5

Information Technology and Labor Markets

One of the most controversial aspects of globalization is its impact on American workers. However, technology also affects workers, and in much similar ways. A substantial research portfolio focuses on the combined forces of technological change and globalization, although parsing out the specific effects of one versus the other is not possible since globalization and technological change go hand in hand. The successful diffusion of IT throughout the US economy into non-IT-producing sectors, accelerated by the globalization of IT and international competition more generally, means that the US labor market is experiencing significant structural change. This change was already examined in the context of workplace practices that enhance productivity growth; this chapter illuminates the issue in the context of wages and employment.

Even if there were no endogeneity between trade and technology, the pervasive and widespread diffusion of IT across economic sectors would mean that a wider and wider swath of the economy and workforce would face the forces of rapid technological change and the business cycles associated with that investment cycle. Data show that IT investment and IT occupations (at both IT and non-IT firms) go hand in hand. So with widespread diffusion of IT throughout the economy, the technology cycle (such as the boom-bust and slow recovery during 1995–2004) generates a business cycle that affects an increasingly larger segment of the US economy and workforce. Since IT also is an increasingly globalized industry and with communications networks enhancing global links, a greater proportion of activities and workers are exposed to international competition. Therefore, IT and communications do have an explicit role in accelerating structural change and transmitting business cycles to a more globally integrated American economy and workforce.

The transformation of the workplace in the face of networked IT implies rapid changes in the skills that are demanded and, more specifically, rapid depreciation of the skills of incumbent workers in the technology professions. Because more and more labor market functions can be replaced by technology, or fragmented and then carried out from remote locations, the challenge to keep skills current and matched to job demands is greater than ever. The issue of skill depreciation comes on account of IT itself (as technology replaces labor) as well as from communications and network-enabled IT that allows competition to come from labor available abroad.

Finally, a specific interplay between IT, globalization, and the labor markets takes place in America. This is the role that specialized technology immigrant visas play in the US labor market pool of technology professionals.

IT and the US Labor Market

IT and its globalization affect the labor market in a number of ways. First, workers are employed by IT producers—that is, at hardware, software, and services (such as database services) firms. Second, with greater investment and use of IT throughout the economy, another group of workers has emerged, those who have skills to implement and integrate the use of IT in the non-IT-producing sector. These are IT professionals, such as computer network software engineers and database administrators, who work in the non-IT-producing sectors (to be sure, some are also employed in the IT-producing sector). Third, an increasing number of workers use IT products on the job, although IT certainly is not their main or even peripheral job activity (e.g., call center staff or financial analysts). Thus, there are three types of workers affected by IT and its globalization: IT occupations at IT-producing firms, IT occupations at IT-using firms throughout the economy, and IT-related occupations (box 5.1).

Even as IT helped the US economy reach unprecedented rates of macroeconomic growth and low unemployment in the 1990s, it also helped usher in an era of significant restructuring of the labor market that continues today. Indeed, the very transformation and networking of business that has generated the macroeconomic gain has, on the other side of the coin, contributed significantly to the restructuring of labor activities. It is difficult to disentangle the available data to determine exactly how important IT has been, or even more narrowly, how important the globalization of IT has been, to the restructuring of the US labor market. Since, arguably, globalization and technological change cannot be disentangled, it would seem best to look at labor market restructuring overall and make inferences regarding the importance of further globalization as facilitated by IT.

Box 5.1 US labor market statistics

Describing the behavior of categories of workers and tracing the implications of the globalization of IT on each of these worker categories presents a variety of challenges.

A first challenge is the extensive data on the labor market from the Bureau of Labor Statistics (BLS). Most official labor data in the United States come from the bureau's three major survey programs: (1) the Occupational Employment Statistics (OES) survey, which gathers data on wages and employment from approximately 400,000 US establishments annually;[1] (2) Current Employment Statistics (CES), a survey of payroll records that covers more than 300,000 businesses on a monthly basis; and (3) the Current Population Survey (CPS), which gathers information on the labor force status of approximately 60,000 households on a monthly basis.[2] The scope of the official survey data collection is substantially larger and consequently more likely to be reliable than any other source of labor market information in the United States.[3]

There are three principal methodologies for presenting official statistical information on jobs in the United States. One is based on occupations, one on geography, and another on economic sectors (industries). The data can be organized by occupation, by geographic region, by industry, or by more than one criterion, i.e., a particular occupation in a given region of the country or a specific industry. For example, the term "US software publishing employment" would refer to all employees in the industries of the total US economy that produce software,[4] irrespective of occupational category (a CEO or a programmer or janitor) or geographic area. "California computer production employment" would refer to all production-floor employees (not the CEO) in the industries of the economy that produce computers in California.[5] Similarly, the term "US engineering jobs" would refer to the occupational category of "engineer," regardless in which industry or geographic area the job is located.[6]

The Bureau of Labor Statistics administers several other surveys to monitor developments in the US labor market. The Dislocated Worker Survey collects data on what happens to US workers after they have lost their job; the Mass Layoff Statistics reports on mass layoff actions (50+) that resulted in workers being separated from their jobs; several national longitudinal surveys collect information at multiple points in time about the labor market and life experiences of several groups of American men, women, and youth; and the Job Openings and Labor Turnover Survey (JOLTS) collects information and data on job openings, hires, and separations. More recently, the American Time Use Survey (ATUS) has been added to collect information on how Americans spend their time.[7]

(box continues next page)

Box 5.1 US labor market statistics *(continued)*

These data tell us about changes in the US labor market, but except for the Mass Layoff Statistics (MLS), they do not shed light explicitly on how globalization or technological change affects US labor markets. Further research using all these data is needed to tease out more insights on the role for globalization and technological change.

---

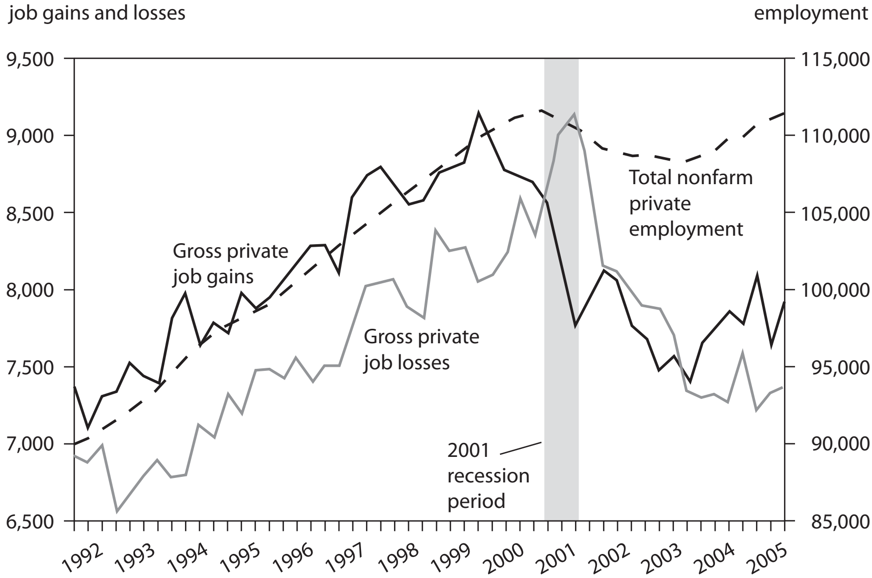
1. This annual total means that each US business can expect to be surveyed about every third year. See the overview of the OES survey at www.bls.gov (accessed April 29, 2005).
2. The US Census Bureau conducts the CPS for the Bureau of Labor Statistics.
3. There exist, however, significant discrepancies between the different surveys, such as the widely publicized discrepancy in employment growth figures between the CES and CPS between 1998 and 2003 (Nardone et al. 2003). However, see Bureau of Labor Statistics Web site, www.bls.gov, for evidence that the CES and CPS data surveys converged.
4. This would be North American Industry Classification System (NAICS) classification 5112 (Software Publishing).
5. These would be NAICS 3341 (Computer and Peripheral Equipment Manufacturing) and 3344 (Semiconductor and Other Electronic Component Manufacturing).
6. Engineers are included in the Standard Occupational Classification (SOC) major category 17–0000 "Architecture and Engineering Occupations" as 17 individual occupational categories for different types of engineers (SOC categories 17–2011 to 17–2171).
7. See Bureau of Labor Statistics Web site for overview of survey resources, www.bls.gov/bls/employment.htm (accessed October 1, 2005).

Job Churn, Business Dynamics, and Structural Change

As a backdrop to any specific analysis of the globalization of IT, it is important to point out that there is a remarkable churning of jobs in the US labor market. That is, there is constant creation and destruction of jobs, with about 7 million to 8 million job increases and decreases occurring every quarter in the United States, accounting for about 6.5 to 7.5 percent of all private jobs. Job churn clearly is related to the overall business cycle, with both increases and decreases in numbers of jobs rising during a business cycle upturn. During such a period, with more creation than destruction, employment rises and unemployment rates generally fall (figure 5.1).

Several researchers have investigated the nature of job churn and job change in recent years (Figura 2003, Schultze 2004, Groshen and Potter 2003, Bradbury 2005). They suggest that structural changes in the distribution of firms and jobs around the economy help to explain labor market behavior of the overall economy since 2000. During previous downturns, people were often laid off but then called back by the same employer during the subsequent recovery to do the same job. But in the recent economic cycle, IT changed the landscape to a greater degree than before—new firms needed new workers with new skills, or old firms changed

Figure 5.1 US job turnover, September 1992–June 2005 (thousands)



Note: Data are for March, June, September, and December of the years indicated; 1992 includes September and December; 2005 covers March and June.

