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During the economic boom of the late 1990's substantial concern was expressed over rapidly escalating wage rates and high rates of turnover as IT workers with critical skills found it easy to obtain substantial increases in wages by changing jobs. The IT market has cooled substantially in the short term. However, significant shortages are still apparent in some skill areas and long term growth projections for the IT profession suggest that similar market pressures are likely to reemerge in future periods of economic growth.

The academic literature provides a number of potential explanations of and prescriptions for dealing with the high job turnover rates of IT workers. Theories range from those that focus on unique aspects of the IT worker and IT jobs to those that suggest that the changing IT job market simply reflects changes, and perhaps represents the vanguard of changes, that are impacting employment relationships across all industries and occupations. In addition, the economic theory of human capital suggests the nature of a worker's skill set (as determined by such things as formal education and formal and informal on-the-job training) is a key factor determining the likelihood of job turnover.

In this study, we will examine alternative theories postulated to explain IT job turnover and determine the extent to which these theories are competing or reinforcing in terms of expected labor market behavior of IT workers. Then, using data from the US Current Population Survey (CPS), we will evaluate the degree to which the alternative theories are supported by US labor market data.

HUMAN CAPITAL THEORY AND TRADITIONAL ECONOMIC THEORY

In a broad sense, wage structures and labor turnover can be explained by the theory of human capital as developed by Becker [7]. According to human capital theory, investments in skill acquisition come at a cost since time that could have been used in production is sacrificed to acquire the skills. A return on this human capital is generated in succeeding periods since the acquired skills enhance the productivity of the worker.

Mincer [39] claims one of the major insights of human capital theory is the observation that individuals can increase their productivity not only through their investments in formal education, but also by learning work skills while they are actually on the job. Training can be formal training programs (on- or off-site) sponsored by employer or informal instruction by supervisors or coworkers.

Becker [7] divides on-the-job training into general training and specific training. General training increases a worker's prospective productivity in a large number of firms. For example, training in the use of a word processing package or conflict resolution skills would be expected to have equal value to a broad set of firms. Competition for the services of a worker with these general skills forces the current employer to pay the full value of the skills to the workers or lose her/him to a competing employer. Therefore, the employer presumably cannot afford to pay for such training. Thus, the employee reaps all of the returns to general training and must, in a competitive labor market, bear all of the costs of such training. The worker compares the expected earnings-experience profile from a job with no training (UU') to the profile for a job that provides general training (GG'). See Figure 1, adapted from [11]. On-the-job training may entail direct costs, as in the instructional expenses of formal training programs, and always entails indirect costs through the diverting of attention from daily production to training activities. Thus, there are expenses to the firm in the form of lost output even when there is no formal program. Workers must bear the costs of general training by accepting a wage below what could be earned elsewhere during the training period. As the workers receiving general training become more skilled, their earnings eventually surpass what they could have earned without training and the workers must assess whether the increased wages in later periods justify the costs of the lower initial wages. If the skills developed are general, the model of on-the-job training is not fundamentally different than that for a worker deciding whether to bear the costs of formal education in anticipation of higher future earnings after completing their formal education.

