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Welfare Trade-Off, US Software Workers, and Immigration Quotas

This chapter first considers the broad efficiency versus equity trade-off related to high-skilled immigration and then takes an in-depth look at the labor-market situation faced by the group of US workers most affected in recent years by foreign high-skilled immigration—software workers. Finally it considers the best ways to match foreign workers with US employers and why the use of quotas in high-skilled immigration policies should be avoided.

Welfare Economic Efficiency Versus Equity Trade-Off

High-skilled immigration sets itself apart from other types of migration by its explicit focus on human capital and skills. Hence it must predominantly be oriented toward generating economic growth by easing high-skilled labor shortages in America in the short term and broadly expanding the productive labor capacity in the long run. At the same time, of course, high-skilled immigration policies ought not to be blind to the rights of American workers and should strive to minimize any adverse economic impact on them. The foreign labor certification (FLC) process in US high-skilled (as well as other) immigration law seeks to achieve this latter goal.

This process is managed by the Department of Labor's Employment and Training Administration (ETA) with the explicit aim of ensuring that "the admission of foreign workers into the United States on a permanent or temporary basis will not adversely affect the job opportunities, wages, and working conditions of U.S. workers" and "certification may be ob-

tained in cases where it can be demonstrated that there are insufficient qualified U.S. workers available and willing to perform the work at wages that meet or exceed the prevailing wage paid for the occupation in the area of intended employment."[1] This policy covers only the applications in employment-based legal permanent resident (LPR) status categories E-2 and E-3 and in the H-1B program. LPR status category E-1 and the L-1 temporary visa do not require an FLC and are instead solely conditional on the applicant meeting the visa category criteria[2] and having a US-located job offer.

Much public discourse concerning particularly the H-1B visa has centered on whether the FLC is credible or not and by extension therefore on whether this process adequately protects US worker rights.[3] It is beyond the scope of this policy analysis to adequately evaluate whether or not this is legally the case with the present FLC system. On the other hand, the international trend in the degree to which other OECD governments use FLC-like "labor-market testing" in relation to high-skilled workers is clear: More OECD countries have been scaling it back in recent years. The OECD's *International Migration Outlook 2007,* in a section illustratively titled "Towards the end of labour market testing," notes that in the OECD countries, it has broadly been the case in recent years that

> [o]n the basis of a precise evaluation of the shortages in certain branches and professions, labour market testing has been lifted for a wider range of occupations. (OECD 2007c, 97)

In other words, other OECD countries are clearly less concerned in today's global economic environment than in previous periods about the welfare impact of high-skilled immigration on their native high-skilled workforces. Ironically, therefore, other OECD countries today are increasingly more "free traders in high-skilled people" than is the "traditional immigrant destination country" of the United States. This observation is pertinent for the efficiency-equity trade-off debate in America.

Chapter 1 established that the compositional improvement of the US labor force will slow dramatically and possibly stop entirely in the next decade as a result of the 30-year stagnation in the skill levels acquired by

1. The process is described on the ETA website at www.foreignlaborcert.doleta.gov.

2. The E-1 "priority worker" LPR status requires that the applicant present extensive documentation showing sustained national or international acclaim and recognition in the field of expertise. For the L-1 visa, the sponsoring company must provide proof that the applicant is hired into a US-located managerial, executive, or specialized knowledge capacity.

3. See, for instance, US House of Representatives, Subcommittee on Immigration, Citizenship, Refugees, Border Security, and International Law Oversight Hearing on "Is the Labor Department Doing Enough to Protect U.S. Workers?" June 22, 2006; GAO (2006); Miano (2007); and Hira (2007).

workforce entrants and the imminent retirement of the highly educated baby boomer generation. Meanwhile, other OECD countries continue to rapidly improve their workforce skill levels. Simply put, America in the 21st century is no longer a skill-abundant country relative to an increasing share of the rest of the world. On the efficiency side, this slowdown in US labor force skill improvement implies that for America to regain its historical status as the most skill-abundant country in the global economy, it must—as even successful education reforms will have an impact only in the long term—expand high-skilled immigration in the short to medium term. On the equity side, ironically, it implies that the labor-market situation for US high-skilled workers—i.e., those with at least a four-year college degree—will in all probability remain benign. "Getting a degree" will continue to be the ticket to a financially secure "good life" as plenty of well-paying jobs are and will be available for graduates new and old. This situation is already manifested in the unemployment rate for high-skilled US workers, which in the latest available data in 2005 was 2.3 percent (and falling relative to that for other workers),[4] while their wages were almost 50 percent (and rising again) higher than those of high school graduates.[5] Moreover, as high-skilled immigrants generally function as complements rather than substitutes to the native workforce, the wages of high-skilled Americans—unlike those of low-skilled workers—are typically not adversely affected by the increased labor-market competition from high-skilled immigrants.[6] (See next section on US software workers.)

In the aggregate, therefore, it seems appropriate to ask whether high-skilled American workers as a group possess a strong prima facie case for government protection in the form of strict labor-market testing and numerical limits on the number of high-skilled immigrants that can enter the United States. I clearly believe that they do not. Shielding high-skilled American workers from labor-market competition in today's era of accelerating skill shortages and increased global competition for talent is simply not an appropriate area for much, if any, US government intervention.

4. See footnote 22 in chapter 1.

5. See Economic Policy Institute, Datazone, Wage and Compensation Trends, table on estimated wage premium for college and high school graduates, 1973–2005, available at www.epi.org/datazone/06/college_premium.pdf.

6. The degree of substitutability between immigrants and native workers will tend to be higher in lower-skilled jobs with fewer training costs and limited language, professional, institutional, and licensing requirements. Orrenius and Zavodny (2007) find that newly arrived high-skilled immigrants in professional occupations have a positive impact on natives' wages, suggesting likely complementarities between, for instance, recently arrived high-skilled temporary workers on H-1B visas and native workers. Friedberg (2000) shows that the returns to skills for immigrants who have acquired educational and professional experience in their home countries are lower in the United States. See also CEA (2007), Ottaviano and Peri (2006), and Borjas (1999). Borjas (2003), however, finds that wages for college graduates declined 4.9 percent due to high-skilled immigration.

Hence, if existing US high-skilled immigration laws remained unchanged in the years ahead, it would represent a remarkable example of regulatory capture and successful rent-seeking strategic behavior by a high-skilled and otherwise privileged special interest group. The result would be the redistribution of economic rents[7] to this group, but at the expense of overall economic growth prospects of the US economy.