Source: Bureau of Labor Statistics, Current Employment Statistics and Business Employment Dynamics Statistics.

what they were doing, how they were doing it, and the skills needed in those hired back.

These structural shifts in the demand for labor across different industries result in permanent job losses and delay permanent job gains. That is, when the same types of firms experience a reduction in demand (due, for example, to lower exports or lower consumer demand), they tend to lay off workers who are then recalled when demand picks up again. But if firms think that the downturn in demand is permanent (or the activity can be replicated abroad), then they simply fire workers. It will then take time for firms to believe that an upturn in demand warrants creating permanent positions; if the activity has been permanently moved abroad or replaced by technology, the same positions will never be recreated. Finally, if workers have to move between industry sectors, they have to entertain a similar commitment (for example, to new skills or to a new geographical location) as the firms.

Other research examines these issues through the lens of job tenure. Hypothetically, at one time workers stayed with a single firm for a long time, working their way up the corporate ladder to higher skills, higher wages, and job security (Schultze 1999). Has IT changed this hypothetical?

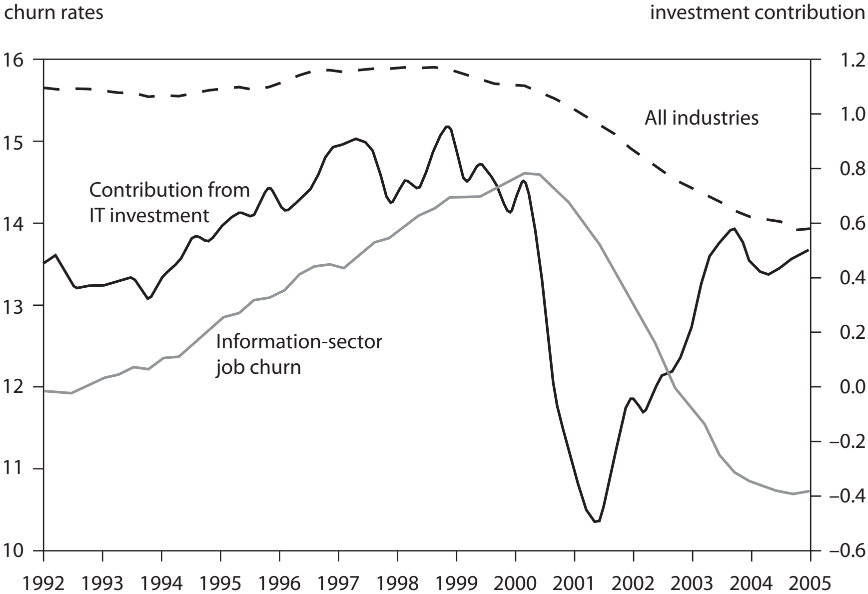
Tenure by occupational category highlights the difference between the overall trend and the trend in the job categories most affected by technological change. While the overall trend from 1983 to 2002 showed a slight increase in worker tenure, the average tenure for engineers over the same period fell from 6.3 to 5.2 years, and that for math and computer scientists fell from 3.8 to 3.2 years.[1] These data might support the hypothesis that the skills of older technology workers become obsolete. But virtually the entire drop in the average worker tenure for these occupations occurred from 1996 to 2002, a period of very tight US labor markets for these professions. On the other hand, tenure for these two groups lengthened considerably over 2002–04, a period of much looser labor market conditions. By 2004, the average tenure for engineers had lengthened again to 5.8 years, the equivalent of the 1996–98 period, while that of math and computer scientists increased by 1.6 years to 4.8 years, the highest since 1987. There are two interpretations of the behavior of worker tenure in these technology-oriented occupations: voluntary job-hopping was considerable in the IT boom period, then stopped as job opportunities disappeared; and new employees in these occupations entered during the economic boom in the late 1990s but then left after 2000, leaving only those with longer tenure behind. These data do not specifically affirm the notion of a depreciation of skills for technology-intensive occupations.[2]

Against this backdrop of job churn rates and job tenure, is there evidence of any specific role for IT (figure 5.2)? During the boom years when IT was being incorporated widely throughout the economy, job churn increased. After the technology bubble popped, job churn rates (churn/employment) for both job gains and job losses fell for IT employment and less dramatically for all employment. Even as investment in IT started to rebound in 2003, churn rates for IT occupations and for overall employment have stayed low. Sluggish IT investment may temper the diffusion of IT into new sectors and thus slow business transformation, which would tend to reduce the pace of job creation and destruction. A period of strong IT growth may be necessary to boost churn rates again. If this hypothesis holds, the next wave of technological innovation and globalization of IT to deepen its use in the US economy, and in particular to diffuse

1. Bureau of Labor Statistics (2002, 2004). Occupational categories here are meta-categories of occupational categories and hence different from those utilized elsewhere in this book.

2. Disaggregating the worker data into different age groups (but all occupation classes) finds some support for the skill depreciation story. Between 1983 and 2002, the job tenure of older men fell substantially, from 7.3 to 5 years for men aged 35–44, from 12.8 to 9.1 years for men aged 45–54, and from 15.3 to 10.2 years for men aged 55–64. However, from 2002 to 2004, men aged 35–44 saw tenure increase slightly again to 5.2 years, while those aged 45–54 saw tenure increase to 9.6 years. Only 45- to 54-year-old men experienced continued shorter average tenure, declining to 9.8 by 2004. Relatively more of these older men whose job tenures shortened were white-collar workers (although through both periods, blue-collar workers were more likely to be displaced). So skill depreciation induced by technological change may be taking its toll on the older workers—or they may be suffering age discrimination more generally.

Figure 5.2 Job churn and IT investment contribution to real GDP growth, 1992–2005 (percent)



Note: Three-year moving average.

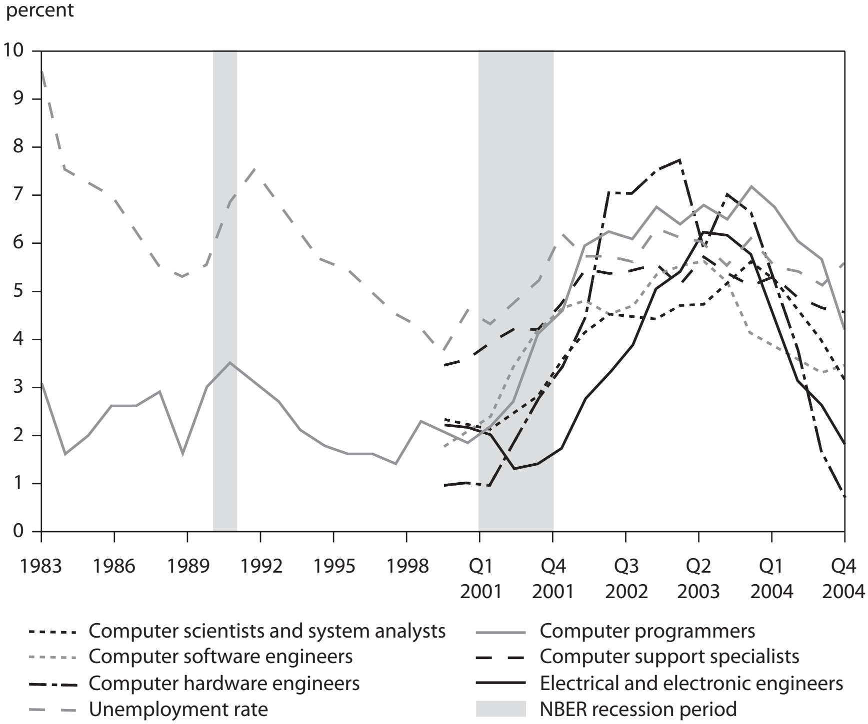
Sources: Bureau of Economic Analysis, National Income and Product Accounts, table 1.5.3, www.bea.gov/bea/dn/nipaweb (accessed October 1, 2005); Bureau of Labor Statistics, Business Employment Dynamics Statistics, www.bls.gov/bdm (accessed October 1, 2005).

it more broadly into the lagging sectors, could propel a new round of business transformation, a rise in job churn (both job losses and job creation), and a second wave of enhanced productivity growth based on that transformation.

IT, Jobs, and the Business Cycle

From an economywide perspective, the higher productivity growth associated with investment and integration of IT translates into higher potential employment and a lower unemployment rate consistent with sustained low inflation. In the mid-1990s, as the US unemployment rate fell below 5.5 percent, pundits and economists thought wage-cost pressures would mount and raise inflation. Federal Reserve Chairman Alan Greenspan interpreted the productivity gains from IT as raising labor productivity and lowering the nonaccelerating inflation rate of unemployment (NAIRU). Thus the Federal Reserve kept interest rates low for a while longer, adding many more jobs to the US economy than would have otherwise been the case.

Figure 5.3 Unemployment rates, total and selected categories of IT-related occupations, 1983–2004



Notes: Annual data from 1983–99 and four quarter moving averages from 2000–05.

Sources: Economic Policy Institute and Bureau of Labor Statistics.

But IT does not eliminate the business cycle; indeed, the widespread diffusion of IT throughout the US economy appears to have accentuated the impact of the business cycle on workers in the IT profession. As IT becomes more deeply integrated throughout the economy, workers with IT skills will be more exposed to the general business cycle because they are not necessarily working in the IT sector but rather in IT occupations throughout the economy. Data suggest that heretofore, employment of engineers and computer programmers was less cyclical than the economy as a whole, but that now the unemployment rate dynamics for these professions look much more similar to those of the economy as a whole (figure 5.3). In fact, by the end of the 1990s, two-thirds of IT professionals worked outside the IT-producing sector (hardware and services/software).