Figure 1: The Effect of Training on Productivity
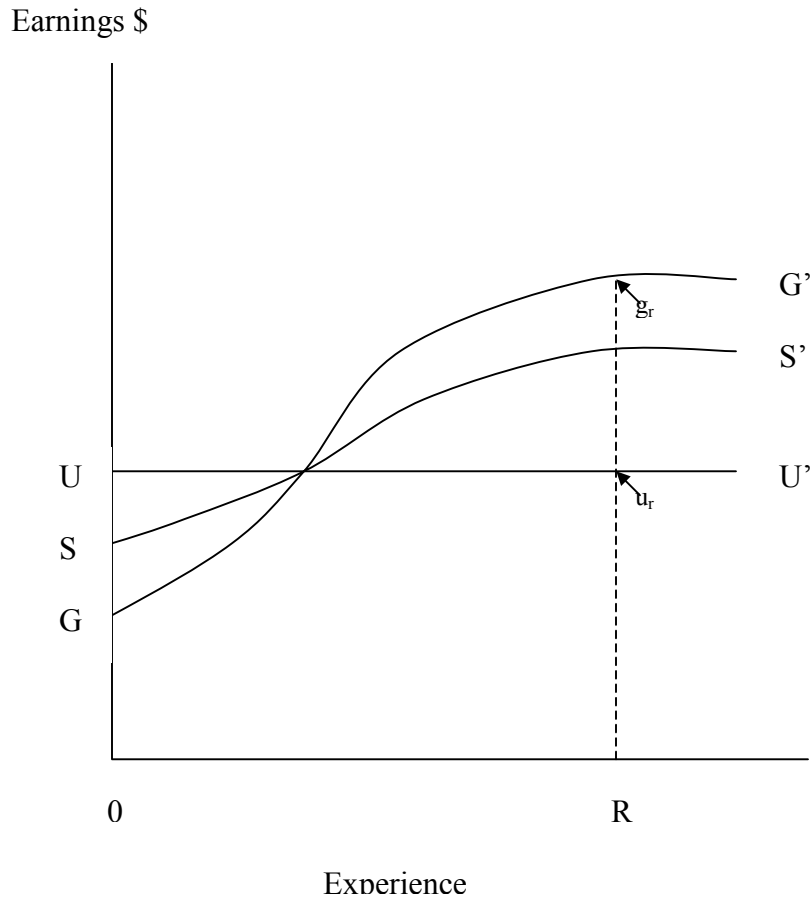
Specific training increases the worker's productivity only at the firm that provides the training. For example, one may learn how to get things done within a particular organization or deal with the idiosyncrasies of a particular piece of equipment. Figure 1 shows a worker's productivity on the job as profile GG' (which is identical to the earnings profile if the training were general). However, this enhanced productivity is only achieved if the worker remains with the current firm. For all other firms, productivity (and therefore the worker's value) is still at the level of the curve UU'. Once specific training has occurred the employee has incentive to remain with the firm as long as she/he receives a wage at least as high as the UU' line and the firm will gain from retaining the employee as long as it does not pay more than wage indicated by the GG' line. Neither party can expect to capture all of the gains from specific training since the employee might leave for another firm unless she/he is paid some premium above the UU' line and competitive wage offers do not require the employer to offer the full value of increased productivity GG'. Because neither employer nor employee can expect to reap the full value of the benefits from specific training, neither can afford to bear the full costs of this training. The most likely solution is one where the worker and employer share both the costs of, and the returns to, specific training – as shown in the earnings-experience profile SS'. At experience level R the worker is better off remaining with the firm as long as the wage is above the u_r and the employer benefits from retaining the worker as long as it pays less than g_r. The range of mutually advantageous wages between u_r and g_r is likely to lead to a long-term attachment between the worker and the firm.

The expectation then is that training to acquire general skills will be the employee's responsibility and that it is the employee who bears the costs of training and reaps the return of a competitive wage. Formal schooling is clearly one example of this. Specific training however, requires that the employee and employer strike a mutually beneficial bargain to share costs and returns of training, which enhances job security for the employee and reduces voluntary turnover for the employer.

Human capital theory suggests that wages tend to increase with labor market experience because on-the-job training augments a worker's productivity as shown by the GG' line of Figure 1. However, critics of this theoretical supposition [37] argue that the rise in wages with experience may simply reflect returns to seniority. Lazear [31] suggests the upward sloping earnings profiles, that reward experience with a particular firm (tenure), motivate employees to work hard in order to remain with the firm and gain the higher earnings that come with longer tenure.

When applying human capital theory to information systems (IS) professionals and other high-tech workers, it is important to note that specific skills as defined by Becker are far different than specialized skills. Highly specialized skills in mechanical engineering, JavaScript programming, or even in the implementation of a specific ERP software package are likely to be of value to a substantial number of firms constituting a competitive labor market. Thus, such skills are *general* in Becker's terminology. To avoid confusion, we will henceforth use the term "generally-valued" for Becker's general skills and firm-specific for his specific skills.

THE TRANSFORMATION OF WORK AND THE NEW LABOR CONTRACT

Increased global competition and rapid changes in technology of the 1980's and 1990's set the stage for dramatic changes in the nature of work and the structure of organizations. To accommodate these changes, many researchers believe that a new employment relationship between employers and employees has emerged and that IT is in the forefront of this emergence. Sommers [47] remarks: "Employees are now loyal first to their individual careers, second to their peers, and third to their company".

Under the old labor contract, the expectation was that good work and loyalty on the part of employees would be appreciated and rewarded with good pay and job security by the employer. However as Chilton and Orlando [13] argue: "Years of complacency under the old social contract had created high cost labor systems with insufficient incentives for producing high quality goods." Rapidly changing needs of business for employees with specialized skills shifts employees' focus away from job security to employment security. Hall and Moss [23] suggest a new "Protean Career Contract" is emerging in which –"The career is managed by the person, not the organization." Development is self-directed, continuous, and often found in work challenges. The organization is expected to provide challenging assignments, developmental relationships, information, and training opportunities.

