Is Services Outsourcing a Threat to Skilled Labor?
How Information Technology Services Outsourcing Affects Domestic Employment Across Skill Levels

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Table of contents.

1 **Introduction.**

This study addresses the question: what is the effect of information technology (IT) services outsourcing on domestic employment in IT-related occupations of different skill levels? It hypothesizes that this effect differs for high and low skill IT occupations; in particular, that outsourcing decreases domestic employment in low skill IT occupations, but increases domestic employment in those that are high skill.

This issue is of particular interest because it is likely that firms will engage in increased offshore outsourcing of services as they continue to search for ways to reduce production costs, technology enabling services outsourcing becomes cheaper, and the quality of services imports improves. Is continued IT services outsourcing a threat to highly skilled IT professionals? Anecdotal evidence suggests that IT services outsourcing has already had a negative effect on employment in computer programming, an occupation that is generally classified as high skill.

However, this paper argues that outsourcing has a positive effect on employment in high skill IT occupations *overall*, while it is the low skill IT occupations that tend to be outsourced. Why might outsourcing have a positive overall effect on high skill employment? Jobs that are easy to outsource tend to be labor-intensive, information-based, codifiable, and high-transparency (Garner, 2004, p. 17).[1] These characteristics are usually found in low skill jobs, making them vulnerable to outsourcing. However, most high skill occupations do not exhibit these qualities. By the nature of the work, many high skill occupations involve open-ended, uncodifiable activities (such as design or management) or require on-site presence.

[1] Garner defines "labor-intensive" job as one for which labor makes up a large share of production costs; an "information-based" job as one that collects, manipulates, or organizes information; a "codifiable" job as one that can be reduced to a routine set of instructions that can be conducted easily at a remote location; and a "high-transparency" job as one for which the information to be exchanged between the customer and the service provider is easy to measure and verify.

Thus, the majority of high skill occupations are unlikely to be vulnerable to outsourcing. In fact, outsourcing may contribute to the creation of high skill jobs. Because it lowers the price firms must pay for some types of IT services, firms' investment in IT may increase. The use of IT would then become increasingly deeply integrated into their business processes. As a result, firms would need more employees to perform high skill activities such as management, design, or maintenance of their systems. In this way, IT services outsourcing could increase labor demand for workers with sophisticated IT skills.

1.1 Background.

There is some ambiguity in exactly what "outsourcing," sometimes called "offshoring" or "offshore outsourcing," means when used casually in the news. The World Trade Organization (WTO) defines four types of services trade. Mode 1 services trade in the WTO terminology is defined as the arm's–length supply of services, with the supplier and buyer remaining in their respective locations. Mode 2 services are provided by moving the recipient of the service to the location of the provider (e.g. tourism). In Mode 3, the service provider establishes a commercial presence in another country (e.g. direct investment). In Mode 4, the service seller moves to the location of the service buyer (e.g. consulting services). For the purposes of this study, the term "outsourcing" will refer to Mode 1 services trade. Though the alternate definitions are sometimes conflated or used interchangeably with that of Mode 1 in news articles about outsourcing, they will be treated as distinct from the term "outsourcing" in this paper.

The outsourcing of white-collar service jobs from the U.S. to low-wage countries, particularly IT jobs, has become a controversial topic over the last few years. While it is not a new phenomenon, outsourcing had always been practiced predominantly among bluecollar jobs in the manufacturing sector. Today, changes in technological, economic, and regulatory factors have enabled the spread of outsourcing to service sector jobs. The subject of many recent studies and news articles, services outsourcing has sparked widespread alarm in the U.S. workforce over the possibility that it will now also "steal" the highly paid jobs of skilled U.S. workers and send them overseas, as firms attempt to reduce their labor costs by outsourcing services operations. As mentioned above, the situation for computer programmers (who earned an average of approximately $65,000 in 2003 in the U.S.[2]) has often been cited as anecdotal evidence of outsourcing's detrimental effect on the employment of high-skilled IT labor in the U.S. India, home to the dominant recipients of U.S. IT outsourcing contracts (Tata Consultancy Services, Infosys Technologies, Wipro Technologies, Satyam Computer Services, and HCL Technologies), bears much of the political backlash. Legislators are under pressure to pass protective measures to preserve the jobs deemed at risk of moving offshore.

How many jobs are actually lost as a result of outsourcing? Quantifying this has proven difficult. It is hard to pinpoint how many relocated jobs are lost due to outsourcing *offshore* as opposed to outsourcing *onshore*, which still makes up 96-97% of all outsourcing activity ("Relocating the back office," 2003). In addition, it is difficult to estimate how many jobs *would* have been created in the U.S., were outsourcing not a factor.

Some have nevertheless tried to address this question, though their studies and surveys usually focus on general service industry jobs rather than IT services jobs. One example is the Bureau of Labor Statistics (BLS). Since January 2004, the BLS has attempted to collect this data by surveying senior executives of companies that lay off more than fifty people within a five-week period. As it turns out, even employers cannot say with certainty

[2] According to the BLS' Occupational Employment Survey data. See the Appendix for more wage data.

how many of their layoffs are due to the offshore relocation of work. As recently as the third quarter of 2004, the proportion of employers who could not provide this data was high enough that the BLS concluded that their count was not “meaningful” (Rebello, 2004).

Private surveys have attempted to provide estimates as well. The most-cited of these reports, published by Forrester Research, estimates that 3.3 million service industry jobs will have gone overseas by 2015 (“The Great Hollowing Out Myth,” 2004). Another study by Mark Zandi of Economy.com estimated that general service jobs were lost at a rate of about 75,000 per year from February 2001 to October 2003 (Garner, 2004, p. 9).

A 2004 Global Insight survey, focusing on the U.S. software industry, reported that 104,000 jobs had been displaced up to 2003, including those created overseas (“When Push Comes to Shove,” 2004[3]).

The accuracy of these studies and surveys is uncertain, and they do not account for skill levels or potential job creation resulting from outsourcing. Interestingly, though, Kierkegaard (2003, p. 13) notes that the majority (57%) of the job losses predicted by the Forrester report are forecasted to occur in the two occupational categories with the lowest average yearly salary.[4]

1.2 Literature review.

Mann (2003) provides an explanation similar to this paper’s as to why an increase in IT services outsourcing may have a positive effect on employment in high skill IT occupations. She likens today’s increase in IT services outsourcing to the globalization of IT

[3] This article also notes that the U.S. software industry employs a total of 3.7 million software writers and implementers.
[4] The Forrester Research report identifies nine major Standard Occupational Classification (SOC) system categories that are threatened with job losses from outsourcing. The two categories Kierkegaard refers to are Office and Administrative Support Occupations and Sales and Related Occupations. He finds that, as of 2002, they have the lowest average yearly salary of the nine categories (approximately $28,000 and $31,000 respectively, versus a U.S. national average of approximately $35,500).

hardware production two decades ago. In the case of IT hardware, she notes that globalized production accounted for 10-30% of the decline in hardware prices. This decline in prices promoted IT investment in several industries during the 1990s, particularly wholesale trade, securities and commodity brokerage, depository institutions, and telecommunications. The diffusion of IT throughout the economy increased productivity levels and helped propel job growth for workers with IT skills to twice the rate of overall job growth. Through the 1990s boom, jobs demanding IT skills (and not just at IT-producing firms) increased by 22%, double the overall rate of job creation. (Mann, 2003, p. 3)

The bulk of IT investment is now in software and IT services, as companies try to put their hardware investments to more efficient use. Software and IT services spending from 1993 to 2001 increased from 58% to 69% of total IT spending, and grew at a rate of 12.5%, versus 6.7% for hardware spending. (Mann, 2003, p. 2) As outsourcing contributes to the decline of software and IT services prices, the diffusion of IT throughout the economy is likely to increase, especially as firms that were barred from the initial wave of IT investment because of high costs begin to invest.

Outsourcing may be a substitute for low skill IT jobs, tending to shift those jobs overseas. Mann expects that domestic labor demand for highly skilled IT workers, on the other hand, will increase as outsourcing causes IT to become more deeply integrated into firms' business processes. In the U.S., the newly created jobs will likely require sophisticated skills, involving the design, customization, implementation, and maintenance of IT packages for a broad range of industries and firms.

There have been few studies conducted specifically about the relationship between IT services outsourcing and occupational employment. Much more has been written about the effect of *general* services outsourcing on *sectoral* employment, or of *production* outsourcing on employment in the manufacturing sector. However, these types of studies provide insight into the question this paper addresses, since both situations parallel that of IT services outsourcing in many ways.

Amiti and Wei (2004) perform a short econometric analysis on U.K. data that suggests general services outsourcing creates new jobs in certain sectors, while it sends jobs overseas in others. They model sectoral labor demand and disaggregate the economy into 96 sectors. At the most disaggregated levels, they find that every outsourced job leads to a corresponding decrease in employment in the given sector. However, as they begin to aggregate the sectors, they find that employment changes are no longer apparent: a job lost in one sector is made up for by a job created in another. The authors' conclusions corroborate this paper's hypothesis that outsourcing creates some jobs while it destroys others, but because the analysis is organized only by sector, it reveals nothing about the skill levels of the jobs lost and created.