Software Workers: The Most Affected High-Skilled Americans

The economics literature has generally found that high-skilled (unlike low-skilled) immigrants have no adverse effects on native workers.[8] A brief look at the fate of high-skilled software workers will be illustrative, as it will allow for a test of this general hypothesis on a particular group of affected high-skilled workers of obvious policy and media interest. Chapter 2 found that a large number of Indian nationals have been offered jobs in computer-related occupations in the United States in recent years, particularly through the L-1 and H-1B programs. Similarly, a great deal of anecdotal evidence on US software workers losing their jobs to Indians on high-skilled visas has been reported in the US press, as well as presented at hearings before the US Congress.[9] American software workers would thus seem an obvious group of high-skilled Americans adversely affected by high-skilled immigration. Indeed, given that computer-related companies and occupations dominate the L-1 and H-1B high-skilled immigration programs (chapter 2), it is implausible that US workers in any other single occupation could have been adversely affected by high-skilled immigration to the same degree. In other words, if adverse effects on native US high-skilled workers cannot be discerned among US software workers, then such adverse effects would be highly unlikely among US workers in other high-skilled occupations, which have experienced far lower inflows of foreign high-skilled workers.[10]

7. The term "economic rents" is used here in its usual Ricardian sense: the difference between what a factor of production is paid and how much it would need to be paid to remain in its current use.

8. See, for instance, CEA (2007), Orrenius and Zavodny (2007), Lowell (2007), Passell (2007), Ottaviano and Peri (2005), Camota (1997), and Friedberg (2001). Borjas (2003) finds that unskilled workers are even more negatively affected by immigrants than are high-skilled workers.

9. See, for instance, testimony by John Miano before the Subcommittee on Immigration, Citizenship, Refugees, Border Security, and International Law on March 30, 2006 and June 22, 2006 or the testimony of David Huber before the same committee on March 30, 2006.

10. This statement is based only on comparing the "quantitative supply" of foreign high-skilled immigrants, which is far higher in software occupations than in others. It is possible

As tentatively alluded to in table 2.2, however—and as elaborated in this section—the actual labor-market devastation that American software workers have experienced in recent years is far from obvious, either in employment or wage terms.

As can be seen in figure 3.1,[11] unemployment rates for computer programmers have historically been significantly below the overall unemployment level in America. However, following the collapse of the internet bubble and the end of the Y2K mania, unemployment rose by mid-2002 to above the level for the total US economy. In late 2004, however, unemployment rates for computer programmers again fell below that of the total economy and have since 2005 been about 2 percent or about the level for all university graduates (2.3 percent in 2005). Allowing for frictional unemployment, levels close to 2 percent imply essentially full employment. As such, the aggregate data show that unemployment among computer programmers in America for the last two years has been negligible. Figure 3.1 shows a similar trend in the other major software occupation, that of software engineers,[12] for whom data are available only for 2000–2007: a sig-

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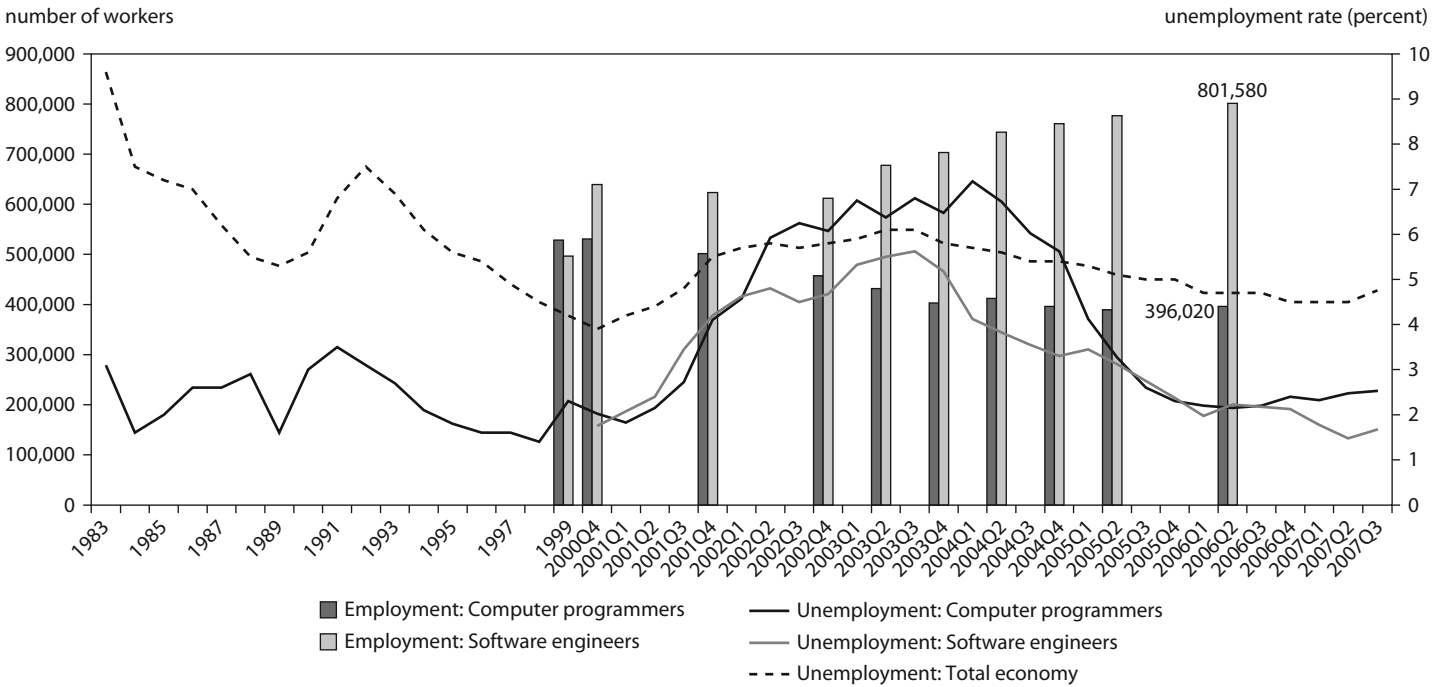
that American-born workers in other occupations, with less job creation in recent years (or outright net job losses) than has been observed among software occupations, could be more affected by lower numbers of high-skilled foreign immigrants. However, this seems improbable given the very high numbers for high-skilled software-related immigrants and the diversity among "nonsoftware" high-skilled immigrants.

11. Figure 3.1 combines data from the National Science Foundation for computer programmer unemployment from 1983 to 1999 with more recent unemployment data from the detailed occupational tables in the Current Population Survey by the Bureau of Labor Statistics (BLS) and US Census Bureau, as well as available BLS Occupational Employment Statistics (OES) employment data from 1999 to 2007. The OES website, www.bls.gov/oes, lists several methodological reasons why one should be careful with using OES data as a time-series as is done in figure 3.1. However, the data presented in figure 3.1 are national employment data for all industrial sectors in only the 2000 Standard Occupational Classification and do not concern occupations in which seasonal variation is a major concern. Consequently, the methodological considerations regarding time-series use of OES data are nonmaterial for the data used here. OES data have been published at irregular intervals since 1999, but the survey data values are benchmarked to either May or November reference periods. As such, in the treatment here, OES data will be referred to as either Q2 (May data) or Q4 (November data). For more methodological detail, see technical notes for the May 2006 OES estimates at the BLS website at www.bls.gov/oes/current/oes_tec.htm.