Sommers [47] further suggests that "the new employment relationship includes valuing of performance and skills, commitment to self and team, challenging work and cross-functional assignments, multiple careers, continual development and retraining, self-sufficiency and empowerment, and customer focus."

A recent content analysis of articles specifically examining the New Employment Relationship in the human relations literature [43] identified as the most common characteristics of this new relationship the requirement for employers "to provide training, education, and skill development opportunities" and for the employee to "assume responsibility for developing and maintaining skills." Thus firms are demanding, and in need of, cutting-edge skills and employees need maintenance of employability through continual training opportunities.

While most recent studies have argued that a new labor contract is either in effect or on its way, others are skeptical. Jacoby [26] argues that the current labor market is in flux, but feels that "it is too early to predict the nature of basic changes that may be on the horizon."

Cappelli [12] states: "a market-driven retention strategy begins with the assumption that long-term, across-the-board employee loyalty is neither possible nor desirable." The focus shifts to "highly targeted efforts aimed at particular employees or groups of employees. Another set of people will be important to retain for shorter well-defined periods – employees with specific (specialized) skills that are currently in short supply, for instance, or members of a team creating a new product or installing a new information system."

Echoing these ideas, Stokes [48], in discussing aspects of the IT worker shortage, suggests that neither the employee nor employer desires a career length commitment, so that reward and incentive structures should be built around the desired length, such as, keeping workers through the completion of a project.

Zuboff [56] argues that computer technology, in addition to automating certain functions, serves to "informate" business enterprises. That is, computer systems make it easier to acquire information about an organization. They formalize and expose data about company operation and policies and procedures. This changes the nature of relationships within an organization, and also makes it easier for those outside the firm to gain an understanding of its systems. If this is the case, computerization is in effect increasing the proportion of general skills as compared to firm-specific skills.

In response to the transformation of work and the new labor contract, business organizational structure is also changing. Hierarchical command and control design may no longer be an appropriate management system model. Thus researchers, such as McConnell [34], contend that the impact of computers is pervasive across occupation and industry lines – "moving many organizations from a pyramid shape structure to a flatter structure."

Quinn, Anderson, and Fenkelstein [42] argue the ability to leverage information and intellect is leading to a variety of new organizational structures (infinitely flat, starburst, spider web, and inverted structures) which are centered on intellectual skill set and do not follow hierarchical lines. They further argue that "leveraging intellect" by hiring the best people, stimulating them to internalize the information knowledge, skills, and attitudes needed for success, creating systematic organizational structures to capture, focus, and leverage intellect, and demanding and rewarding performance is the key to success. Workers in such a firm will stay because the intellect-nurturing climate helps them increase their value, so they are less likely to be lured away by offers from other firms.

Thus, Becker and Huselid [6] conclude that HR practices of high performance companies emphasize – selective hiring, decentralized decision-making, well-paying jobs, extensive employee development, reduced status differentiation, and information sharing.

The studies cited above suggest that loyalty, job security, and the expectation of long-term employment with the same firm are less important under the new labor contract. Employers are not expected to offer continued employment across a career and employees are not expected to forego short-term wage gains from alternative offers in exchange for a long-term commitment to the firm. At the same time, the new contract requires employers to provide employees access to new skills, to provide performance-based incentives and frequent performance appraisals, and requires employees to remain employable – that is they are required to take advantage of training opportunities and proactively seek out opportunities that allow them to maintain a skill set such that *the company would want to rehire them if they were not already with the firm.*

As might be expected, not all researchers agree with this view of IT-driven changes in the organization of work. Winter and Taylor [54] argue that the post-industrial organization of work has many characteristics in common with the proto-industrial organization of work present in the early stages of the industrial revolution. Thus, they question the extent to which computers and IT have been the causes of observed changes such as outsourcing, downsizing, and a shift to smaller organizations.

If, however, changes in IT are an important factor in the emergence of new organizational relationships, we would expect the IT labor market to be on the leading edge of this change. The reduction of loyalty under the new labor contract and the increased proportion of generally-valued skills in computer-based systems suggest that IT workers would have higher turnover rates than other professions.