Feenstra and Hanson (1996) do conduct an analysis based on workers' skill levels, though their focus is also somewhat different from that of this paper: they study the effect of *production* outsourcing on the relative labor demand for skilled versus unskilled workers in the 1979-1990 time period. Focusing solely on the manufacturing industries, they define relative labor demand for skilled workers in a given industry as the non-production workers' share of the industry wage bill. They find that outsourcing is significantly positively correlated with relative labor demand for skilled workers, and that production outsourcing accounted for 31-51% of the increase in relative demand for skilled manufacturing labor during the 1980s. Their result supports this paper's hypothesis, but because the authors measure *relative* labor demand, the implications for skilled workers' absolute employment are somewhat unclear. The increase in non-production wage share during that period may indicate merely that the employment of unskilled workers fell as a result of production outsourcing, not that the employment of skilled workers rose. This paper will attempt to show that absolute employment for skilled IT workers increases as a result of IT services outsourcing, rather than relative employment.

As discussed in Section 2.1, trends in recent data (from 1999, just before the recession, to 2003) indicate an overall increase in employment in high skill IT occupations, and vice versa for low skill. One may argue that, during a recession, employment for *all* highly skilled workers increases and for *all* less skilled workers decreases, not only IT workers. If that were the case, then the changes evident in the data for IT occupations would merely be consistent with overall trends, and would not necessarily be the result of outsourcing. However, a study by Gautier et al. (2002) finds that the evidence for this is thin. They compare the difference in education levels of "inflow" and "outflow" workers at particular firms and levels of job complexity, during both "downturn years" (1993, 1994) and "upturn years" (1995, 1996). If employment for *all* skilled workers tends to increase during a recession and vice versa for less skilled workers, then one would expect the difference in education levels between inflow and outflow workers to be larger during downturn years (e.g. more highly-skilled workers are hired, and less-skilled workers are let go). However, they find that there is no significant increase in education level differences during downturn years. Thus, the 1999-2003 trends for high skill IT employment noted in this paper are unlikely to be merely the result of general employment patterns during recessions.

2 Data trends and sources.

The following sections examine trends in the data over the periods 1992-2003, 1997-2003, and 1999-2003, and describe the construction and sources of the dataset.

2.1 IT services outsourcing and employment trends.

This section examines trends in the data for IT services outsourcing and domestic employment in IT occupations over three periods: 1992-2003, 1997-2003, and 1999-2003.[1] In looking at changes in employment, one should remember that a decline does not necessarily indicate that jobs went overseas. Jobs may have been lost for other structural or cyclical reasons. Also, much of the recent employment decline is due to the loss of unsustainable "bubble" jobs during the 2000-2002 bust period ("The Great Hollowing-Out Myth," 2004). That said, do trends in the data support the hypothesis?

This paper uses a measure of IT services outsourcing intensity (OSS), which is defined as the share of IT services inputs imported. (This measure will be discussed in greater detail in Section 3.1.) Figure 2.1 shows IT services outsourcing intensity for the entire U.S. economy for the years 1992, 1997, 1999, and 2003. There is a clear upward trend, so one would expect employment in high skill IT occupations to increase for each period, and vice versa for low skill occupations.

[1] Employment and wage data are much more complete in recent years. 1999 is the earliest year for which the data available corresponds exactly with the data available for 2003. Because this is a period of only four years, this paper also examines effects for 1992-2003 and 1997-2003, although fewer observations are available in 1992 and 1997.

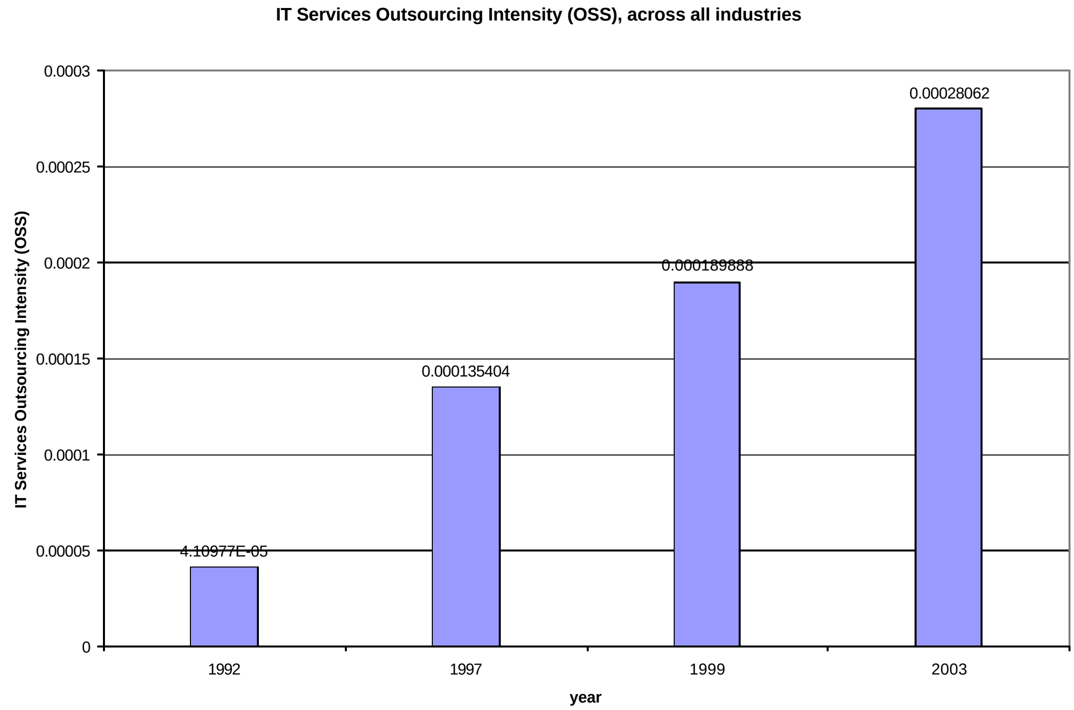


Figure 2.1

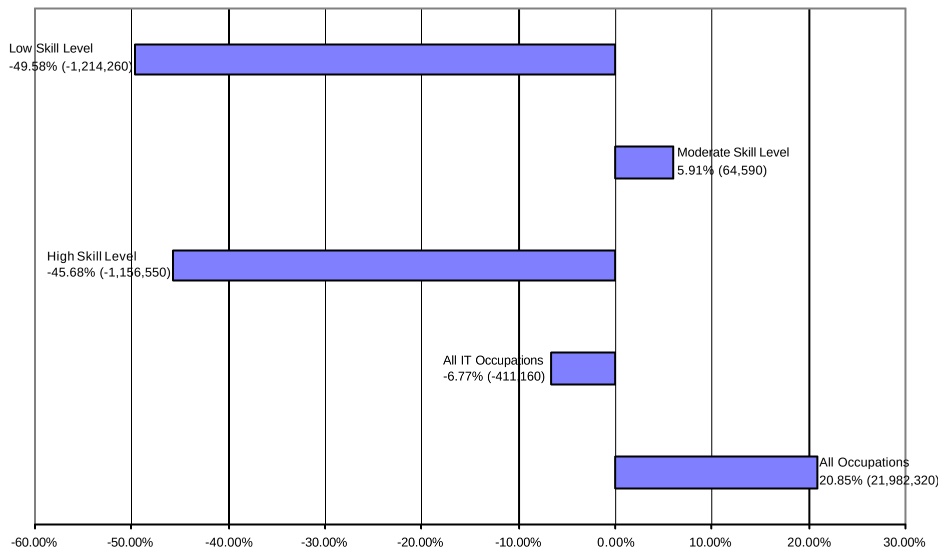
Grouped into general skill categories (high, moderate, and low), how did domestic employment in IT occupations change as the intensity of outsourcing increased?

Support for the hypothesis in the 1992-2003 and 1997-2003 periods is mixed. Figure 2.2 and Figure 2.3 show that employment in low skill IT occupations did decrease in both periods. However, they also show that high skill IT employment decreased, though to a lesser extent than low skill. One possible explanation for this unexpected pattern is the incompleteness of data for 1992 and 1997, especially for high skill IT occupations. Of the five occupations not surveyed in 1997, four are high skill and one is moderate skill; and of the eight occupations not surveyed in 1992, seven are high skill and one is moderate skill.[2] This introduces a clear selection bias problem in the 1992-2003 and 1997-2003 data. Thus it

[2] See the Appendix for details about data availability for occupations.

will be informative to examine in detail employment trends for the 1999-2003 period. Figure 2.4 shows these trends by skill category.