12. This policy analysis has chosen a relatively narrow definition of software workers, including only computer programmers and software engineers. This is an intentional attempt at isolating the experiences of a group of high-skilled workers who have been subject to overwhelming media interest in recent years. Further, it is an intuitively valid demarcation of software workers as the following BLS employment classification descriptions show. The BLS definition of "Computer Programmers" (SOC 15-1021) is: Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information. May program websites. The BLS definitions of the two "software engineers" categories, "Computer Software Engineers, Applications" (SOC 15-1031) and "Computer Software Engineers, Systems Software" (SOC 15-1032), are as fol-

Figure 3.1 US software employment and unemployment, 1983–2007



Note: Annual data for 1983–99; four-quarter lagging moving average for 2000–2007; "software engineers" includes both applications and systems software. The availability of data used in this figure has been irregular due to repeated changes by the Bureau of Labor Statistics in the survey methodology.

Sources: National Science Foundation; Bureau of Labor Statistics and Census Bureau, Current Population Survey, available at www.bls.gov/cps; Bureau of Labor Statistics, Occupational Employment Statistics, available at www.bls.gov/oes.

nificant rise after the technology bust, followed by a return to full employment by 2005. While in the constant creative destruction in the dynamic US economy, even high-skilled software workers often lose their jobs (or equally likely leave voluntarily for another) and hence do not have full job security, a 2 to 3 percent unemployment rate indicates that they have near complete employment security (see box 3.1).

Turning to software employment numbers, the bars in figure 3.1 show that at the time of the earliest available data in 1999, there were roughly the same number of computer programmers and software engineers in America, at about half a million each. During the peak year of the internet bubble in 2000, the number of US computer programmers was flat, while the number of software engineers rose by about 125,000 to a combined employment level of about 1.15 million at the peak of the bubble. Following the internet bust, US software employment declined by about 100,000 workers, mostly computer programmers, to about 1.05 million at the trough by end of 2002. During 2003, employment among software engineers rebounded strongly, while that of computer programmers continued to decline to about 400,000 by 2004, a level at which it has since remained roughly steady. Employment of software engineers in 2006Q2 (latest available) had risen to a record more than 800,000, pushing total US software employment to a new record of 1.2 million.

Recall box 2.1, which estimates that the total number of H-1B workers in computer-related occupations in the United States could have been up to 324,000 in 2005. It is important to note here that the category of computer-related occupations is significantly broader than just the two occupations included in software employment (computer programmers and software engineers). Hence, directly relating these two datasets would be akin to comparing apples and oranges. The closest occupational category to computer-related occupations is the broader Standard Occu- pational Classification of SOC 15-0000 "Computer and Mathematical Occupations."[13] In May 2005 total net employment in this category was 2.95 mil-

lows: "Computer Software Engineers, Applications"—Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team. Exclude "Computer Hardware Engineers" (SOC 17-2061); "Computer Software Engineers, Systems Software"—Research, design, develop, and test operating systems-level software, compilers, and network distribution software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications. Set operational specifications and formulate and analyze software requirements. Apply principles and techniques of computer science, engineering, and mathematical analysis. These definitions are available at www.bls.gov/oes.

13. This SOC major group comprises the following occupations: Computer and Information Scientists, Research; *Computer Programmers; Computer Software Engineers, Applications; Com-*

Box 3.1 The secure US job market for software workers in 2007

Despite much concern, especially during the 2004 US presidential campaign, the US software sector has so far not relocated to India. Rather, it has in recent years positively thrived in global competition, any adverse effects from offshore outsourcing notwithstanding. Moreover, rapidly rising wages for high-skilled Indian workers suggest that the scope for further large-scale offshore outsourcing of US software work solely for the purposes of labor arbitrage may be narrowing. Recent anecdotal data suggest that salaries for top Bangalore-based software engineers have risen from 20 to 75 percent of US levels in just two years from 2005 to 2007,[1] while most wage surveys for broader categories of experienced workers still indicate that Indian wages are at about half of US levels.[2] Evidently, while there are thousands of highly skilled and competent Indians in the country's software sector, they are just not as cheap as they used to be, relative to US workers.

It is encouraging that literally thousands of high-skilled software positions are currently available in the United States. A quick search of US-based directly software-related job openings at the online career center of Microsoft, the largest US software company, at members.microsoft.com/careers, on September 28, 2007 yielded 15 vacant positions for software architect, 716 vacant positions for software development engineer, and 515 vacant positions for software development engineer in testing/software test engineer.[3]

A similar search on the same day at the online career center at IBM at www-03.ibm.com/employment/us for all positions in software engineering requiring a bachelor's, master's, or doctoral degree yielded 1,469 regular full-time US vacancies. Yet another similar online search, also on the same day, at Oracle, another large US software company, at www.oracle.com/corporate/employment/index.html, yielded more than 500 US-based vacant positions in product development posted during the preceding three-month period. In other words, in less than 10 minutes of searching on websites of just three large US software companies, this author found almost 3,000 vacancies for high-skilled software workers located all over the United States.[4]

Thankfully, one of the most vocal opponents of the H-1B visa program, the Programmers Guild, implicitly acknowledges this extremely benign job market for high-skilled US software workers in its April 2007 online newsletter. It states the following in response to a direct inquiry from a Microsoft hiring manager seeking high-skilled US software workers:[5]

(box continues next page)

Box 3.1 The secure US job market for software workers in 2007 *(continued)*

Microsoft hiring manager seeks your resume

This is not an April Fools' joke. Microsoft has several hundred openings, and a hiring manager has provided his personal email address, asking us to submit our resumes directly to him.

I encourage everyone who has at least a BS degree in Computer Science to send your resume. If American programmers don't even apply for these positions, then it is difficult to argue that we are being displaced by the H-1b workers who do apply. [emphasis in original]

Qualifications? Ideally you will have skills like SQL, C#, .NET or C++, or similar experience and competence in the Microsoft development platform. However, since Microsoft is sponsoring H-1b visas for new graduates—and H-1b workers cannot be hired until October 2007—a BS or higher degree alone should be sufficient for many of the positions that Microsoft is holding open for the H-1b workers it is sponsoring. . . .

With thousands of US-based high-skilled software positions available and a rapidly declining wage differential with Bangalore-based software engineers, the present and future labor market for US software workers in the global economy seem secure. Clearly, some high-skilled US software workers will lose their jobs, and for some it will likely be due to offshore outsourcing. However, with thousands of high-skilled software positions available in the United States, an unemployment rate of 2 to 3 percent, and rising total software employment, this group patently has employment security. Rather than guaranteeing workers their current jobs for life, a dynamic economy should provide them with the chance to always be able to find new jobs.

Some hedge fund managers will lose money even in a rising market, but bailing them out is hardly good government policy. Considering that many less-skilled US workers, for instance, in the manufacturing sector, face genuine hardships—the loss of both job and employment security—as a result of rapid technological innovation and increased global competition, it seems improbable that high-skilled US software workers would have any credible claim for scarce congressional attention or support.