IT, Training, and the Acquisition of Skills

A number of studies have found that IT-based technological change has been responsible for changes in the distribution of income away from less skilled workers toward more highly skilled workers. Berman, Bound, and Griliches [8] investigated shifts in labor demand over the 1980's using data from the US Census of Manufactures. They found that there was a general shift away from unskilled toward skilled workers and that this trend was due to an increase in use of skilled workers within industries rather than due to shifts in employment from less skill-intensive to more skill-intensive industries. Similarly, an international study of developed countries [9] found that demand for less skilled workers declined sharply in those countries in the 1970's and 1980's and that pervasive skill-based change is the source of this decline.

Autor, Katz, and Kruegar [4] found that computer technology has contributed to increases in income inequality. Using US data from 1940-1996 they found increases in the wage share of higher educated workers and of workers in industries with computer use. The latter finding supports an earlier finding that workers using computers on average earned 10 to 15 percent higher wage than similar workers who did not use computers at work [30].

Galor and Moav [19] explain the observed income distribution changes through a growth model in which evolving technological change is ability-based – more able individuals are better able to utilize new technology to enhance their productivity. Thus the evolving technology tends to increase differentials in skill levels and especially differentials in income between unskilled and skilled workers.

Using data from the National Longitudinal Survey of Youth (NLSY) Keane and Wolpin [27] explored more specific aspects of ability and skill tradeoffs. They found that differences in schooling, work, and occupational choice decisions can be explained by unobserved variations (heterogeneity) in skill level where more able individuals invest more in both formal education and on-the-job training settings because their expected return for skill acquisition is greater.

Although hampered by data limitations, several studies have examined training and its relationship with other aspects of the employment environment. A study based on the 1991 National Household Education Survey found that the percentage of employees with training increases with the education level of the employee[24]. Royalty [44], using the NLSY data set, examined differentials in training between men and women and between less educated and more educated workers. She found that males and more educated workers are more likely to receive

training. In part, training is more likely to be offered workers that stay in a job, and males and more highly educated workers tend to stay in jobs longer.

Neal [41] notes that job turnover rates decline with education and that better educated workers are more likely to receive additional training on the job. He argues that this is because more highly educated workers acquire greater stores of specific skills – leading to more incentives for employer and employee to strike a mutually beneficial wage bargain.

A survey of wages and training for US firms from 1982 and 1992, by Barron, Berger and Black [5] found that, after controlling for worker experience and job complexity, there was no evidence that starting salaries were lower when workers received greater on-the-job training. However on-the-job training did cause subsequent increases in wages and productivity.

Generally, more recent training studies imply that access to training opportunities is viewed as a form of fringe benefit that firms can use to attract and retain higher quality workers. Large firms are much more likely than smaller firms to provide formal on-the-job training than smaller firms. Also firms offering more numerous and generous benefits to their employees are more likely to provide training [17] [18] [33]. The incidence of training is also likely to be higher in firms where employee turnover is low [18] and which use high-performance work systems (such as just-in-time or MRP) [33].

Traditional human capital theory holds that the employer can only afford to offer training that builds firm-specific skill (the argument of the Neal paper above). *However, if workers view training opportunities as a significant form of fringe benefit, employers offering strong training opportunities can select the most able workers out of a pool of candidates and pay them the same wage that firms offering less training must pay to less able workers remaining in the candidate pool. This allows employers to in effect recoup training costs by getting a greater stock of ability at the same cost.* This would be incompatible with the Barron, Berger, and Black results above.

Viewing training as a cost of attracting and retaining quality workers is very consistent with the concepts of the new labor contract. *The lessening of loyalty under the new labor contract is perhaps, in part, explained by the fact that firms are forced to provide access to training that is not specific to the firm, but enhances the worker's value in the competitive labor market (generally-valued training).* Although human capital theory indicates that firms are not willing to pay the costs of providing generally-valued training, firms may pay the direct costs of such training, in return for obtaining and retaining higher quality workers at a given cost.

LABOR MARKET CHARACTERISTICS OF IT WORKERS

A number of studies of the IT field over the past 20 years have attempted to explain job satisfaction and job turnover in terms of the unique characteristics of IT workers and the job characteristics they desire. The motivating factors identified for IT workers are similar to those described for workers in general under the new labor contract.

Couger, Zawacki, and Oppermann [15] studied motivational levels of MIS managers and other managers. They found stronger growth needs scores and lower social needs scores for MIS managers. A later study [55] confirmed these results and suggested than managers must recognize this need for growth and new challenges to motivate IT workers. He also suggested the use of alternative technical or staff-oriented career paths for those IT staff who are not a good fit for managerial jobs.