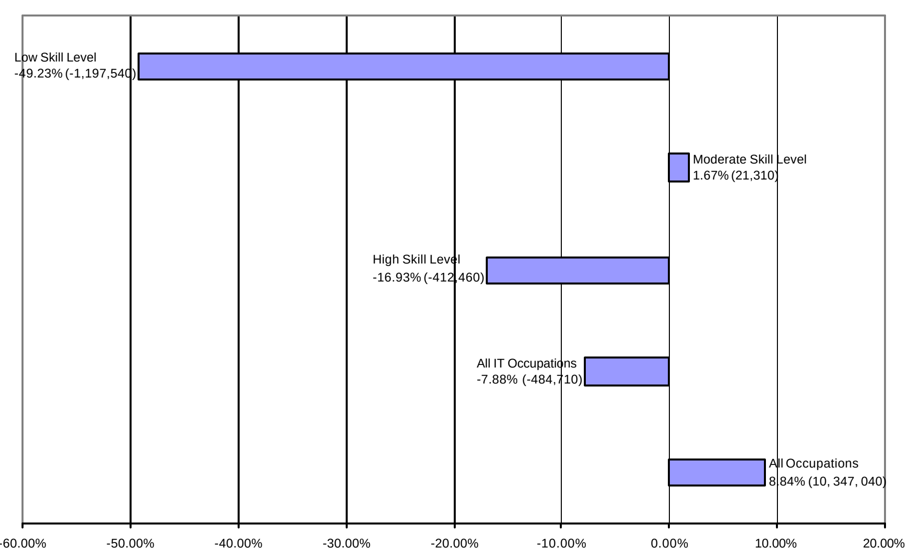
Percent (and absolute) change in employment, 1992-2003



Note: 2003 figures used here do not include occupations not surveyed in 1991.
Source: U.S. Department of Labor, Bureau of Labor Statistics

Figure 2.2

Percent (and absolute) change in employment, 1997-2003



Note: 2003 figures used here do not include occupations not surveyed in 1997.
Source: U.S. Department of Labor, Bureau of Labor Statistics

Figure 2.3

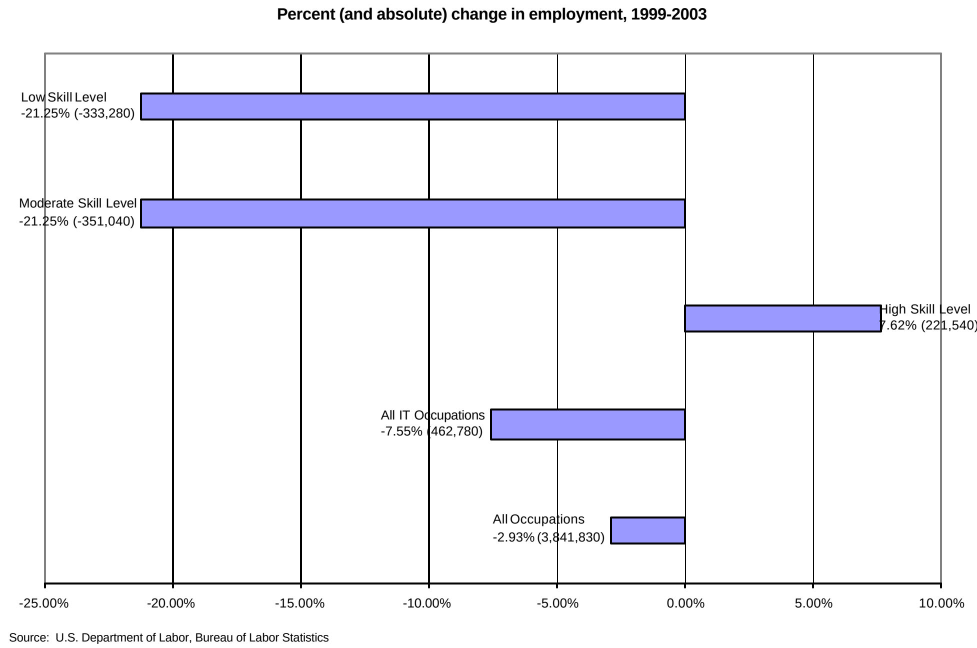
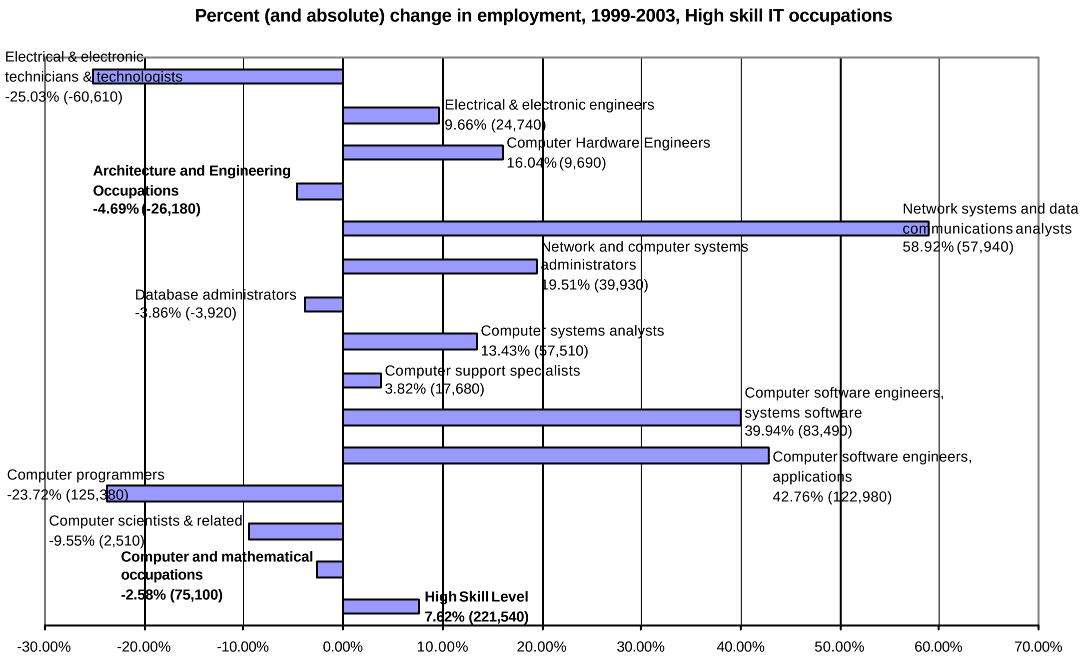


Figure 2.4

Figure 2.4 shows that, grouped into general skill categories, the data for 1999-2003 *do* support the hypothesis. Despite the fall in total U.S. employment, employment in high skill IT occupations as a group grew 7.62% from 1999 to 2003, an increase of 221,540 jobs. Meanwhile, employment in moderate and low skill level IT occupations both fell during that period by 21.25%, a decrease of 351,040 and 333,280 jobs, respectively.

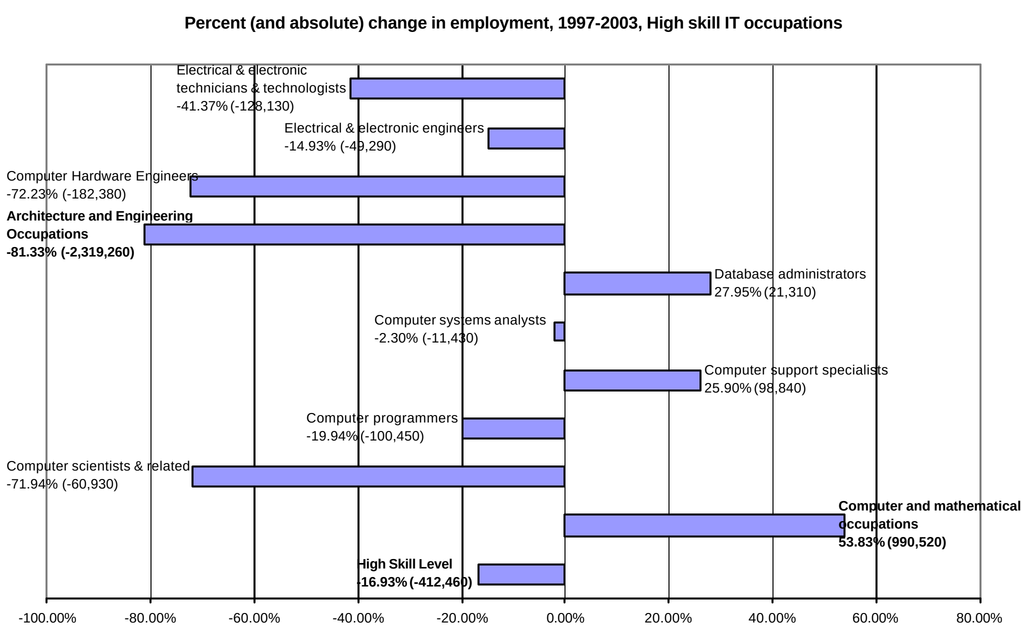
To give an idea of the effect the high skill IT occupations *not* surveyed in 1992 and/or 1997 may have had on the apparent trends for 1992-2003 and 1997-2003, the figures below (Figure 2.5, Figure 2.6, Figure 2.7) show employment changes in individual high skill occupations for all three periods.[3]

[3] Figures for individual moderate and low skill occupations are available in the Appendix.