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1. "Bangalore Wages Spur 'Reverse Offshoring,'" *Financial Times*, July 1, 2007. See also Hewitt Associates LLC (2006) for wage data showing that double-digit real wage increases for Indian professionals have far outstripped those in other countries in recent years.
2. "Engaging India: Outsourcing in Jeopardy?" *Financial Times*, August 2, 2007. The rising wage trend in India seems to be pushing multinational companies to increasingly sell their captive units in India to local companies, which are better able to achieve economies of scale in operations for multiple clients.
3. These results include all US locations, products, and job subcategories.
4. The author conducted similar searches on the same websites on July 9, 2007 and obtained a similar result of more than 3,000 vacancies in the categories listed.
5. See Programmers Guild E-Newsletter, April 2007, available at www.programmersguild.org.

lion workers. Hence, H-1B visa holders in computer-related occupations potentially present in the United States that year could at the most have amounted to about 11 percent of net employment in computer and mathematical occupations. This share is seven times higher than the share of all H-1B visa holders (roughly 1.5 percent) in the total high-skilled US population.

What about the most important labor-market price signal: wages? What has happened to the wages of US software workers in recent years? In terms of base wages, which exclude benefits, nonproduction bonuses, and supplementaries,[14] computer software engineers, at about $84,000 per year in 2006, earned about 20 percent more on average (25 percent in terms of median wages) than did computer programmers (just below $70,000 on average), reflecting the higher skill content of their work. In the aggregate, US software workers, therefore, earned between two and three times the US median base wage of $30,400 in 2006.[15]

As can be seen in table 3.1a, base wages rose in nominal terms across the wage range by an average 25 to 30 percent from 1999 to 2006 for these groups of workers. This rise was about five percentage points above the rate of inflation over the period. Only the highest-earning computer programmers in the 75th percentile did worse, at about 17 percent base-wage growth over this period. This latter group of software workers therefore had negative base-wage growth from 1999 to 2006, as the consumer price index (CPI) rose by almost 20 percent from 1999Q4 to 2006Q2. Nonetheless, despite this outcome, computer programmers in the 75th percentile earned more than $85,000 before any benefits, bonuses, or supplementaries in 2006.[16] It is not possible to discern from the Bureau of Labor Statistics (BLS) Occupational Employment Statistics (OES) data any trends in the

puter Software Engineers, Systems Software; Computer Support Specialists; Computer Systems Analysts; Database Administrators; Network and Computer Systems Administrators; Network Systems and Data Communications Analysts; Computer Specialists, All Other; Actuaries; Mathematicians; Operations Research Analysts; Statisticians; Mathematical Technicians; Mathematical Science Occupations, All Other. See www.bls.gov/oes. Italicized occupational categories are included in "software employment" above.

14. In detail, OES survey wages include straight-time gross pay, exclusive of premium pay. Base-rate cost-of-living allowances, guaranteed pay, hazardous-duty pay, incentive pay including commissions and production bonuses, tips, and on-call pay are included. Back pay, jury duty pay, overtime pay, severance pay, shift differentials, nonproduction bonuses, employer cost for supplementary benefits, and tuition reimbursements are excluded. See OES technical notes at www.bls.gov/oes/current/oes_tec.htm.

15. This number is the annual median wage estimate for "All Occupations" from the May 2006 BLS OES estimates. See table A.4 in the statistical appendix for more details.

16. The BLS OES program covers only full-time and part-time wage and salaried workers in nonfarm industries. The survey does not include self-employed owners and partners in unincorporated businesses, household workers, or unpaid family workers, which means that independent self-employed IT consultants are not included in these data.

Table 3.1a Annual base wages of US software workers, 1999 and 2006 (US dollars)

Occupation	Mean wage	10th percentile wage	25th percentile wage	Median wage	75th percentile wage	90th percentile wage	Consumer price index
Computer programmers							
1999Q4	54,960	29,650	38,780	51,060	72,780	91,260	168.4
2006Q2	69,500	38,460	49,580	65,510	85,080	106,610	(1999Q4)
Change, 1999Q4–2006Q2 (percent)	26.46	29.71	27.85	28.30	16.90	16.82	
Software engineers							
1999Q4	65,969	40,036	50,179	63,873	80,652	98,142	201.7
2006Q2	84,155	51,086	64,796	82,075	101,286	122,225	(2006Q2)
Change, 1999Q4–2006Q2 (percent)	27.57	27.60	29.13	28.50	25.58	24.54	19.77

Sources: Bureau of Labor Statistics, Occupational Employment Statistics, available at www.bls. gov/oes; Bureau of Labor Statistics, Consumer Price Indexes, www.bls.gov/cpi.

value of non–base wage remuneration for US software workers from 1999 to 2006 and therefore not possible to answer the question whether there are systematic biases in the base-wage to non–base wage remuneration ratio across the wage spectrum. This would be the case, for instance, if the highest-earning software workers received a higher share of their total remuneration in the form of, say, stock options than did workers at the low end of the wage spectrum.

Table 3.1b shows that in terms of relative base-wage growth between 1999 and 2006, US software workers belong to the top quintile of the US workforce when compared with the wage growth in other major occupational categories.[17] US workers in only three major occupational categories—management, healthcare practitioners, and business and financial occupations (in other words bosses, doctors, and bankers), representing 14 percent of the total US wage and salaried workforce—saw higher median wage increases than did US software workers over this period. In the aggregate, not too bad for an occupation that over the 1999–2006 period experienced very large relative inflows of foreign high-skilled workers (see chapter 2). The bottom line: Any detrimental effect on software workers' wages from the inflow of foreign high-skilled workers is far from obvious.[18]

It is important to elaborate on the period chosen for tables 3.1a and 3.1b, because the starting and end points of wage growth estimations similar to those in tables 3.1a and 3.1b are crucial. The 1999–2006 period was chosen first and foremost because complete data are available for that period. It is not possible to go back to a starting year earlier than 1999 because the BLS survey methodology was changed in 1999. At the same time, it is historically evident that software workers went through a tremendous boom-bust cycle from 1999 to 2001–02. The fact that data are available from 1999 onward, however, offers a nice opportunity to slice through the top of the internet boom-bust variation. In 1999Q4 (the period to which the 1999 estimates are benchmarked), total US employment was 130.2 million, while at the end of the March–November 2001 recession in December 2001 it was 130.7 million after having peaked at a seasonally adjusted value of 132.6 million in February 2001. Using 1999 data as the start-

17. The level of occupational categories at which one makes this comparison is important, as individual subgroups within the major occupational category shown in tables 3.1a and 3.1b may differ from the higher classification category value. As can be seen in table A.4 in the statistical appendix, the threshold for inclusion in the 90th percentile measured at the level of the total workforce in 2006 was $72,960, indicating that the average computer programmer was about $2,500 away from inclusion in the 90th percentile.

18. Findings in Aldonas, Lawrence, and Slaughter (2007) indicate that as a group in terms of real money earnings (real money earnings in this analysis exclude the value of benefits and equity/stock option grants and are deflated by the CPI), both US college graduates and US master's degree holders saw declines in the period 2000–2005. In other words, US software workers in all probability did far better on wages than even the majority of other US high-skilled workers during this period.

ing point is therefore a sensible approximation of the "sustainable level of employment," thus eliminating the final and worst bubble excesses from 1999 to 2000.