Not only do those in IT occupations face business-cycle risk, some also face explicit technology risk. Following the completion of Y2K work, as well as the decline of the technology boom and the drop in IT investment, it is not surprising that jobs for IT professionals shrank and unemployment rates for these occupations rose dramatically. But certain occupations (such as computer programmers) face additional risk consistent with an increased "commoditization" of these skills. The fragmentation of the production process of software and the advent of communications links change the skills demanded in the United States and allow some of these skills to be purchased abroad.

IT, Skill Demands, and Dispersion of Earnings in the United States

One of the more notable and intensively studied features of the US labor market during the past 25 years has been the evolution in the dispersion of earnings in the economy.[3] Is there an identifiable role for IT? One hypothesis is that the rising wage dispersion in the United States (compared with other industrial countries) mirrors differential US productivity performance, which, as noted, is driven in part by diffusion of IT. This section takes a look at the labor market side of the story.

Recent research has focused on the particular role for IT in affecting what people do on the job, what skills are demanded, and the wage premium received in the marketplace by those tasks and skills. The link between the globalization, price, and widespread use of IT in the US economy suggests a relationship between globalization and wage dispersion. To the extent that the bulk of the price decline and the power capability of computers and software come from technological innovation, then it is technology, not globalization per se, that is the most important factor affecting wage dispersion in the US economy. From the perspective of a policymaker (as well as the public), the globalization versus the technology effect may engender quite different reactions, even if in the end they have quite similar policy implications.

Much of the original research focused on IT capital investment as driving skill-biased technological change. Individual workers and classes of workers in firms and in industries that use IT tended to also have higher skills, as measured by educational attainment, along with higher earnings (Krueger 1993). Exactly why IT investment raised skill demands, and how that might be related to educational attainment, was not clear and spawned a second stage of research that focused on how workplace practices and product characteristics in a sector interact with IT investment and worker skills to raise the level of skills demanded in the workplace (Bresnahan, Brynjolffsson, and Hitt 2002).

3. A large literature on the widening of wage inequality in the United States includes Bound and Johnson (1992); Katz and Murphy (1992); Levy and Murnane (1992); Katz and Autor (1999); Goldin and Katz (2001); Acemoglu (2002); Baily and Kirkegaard (2004); Autor, Katz, and Krueger 1997; and Dunne et al. 2000.

A related question when analyzing the progress of technological diffusion through the economy over time is whether the wage premium received by those skilled enough to use computers was durable or would tend to disappear as computer use became a pervasive requirement of many jobs. Research that disaggregates workers and classifies them by educational attainment shows that the behavior of the wage premium varies by worker education (Valletta and MacDonald 2004). Controlling for various worker characteristics that are known to affect wages (such as age, race, sex, marital status, veteran, union, part-time, and rural/urban), the wage premium to computer use for workers without a bachelor's degree fell from the peak of the wage premium in 1993 (about 22 percent) to about a 15 percent wage premium in 2001. In contrast, for workers otherwise similar except for having a bachelor's degree or higher, the wage premium contracted initially but then widened dramatically—the wage premium to computer use for college-educated workers rose to more than 30 percent by 2001. So, pervasive computer use by workers with lower rates of educational attainment eliminated any wage premium, whereas pervasive computer use by workers with higher rates of educational attainment accentuated their wage premium.

The results suggest that the wage premium that accrues from on-the-job computer use indeed narrowed for most workers as the share of workers using computers as an integral job requirement increased. That the growth in college-educated workers tended to slow over this period also is consistent with the higher wage premium enjoyed by those workers (Card and Lemieux 2000). Did the nature of the jobs change in such a way as to put the workers with lower educational attainment at risk as a result of technological innovation that eliminates their jobs in favor of a computer (e.g., voice and key response technology in answering services) or a foreign worker via low-cost telecommunications networks and codified activities (such as call centers or programmers)?

Key insights on differential returns to computer use come from research on how the availability and price of IT computing capability change tasks (Levy and Murnane 2004; Autor, Levy, and Murnane 2001, 2002). IT complements and enhances some tasks (those that involve problem-solving, judgment, and communications skills) and thus raises the demand for workers in those jobs. IT substitutes for other tasks (those that involve routines that follow explicit rules) and thus reduces the skills demanded by workers in those jobs. This augments the wage premium enjoyed by those using computers for complex tasks on the job and reduces any wage premium heretofore enjoyed by now-routine jobs, even those that may involve use of a computer.[4]

A particularly important result of this research is that the drive to change task content is industry-based. That is, industries that intensively use business processes characterized by routines and explicit rules have invested

4. See Wilson (2004) for an example of this substitution for low-skilled workers by software.

the most in IT, thus changing the mix of tasks between those done by people and those done by IT. IT-intensive industries increase their demand for labor with the skills characterized by judgment, problem solving, and communications, and reduce their demand for workers who performed the routine tasks following explicit rules. Within these industries, tasks did not shift away from lower-education workers to higher-educated ones. Rather, the shift in type of task intensive in the occupational mix was found to be pervasive at all educational levels. This research puts the role for IT directly at the heart of wage dispersion in the United States, not so much as it relates to educational attainment across all sectors but as it relates to tasks done within the industry sector.

From a number of different perspectives, factors that have reduced the price of IT and thus facilitated more investment in IT differentially affect US workers with different levels of educational attainment, and who do different tasks in different sectors. Greater investment in IT in some industries yielded higher returns to those workers with educational attainment beyond high school. Industries whose business processes favored investment in IT moved the task mix in favor of workers with higher skills, as often proxied by educational attainment. All told and through several channels, IT appears to play a role in the rising earnings dispersion observed in the data.[5] To the extent that the globalization of IT reduces its price and promotes its diffusion, globalization and IT appear to work together to raise earnings inequality in America.

Globalization of Business Services and White-Collar Jobs

IT and communications networks are not just a US phenomenon. Increasingly, other countries are investing in these technologies, so more cross-border services trade is inevitable. Moreover, because IT and communications networks enable the fragmentation, digitization, and codification of all sorts of services activities, the potential for international trade in services goes well beyond the narrow confines of IT services and software. Chapter 4 discussed how the globalization of IT services and software, in particular, portends a second wave of IT-based productivity growth in the United States. What does the globalization of services to date tell us about the potential impact on different kinds of workers?

Which Workers Are Exposed to Globalization of Services?

Assessing the impact of increased globalization of services on workers first requires identifying which services activities and occupations have

5. However, Lawrence Mishel and Jared Bernstein (2003) do not find a relationship between computer use and increased wage dispersion.

the greatest potential exposure to technology-enabled international trade. While it might be desirable to distinguish between occupations at risk for cross-border trade replacement and technology replacement, this is difficult to do, for the very reason that trade and technological change are endogenous.

Nevertheless, one approach, by the Organization for Economic Cooperation and Development (OECD) Working Party on the Information Economy, uses a methodology to identify which occupations may be affected by globalization of services (Vickery and van Welsum 2005).[6] The OECD suggests that workers in occupations with tasks characterized by four criteria are at potential high risk of being affected by technology-enabled international trade: (1) an intensive use of information technologies; (2) out-put that can be traded or transmitted using IT-enabled trade in services; (3) tasks with high explicit information or "codified knowledge"; and (4) little face-to-face contact required.

Examining data from several countries, the OECD classified 68 US occupations at risk from offshore outsourcing. From 1995 to 2002, the share of total employment in the United States in these occupations declined from 19.2 to 18.1 percent. Among the countries examined, only the United States experienced a decline in the share of affected occupations.[7] This may be a direct effect of increased job loss to offshore suppliers of these services, but may also come from more extensive adoption of transformative technology in the United States compared with other countries, which would lead to more American jobs disappearing sooner as they become automated or digitized.

Another data-driven approach to estimating the share of the US workforce potentially at risk from global forces considers the geographic concentration of occupations and industries (Jensen and Kletzer 2005). Geographically concentrated production likely exhibits economies of scale, which is positively related to tradability, whereas geographically dispersed production is less likely to be tradable on account of characteristics such as weight, local regulations, or requirements of face-to-face delivery. Thus, services occupations and industries that are highly geographically concentrated in the US economy may be more likely to be tradable domestically

6. Another study with a similar approach is Bardhan and Kroll (2003). The OECD does not take into account three factors mentioned in Bardhan and Kroll: a high wage differential with similar occupations in destination countries, low set-up barriers, and low social networking requirements.

7. The share of total employment made up by occupations at risk of being affected by offshore outsourcing may also decline if this group has lower employment growth than the economy as a whole. Such a scenario may also be caused by offshore outsourcing, as the phenomenon, while not causing an absolute decline in employment, may cause employment growth to rise less than would otherwise have been the case in affected occupations.

and may therefore have greater potential to be traded internationally on account of globalized IT and networks. The research finds that although the services industries are generally less potentially tradable than manufacturing sectors, more workers in services industries may be affected by trade forces because services represent a larger share of employment in the US economy. About 14 percent of employment in US services industries is potentially tradable, as compared to about 12 percent of manufacturing employment. Since what matters for potential exposure to international forces is occupation, not industry, some workers in "nontradable" sectors still can be affected. So over the whole labor force, some one-third of employment could potentially be tradable!

What do we know about these workers? Controlling for worker characteristics and for the sector in which they work, Bradford Jensen and Lori Kletzer (2005) find that workers in tradable services occupations earn about 17 percent more than similar workers in nontradable services occupations. On the other hand, these workers also face a more volatile job environment, with higher rates of job loss. Bringing these characteristics together with others already noted, it can be said that these highest-earning, yet volatile, occupations appear to be in the same sectors that have the highest IT intensity and make the greatest contribution to productivity growth, and where there is comparative advantage in international trade.