Bolded labels indicate occupation supercategories.
Source: U.S. Department of Labor, Bureau of Labor Statistics

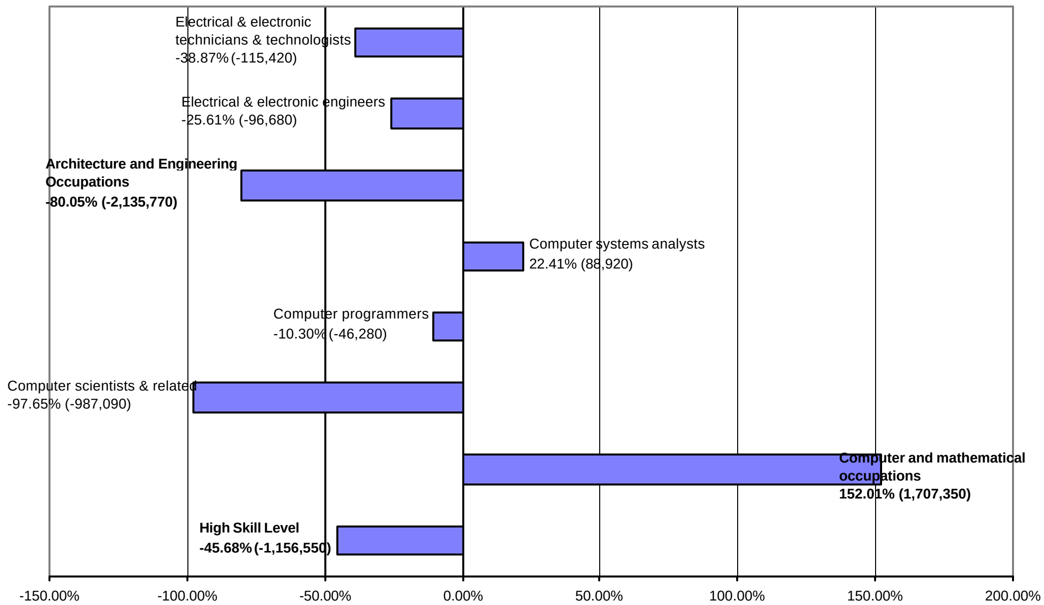
Figure 2.5



Bolded labels indicate occupation supercategories.
Note: 2003 figures used here do not include occupations not surveyed in 1997.
Source: U.S. Department of Labor, Bureau of Labor Statistics

Figure 2.6

Percent (and absolute) change in employment, 1992-2003, High skill IT occupations



Bolded labels indicate occupation supercategories.
Source: U.S. Department of Labor, Bureau of Labor Statistics

Note: 2003 figures used here do not include occupations not surveyed in 1992.

Figure 2.7

For the most part, high skill occupations that were *not* surveyed in 1992 and/or 1997 grew in employment in 1999-2003, suggesting that the declines reported for 1992-2003 and 1997-2003 may be overstated. Four occupations were not surveyed in either 1992 or 1997 (Network systems and data communications analysts; Network and computer systems administrators; Computer software engineers, systems software; and Computer software engineers, applications). Figure 2.5 shows that these same occupations had the *largest* percentage increase in employment in 1999-2003. Three additional high skill occupations were not surveyed in 1992 only. Of these, two grew in employment in 1999-2003.

One might argue that perhaps employment in all high skill IT occupations grew in 1999-2003, and that their growth is merely a function of the period. However, this is not the case. Most of the occupations for which employment decreased did so consistently across all three periods; in other words, if an occupation decreased in employment in 1992-2003 and 1997-2003, it often *also* decreased in 1999-2003. For example, of the four occupations in which employment decreased in 1992-2003, three also decreased in employment in 1999-2003 (Electrical & electronic technicians & technologists; Computer programmers; and Computer scientists & related), as shown in Figures 2.5 and 2.7. The same is true of the six occupations that had a decrease in 1997-2003 (see Figures 2.5 and 2.6).

That overall employment for high skill occupations grew in 1999-2003, despite decreases in those occupations that had consistent decreases, also suggest the possibility that the overall declines in high skill employment shown in the data for 1992-2003 and 1997-2003 are at least overstated, if not of the wrong sign.

Again, however, the recent data trends do seem to support the hypothesis. As the overall intensity of IT services outsourcing increased over the 1999-2003 period, employment in IT occupations categorized as high skill generally increased, but decreased in those categorized as moderate or low skill.

2.2 The dataset and sources.

The two-level cross-sectional dataset consists of three subsets, one each for the periods 1992-2003[4], 1997-2003, and 1999-2003. Each has 27 IT occupations, 18 industries, and four variables: employment, average annual wage, OSS (IT services outsourcing intensity by industry, discussed in Section 3.1), and output by industry. Each of the 27 occupations is classified as high, moderate, or low skill. The log change is taken for each variable. The dataset is unbalanced, particularly for 1992-2003 and 1997-2003. Many data points are

[4] Prior to 1996, the BLS collected occupational employment data from only selected industries in each year over a three-year cycle. 1991-1993 is one such cycle. This paper compiles 1991-1993 occupational employment data into a complete set, treating it as belonging to one year (1992).

missing for those periods; and again, some high skill occupations were not surveyed in 1992 and 1997, creating a selection bias problem for those years.

IT-related occupations are categorized and classified by skill according to the Department of Commerce's *Digital Economy 2002* (p. 44, Box 5.1). These occupation categories are based on the Standard Occupational Classification (SOC) system used by the BLS. Industry categories are based on a consolidation of the Standard Industrial Classification (SIC) system and the North American Industrial Classification System (NAICS), according to SIC/NAICS correspondence tables published by the U.S. Census Bureau. See the Appendix for full occupation and industry listings and classification details.

Data from the BLS' Occupational Employment Survey (OES) is used to measure both employment and wage by occupation and industry. (In 1992, only wage data by industry is available, so industry-level wage data is used for the period 1992-2003.)

Data from the Bureau of Economic Analysis' (BEA) industry make-use tables are used to calculate industry output.[5]

OSS is constructed with industry-level input-output data and import-export data. The BEA's industry make-use tables mentioned above are also used to calculate this measure. The BEA also makes available import-export data for IT services in Table 7[6] ("Business, Professional, and Technical Services, Unaffiliated") of the U.S. international services data published annually in the *Survey of Current Business*.

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[5] Data from these make-use tables are available on a SIC basis for 1992 and 1997, and on a NAICS basis for 2003. This data is consolidated into comparable industry categories in the same manner as employment and wage data, as described in the Appendix.

[6] Imports (or exports) of IT services is the sum of imports (or exports) of "Computer and data processing services" and "Database and other information services."

3 Empirical model.

This chapter is a discussion of the measurement of IT services outsourcing intensity, as well as the system and panel techniques that will be used to estimate the relationship between IT services outsourcing and employment in IT occupations of high and low skill.

3.1 Construction of OSS.

The generalized model of labor demand discussed in Section 3.2 includes a vector of input prices other than wage rate. Since the price of IT services outsourcing is not available, this study will proxy for it using a measure of IT services outsourcing intensity (OSS_i). Alternate versions of this proxy are used in Amiti and Wei (2004) for general services outsourcing, and in Feenstra and Hanson (1996) for material outsourcing. A decrease in the price of outsourcing may be interpreted as an increase in outsourcing intensity, and vice versa.

The intensity of IT services outsourcing for each industry is defined as the share of IT services inputs imported, and is calculated as follows:

$$OSS_i = \left[\text{input purchases of IT services } ITs \text{ by industry i} \,/\, \text{total non-energy inputs used by industry i}\right] * \left[\text{imports}_{ITs} \,/\, \text{production}_{ITs} + \text{imports}_{ITs} - \text{exports}_{ITs}\right]$$

Equation 3.1

The first bracketed term, and production_{ITs} in the second bracketed term, is calculated using BEA industry make-use tables, as discussed in Section 2.2. Import and export data in the second bracketed term are calculated using the U.S. international services data published in the *Survey of Current Business*, which gives the volume of IT services imports as unaffiliated payments for “Computer and data processing services” and “Database and other information services” imports in U.S. dollars. Import and export data are not available by industry, so an overall economy import share is applied to each industry.

3.2 System and panel estimation.

The effects of IT outsourcing on employment in IT-related occupations is estimated using an adaptation of a common log-log framework for labor demand functions (Hamermesh, 1993):

$$l_i = a_0 + a_1 w_i + a_2 ?_i + ?\, y_i$$

Equation 3.2

where lowercase letters indicate that the variable is in log form. w is the wage rate, ? is a vector of other input prices, and y is the level of output. Generally, wage rate and input prices are expected to have a negative effect on employment demand, and output is expected to have a positive effect.

The input price of interest for this paper is the price of IT services outsourcing. As discussed in the previous section, OSS_i will be used as a proxy for the price of IT services outsourcing. The base regression system used in this analysis is given by 27 equations (one per occupation c) of the form:

$$?\, l_{ci} = a_0 + a_1 ?\, w_{ci} + ß_{s(c)} ?\, oss_i + a_2 ?\, y_i + e_{ci}$$

Equation 3.3

where, over a given period, $?\, l_{ci}$ is the log difference in employment in occupation c in industry i; $?\, w_{ci}$ is the log difference in wage rate in occupation c in industry i; $?\, y_i$ is the log difference in output in industry i; and $?\, oss_i$ is the log difference in IT services outsourcing intensity in industry *i*, as adapted from the measure of general services outsourcing intensity used in Amiti and Wei (2004). The system will be estimated using ordinary least squares (OLS), as well as the seemingly unrelated regression (SUR) technique in order to account for possible correlation between error terms across the equations.