Given the intensity of the boom in software-related occupations in the late 1990s, one would expect this particular category of workers to have experienced the highest wage increases among US workers from 1999 to 2001 while at the same time also a sharper drop during the subsequent bust. Figure 3.2, which shows the real median base-wage developments for US software workers relative to selected occupational categories, illustrates that at least part of these predictions indeed materialized.[19]

Computer programmers (in particular) and software engineers did experience the highest base-wage growth rates of any major occupational category from 1999 to 2001, after which management occupations overtook them. However, it is noteworthy that US software workers "gave up" fewer of these "boom-year" median-wage gains during the subsequent bust than what one would have predicted, especially considering the continued inflow of foreign high-skilled workers to these occupations (see chapter 2). Instead, median wage developments for US software workers after 2001 pretty much mirrored those among other occupational categories—i.e., were basically flat.[20] Hence, by 2006 this group of high-skilled workers was still found to be among the top quintile of American workers in terms of wage growth over the entire 1999–2006 period. As can also be seen in figure 3.2, American workers who have really suffered in terms of relative real wage growth are those in traditional low-skilled occupations, such as food preparation, personal care, and construction.

While the aggregate real base-wage developments for US software workers in recent years have not been as buoyant as these workers would have liked, they are nonetheless on par with the—likely equally disappointing—real wage developments in the broader US economy. As such, there is precious little empirical support for assertions that US software workers have been adversely affected by the large inflows of foreign high-skilled workers to their occupation. Instead, they have held their ground quite nicely in an overall economic environment of stagnant real wages (see table A.4 in the statistical appendix for a detailed listing of employment and real wage developments in US occupations from 1999 to 2006).

This section has perhaps not definitively answered whether US software workers have been adversely affected by foreign high-skilled entrants to the workforce, because it does not address the hypothetical

19. The deflator used is the BLS CPI, all items, seasonally adjusted city average. Data for "All Occupations" are available only from 2001 onward.

20. As can be seen in figure 3.2, the biggest beneficiaries of the 1999–2001 internet boom, computer programmers, have from 2001 to 2006 seen a small decline in real wages similar to that found among some lower-skilled occupations.

Table 3.1b Change in base wages for major SOC groups, ranked by median wage change, 1999–2006 (percent)

Occupation	Mean wage	10th percentile wage	25th percentile wage	Median wage
Management	42.0	42	42	40.64
Healthcare practitioners and technical	37.1	30	31	33.45
Business and financial operations	30.2	27	27	28.54
Software engineers	27.6	28	29	28.50
Computer programmers	26.5	30	28	28.30
Life, physical, and social sciences	30.7	26	25	27.43
Computer and mathematical (all)	26.1	21	24	27.20
Architecture and engineering	28.3	24	26	26.76
Protective services	24.9	20	25	24.25
Farming, fishing, and forestry	21.2	18	20	23.96
Sales and related	26.9	18	22	23.52
Healthcare support	24.4	23	24	23.22
Legal	27.8	24	26	22.88
Community and social services	23.3	22	22	22.86
Education, training, and library	25.7	28	24	22.39
Production	20.0	18	20	22.36
Office and administrative support	20.0	17	19	21.24
Arts, design, entertainment, sports, and media	22.5	27	24	21.18
Building and grounds cleaning and maintenance	19.4	17	20	20.70
Transportation and material moving	19.6	18	19	19.23
Installation, maintenance, and repair	19.0	18	19	18.95
Food preparation and serving related	18.1	9	13	18.89
Personal care and services	12.9	12	16	17.21
Construction and extraction	16.8	18	18	15.00

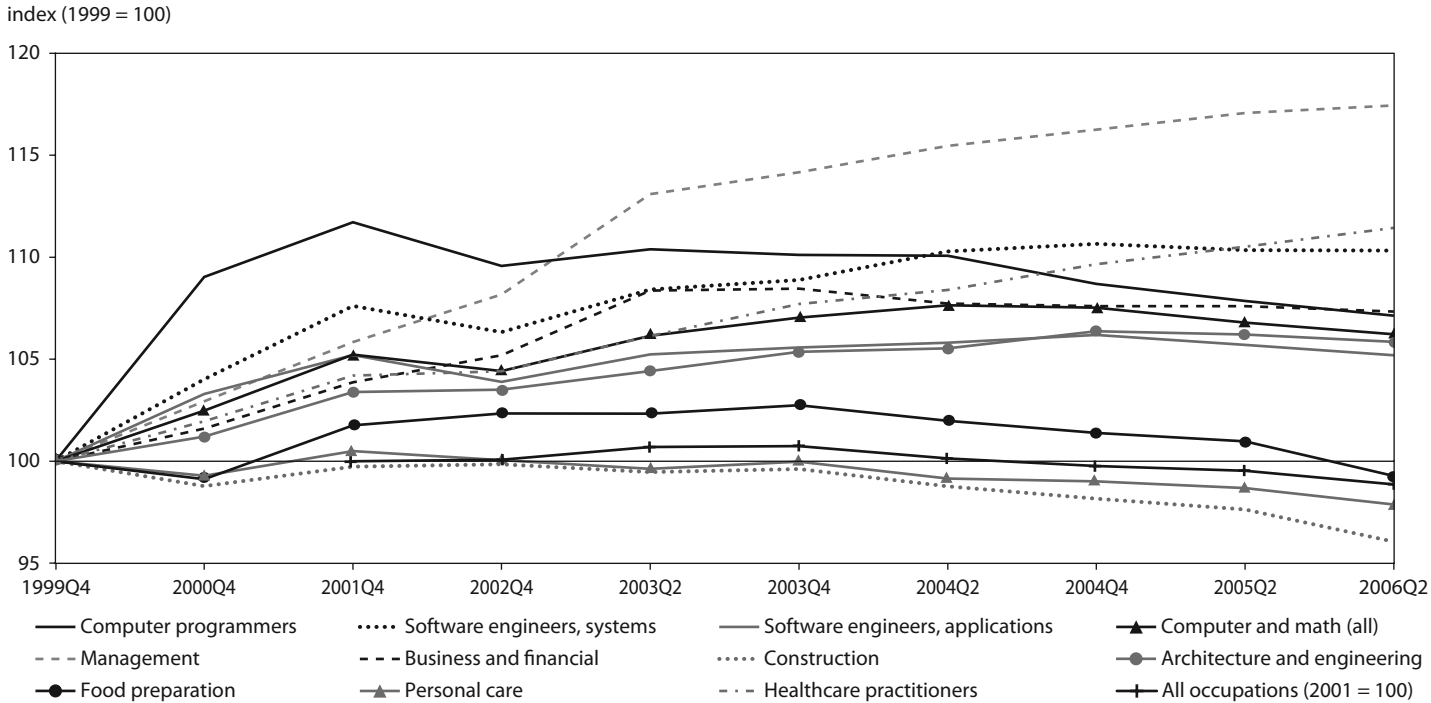
n.a. = not available
SOC = Standard Occupational Classification

Note: Wages from the Bureau of Labor Statistics, Occupational Employment Statistics survey are straight-time, gross pay, exclusive of premium pay. Base rate, cost-of-living allowances, guaranteed pay, hazardous-duty pay, incentive pay including commissions and production bonuses, tips, and on-call pay are included. Excluded are back pay, jury duty pay, overtime pay, severance pay, shift differentials, nonproduction bonuses, employer cost for supplementary benefits, and tuition reimbursements. Shaded occupations are the focus of this chapter.