A third view on prospects for wages and employment is the projections by the Bureau of Labor Statistics (BLS) for growth (and decline) in occupations, which may shed light on technological replacement of jobs versus technology-enabled global replacement of jobs. A BLS report issued in February 2006 projects that four of the top 10 and six of the top 20 occupations that will grow most rapidly between 2004 and 2014 will be IT-skilled occupations, including network systems and data communications analysts; network, computer systems, and database administrators; and software application and systems software engineers (BLS 2006). For these IT occupations, projected growth of 45 percent is 3.5 times the projected growth of jobs overall in the economy. Because of the higher estimated income elasticity of demand for the products and activities that workers with these skills produce, demand for these workers is projected to expand at well more than the rate of growth of the economy overall. On the other hand, the BLS projects an acceleration in the rate of decline of certain occupations expected to be replaced by technology or characterized by a more routine and codified set of skills, such as data entry, word processing, and typing. For computer programmer occupations, the rate of growth is projected to be well below that for the economy as a whole.[8]

8. See the appendix to the BLS report at ftp://ftp.bls.gov (accessed March 15, 2006).

What Do Occupation Data Reveal?

Detailed data highlight several additional perspectives on the US labor market. Since internationally tradable occupations have the potential to cut across industry sectors, employment data should be categorized by occupation (software programmer) rather than sector (information publishing). In addition, it is important to cut through the boom-and-bust period, using the longest time period of consistent data available.[9] What do these data say about trends in US employment in tradable sectors and occupations?

First, the mix of jobs has moved relatively more toward those services occupations thought to be most affected by globalization and technological change (table 5.1). For example, business and financial occupations never declined even through the recession; computer and math occupations (mostly the former) have recovered to the previous technology-boom peak; and architecture and engineering occupations (mostly the latter) have nearly recovered to the previous peak.

Second, over the whole economy, the main decline in jobs has been in the manufacturing sector, but about 20 percent of the job loss in the manufacturing sector is in services occupations within manufacturing industries. This points to the fact that IT, which makes possible the international production of goods, also impacts services workers at manufacturing firms. On the other hand, the services occupations in the manufacturing sector rebounded after the 2001 recession, whereas production occupations did not. Finally, management occupations have been particularly hard hit. Whether this is due to the ability of IT to "flatten" the management hierarchy is an open question.

The occupational categories in table 5.1 are too broad to distinguish skill characteristics that might match the analyses of skill class discussed above. Detailed data on occupations in IT-related fields point to how technological change and globalization together may affect jobs and wages in the US labor market (table 5.2).

Low-wage workers who use IT appear to be particularly hurt by the combined effect of technology and international trade. These occupations, which in general earn about $25,000 annually—telemarketers, switchboard operators, telephone operators, computer operators, data entry keyers, word processors and typists, and office machine operators—experienced very large job losses (almost 712,000) over the entire period of available data (from 1999 to November 2004). The decline represents about 30 percent of all those employed in these categories as of 1999. Over the five-year period, these occupations never experienced a boom and are not likely to return to the United States or indeed anywhere, to the extent that they have been replaced by technology itself.

9. See Kirkegaard (2004) for a detailed discussion of alternative BLS data.

Table 5.1 US employment, 1999–2005 (millions)

Sector/occupation	1999	2000	2001	2002	May 2003	May 2004	November 2004	November 2005
Total nonfarm private employment	110.0	111,643	109.3	108.5	108.3	109.8	110.6	112.4
Manufacturing	17.3	17,175	15.7	14.9	14.6	14.3	14.3	14.3
Private services providing	85.4	87,071	86.2	86.3	86.5	87.9	88.6	90.1
Total IT occupations[a]	6.1	6,383	6.1	5.9	5.8	5.8	5.9	n.a.
Of which:								
Nonproduction occupations	5.6	5,875	5.6	5.5	5.5	5.5	5.6	n.a.
Production occupations	0.5	508	0.4	0.4	0.4	0.3	0.3	n.a.
Management occupations[b]	8.1	7,783	7.2	7.1	6.7	6.2	6.1	6.4
Business and financial occupations[b]	4.4	4,619	4.7	4.8	4.9	5.1	5.3	5.1
Computer and mathematical occupations[b]	2.6	2,933	2.8	2.8	2.8	2.9	2.9	2.9
Architecture and engineering occupations[b]	2.5	2,576	2,.5	2.4	2.4	2.4	2.4	2.4
Of which engineers	1.1	1,198	1.2	1.2	1.2	1.2	1.3[c]	n.a.

n.a. = not available

a. IT occupations as defined by the US Department of Commerce in *Digital Economy* 2002 and 2003, annual data.

b. The November 2005 number has been generated using the rate of change from November 2004 to November 2005 in the seasonally unadjusted data from the Bureau of Labor Statistics, Current Population Survey, series LNU02032453 (Management), LNU02032454 (Business and Finance), LNU02032455 (Computer and Mathematical) and LNU02032456 (Architecture and Engineering) on the November 2004 data.

c. For time consistency, the current Standard Occupational Classification (SOC) category 17-2199 "Engineers, All Other," existing only in 2004 has been excluded. As such, in November 2004, total engineering employment in the United States was 153,000 higher (at 1.40 million) than the data total indicated in this table.

Source: Bureau of Labor Statistics, Occupational Employment Statistics, www.bls.gov/oes/home.htm (accessed October 1, 2005).

Table 5.2 US technology-related occupations, 1999 to end-2004

	Number of employees					
Occupation	**1999**	**End-2004**	**Total change**	**Percent change**	**Annual wage, 2004** (dollars)	**Annual real wage change 1999–2004** (percent)
Call center–type occupations						
Telemarketers	485,650	407,650	–78,000	–16.1	23,520	–0.3
Telephone operators	50,820	36,760	–14,060	–27.7	29,980	–0.3
Low-wage technology workers						
Switchboard operators, including answering service	248,570	202,980	–45,590	–18.3	22,750	0.3
Computer operators	198,500	133,230	–65,270	–32.9	33,140	0.8
Data entry keyers	520,220	307,400	–212,820	–40.9	24,560	0.6
Word processors and typists	271,310	161,730	–109,580	–40.4	29,800	1.6
Desktop publishers	37,040	30,340	–6,700	–18.1	34,210	–0.7
Electrical and electronic equipment assemblers	387,430	207,050	–180,380	–46.6	27,960	2.5
Semiconductor processors	42,110	43,420	1,310	3.1	32,080	0.6
Total call center and low-wage technology workers	**2,241,650**	**1,530,560**	**–711,090**	**–31.7**	**26,539**	**0.7**
Comparable production workers in the manufacturing sector				–19.0		
Total mid-level IT workers						
Computer support specialists	462,840	491,680	28,840	6.2	43,660	–0.5

High-wage technology workers						
Computer and information scientists, research	26,280	26,950	670	2.5	90,860	3.7
Computer programmers	528,600	396,100	–132,500	–25.1	66,480	1.3
Computer software engineers, applications	287,600	439,720	152,120	52.9	78,570	1.1
Computer software engineers, systems software	209,030	321,120	112,090	53.6	83,460	2.2
Computer systems analysts	428,210	497,100	68,890	16.1	69,470	1.2
Database administrators	101,460	100,420	–1,040	–1.0	64,380	1.6
Network and computer systems administrators	204,680	262,930	58,250	28.5	62,300	1.9
Network systems and data communications analysts	98,330	176,840	78,510	79.8	64,080	0.3
Computer hardware engineers	60,420	79,670	19,250	31.9	85,540	2.5
Electrical engineers	149,210	147,120	–2,090	–1.4	75,540	1.6
Electronics engineers, except computer	106,830	133,410	26,580	24.9	78,620	1.8
Total high-wage technology workers	**2,200,650**	**2,581,380**	**380,730**	**17.3**	**71,680**	**1.7**
Comparable total CES employment				3.0		

Sources: Bureau of Labor Statistics, Current Employment Statistics (CES) data, 1999, 2000, 2001, 2002, May 2003, November 2003, and May 2004 national occupational employment and wage estimates, www.bls.gov/ces/home.htm (accessed on October 1, 2005).

On the other hand, jobs held by high-skilled, judgment-oriented, and problem-solving IT workers—applications and systems software engineers, database administrators, and network systems engineers and administrators, earning on average $72,000 annually—increased by about 380,000 from 1999 to November 2004. This represents a 17 percent increase in employment in these high-wage IT professional occupations for the period against a 3 percent increase in employment for the economy as a whole.

However, the data also show the rising skill "bar" against which domestic and foreign workers compete in the global marketplace.[10] Between 1999 and November 2004, the number of "programming" jobs earning on average $65,000 fell by 132,000, or 25 percent of the number of these jobs held as of 1999. Whether US programmers were replaced by workers abroad or whether US programmers upgraded their skills to become systems software and network engineers cannot be determined from the data. Clearly the consequences for both individuals and the US economy differ based on the outcome, with spillover gains to the US economy (and individuals) enhanced by skill upgrading but job destructive for those unable to raise their skills.[11]

In sum, BLS data on IT-related occupations suggest that as US firms have integrated technology into the workplace, there has been a reduction of commoditized jobs and a rise in jobs with "integrating" skills—skills that design, customize, and integrate IT applications and services. These workers, although they are in the occupational category of "IT occupations," work throughout the US economy and have a wealth of sector-specific knowledge that is absolutely crucial to their work. Although some technology skills can be replicated remotely, the knowledge specific to a customer need is unique to the location where the worker resides.