This regression equation is modeled closely after that used in Amiti and Wei (2004). A major difference is, of course, the change in definition of OSS_i from general services outsourcing intensity to IT services outsourcing intensity. In addition, Amiti and Wei run their regression on time-series, industry cross-section data; the regression used in this analysis will be run on data cross-sectioned by industry and occupation.

As with the generalized framework mentioned above, a_1 (the parameter for wage) is expected to be negative, and a_2 (the parameter for output) is expected to be positive. However, the sign of $ß_{s(c)}$ may be either positive or negative for varying *s(c)*, where *s(c)* is the skill level of occupation *c* (either low, high, or moderate). There are a few ways IT services outsourcing may affect labor demand, depending on occupation *c*. There may be a substitution effect: if domestic IT labor in occupation *c* and IT services outsourcing are substitutes, an increase in OSS_i would lead to a decrease in labor demand. There may also be output effects: if an increase in OSS_i makes a particular firm more competitive and increases demand for its output, its labor demand may increase. Or as Mann predicts, the increased usage of IT arising from increased OSS_i (even in firms which do not produce IT-related output) will increase labor demand for some *c*'s. Again, the expected result is that in high skill IT occupations, an increase in IT services outsourcing intensity causes an increase in labor demand, while lower skill IT occupations experience the opposite effect (presumably because of dominating substitution effects). Thus $ß_{s(c)}$ is expected to differ for occupations of different skill levels: if occupation *c* is high skill then $ß_{s(c)}$ should be positive, and if occupation c is low skill then $ß_{s(c)}$ should be negative. If occupation c is moderate skill then $ß_{s(c)}$ may fall somewhere between the two extremes.

A very closely related panel-based regression equation is also estimated. It is given by:

$$? l_{ci} = a_0 + a_1 ? w_{ci} + ß_0 ? oss_i + ß_1(? oss_i * D_{low}) + ß_2(? oss_i * D_{high}) + a_2 ? y_i + e_{ci}$$

Equation 3.4

where, as in Equation 3.3, $? l_{ci}$ is the log difference in employment in occupation c in industry i; $? w_{ci}$ is the log difference in wage rate in occupation c in industry i; $? oss_i$ is the log difference in IT services outsourcing intensity in industry i, and $? y_i$ is the log difference in output of industry i. D_{low} and D_{high} are dummy variables for low and high skill occupations. Note that $ß_0 + ß_1$ is equivalent to $ß_{low}$ in Equation 3.3, and $ß_0 + ß_2$ is equivalent to $ß_{high}$. Ordinary least squares estimations of Equation 3.3 and Equation 3.4 would yield the same values for these equivalent parameters.

Equation 3.4 will be estimated using pooled, fixed-effects, and random-effects models. a_1 is again expected to be negative, and a_2 positive. $ß_0$ will indicate the overall effect of outsourcing on employment in IT occupations, and may have either positive or negative sign. $ß_1$ will indicate the difference between that overall effect and the effect on employment in low skill occupations specifically. Thus it should be negative, and vice versa for $ß_2$. $ß_0 + ß_1$, which will indicate the actual effect of outsourcing on employment in low skill IT occupations, should also be negative; and vice versa for $ß_0 + ß_2$.

4 Results.

Table 4.1 gives the system estimation results, using both OLS and SUR techniques.[1] These results do not show systematically significant correlation between outsourcing and IT employment; the estimates are significant only for low skill employment in 1999-2003, and moderate and high skill employment using SUR in 1997-2003. Though not consistently significant, the OLS and SUR results generally show that correlation between both low and high skill employment and outsourcing is negative. However, the results for 1999-2003 (for which the dataset is most complete) do indicate that outsourcing has a *less* negative effect on high skill IT employment than on low skill IT employment, with the effect on moderate skill employment falling between the two.

Estimation with the SUR technique preserves the sign of each result, but generally makes the effect of each variable smaller. In 1997-2003, the coefficient for outsourcing for moderate and high skill employment becomes significant with SUR estimation, but the sign of the coefficient for high skill employment is still negative.

Table 4.2 gives the probability results of Wald coefficient tests on $ß_{s(c)}$. The first row, which is of greatest interest, shows results for the test that $ß_{s(c)}$ is the same for both high and low skill occupations, and similarly for the second and third row. With OLS estimation, the effect of outsourcing on IT occupational employment does not differ significantly over skill levels. With SUR estimation, the test results also show that $ß_{low}$ and $ß_{high}$ do not differ significantly for 1997-2003 (which, again, has the more biased dataset of the two periods). However, the probability that $ß_{low}$ and $ß_{high}$ are equal is shown to be approximately zero in 1999-2003, bolstering the pattern shown in the SUR column for that period in Table 4.1:

[1] Results are not available for 1992-2003 because too many observations are missing in the dataset for that period.

that IT services outsourcing has a significantly smaller negative effect on high skill IT employment than on low skill IT employment.

Table 4.1

variable (coefficient)	1999-2003 OLS	1999-2003 SUR	1997-2003 OLS	1997-2003 SUR
?ln(wage) (a_1)	0.2545 (0.36)	0.2772** (2.173)	3.4** (2.996)	2.081** (7.167)
?ln(oss) ($ß_{low}$)	-0.1429** (-1.987)	-0.114** (-4.492)	-0.0623 (-0.6385)	-0.0314 (-1.49)
?ln(oss) ($ß_{moderate}$)	-0.0744 (-0.909)	-0.0407 (-1.738)	0.1085 (0.8807)	0.0656** (2.391)
?ln(oss) ($ß_{high}$)	-0.0325 (-0.6058)	-0.0324 (-1.695)	-0.0628 (-0.8046)	-0.0377** (-2.135)
?ln(output) (a_2)	0.7883** (2.692)	0.9216** (6.257)	0.3014 (0.5123)	0.4008** (2.556)
Constant (a_0)	0.3406 (1.8526)	0.1661** (2.404)	-0.3117 (-0.627)	-0.2394** (-1.999)

t-statistics in parentheses. Starred values are significant at the 5% level.

Table 4.2

test	1999-2003 OLS	1999-2003 SUR	1997-2003 OLS	1997-2003 SUR
$ß_{high} = ß_{low}$	0.1817	0**	0.997	0.6596
$ß_{high} = ß_{moderate}$	0.6435	0.6788	0.2089	0**
$ß_{moderate} = ß_{low}$	0.5002	0.0001**	0.2428	0.0005**

Values shown are probabilities. Starred values indicate a significant difference at the 5% level between the two coefficients tested.

Table 4.3, Table 4.6, and Table 4.9 give panel estimation results for 1999-2003, 1997-2003, and 1992-2003 respectively, using pooled, fixed-effects, and random-effects models. Note that $ß_1$ and $ß_2$ in the panel-based Equation 3.4 are coefficients for interaction terms; hence $ß_0 + ß_1$ in the following tables is equivalent to $ß_{low}$ in Table 4.1, and likewise $ß_0 + ß_2$ is equivalent to $ß_{high}$. Thus results given in Column 2 of Table 4.3 and Table 4.6 are equivalent to the OLS results in Table 4.1.

Table 4.4, Table 4.7, and Table 4.10 show the values of $ß_0 + ß_1$ and $ß_0 + ß_2$ as well as results for the tests $ß_0 + ß_1 = 0$ and $ß_0 + ß_2 = 0$. Significance shown in these test results correspond with significance shown by t-statistics for $ß_{low}$ and $ß_{high}$ in Table 4.1.

For each of the three periods and five specifications, the tables below show that the effect of IT services outsourcing on *overall* IT employment is negative, but not significant. The signs of $ß_1$ and $ß_2$ vary but are almost never significant, indicating that there is generally no difference in the effect of outsourcing on overall IT employment versus specifically low or high skill IT employment.

However, the pattern found in the system estimation results for 1999-2003 continues to hold with the inclusion of occupation and industry random effects: $ß_1$ is negative and $ß_2$ is positive, indicating outsourcing's less negative effect on high skill IT employment than on low skill. The 1992-2003 results below also exhibit a similar pattern. (See Columns 4 and 5 in Table 4.3 and Table 4.9.)

The test results in Table 4.4, Table 4.7, and Table 4.10 show, once again, that outsourcing's negative effect on employment in low skill IT occupations is significant in 1999-2003 using only the base specification. Inclusion of fixed and random effects preserve the 1999-2003 pattern discussed above, though the estimates for those specifications are not significant.

Table 4.5, Table 4.8, and Table 4.11 show results for the test $ß_1 = ß_2$, which is comparable to the test $ß_{low} = ß_{high}$. The estimates for the two parameters are again shown not to be significantly different in the base OLS specification; nor are they significantly different in the fixed- and random-effects specifications.