Sources: Bureau of Labor Statistics, Occupational Employment Statistics, available at www.bls.gov/oes; Bureau of Labor Statistics, Consumer Price Indexes, www.bls.gov/cpi.

75th percentile wage	90th percentile wage	Annual average wage, 2006Q2 (US dollars)	Annual median wage, 2006Q2 (US dollars)	Share of total US employment (percent)	Cumulative share of US employment (percent)
38	n.a.	91,930	80,980	4	4
36	43	62,030	51,980	5	10
31	32	60,000	53,690	4	14
26	25	69,500	65,510		
17	17	84,155	82,075		
33	35	59,660	53,010	1	1
28	26	69,240	66,130	2	3
28	27	66,190	62,390	2	5
25	25	37,040	32,070	2	7
22	21	21,810	17,950	0	8
26	29	34,350	23,160	11	18
25	27	24,610	22,870	3	21
20	n.a.	85,360	67,730	1	22
23	23	39,000	35,790	1	23
24	26	45,320	41,100	6	29
19	18	30,480	27,360	8	37
21	19	30,370	28,080	17	54
19	18	46,110	38,340	1	56
21	19	22,580	20,290	3	59
18	17	29,460	25,300	7	66
19	18	39,060	36,720	4	70
21	24	18,430	16,430	8	79
16	9	22,920	19,070	2	81
15	18	39,290	35,450	5	86

Figure 3.2 Real median wages, selected occupational categories, 1999–2006 (1999Q4 = 100, CPI deflated)



CPI = consumer price index

Source: Bureau of Labor Statistics, Occupational Employment Statistics, available at www.bls.gov/oes; Bureau of Labor Statistics, Consumer Price Indexes, All Items Data, www.bls.gov/cpi.

question of what would have happened to US software workers if foreign high-skilled worker inflows were absent. Such "what if" estimates require substantially more data than what are available for the detailed category of software workers.[21] From the standpoint of basic labor economics, it is straightforward to hypothesize that, in the absence of inflows of foreign high-skilled workers to their occupation from 1999 to 2006 (described in chapter 2), US-based software workers would in all probability have seen even higher wage increases than what were found to have materialized (tables 3.1a and 3.1b and figure 3.2). However, given the findings here—that we are dealing with a group of American workers who in terms of base-wage increases from 1999–2006 belong to the top quintile—the pertinent policy question cannot be, How much more would US software workers have earned without the H-1B visa program, for instance? Instead, a more pressing policy question must be: At what costs to the rest of the US economy would additional economic rents accruing to this group come?

In summary, this section has raised several noteworthy issues concerning the labor-market situation US software workers have faced in recent years.

First, unemployment rates among software workers have been at full employment levels since 2005. Second, employment in software occupations in mid-2006 (latest available) was at an all-time high at 1.2 million workers. Third, the composition of the software workforce has changed, with higher-skilled software engineers making up two-thirds of the total software workforce in 2006 and computer programmers one-third, as opposed to both having been at the same level in 1999. This general development toward higher skill content in the US software workforce is predictable for a high-wage country. Fourth, between 1999 and 2001 base wages of the US software workforce—which are at two to three times the US average base wages—rose faster than those in any major US occupational category, while from 2001 to 2006 they changed at essentially the same rate as those for the rest of the US workforce. Finally, real base wages for the US software workforce have risen substantially more than

21. See Borjas (2001, 2003) and Ottaviano and Peri (2006) for examples of such approaches, utilizing factor proportions models and attempts to control for endogenous effects (i.e., that immigrants disproportionately settle in areas with high levels of wage increases). These approaches, however, work on more aggregate worker categories where more data are available. Madeline Zavodny (2003) attempts to estimate the wage and employment impacts of the H-1B program using the number of the Department of Labor's so-called labor condition applications (LCAs)—the first step in an H-1B application—as a proxy. This is an admirable attempt by Zavodny to use available data to shed light on this issue. However, as described in Kirkegaard (2005), the data uncertainties related to the firm-level LCA data (available at www.flcdatacenter.com) are so daunting that their validity is terminally impaired. Zavodny (2003, 7) nonetheless concludes that "H-1B workers also do not appear to depress contemporaneous earnings growth…. H-1Bs do not appear to have an adverse impact on contemporaneous unemployment rates."

base wages earned by more than 80 percent of the total US workforce. This rise in wages has come despite a significantly larger presence of foreign workers on H-1B visas in computer-related occupations than in other high-skilled occupational categories. This clearly suggests that foreign workers in this field are in general complements to US workers, rather than substitutes.

These findings make it hard if not impossible to convincingly argue—media anecdotes notwithstanding—that the aggregate labor-market situation facing the US software workforce has, after a postinternet boom downturn, been or remains anything other than booming relative to the rest of the US economy despite far larger inflows of foreign workers than in any other high-skilled area in recent years. These findings thus follow earlier studies such as Lowell and Christian (2000), the National Research Council (2001), and Zavodny (2003), all of which found that adverse effects of the H-1B program on native US workers could not be estimated with confidence.

These findings thrust a heavy burden of both proof and responsibility onto the shoulders of those publicly espousing the view that young Americans have next to no future in software occupations due to the inflow of foreign high-skilled workers to the United States, as well as the broader phenomenon of offshoring in the IT sectors.[22] It would be a tragedy if young people in the United States today were indeed turned off from pursuing careers in software occupations due to excessive alarmist rhetoric on this subject instead of being given the facts on the actual labor-market situation, based on empirical investigations using official publicly available data, such as those presented in this policy analysis.[23]

Furthermore, recent developments in the United Kingdom are consistent with the finding that high levels of foreign workers have had no significant adverse effects on US software workers. Data from the UK Home Office show that during 2006, 33,756 new work permits were issued to foreign IT workers. About 80 percent (26,835) were issued to Indian IT workers. As the total UK workforce was only about one-fifth of that in the

22. For an example of such a line of argument, see, for instance, Hira and Hira (2005), in particular the foreword in it by Lou Dobbs.

23. It is noteworthy that this concern is not an isolated US phenomenon. In their September 2007 communication to the EU Council concerning the imminent shortage of e-skills in the European Union, the European Commission notes: "Higher-level e-skills cannot be easily encoded, which puts a premium on these skills in a European workforce context. The issue is debated in the media as the emergence of a significant restructuring of the labour market. Several sources report a deterioration of the image of the ICT sector and ICT work, which is reflected in the decline in the number of students starting ICT courses" (European Commission 2007, 5).