International Trade in Skilled Labor: Cross-Border Movement of IT Professionals

The increased globalization of services has another new element—the cross-border movement of skilled workers. That is, rather than firms fragmenting the production of IT-related services and doing some part of the activity abroad, they import skilled workers to do the job in the United States. During the technology boom period, domestic skilled labor was augmented by US companies' use of temporary foreign labor, predominantly through so-called "intrafirm transfers" of L-1 visa holders—employees

10. Samuelson (2004) argues that "catch-up" by foreign countries leads to pressures on higher-skilled workers.

11. Jensen and Kletzer (2005) examine the dislocated worker survey in the broader context of understanding the consequences of potential trade in services employment. A more detailed examination of labor market data, and continuing to collect these data, are necessary to appropriately design labor market policies.

hired outside the country and then transferred to work at company facilities in the United States—as well as the use of "foreign specialist workers" (H-1B visa holders).[12] After the IT bubble burst, there was an extended period of minimal net job gains, and in particular, an unexpectedly high unemployment rate of IT professionals. The impact of the bust in IT investment and skill depreciation on incumbent US workers has already been discussed. But were the foreign workers a further drag on the wages and employment prospects of incumbent US workers with IT skills?[13] Moreover, looking forward, what do the data suggest with regard to this new international trade in professional labor services for businesses and workers in the US IT services sector?

Characteristics of Visa Holders

How many visa holders are in the United States, where do they come from, and what do they do?[14] It is actually rather difficult to answer these questions, although box 5.2 does provide some of the information available. The longest time series available is on annual admissions, which is the number of times a visa holder enters the United States. Of course, any given visa holder might enter the country more than once a year (figure 5.4). The number of admissions of L-1 and H-1B visa holders rose substantially from 1990–2004. But the statistics clearly reflect the technology and business cycle, with a peak in admissions in 2001 and a decline of about 10 percent from 2001 to 2003, before a modest rebound in 2004.

What do we know about the nationality and occupation of these visa holders? The L-1 visa is for an intrafirm transfer within a multinational enterprise; it is issued for three years, and renewable for either two or two times two more years (a maximum of five or seven), depending on the position within the company. Countries with close economic relations in terms of direct investments in and cross-ownership of companies, such as the United Kingdom, Japan, and Germany, consistently top the list of countries whose citizens are admitted on L-1 visas (Kirkegaard 2005). However, the admissions of L-1 visa holders from India rose tenfold from about 2,000 in 1996 to some 22,000 in 2003. The Indian IT sector developed very rapidly in that decade and about a quarter of the Indian IT sector is fully owned by US-parent multinationals.[15] Both factors would tend to ac-

12. H-1B holders must hold a minimum of the equivalent of a US bachelor's degree to be eligible for this visa category, as well as adhere to a list of other requirements. See link to "Temporary Workers" at www.uscis.gov (accessed March 15, 2006).

13. See Tim Gray, "Brain Drain in the Tech World?" ZDNEWS, July 15, 2005; Adam Geller, "Outsourcing Themselves," Associated Press, June 21, 2005; and Richard Ernsberger Jr., "The Big Squeeze," *Newsweek International,* May 30, 2005.

14. This section draws extensively on Kirkegaard (2005).

15. National Association of Software and Services Companies (NASSCOM) IT Industry Fact Sheet 2005, available at www.nasscom.org (accessed March 15, 2006).

Box 5.2 US visas for "highly skilled" workers

First, what data are available to measure "imported" highly educated workers? US immigration authorities register information regarding L-1 and H-1B visa holders in three main ways: the number of times a visa holder has been admitted to the United States, the number of visa petitions granted, and the number of visas actually issued to foreign citizens.[1] Official statistics on admission numbers by visa category are the only data available for the entire period of the 1990s. But clearly the number of times in a year a given group of visa holders is admitted to the United States (i.e., crosses the border) is likely to exceed the annual number of visa petitions granted and issued, particularly since both L-1 and H-1B visas are multiyear visas and may be extended.

Next, detailed statistics on the number of visa petitions granted are available only for the H-1B category and only from 1999 to fiscal year 2003. Some detail on actual issuances at US overseas consular offices of other types of visa—including the L visa—is available from 1996 to 2003.[2]

Finally, the number of actual visas issued is significantly lower than the number of visa petitions granted, as multiple employers (frequently different entities within the same organization) often petition for the same individual worker. On the other hand, an actual H-1B visa issued may last for up to six years, so an individual foreign citizen may be issued only one visa but require two successful three-year H-1B petitions during his or her time in the United States.

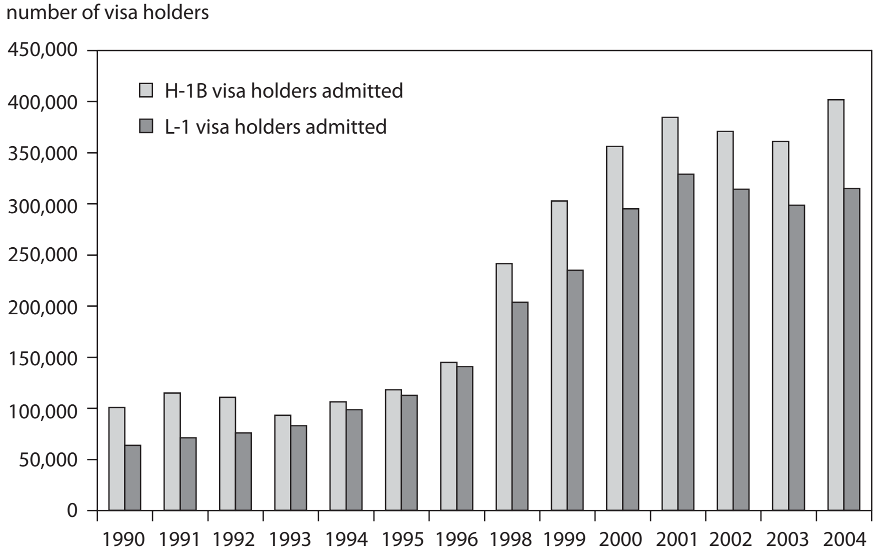
All told, the precise number of L-1 or H-1B visa holders working in the United States at any given time cannot be precisely determined, only approximated, from available official data. Nevertheless, bringing together all the data does bring some focus to the issues broached above.

1. In all cases the data are collected by fiscal years, rather than calendar years.
2. US Department of State, *Annual Report of the Visa Office,* 2002, 2003, and 2004. The 2003 data are from OECD (2004b).

celerate recent L-1 visa usage by Indian nationality worers. Without more comprehensive data that classifies L-1 visa holders by occupation and distinguishes between stock and flow of workers in the United States (rather than simply by the number of admissions), it is not possible to assess the impact of L-1 visa holders on employment and wages of the US industry as a whole, or within specific occupations, such as computer programmers. Given the importance and widespread use of these visas, additional information on the holders, at least as comprehensive as the H-1B discussion that follows, is warranted.

Turning to H-1B visas, the American Competitiveness and Workforce Improvement Act (ACWIA) of 1998 requires US immigration authorities to collect and present to the US Congress information on the countries of

Figure 5.4 H-1B and L-1 visa holders admitted into the United States, by fiscal year, 1990–2004



Note: No data available for 1997.

Source: USCIS (2004b).

origin, occupations, educational attainment, and compensation paid to foreign citizens who obtain H-1B status.[16] In addition, the US State Department collects nationality data for H-1B visas issued at overseas US consular offices. Even so, for a number of reasons, these data do not reveal the precise number of H-1B visa holders inside the United States at a given point in time, nor whether a "new" H-1B visa represents a "new" foreign worker.[17]

H-1B visas are issued for three years and can be extended for another three years. Key challenges to interpreting the details of the H-1B data are,

16. Public Law 105-777, Division C, American Competitiveness and Workforce Improvement Act, Section 416(c)(2).

17. Moreover, these data are almost entirely unrelated to the frequently quoted number of "available H-1B visas under the Congressional cap." This cap was 65,000 from 1992 to 1998, before being raised to 195,000 until the end of fiscal year 2003, when it reverted to 65,000. Under the H-1B Visa Reform Act of 2004, an additional 20,000 H-1B visas were added to the 65,000 exclusively for foreign citizens with a master's degree or higher from a US institution of higher education (US Citizenship and Immigration Services press release, May 4, 2005). Finally, many H-1B visas "do not count" toward this cap—in particular, H-1B visa extensions (for a second three-year period), "visas issued to educational organizations," and those issued to "nonprofit institutions." (The latter two categories are not likely to be particularly relevant when considering the impact of H-1B visas on the US IT services sector.)

first, that H-1B visas can be issued to foreign citizens already in the United States on another visa, and second, that they can be extended. Thus, there is a stock-flow issue when interpreting visa data. As the trends regarding visas issued and extended are similar, table 5.3 focuses on "new" H-1B visas granted for initial employment in the United States.[18]

The pattern of H-1B visas has several features related to the technology cycle, but also to the post-9/11 environment for granting visas and to policy responsiveness to labor market concerns. First, the number of H-1B visas granted (both new and extensions) rose from 2000 to 2001 before dropping significantly in 2002 and rebounding modestly in 2003 (row 2 in table 5.3).[19] This pattern is similar to overall technology employment discussed earlier. Second, the share of new H-1B visas granted among the total peaked at 61 percent in 2001, after which both the number and share of new H-1Bs granted dropped (row 3). Finally, the share of new H-1B visas granted to foreign citizens outside the United States dropped significantly in 2002 and 2003, from well above 50 percent of new visas granted to foreign citizens outside the United States (1999 to 2001) to 60 percent or more granted to foreign citizens inside the United States (2002 and 2003) (rows 4 and 5).