Table 4.3

variable (coefficient)	1999-2003 (1)	(2)	(3)	(4)	(5)
?ln(wage) (a_1)	0.2827	0.2545	0.0791	0.1504	0.5498
	(0.4014)	(0.36)	(0.1097)	(0.2181)	(0.7882)
?ln(oss) ($ß_0$)	-0.0701	-0.0744	-0.0421	-0.0682	-0.0689
	(-0.1622)	(-0.9086)	(-0.0479)	(-0.8379)	(-0.0683)
?ln(oss * D(low)) ($ß_1$)		-0.0685	0.0103	-0.0227	-0.071
		(-0.6742)	(0.0914)	(-0.2206)	(-0.7238)
?ln(oss * D(high)) ($ß_2$)		0.0418	-0.037	0.0164	0.0376
		(0.4628)	(-0.3687)	(0.1796)	(0.4301)
?ln(output) (a_2)	0.7852**	0.7883**	0.7684**	0.7873	0.757
	(2.684)	(2.692)	(2.736)	(2.826)	(1.478)
constant (a_0)	0.3337	0.3406	0.3556	0.3765	0.2882
	(1.82)	(1.853)	(1.971)	(1.8489)	(1.049)
fixed occupation effects	no	no	yes	no	no
random occupation effects	no	no	no	yes	no
random industry effects	no	no	no	no	yes
N	338	338	338	338	338
R-squared	0.0233	0.0285	0.1962	0.0269	0.0149

t-statistics in parentheses. Starred values are significant at the 5% level.

Table 4.4

variable/test	equivalent to	1999-2003 (2)	(3)	(4)	(5)
$ß_0 + ß_1$	$ß_{low}$	-0.1429**	-0.0318	-0.0909	-0.1399
test: $ß_0 + ß_1 = 0$		(3.948)	(0.1848)	(1.632)	(2.362)
$ß_0 + ß_2$	$ß_{high}$	-0.0326	-0.0791	-0.0518	-0.0313
test: $ß_0 + ß_2 = 0$		(0.367)	(2.101)	(0.9685)	(0.1582)

F-statistics in parentheses, with (1, 332) degrees of freedom. Starred values indicate significance at the 5% level.

Table 4.5

test	comparable to	1999-2003 (2)	(3)	(4)	(5)
$ß_1 = ß_2$	$ß_{high} = ß_{low}$	0.1817	0.5981	0.6409	0.1687

Values shown are probabilities.
Starred values indicate a significant difference at the 5% level between ß1 and ß2.

Table 4.6

variable (coefficient)	1997-2003 (1)	(2)	(3)	(4)	(5)
?ln(wage) (a_1)	3.271**	3.4**	3.427**	3.5**	3.297**
	(2.895)	(2.996)	(2.65)	(2.903)	(2.903)
?ln(oss) (ß$_0$)	-0.0334	0.1085	-0.1879	-0.0636	0.1102
	(-0.5423)	(0.8807)	(-1.432)	(-0.5161)	(0.8378)
?ln(oss * D(low)) (ß$_1$)		-0.1708	0.2104	0.0544	-0.1699
		(1.168)	(1.312)	(0.3622)	(-1.172)
?ln(oss * D(high)) (ß$_2$)		-0.1713**	0.141	0.003	-0.1732
		(3.000)	(0.9425)	(0.02167)	(-1.275)
?ln(output) (a_2)	0.3333	0.3014	0.6899	0.5422	0.3057
	(0.5679)	(0.5123)	(1.289)	(1.021)	(0.4266)
constant (a_0)	-0.2698	-0.3117	-0.4076	-0.1486	-0.3
	(-0.5441)	(-0.627)	(-0.7958)	(-0.2422)	(-0.531)
fixed occupation effects	no	no	yes	no	no
random occupation effects	no	no	no	yes	no
random industry effects	no	no	no	no	yes
N	271	271	271	271	271
R-squared	.0338	.0403	.2922	.0424	.0368

t-statistics in parentheses. Starred values are significant at the 5% level.

Table 4.7

variable/test	equivalent to	1997-2003 (2)	(3)	(4)	(5)
ß$_0$ + ß$_1$	ß$_{low}$	-0.0623	0.0225	-0.0092	-0.0597
test: ß$_0$ + ß$_1$ = 0		(0.4077)	(0.0546)	(0.0097)	(0.3144)
ß$_0$ + ß$_2$	ß$_{high}$	-0.0628	-0.0469	-0.0606	-0.063
test: ß$_0$ + ß$_2$ = 0		(0.6474)	(0.3751)	(0.6592)	(0.5019)

F-statistics in parentheses, with (1, 265) degrees of freedom. Starred values indicate significance at the 5% level.

Table 4.8

test	comparable to	1997-2003 (2)	(3)	(4)	(5)
ß$_1$ = ß$_2$	ß$_{high}$ = ß$_{low}$	0.9970	0.5690	0.6602	0.9771

Values shown are probabilities.
Starred values indicate a significant difference at the 5% level between ß1 and ß2.

Table 4.9

variable (coefficient)	1992-2003 (1)	(2)	(3)	(4)	(5)
?ln(wage) (a_1)	-1.134	-1.149	-1.154	-1.149	-1.097
	(-0.6316)	(-0.6366)	(-0.627)	(-0.6301)	(-0.541)
?ln(oss) ($ß_0$)	-0.0119	-0.0275	0.0316	-0.0275	-0.0314
	(-0.221)	(-0.2464)	(0.2116)	(-0.244)	(-0.2741)
?ln(oss * D(low)) ($ß_1$)		0.0016	-0.0597	0.0016	0.006
		(0.0133)	(-0.3518)	(0.0131)	(0.0504)
?ln(oss * D(high)) ($ß_2$)		0.0322	-0.0735	0.0322	0.0366
		(0.2677)	(-0.4352)	(0.2649)	(0.3036)
?ln(output) (a_2)	0.4161	0.4286	0.5274	0.4286	0.3651
	(0.3457)	(0.3532)	(0.4215)	(0.3496)	(0.2716)
constant (a_0)	1.183	1.205	1.186	1.205	1.188
	(0.7034)	(0.7104)	(0.6845)	(0.7032)	(0.6249)
fixed occupation effects	no	no	yes	no	no
random occupation effects	no	no	no	yes	no
random industry effects	no	no	no	no	yes
N	189	189	189	189	189
R-squared	.0032	.004	.0834	.004	.0026

t-statistics in parentheses. Starred values are significant at the 5% level.

Table 4.10

variable/test	equivalent to	1992-2003 (2)	(3)	(4)	(5)
$ß_0 + ß_1$	$ß_{low}$	-0.0259	-0.0281	-0.0259	-0.0254
test: $ß_0 + ß_1 = 0$		(0.1252)	(0.1144)	(0.1227)	(0.1075)
$ß_0 + ß_2$	$ß_{high}$	0.0047	-0.0419	0.0047	0.0052
test: $ß_0 + ß_2 = 0$		(0.0046)	(0.262)	(0.0045)	(0.0049)

F-statistics in parentheses, with (1, 183) degrees of freedom. Starred values indicate significance at the 5% level.

Table 4.11

test	comparable to	1992-2003 (2)	(3)	(4)	(5)
$ß_1 = ß_2$	$ß_{high} = ß_{low}$	0.7292	0.9043	0.7319	0.7294

Values shown are probabilities.
Starred values indicate a significant difference at the 5% level between ß1 and ß2.

5 <u>Conclusions.</u>

This paper hypothesizes that IT services outsourcing is positively correlated with employment in high skill IT occupations, and vice versa for low skill IT occupations. Recent data trends for 1999-2003 support the hypothesis; they show that, as IT services outsourcing increased, employment in high skill IT occupations grew while employment in low skill IT occupations decreased. Though this does not hold for trends over the periods 1992-2003 and 1997-2003, it is plausible that the high skill employment declines reported were caused by the selection bias problem in the datasets for those periods, and therefore were overstated or of the wrong sign.

Overall, the regression equation estimations and coefficient tests yield mixed results. The base OLS estimations are not systematically significant, though results for 1999-2003 indicate that the effect of outsourcing on employment in high skill IT occupations is *less* negative than on employment in low skill IT occupations. The addition of fixed occupation effects, random occupation effects, and random industry effects to the base specification do not produce significant estimates either, though the pattern mentioned above for 1999-2003 continues to hold under the random-effects models. Estimation with the SUR technique preserves this pattern, and shows that the two coefficients are significantly different.

In light of these mixed results, it is uncertain whether the hypothesis is correct; though not significant, the effect of IT services outsourcing on IT employment was generally negative for both high and low skill levels. However, given the pattern observed in the 1999-2003 results, as well as the fact that the dataset for that period is the most complete and least biased, it can be concluded that the results may indicate that the effects of outsourcing on employment in high and low skill IT occupations differ, and that the effect on low skill IT occupations is more negative than on high skill IT occupations.

6 Appendix.

6.1 Occupation category correspondence, skill level, annual average wage in 2003.

In 1999, the BLS' OES program began to use the standard SOC system instead of its old OES occupation classification system. As a result, some occupations were renamed, divided into two or more separate occupations, or were added to the classification system. The following table details the correspondence between the pre-1998 and post-1998 systems and the occupation classifications used in this paper.

