have a computer science degree. About 36 percent of entrants into computer occupations do not have any four-year degree. Thus, we estimate that demand for new workers in computer occupations with a computer science degree as approximately 29 percent of the BLS projection of total demand for new workers (64% of new workforce entrants in computer occupations have a four-year degree and 46% of those have a degree in computer science, or 29% of all new workforce entrants). Using the actual educational composition of the computer occupations as an estimate of hiring demand by education and degree, the supply of computer science graduates needed to meet industry demand would be approximately 36,500 computer science graduates each year (based on the BLS projection of 124,000 new jobs; see U.S. Bureau of Labor Statistics, 2014). Figure 2 shows the historical graduation numbers of computer science graduates.

Figure 2: Education of IT Workforce with Postsecondary Education

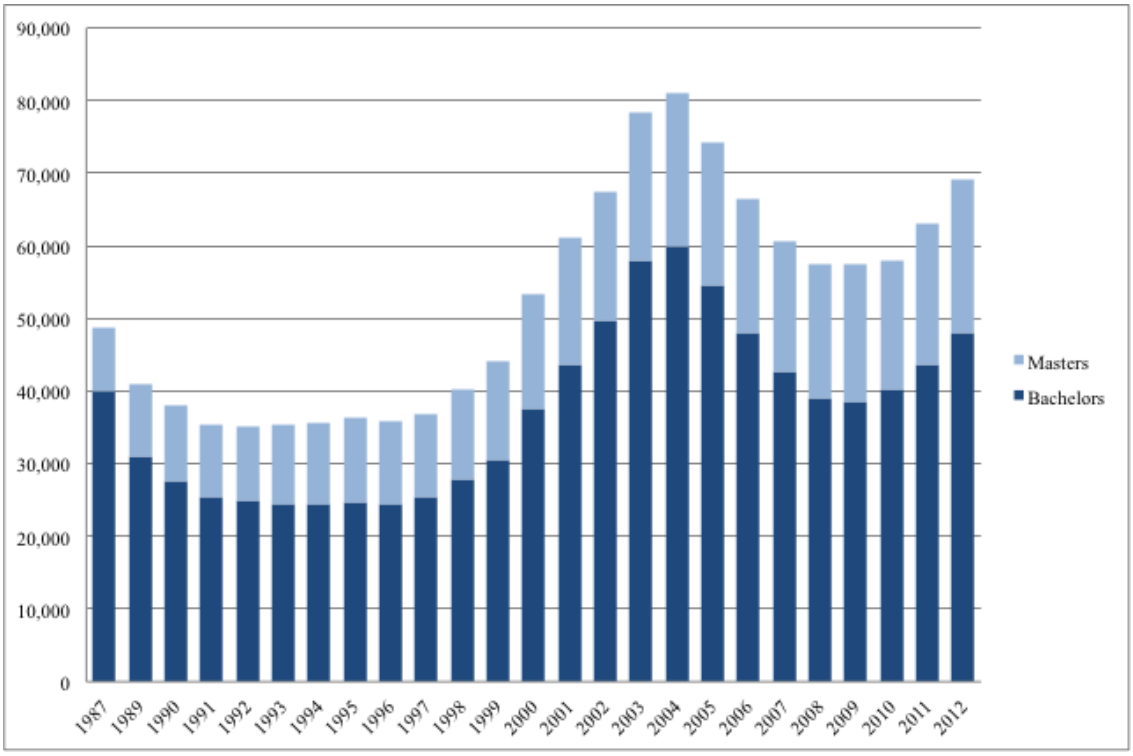


Source: National Center for Education Statistics. (2013). 2003–2004 Beginning Postsecondary Students Longitudinal Study (BPS) [Restricted data file]. Washington, DC: U.S. Department of Education; tabulations by authors.

Current graduation rates indicate that projected employment demand specifically for computer science (CS) graduates can be met by about half of the current supply of 65,000 to 70,000 CS graduates (with at least a bachelor's degree) each year, and the balance of demand can be met by those graduating with a range of other degrees, as is the historical pattern. Even if current industry hiring is for a much greater level of computer scientists than historical hiring patterns, the current pool of graduates would provide sufficient numbers of computer scientists to meet industry demand. Our analysis of a large, nationally representative survey of a recent college cohort by the National Center for Educational Statistics finds that only two-thirds of computer science graduates went into IT jobs in 2009 (that would include all IT jobs, not just those for formally defined "computer occupations"). Of those not landing an IT job, half

said they found a better job elsewhere. Fully one-third reported there were no IT jobs available (although this was the year after the start of the Great Recession, this is only slightly lower than the historical trend; Salzman, et al., 2013). Also worth noting is that an additional 64,341 students earned an associate degree or certificate in IT in 2012, also far exceeding the expected growth of 44,600 new IT workers with less than a bachelor's degree for work in the computer occupations (many of whom do not require an associate degree or certificate).

Figure 3: Number of Computer Science Graduates Annually



Source: National Center for Education Statistics, Higher Education, General Information Survey and Integrated Postsecondary Education Data, 1987–2012; tabulations by Daniel Kuehn, American University; David Hersh and Hal Salzman, Rutgers University.