Who are the potential H-1B recipients already inside the United States? The foreign citizen could be inside the United States and already part of the US labor force at the time an employer files for the H-1B visa, as the foreign citizen may be transferring from another US visa category.[20] Comparing the peak of the technology boom to the post-boom and 9/11 period, US-located companies did "import" about 270,000 highly skilled workers from abroad from 1999 to 2001, and this group constituted the majority of H-1B visas granted for initial employment to foreign citizens. However, in 2002 and 2003, US-located firms hired many more foreign graduates from US educational institutions and reduced imports of foreign high-skilled labor from abroad. This difference between foreign citizens inside and outside the United States at the time of the H-1B application is further

18. For both extended and new visas, see Kirkegaard (2005).

19. This is further supported by data from a General Accounting Office (2000) report, which shows that from 1992–98, the number of "new H-1B non-immigrants approved" was between 50,000 and the annual cap of 65,000. This is substantially lower than the approximate 100,000 entries of H-1B visa holders seen in figure 5.4. However, the data from the GAO publication refer only to those H-1B visas granted, which count toward the annual Congressional cap.

20. For example, a transfer of visa status could occur if an alien transfers from an academic F-1 visa, which gives the alien an option of one year of work (called optional practical training, or OPT) in the United States after graduation from an accredited US educational institution with a bachelor's degree or higher academic degree. An H-1B visa granted to such a student would not result in an addition to the US labor force if the visa were granted to a student at a time when he or she was already working in the United States during his or her OPT.

Table 5.3 US Citizenship and Immigration Services statistics on successful H-1B petitions, fiscal 1999–2003

		1999[a] (1)	2000 (2)	2001 (3)	2002 (4)	2003 (5)
Petitions for initial employment						
1	Number of times an H-1B visa holder was admitted into the United States	302,326	355,605	384,191	370,490	360,498
2	Total number of H-1B petitions granted (percent of admittances)	n.a.	257,640 (72)	331,206 (86)	197,537 (53)	217,340 (60)
3	Of which: Number of H-1B petitions granted for initial employment (percent of total petitions granted)	134,400 (n.a.)	136,787 (53)	201,787 (61)	103,584 (52)	105,314 (48)
4	Of which: Alien was outside the United States at the time of employer petition (percent of total initial employment petitions granted)	81,100 (60)	75,785 (55)	115,759 (57)	36,494 (35)	41,895 (40)
5	Of which: Alien was in the United States at the time of employer petition (percent of total initial employment petitions granted)	53,300 (40)	61,002 (45)	85,320 (43)	67,090 (65)	63,419 (60)
6	Of which: Number 1 country of origin (percent of total)	India 63,900 (48)	India 60,757 (44)	India 90,668 (45)	India 21,066 (20)	India 29,269 (29)
7	Of which: Number 2 country of origin (percent of total)	China 12,400 (9)	China 12,333 (9)	China 16,847 (8)	China 11,832 (11)	China 11,144 (11)
8	Of which: Number 3 country of origin (percent of total)	United Kingdom 4,400 (3)	Canada 5,465 (4)	Canada 9,184 (5)	Canada 7,893 (8)	Canada 6,201 (6)
9	Of which: Number 1 occupational group (percent of total) and median earnings		Computer-related occupations 74,551 (55) $50,000	Computer-related occupations 110,713 (55) $51,600	Computer-related occupations 25,637 (25) $55,000	Computer-related occupations 28,879 (27) $50,500

(table continues next page)

Table 5.3 US Citizenship and Immigration Services statistics on successful H-1B petitions, fiscal 1999–2003 *(continued)*

		1999[a] (1)	2000 (2)	2001 (3)	2002 (4)	2003 (5)
10	Of which: Number 2 occupational group (percent of total) and median earnings	n.a.	Occupations in architecture, engineering, and surveying 17,086 (12) $51,480	Occupations in architecture, engineering, and surveying 25,365 (13) $56,485	Occupations in architecture, engineering, and surveying 14,467 (14) $52,000	Occupations in education 15,008 (14) $36,000
11	Of which: Number 3 occupational group (percent of total) and median earnings		Occupations in administrative specializations 11,468 (8) $38,000	Occupations in administrative specializations 15,573 (8) $40,000	Occupations in education 13,996 (14) $35,000	Occupations in administrative specializations 13,892 (13) $38,900
12	Of which: Number employed in IT services industry (percent of total)[b]	n.a.	n.a.	88,613 (44)	17,803 (17)	19,347 (19)
13	Of which: Number employed in IT hardware industry (percent of total)[c]	n.a.	n.a.	4,824 (2)	2,210 (2)	1,554 (1)
14	Addendum: Number of H-1B visas issued by the US State Department (percent of total H-1B petitions granted)[d]	116,513 (n.a.)	133,290 (52)	161,643 (49)	118,352 (60)	107,196 (49)
15	Addendum: Number of H-1B visas issued by the US State Department to Indian nationals (percent of total H-1B petitions granted to Indians)	55,062 (n.a.)	61,530 (49)	74,078 (46)	44,012 (68)	42,245 (53)
16	Addendum: Number of H-1B visas issued by the US State Department to Chinese nationals (percent of total H-1B petitions granted to Chinese)	5,775 (n.a.)	7,489 (33)	9,076 (33)	7,576 (40)	5,608 (28)

17	Addendum: Number of H-1B visas issued by the US State Department to British nationals	6,664	7,304	8,462	6,842	6,095
Petitions for continuing employment						
1	Number of times an H-1B visa holder was admitted into the United States	302,326	355,605	384,191	370,490	360,498
2	Total number of H-1B petitions granted	n.a.	257,640	331,206	197,537	217,340
3	Of which: Number of H-1B petitions granted for continuing employment (percent of total)	n.a.	120,853 (47)	130,127 (39)	93,953 (48)	112,026 (52)
6	Of which: Number 1 country of origin (percent of total)	n.a.	India 63,940 (53)	India 70,893 (54)	India 43,914 (47)	India 49,897 (45)
7	Of which: Number 2 country of origin (percent of total)	n.a.	China 10,237 (8)	China 10,483 (8)	China 7,009 (7)	China 8,919 (8)
8	Of which: Number 3 country of origin (percent of total)	n.a.	Canada 2,900 (2)	Canada 3,542 (3)	Canada 3,867 (4)	Canada 4,959 (4)
9	Of which: Number 1 occupational group (percent of total) and median earnings		Computer-related occupations 73,875 (61) $65,000	Computer-related occupations 80,684 (62) $69,000	Computer-related occupations 49,477 (53) $64,739	Computer-related occupations 54,235 (48) $63,000
10	Of which: Number 2 occupational group (percent of total) and median earnings	n.a.	Occupations in architecture, engineering, and surveying 14,298 (12) $65,000	Occupations in architecture, engineering, and surveying 15,023 (12) $68,000	Occupations in architecture, engineering, and surveying 10,730 (11) $63,600	Occupations in architecture, engineering, and surveying 14,292 (13) $64,756

(table continues next page)

Table 5.3 US Citizenship and Immigration Services statistics on successful H-1B petitions, fiscal 1999–2003 *(continued)*

		1999[a] (1)	2000 (2)	2001 (3)	2002 (4)	2003 (5)
11	Of which: Number 3 occupational group (percent of total) and median earnings		Occupations in administrative specializations 6,951 (6) $50,000	Occupations in administrative specializations 8,221 (6) $54,429	Occupations in education 7,250 (8) $39,000	Occupations in administrative specializations 9,180 (8) $50,000
12	Of which: Number employed in IT services industry (percent of total)	n.a.	n.a.	60,071 (46)	35,814 (38)	39,323 (35)
13	Of which: Number employed in IT hardware industry (percent of total)	n.a.	n.a.	4,347 (3)	2,293 (2)	3,774 (3)

n.a. = not available

a. Period from May 1998 to July 1999.

b. Defined as North American Industry Classification System (NAICS) categories (3341) Computers and Peripheral Equipment and (3344) Semiconductor and Other Electronic Component Manufacturing.

c. Defined as NAICS categories (5415) Computer Systems Design and Related Services, (5141) Information Services, (5142) Data Processing Services, and (5112) Software Publishers. Data not available for all categories each year.

d. Actual issuance by the US State Department of H-1B visas in 1996, 1997, and 1998 amounted to 58,327, 80,547, and 91,360, respectively. India, China, and Britain ranked one, two, and three, respectively, in terms of visa issuance for 2000–2003, followed by Japan, the Philippines, and Germany. Individual country data provided by the US Office of Public and Diplomatic Liaison, Visa Services.

Note: Shaded areas denote H-1B petitions that are exempt from the congressional cap on H-1B visas.