Table 6.1

Occupation category	Average annual salary in 2003	Corresponding Occupation Categories in 1999, 2003	Corresponding Occupation Categories in 1992, 1997
		HIGH SKILL	
Computer hardware engineers	82040	Computer hardware engineers	Computer Engineers **(N/A in 1992)**
Computer programmers	65170	Computer programmers	Computer Programmers
Computer scientists & related	85240	Computer and information scientists, research	Other Computer Scientists & Related
Computer software engineers, applications	76260	Computer software engineers, applications	**N/A**
Computer software engineers, systems software	79790	Computer software engineers, systems software	**N/A**
Computer support specialists	43140	Computer support specialists	Computer Support Specialists **(N/A in 1992)**
Computer systems analysts	67040	Computer systems analysts	Systems Analysts
Database administrators	62100	Database administrators	Data Base Administrators **(N/A in 1992)**
Electrical & electronic engineers	74038	Electrical engineers; Electronics engineers, except computer	Electrical & Electronic Engineers
Electrical & electronic technicians & technologists	46190	Electrical and electronic engineering technicians	Electrical/Electronic Technicians & Technologists
Network and computer systems administrators	60100	Network and computer systems administrators	**N/A**
Network systems and data communications analysts	62220	Network systems and data communications analysts	**N/A**
		MODERATE SKILL	
Computer, automated teller, and office machine repairers	35450	Computer, automated teller, and office machine repairers	**N/A**

Data entry keyers	23780	Data entry keyers	Data Entry Keyers, Except Composing; Data Entry, Composing
Electrical & electronic equipment assemblers	25890	Electrical and electronic equipment assemblers	Electrical/Electronic Equipment Assemblers, Precision
Electrical & electronics repairers, commercial & industrial equipment	41990	Electrical and electronics repairers, commercial and industrial equipment	Electronics Repairers, Commercial/Industry Equipment
Electrical powerline installers and repairers	47730	Electrical power-line installers and repairers	Electrical Powerline Installers & Repairers
Electromechanical equipment assemblers	27290	Electromechanical equipment assemblers	Electromechanical Equipment Assemblers, Precision
Semiconductor processors	28810	Semiconductor processors	Electronic Semiconductor Processors
Telecommunications equipment installers & repairers, except line installers	46900	Telecommunications equipment installers and repairers, except line installers	Telephone & Cable TV Installers & Repairers
Telecommunications line installers & repairers	40840	Telecommunications line installers and repairers	Telephone and Cable Television Line Installers and Repairers
LOW SKILL			
Billing & posting clerks & machine operators	27590	Billing and posting clerks and machine operators	Operators, Billing/Posting/Calculating Machines; Billing, Cost & Rate Clerks
Computer operators	32190	Computer operators	Computer Operators, Except Peripheral Equipment
Mail clerks and mail machine operators	22860	Mail clerks and mail machine operators, except postal service	Mail Clerks, Except Machine Operators; Mail Machine Operators, Preparation & Handling
Other office machine operators	24360	Office machine operators, except computer	Other Office Machine Operators; Office Machine Operators, Data Processors
Switchboard operators	22460	Switchboard operators, including answering service	Switchboard Operators
Word Processors & Typists	28860	Word processors and typists	Typists, Including Word Processing

Source: U.S. Department of Labor, Bureau of Labor Statistics

6.2 Industry category correspondence.

In 2002, the BLS' OES program stopped collecting data on a SIC basis and instead began to collect data on a NAICS basis. The following table details the industry correspondence rules used in this paper, and is based on 1987 SIC and 2002 NAICS correspondence tables available from the U.S. Census Bureau.[1]

Table 6.2

Industry category	Corresponding SIC codes (1992, 1997, 1999)	Corresponding NAICS codes (2003)
Accommodation and food service	58, 70	72
Agriculture, forestry, fishing, and hunting	07	11
Arts, e ntertainment, and recreation	79	71
Construction	15-17	23
Educational services	82	61
Finance and insurance	60-64, 67	52
Health care and social assistance	80, 83	62
Information	27, 48, 78	51
Manufacturing	20-26, 28-39	31-33
Mining	10-14	21
Other services (except public administration)	72, 75, 76, 86, 89	81
Professional, scientific, and technical services	73, 81, 87	54
Public administration	90	92
Real estate	65	53
Retail trade	52-57, 59	44-45
Transportation and warehousing	40, 41, 42, 44, 45, 47	48-49
Utilities	49	22
Wholesale trade	50, 51	42