United States in 2006,[24] this figure would correspond to an annual inflow of foreign IT workers to the United States in 2006 of more than 170,000 (of which about 140,000 would be Indians). This number is a third more than the peak inflow to the United States in 2001, when about 110,000 H-1B visas for initial employment in computer-related occupations were issued (see table 2.2). Simultaneously, in 2006, wages for IT professionals in the United Kingdom rose by substantially above the national UK average to £34,500 (about $65,000 in 2006).[25] The UK data further illustrate that large inflows of foreign, especially Indian, technology workers are not limited to the United States and that other countries are increasingly permitting such inflows.[26]

US law sensibly requires that the foreign high-skilled entrants to the workforce requiring an FLC be paid the "prevailing wage," which is defined by the Department of Labor "as the average wage paid to similarly employed workers in the requested occupation in the area of intended employment."[27] It is beyond the scope of this policy analysis to evaluate whether computer-related or other foreign high-skilled H-1B workers are generally remunerated according to US law.[28] Opinions vary significantly on this matter,[29] but as laid out earlier, the overall labor-market situation facing US software workers is quite auspicious. Given the very high concentration of H-1B use among a limited number of IT services and software companies, any enforcement effort to ensure that US laws are being adhered to in this sector would seem quite manageable, especially as each H-1B (and L-1) application must (since May 2005) be accompanied by a special $500 "fraud prevention and detection fee," which is earmarked for enforcement.[30]

It is noteworthy that in June 2007 the Department of Labor settled a major case for $2.4 million (or about $4,000 per person) with Patni Computer Systems, Inc.—one of the top 10 H-1B employers (table 2.3)—con-

24. 28 million workers in the United Kingdom versus 144 million in the United States, according to OECD labor-market data.

25. All data are from ATSCO (2006, 2007).

26. ATSCO (2007) shows that issuance of new IT work permits in the United Kingdom more than doubled by 2006 from just 12,726 in 2000.

27. See page on Frequently Asked Questions on Foreign Labor Certification Prevailing Wages at www.foreignlaborcert.doleta.gov/wages.cfm.

28. Until the Omnibus FY2005 Appropriations bill (HR 4818), which raised it to 100 percent, the "prevailing wage" was legally defined as only 95 percent of what US workers earned. See Kirkegaard (2005) for data showing that employers made wide use of this loophole.

29. See, for instance, Miano (2007) or Hira (2007).

30. See USCIS press release, USCIS Implements L-1 Visa Reform Act of 2004, June 23, 2005, at www.uscis.gov.

cerning 607 H-1B workers who had not been paid prevailing wages during 2004–05.[31] More such targeted enforcement of existing laws would seem the appropriate answer to any concerns over possible underpayment by IT services companies of foreign high-skilled H-1B workers.

Matching Employers with Foreign High-Skilled Workers

Thanks to internet-based job searches and advertising, high-skilled workers, employers, and other potential foreign employees rarely face overwhelming informational obstacles in "matching each other in a labor market" across international borders. This is particularly so in the United States and other English-speaking nations (but also to a lesser degree in French- and Spanish-speaking nations). English is the lingua franca of international business, and a substantial potential pool of English-speaking foreign high-skilled workers exists outside US borders. For high-skilled workers, the principal practical obstacle to cross-border labor-market matching is immigration laws. The degree to which a country's laws choose to accommodate (or not) this relatively easy high-skilled cross-border labor-market matching is a straightforward immigration policy choice.

As mentioned in chapter 1, immigration flows that are family-based, humanitarian, and illegal in nature are of limited high-skilled relevance, and immigration policies emphasizing these types of flows—as in the United States presently—relative to employment-related or student-based immigration thus explicitly downplay the importance of the skills component. However, there are also important differences in the way employment (and student)–oriented immigration functions in terms of guiding domestic employers to potential foreign high-skilled recruits.

Employers in the OECD are generally free to transfer top foreign researchers and executives to a particular country, as is done via the US L-1 visa program. Employers are hence free to manage entirely on their own the cross-border selection of this particular group of high-skilled workers. Alternatively, countries utilize a range of criteria, such as educational qualifications (similar to the requirement in the US H-1B system of at least a bachelor's degree or equivalent), salary levels, or a government-provided list of "occupations with labor shortage" or quotas (like the annual 65,000 H-1B visa cap in America).

Several, especially other Anglo-Saxon, countries utilize so-called points systems, where foreign workers can qualify for a work permit if they obtain a certain number of points, based on a government-issued and usually skills-oriented criteria list. A major advantage of the points system

31. See Department of Labor press release dated June 7, 2007, at www.dol.gov/opa/media/press/esa.

is its flexibility, as it can, in theory, be relatively easily calibrated to target particular categories of foreign skills needed at a particular time in the national labor market. Targeted foreign workers can subsequently "self select" and apply of their own initiative or even choose to upgrade their skills prior to applying, should it be required to meet the threshold. Points systems are inherently more focused on skill levels than, say, family-based immigration systems and hence are preferable for alleviating skill shortages.

However, points systems also have drawbacks. As laid out in OECD (2007c, 97ff), their efficient operation requires a substantial and expensive apparatus for verifying foreign-earned credentials and diplomas. Also, points systems frequently substitute educational attainment and degrees for actual skills and qualifications demanded by employers. While any degree holder will be preferred in skill terms to one with no degree, a points system nonetheless runs the risk of facilitating immigration of high-skilled workers—say, liberal arts graduates—less employable than those graduates possessing skills, say, in the science and engineering fields, directly sought by employers. Hence, in terms of labor-market efficiency, a system—like the US H-1B (and L-1)—that allows employers themselves to directly locate, screen, and ultimately via an employer-sponsored work visa hire foreign high-skilled workers is preferable in labor-market efficiency terms to a points-based high-skilled immigration system.

The use of quotas for high-skilled immigration purposes is invariably the worst possible approach from the perspective of labor-market efficiency. It is basic trade economics that quotas imply an inescapable efficiency loss. Moreover, in immigration, their use raises the issue that the number of permits legislatively permitted—like the *rhetorical* 65,000 H-1B cap in the United States—is set ex ante, while actual labor-market needs are ascertained ex post.[32] So even if politicians set a high-skilled worker quota based on objective demand criteria rather than exogenous political pressures, which is extremely unlikely, they would still be overwhelmingly likely to get it badly wrong. The initial H-1B cap was set at 65,000 in the Immigration and Nationality Act of 1990 based at least partly on earlier years' high-skilled worker inflows, and it has returned to this level in FY2004. The H-1B program is a clear example of demand-supply mismatch: In the spring of 2007, the entire quota for FY2008 was used up in less than a day![33]

Another example of the nonsensical use of prefixed quotas for high-skilled visas is the special H-1B carve-outs (see below) that Chile and Singapore received with their free trade agreements (FTAs) with the United

32. See OECD (2007c, 97ff) for an elaboration of this sequencing issue.

33. See USCIS press release, USCIS Runs Random Selection Process for H-1Bs, April 13, 2007 (revised), at www.uscis.gov. The technicalities of this oversubscription are discussed later.