Sources: US Immigration and Naturalization Service (INS 2000a, 2002a, 2002b); US Citizenship and Immigration Services (USCIS 2003, 2004a); US Department of State, *Report of the Visa Office* 2000, 2001, 2002; and OECD (2004b). It must be emphasized that the USCIS qualifies its annual reports to Congress on H-1B visas by stating that "very little editing has been done to the data," and that, consequently, there may be some errors in the data. Whether these are systematic cannot be discerned.

illustrated by the significantly lower number of H-1B visas actually issued to foreigners at overseas US consular offices—107,200 in FY2003 compared with the 161,643 granted overseas in FY2001 and to the total number of H-1B petitions granted in FY2003 (217,340). Indeed, only about half the H-1B petitions granted result in an actual H-1B visa being issued to a foreigner overseas (row 14).[21]

In terms of country and occupational detail, Indian citizens accounted for about half of all H-1B visa petitions granted in 1999–2001, followed distantly by China, Canada, and Britain. "Computer-related occupations" is by far the biggest occupational category of H-1B recipients, and about half of all H-1B recipients were employed in the US IT services and hardware industry. This suggests that "imported" Indian labor was widespread during the technology boom years. The rapid rise in imported IT workers by US-located firms during the 1990s is evidenced by the fact that, in 1992, only about 6,000 H-1B visas (of approximately 50,000 granted that year) were issued to IT-related occupations (rows 6–8, 9–11, and 12–13).[22]

On the other hand, Indians account for about 70 percent of the total decline in numbers of H-1B visa petitions granted for initial employment from 2001 to 2002 (70,000 of a total decline of 98,000). This decline corresponds closely to the decline in the number of petitions granted in computer-related occupations and the number of petitions granted and employed in the US IT services and hardware sectors.[23] Individual petitions cannot be "cross-tabbed" across petitions, but the similar size of the decline in all three categories suggests that there was a very large decline from 2001 to 2002 in the number of H-1B visas granted for initial employment to Indians in computer-related occupations employed in the US IT services and hardware sectors, and that the level in all of the categories remained low in 2003.[24]

---

21. Row 14 differs from row 4 (49 percent versus 40 percent) because of the timing of the data collection. Row 4 is a snapshot measured at the time of the USCIS granting (or rather receipt of application) of the H-1B petition (regardless of whether the beneficiary was inside or outside the United States), whereas row 14 measures over the entire year how many visas were actually issued and relates them to the number of petitions granted.

22. Fiscal year 1992 was the first year that the H-1B visa could be granted to aliens under the Immigration Act of 1990, and hence most visas granted that year would count against the 65,000 annual cap, especially as no extensions could logically be granted. Earlier, H-1B visas were referred to as "specialty occupation visas" and had no upper limit (GAO 2000, 8).

23. A similar trend is observed for recipients of extensions of H-1B visas, where the number of Indian recipients, computer-related occupations, and IT services and hardware employees all declined by about 30,000 from 2001 to 2002.

24. These data are in part confirmed by other sources. For example, NASSCOM, the Indian IT industry association, estimates that the number of Indian IT professionals traveling to the United States on H-1B visas dropped from 77,000 in 2001 to 33,000 in 2002. NASSCOM expected the number in 2003 to be about 30,000, according to Wipro Ltd.'s 2004 20-F filing with the Securities and Exchange Commission, available at www.sec.gov/edgar (accessed on August 3, 2005).

How large are these numbers in comparison with overall IT employment? In 2002 and 2003, there were nearly 30,000 H-1B visa petitions granted for initial employment in "computer-related occupations" in each year. Occupational detail for L-1 visas is not known. And BLS occupation categories cannot be mapped directly into the visa occupation category. However, the number of jobs in the medium- and high-wage IT occupation categories (as in table 5.2) fell from 2,892,000 to 2,847,000 and then rose to 3,073,000 (2001, 2002, 2004 respectively). There were declines in the number of jobs only in the "programmer" category (which at about 500,000 employed in 1999 was the largest subcategory). Comparing wage rates, foreign workers' average wages—$50,500 in 2003 for new H-1B visa holders in computer-related occupations and $63,000 for H-1B holders continuing their employment, probably with three years of work experience—lies between the average wage for the medium- and high-wage IT occupations (table 5.2). Over 2001–04, average wages for high-wage IT workers rose substantially, about twice the rate for the mid-level IT occupations. Would employment and wages of incumbent workers have been different over the period if there had been no H-1B or L-1 visas? More detailed information on numbers, occupations, and wages is needed for this research question.

Taking the 1990s as a whole, the H-1B program reflects the US technology and business cycles as well as homeland security issues. US companies imported foreign high-skilled labor in periods of rapid economic growth (such as 1999–2001), while in periods of slower US economic growth (2002–03) US companies hired highly skilled foreign graduates coming out of US universities and other high-skilled foreign citizens already in the United States. Additional research is needed to gauge the impact of these imported workers on the incumbent workforce, including the existing stock of visa holders.

Corporate Use of Visas and Wages Paid

Which US companies hire H-1B or L-1 visa holders? Detailed data reveal only which US-located companies *apply* for permits to employ H-1B visa-holding foreign citizens.[25] But these data cannot be used to infer anything about the number of H-1B visa holders that a US company might employ in the United States. This is because an application for an H-1B visa entails two separate filings: a filing of a labor condition application (LCA) request at the Department of Labor Office of Foreign Labor Certification (DOL-FLC) and a filing for an H-1B visa with the US Citizenship and Im-

25. In 2000, the INS published a list of the leading US employers of H-1B visa holders in the first part of FY2000 (INS 2000b). The US Department of Labor maintains an online database of all the US companies that file the required LCA petitions for employing H-1B visa holders. See www.flcdatacenter. com/CaseData.aspx (accessed March 15, 2006).

migration Services (USCIS), with the former required for the latter petition to be granted. The filing by an employer of an LCA does not mean that an H-1B visa will automatically be issued—indeed, the Department of Labor explicitly states that no one-to-one relationship exists. In fact, there typically are three times as many LCA requests as the number of H-1B visa petitions granted.[26] With such large discrepancies at the aggregate level, the FLC database cannot be used to infer anything valid about the numbers of H-1B visa holders that individual companies employ.

An alternative approach examines selected large US-located employers of H-1B visa holders in 1999–2000 using special data for actual H-1B visa petitions granted directly from the US Immigration and Naturalization Service (INS 2000b) and cross-tabbed with information from filings with the Securities and Exchange Commission (SEC) (table 5.4). Most of the corporate users of H-1B workers from late 1999 to early 2000 were household names in the US IT industry, including Motorola, Oracle, Cisco, Intel, and Microsoft. But the US finance industry and major educational institutions also were well represented. Only seven of the top 100 US-located employers were Indian IT services companies. On the other hand, several companies, both US and Indian, relied heavily on foreign H-1B (and L-1) visa holders in their US workforce in 2003.[27] This could be taken as an indication that some companies have as their primary US business model to bring in foreign (in all likelihood mostly Indian) IT workers to work in the United States.

Even if H-1B and L-1 visas are crucial to the business model of some firms, does this extend to paying wages below the prevailing wage of the incumbent workforce? The DOL-FLC database of employer-filed LCAs contains data for both the wage to be offered the individual H-1B recipient should an H-1B visa be granted by the USCIS, as well as the regional prevailing wage for the occupation in question. By taking all the individual FLC petitions for each of the Indian companies and similar American companies listed in table 5.4, one can see whether, for petitions for FY2004, these companies systematically underpaid their foreign workers and thus directly put downward pressure on US wages in IT occupations. Looking at all incidences of filings, a scatter plot of the prevailing wage against FLC

26. See www.flcdatacenter.com/CaseData.aspx (accessed March 15, 2006).

27. Many of the companies in table 5.4 do not make H-1B or L-1 data available. The companies for which data are available generally provide these data in SEC filings as part of their general description of their business model and risk associated with it. Hence, companies are likely to provide information about the number of H-1B/L-1 visa holders in their US workforce if the number is so big that it is important to their business model. For public companies that do not report such data, it is likely that the share of H-1B/L-1 visa holders is low and not crucial to the business model. The same cannot be said for privately held Indian companies, which do not provide filings to the SEC or other similar entities. For the private Indian companies that are in direct competition with public Indian companies, the average number of H-1B/L-1 visa holders is likely to be of the magnitude found in those in Indian companies and US competitors for which data are available.

Table 5.4 Leading US employers of H-1B visa holders

Rank	Company	Number of H-1B visas approved[a]	Country of parent company	Share of US workforce on H-1B or L-1 visas, 2003–04 (percent)
1	Motorola Inc.	618	United States	n.a.
2	Oracle Corporation	455	United States	n.a.
3	Cisco Systems	398	United States	n.a.
4	Mastech (iGate)	389	United States	13 (H-1B only)
5	Intel Corporation	367	United States	n.a.
6	Microsoft Corporation	362	United States	n.a.
7	Rapidigm	357	United States	n.a.
8	Syntel Inc.	337	United States	59 (486 H-1B, 268 L-1)
9	Wipro Ltd.	327	India	>50 (1,130 H-1B, 1,491 L1)
10	Tata Consulting Services	320	India	n.a.
11	PWC LLP	272	United States	n.a.
12	PeopleCom Consultancies	261	Unknown	n.a.
13	Lucent Technologies	255	United States	n.a.
14	Infosys Technologies Ltd.	239	India	>50 (3,200 H-1B, 700 L-1)
15	Nortel Networks, Inc.	234	Canada	n.a.
16	Tekedge Corporation	219	United States	n.a.
17	Data Conversion	195	United States	n.a.
18	Tata Infotech	185	India	n.a.
19	Cotilligent USA, Inc.	183	United States	n.a.
20	Sun Microsystems, Inc.	182	United States	n.a.
26	Hewlett-Packard Co.	149	United States	n.a.
33	Birlasoft	128	India	n.a.
35	IBM	124	United States	n.a.
39	Satyam Computer Services	123	India	Close to 100 (687 H-1B, 635 L-1, March 2002)
42	University of Washington	113	United States	n.a.
52	University of Pennsylvania	97	United States	n.a.
58	Merrill Lynch	87	United States	n.a.
65	General Electric	80	United States	n.a.
71	Goldman Sachs	75	United States	n.a.
75	Stanford University	73	United States	n.a.
79	Morgan Stanley	71	United States	n.a.
82	Harvard University	70	United States	n.a.
94	Ramco Systems	63	India	n.a.
99	Yale University	61	United States	n.a.

n.a. = not available

a. Data are for October 1999 to February 2000.