[1] http://www.census.gov/epcd/naics02/

6.3 Percent and absolute change in employment, moderate and low skill IT occupations.

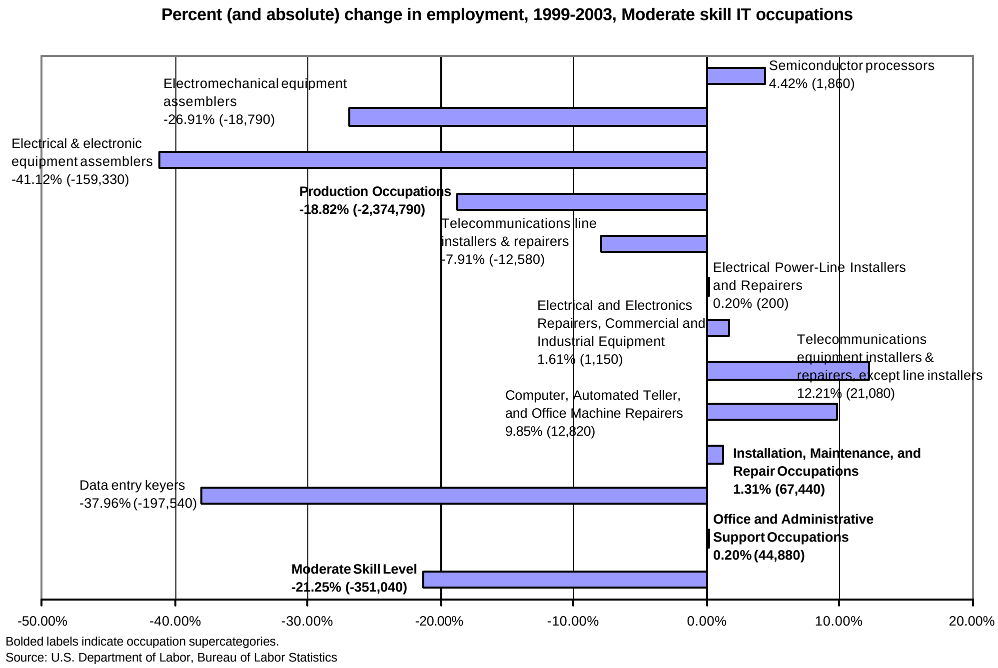

Figure 6.1

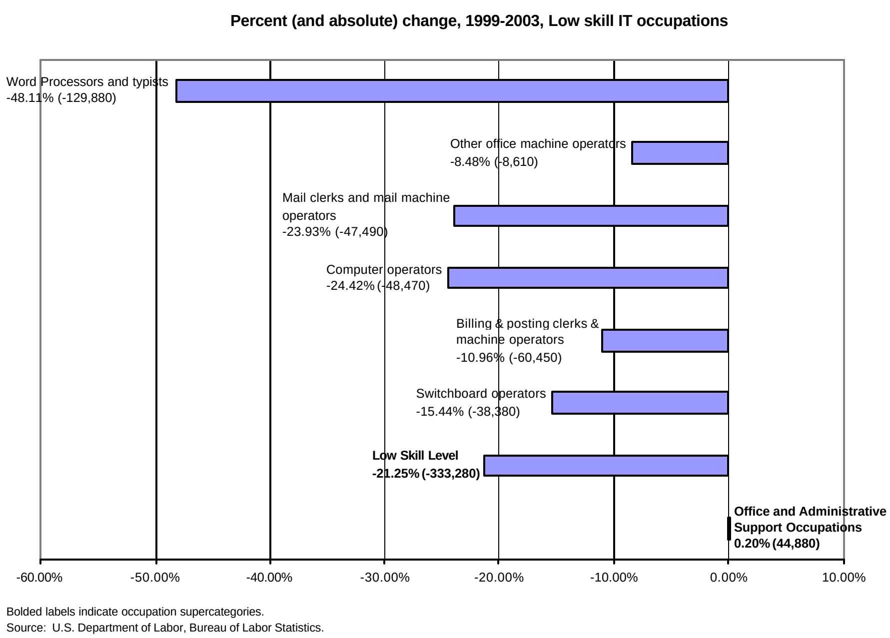

Figure 6.2

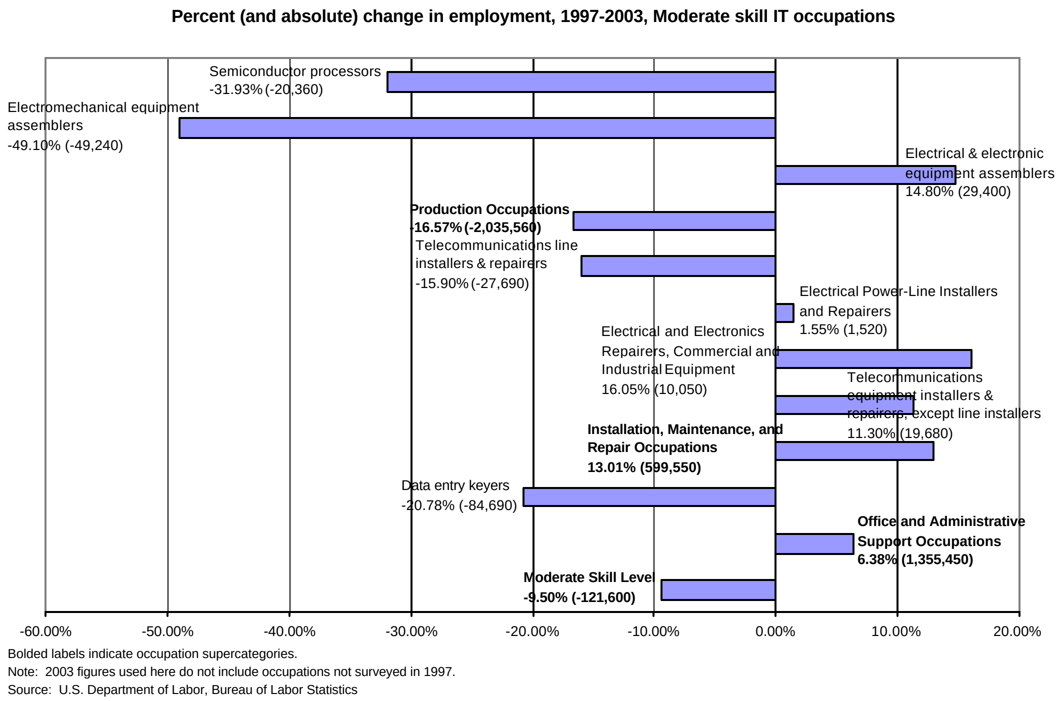

Figure 6.3

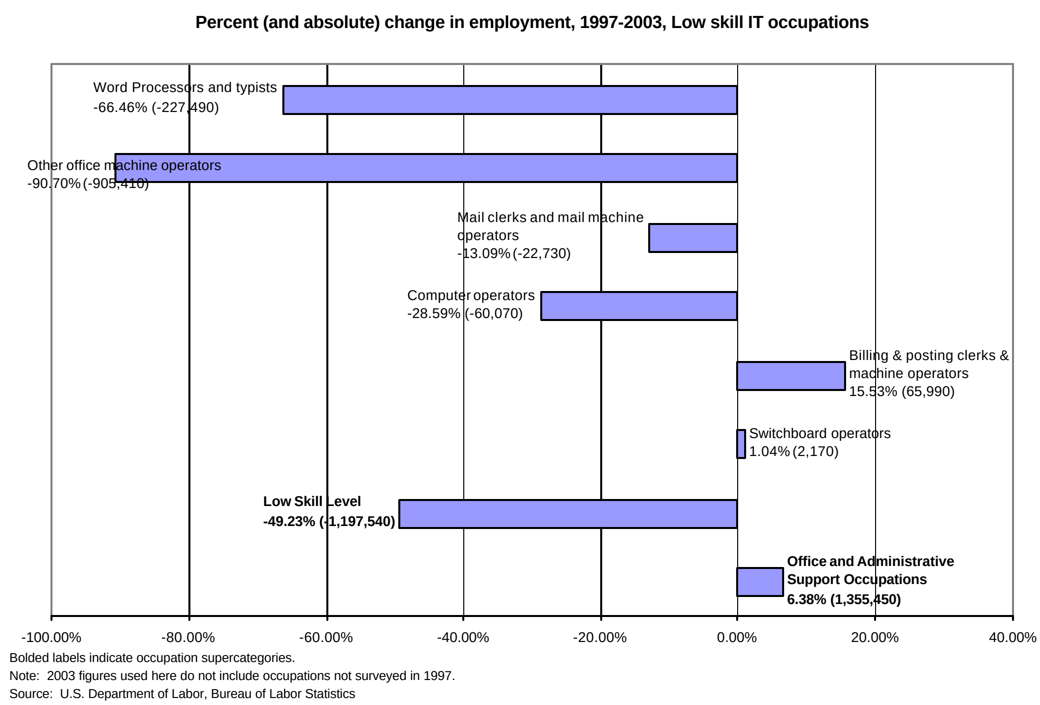

Figure 6.4

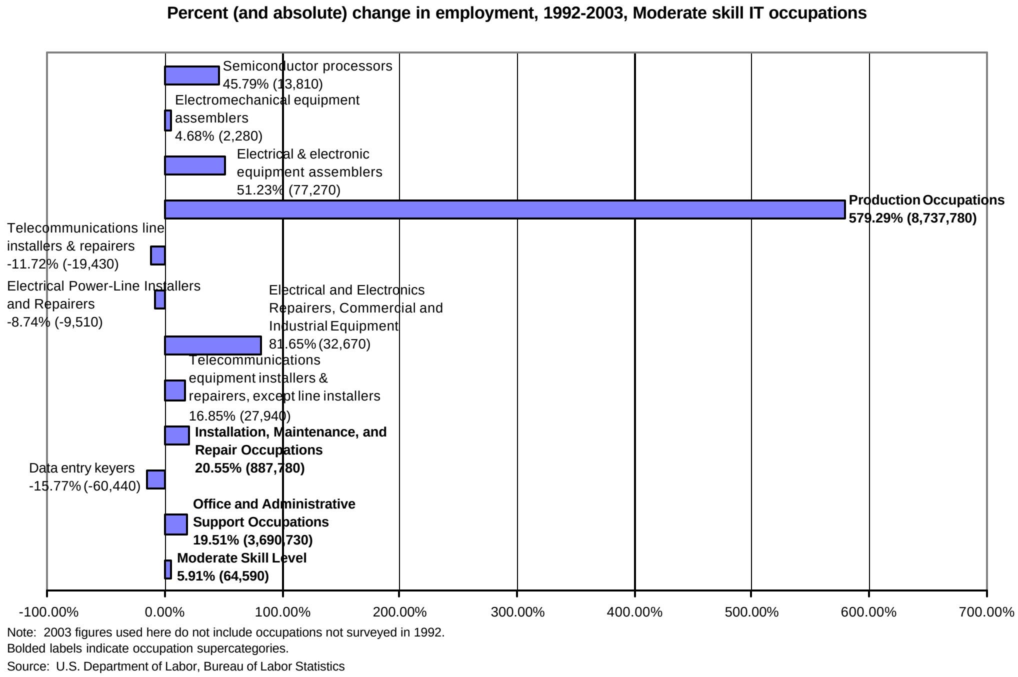

Figure 6.5

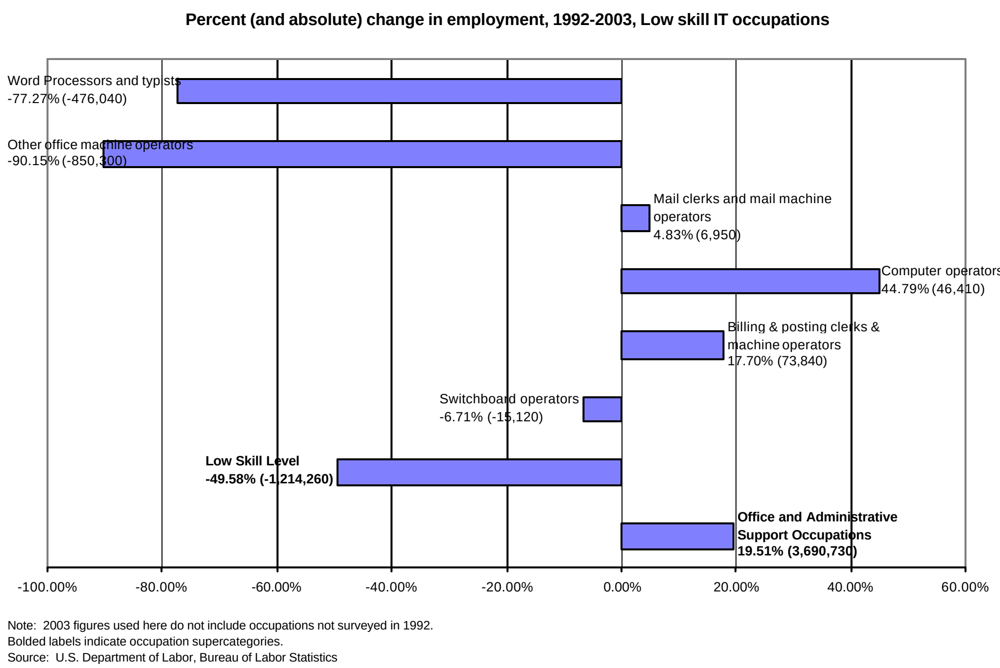

Figure 6.6

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