States. These two countries get "first choice" of a total of 6,800 H-1B visas annually (or more than 10 percent of the total). If nationals of the two countries do not use the entire quota of these 6,800 visas, also referred to as H-1B1, then the remaining roll over to the initial "open pool" of 58,200 in the following fiscal year. In FY2006 nationals of Chile and Singapore used only 700—just 10 percent—of the 6,800 H-1B visas that their trade negotiators secured for them.[34] Certainly this system works wonderfully for US employers of high-skilled Chileans and Singaporeans, who are guaranteed an H-1B visa should they apply. However, while it is unclear just what concessions the two countries had to give during the FTA negotiations in exchange for their quota carve-outs, the 10 to 1 mismatch between the quota and its actual use amply illustrates the difficulties of predicting ex ante the correct size of a high-skilled visa quota. A similar situation can be seen with the E-3 high-skilled visas for Australian nationals, of which 10,500 were made available in late 2005 based on the US-Australia FTA.[35] In 2006, the first full year the quota was in force, just 1,918 "Australian specialty occupation professionals" were issued visas—i.e., less than a fifth of the available number of visas![36]

Moreover, the bottleneck of a quota creates adverse incentives and harmful uncertainty for business planning. With the economic future evidently always uncertain, companies that most depend on foreign workers will rationally seek to acquire as many visas under the quota as possible—"visa hoarding" is the rational response to this scarce resource—both to guarantee their own access to foreign high-skilled workers and to deny that access to their competitors. It is therefore no surprise that several Indian (and US) IT-related companies dominate the H-1B program. They simply have the most at stake and the biggest economic interest in acquiring these visas.

34. See USCIS press release, USCIS Reaches H-1B Cap, June 1, 2006 at www.uscis.gov. Subsequently, 6,100 of the two countries' FY2006 quota were allocated to the open pool of 58,200 in FY2007 for an initial total of 64,300.

35. The law was publicized in the *Federal Register* on September 2, 2005. Unlike the FTAs with Singapore and Chile, the US-Australia FTA has, following the congressional turf war over this issue, no direct mention of the high-skilled immigration issue. Indeed, a side letter to the agreement specifically states that "no provision in it shall be construed to impose any obligation on a party regarding its immigration measures." See the side letter on immigration in chapter 10 of the final text of the US-Australia FTA, available at the USTR website, www.ustr.gov. This side letter is merely a legal fig leaf, aimed at pleasing the US Congress to make it appear that there is no link between FTAs and US immigration law. The *Federal Register* on September 2, 2005 announced the new rule, following an amendment to the Immigration and Nationality Act of 1990 attached to the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005, Public Law 109-12 119 Stat. 231, which created the E-3 visa *only* for Australians.

36. Children or spouses of specialty occupation recipients took 1,053 E-3 visas in 2006. See Department of State (2006, table XVI (B)).

Hence, such companies are likely to mobilize substantial economic resources toward this goal. Stuart Anderson (2006) in testimony before the US Congress estimated that each H-1B visa today costs up to $5,000 to $6,000, depending on whether employers pay the $1,000 "premium processing fee." Infosys, the top user of H-1B visas (table 2.3), stated the following in its 2007 20-F filing:

> In addition, the availability of visas for working in the United States may vary substantially from quarter to quarter. Visas for working in the United States may be available during one quarter, but not another, or there may be differences in the number of visas available from one quarter to another. As such, the variable availability of visas may require us to incur significantly higher visa-related expenses in certain quarters when compared to others. For example, we incurred $11.0 million in costs for visas in the three months ended June 30, 2006, compared to $3.0 million for the three months ended March 31, 2006. Such fluctuations may affect our operating margins and profitability in certain quarters during a fiscal year.[37]

With Infosys and likely most other companies at the top of the H-1B usage list literally spending millions of dollars each quarter on securing these visas, potentially interested US employers with less financial resources to pay immigration lawyers and fees—such as most US startups and small and medium-sized enterprises—are certain to lose out in accessing foreign high-skilled talent.

Perversely, one might argue that an "H-1B auction system" has inadvertently been established such that only those companies with the greatest economic interest in acquiring H-1B workers may do so in reality. In some respects such an implicit H-1B auction system would be economically efficient but begs the question why the US Citizenship and Immigration Service (USCIS) and immigration lawyers should reap the majority of the proceeds from such an auction?

Such H-1B auction rents are far from negligible. Through current visa regulations, the USCIS estimates that in FY2006 it "earned" $138 million in annual fee revenue.[38] The Omnibus FY2005 Appropriations bill (HR 4818) earmarks $1,500 per application as a "retraining fee,[39] which goes toward US workers, and $500 as an "antifraud fee," which goes toward enforcement activities. However, these data include only the 85,000 fully fee-earning H-1B visas processed annually under the congressional cap.

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37. Available at the Securities and Exchange Commission's EDGAR database for company information at www.sec.gov/edgar.

38. Based on 85,000 fee-paying petitions. The Office of Management and Budget (OMB Circular no. A-25 on "User Charges") demands that federal agencies charge "full cost" of providing special benefits to a recipient when calculating fees. Full cost is defined as "all direct and indirect costs to any part of the Federal Government of providing a good, resource or service." See Gonzalez (2007) and GAO (2005).

39. It is $750 for companies employing fewer than 25 full-time employees.

Yet, table 2.1 showed that in FY2005, more than 267,000 H-1B visas were issued when all categories are included. This implies that when viewed from the perspective of US-based employers—who ultimately pay the bills—the total annual costs of acquiring H-1B visas may have approached $1 billion in FY2005.

A "back-of-the-envelope" estimate, based on Anderson (2006), for total costs of $5,000 per visa for the 85,000 visas under the FY2005 cap and $3,000 for all 182,000 visas granted that did not count toward the cap in FY2005 (which means that they wereexempt from the fees mentioned above) equals total costs in the $1 billion range.[40] As currently implemented, the H-1B cap thus clearly favors highly H-1B dependent Indian IT companies and (as usual) US lawyers.

Given this cost level for US businesses, it is ironic that the USCIS in April 2007, following the receipt of more than 123,400 H-1B applications on April 2–3, introduced a lottery (or in USCIS language, "computer-generated random selection process") to distribute the 65,000 visas available in FY2007.[41] While in some respects perhaps legally fair, such a lottery approach is without doubt the least economically efficient way to match employers and foreign high-skilled workers.

40. GAO (2005) indicates that US businesses may spend more than $100 million on accessing the 20,000 H-1B visas available to foreign recipients of master's degrees or higher at US universities.

41. See USCIS press release, Change in H-1B Procedures Trims Weeks off Final Selection Process, April 19, 2007, at www.uscis.gov. April 1, 2007 was a Sunday, and hence the USCIS started receiving petitions only on April 2. The agency did not notify the public until April 3 that the cap of 65,000 had been reached (USCIS press release, USCIS Reaches FY2008 H-1B Cap, April 3, 2007), and it was subsequently administratively determined that all petitions filed prior hereto had been legally received on the "final receipt day."