Sources: US Immigration and Naturalization Service (INS 2000b); company 10-K or 20-F filings with the Securities and Exchange Commission; and company Web sites.

petitions shows that, at least for H-1B petitions in FY2004, none of these companies systematically underpaid their foreign workers (figure 5.5).[28] Indeed, the average offered wage was 111 percent of the prevailing wage. None of the individual H-1B requests offered less than 95 percent of the prevailing wage.[29] (However, see box 5.3 and Kirkegaard 2005 for more discussion of "prevailing wage"; moreover, these data are only for H-1B visas, with no comparable information available for L-1 visas.)

Since the employer applies for the H-1B visa on behalf of the foreign recipient, the opportunities for the foreigner to seek employment elsewhere in the United States are conditional upon finding another employer to sponsor him or her. Hence the opportunities for "job-hopping" in search of better wages for H-1B visa holders are limited, which offers employers some scope for downward wage pressure, despite what the FLC filing may state. As such, the official filing data from the FLC database should not be viewed as a definitively valid official data source. Rather, it is simply the best data source available.

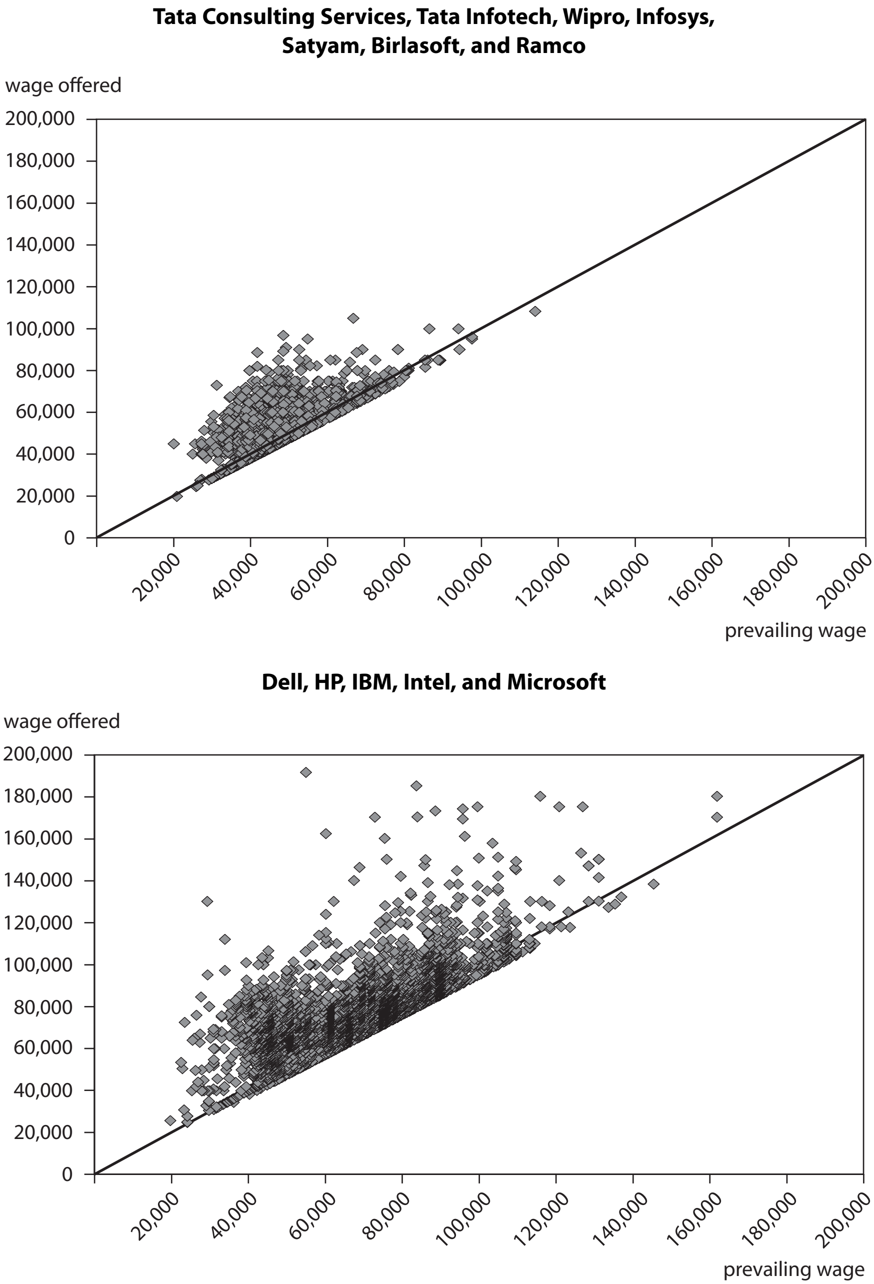
Large US IT companies show a similar pattern, with no filings below 95 percent of the prevailing wage and an average offered wage of 116 percent of this prevailing wage (figure 5.5). But US firms show a much wider dispersion of wages offered compared with the Indian firms as well as a higher average wage. This suggests that US firms consider a wider diversity of candidates in terms of skills and specialized knowledge. In contrast, the Indian firms appear to be filing petitions for a more standardized type of worker and at a lower average wage offered. Incumbent US workers in that occupational and skill class could experience a more concentrated exposure to the H-1B candidates being considered by the Indian firms. By the same token, how technology impacts the mix of narrowly defined skills has changed, and this too will affect the prospects for employment and wages, regardless of whether the worker is incumbent or "imported." Both trade and technology point to potential policy initiatives with regard to skill upgrading and job matching for incumbent workers to move away from more exposed occupations. More data and research on the occupations of visa holders and incumbent workers are needed.

---

28. The figures are constructed such that if a dot is above the diagonal line, it indicates that the H-1B visa recipients are offered a wage above the prevailing wage, while if it is below the diagonal, the wage offered is below the prevailing wage. It is important to emphasize that each dot represents a single LCA filing, which may be on behalf of more than one H-1B recipient. The number of dots in the figure is therefore only vaguely indicative of the actual number of individuals on whose behalf a company is applying for H-1B visas. Fiscal 2004 is the only time period for which data for all petitions—whether filed electronically or by fax—are available.

29. Average prevailing wages and offered wages can be calculated and compared for all petitions by the companies in question. However, such "average prevailing and offered wages" are only indicative of the average wages actually offered and paid to H-1B recipients, since it is not known which of the individual cases in the FLC database ultimately received H-1B visas from the USCIS.

Figure 5.5 Labor condition application requests, FY2004 (US dollars)



Note: For presentational reasons, five labor condition application filings offering wages above $200,000 were excluded.

Source: Department of Labor, foreign labor certification datacenter, www.flcdatacenter.com.

Box 5.3 H-1B visa holders and the "prevailing wage"

Because wage rates vary so substantially across countries, US law has very specific rules about what H-1B visa holders have to be paid. They must be paid either the actual wage or the prevailing wage. The actual wage is the rate paid by the employer to all other individuals with similar experience, qualifications, education, job responsibilities and functions, specialized knowledge, and other legitimate business factors for the specific employment in question. However, in the absence of similar existing US workers at the workplace, the H-1B recipient must be paid the prevailing wage for the occupational classification in the area of intended employment.

How is the prevailing wage determined for a given H-1B visa petition? A request for a prevailing wage determination may be filed with a local State Employment Security Agency (SESA). Other sources of consultation can be the Bureau of Labor Statistics Occupational Employment Statistics (OES) survey (www.bls.gov),[1] the federal government online wage determination (www.wdol.gov), or other independent authoritative sources, including private compensation surveys by such companies as Watson Wyatt (www.watsonwyatt.com), the Economic Research Institute (www.erieri.com), and the American Society of Employers (www.aseonline.org).

It is the responsibility of the employer that files the H-1B petition to guarantee the truthfulness of the information. Since there are numerous potential sources of information on prevailing wages, can employers choose the lowest estimate? The US Department of Labor must determine whether a source is acceptable as authoritative, and the foreign labor certification will be denied if the prevailing wage information provided is deemed nonauthoritative. Third parties may launch a complaint with the Labor Department alleging inaccuracy of prevailing wage information provided in individual petitions.

US employers are required to post the wage offered to H-1B visa holders at a public location at the workplace. If the majority of H-1B petitions use official prevailing wage data,[2] it seems unlikely that employers can systematically depress wages by providing inaccurate data. On the other hand, federal law CFR 665.731 (d)(4) explicitly states that "[n]o prevailing wage violation will be found if the employer paid a wage that is equal to, or more than 95 percent of, the prevailing wage . . ." (www.dol.gov). Therefore it is essentially legal for US employers to pay H-1B recipients 5 percent less than the prevailing wage—yet that is not the case for the fiscal year 2004 data reported above. However, if US employers are found by the Labor Department to pay their H-1B workforce less than 95 percent of the

(box continues next page)

Box 5.3 H-1B visa holders and the "prevailing wage" *(continued)*

prevailing wage, they will be required to pay them the full 100 percent. Therefore, companies face no significant financial penalty for not paying their workforce the prevailing wage.[3] While challenges to systematic underpayment of the workforce cannot be dismissed, no data are available from the Labor Department with regard to such investigations.

1. Web sites cited in this box were accessed on March 15, 2006.
2. See appendix A for more on this point as well as details for selected employers in the IT sector.
3. See Kirkegaard (2005) for other, nonfinancial sanctions.