With respect to more specific aspects of job motivation, Couger [14] identified the top motivating factors for analysts and programmers as: the work itself, opportunity for achievement, opportunity for advancement, pay and benefits, recognition, and increased responsibility. Job security, working conditions, company policies, and interpersonal relations were ranked lower. Smits, McLean, and Tanner [46] found that the desire for interesting and challenging work and task variety and autonomy are key motivational factors for high achieving IS professionals and a recent survey IS professionals in the Midwest [36] found that the employees' assessments of career development prospects with their current firm had a substantial impact on retention.

It is worth noting that there is a distinction between worker satisfaction with the work environment and worker turnover intentions. Guimaraes and Igbaria [22] found that job satisfaction was the primary factor for IT workers to feel organizational commitment. However, they found that job satisfaction had no direct effect on turnover intentions.

To address the needed motivational factors of IT workers, several studies have postulated what might be appropriate strategies for IT hiring and retention and further suggested that these strategies may vary across workers and groups of workers. Tsui, Pearce, Porter, and Hite [51] categorize employment practices of firms into job-focused and organization-focused relationships. They suggest that employees tend to self-select into firms with the focus that best suits them. Agarwal and Farratt [3] identified four alternative strategies for IT hiring and retention:

long-term investment, balanced professional, high-performance professional, and short-term producer. They suggest that any one of these strategies might be most effective for an organization depending upon its size and market position. Another study identified three basic career-anchoring dimensions: leadership, stability, and technical, which were similar to those for other professionals. They identified a group of workers who seek geographical stability (are willing to change employers to stay in a geographic area), as well as, a group seeking stability in employment within an organization[16].

Stokes [48] comments that reasons workers stay or leave an organization "vary as much as these professionals' skills and personalities and organizations' cultures and IT functions." He argues for the use of employability training and notes that: "Successful firms accept the marketability of employability." While it may be beneficial to use training as part of a retention strategy, Sheehan [45] contends that organizations tend to use training for reward purposes rather than as a discipline-driven reskilling strategy.

Several of the studies reviewed above suggest that employers wishing to minimize voluntary turnover of IT workers should ensure that jobs are varied and challenging and that they involve the opportunity for acquisition of new skills. The new labor contract literature also suggests that those characteristics are important for obtaining high-quality professional workers, but is less clear on retention. Workers who are provided good access to skill improvement opportunities may have higher job satisfaction, but this may not translate into higher retention.

Shortages of workers with specialized skills may force employers of IT workers to provide training in these areas even though these skills are immediately valuable to other competing firms. Firms must balance training costs and an increased risk of losing trained workers against the increase in the ability level of the workers they attract and the enhanced productivity of the workers during their employment with the firm. *The choice may become one of: fail to provide training and retain a set of less qualified workers for a longer period of time, or provide training and retain more able and skilled workers for a shorter period of time.*

IMPLICATIONS FOR EXPECTED VOLUNTARY LABOR TURNOVER

The alternative theories described above offer differing expectations with respect to voluntary labor turnover of IT workers. Under the new labor contract with its lessened emphasis on loyalty, it would be expected that voluntary turnover would be increasing across the board. However, if IT workers are on the leading edge of this trend, we would expect their voluntary turnover rates to be higher than those of other professions that are less affected by the new economy. Human capital theory reaches the same conclusion. Job skills that are more generally-valued have a more competitive labor market and thus there is less room for employers and employees to strike a mutually beneficial bargain for the employee's labor. Thus, labor turnover would be expected to be higher the more generally-valued a worker's set of skills. *If IT makes the internal workings of a business more transparent, it makes skills more generally-valued and IT workers, on the leading edge of that transformation would be expected to have a higher proportion of generally-valued skills, and thus higher rates of voluntary turnover.*

On the other hand, the literature on job motivation of IT workers suggests that they are likely to be better satisfied and thus (probably) less likely to move to another job to the extent that their current job gives them access to the opportunity to learn new skills and the ability to perform interesting and fulfilling work. Thus, workers would generally be less likely to voluntarily leave jobs with more access to learning new skills.

TURNOVER AND WAGE RATE

Also of interest in this study is the impact of voluntary job turnover on the wage of employees. Rational economic behavior predicts that, other things being equal, an employee would voluntarily change jobs only if he or she received a wage premium for doing so. Labor market analyses that have measured wages longitudinally (so that a worker's current wage may be compared to a former wage level for that same employee) have found the expected positive wage effect for a voluntary job change. Keith and McWilliams [28] examined the change in wage between two time periods and found voluntary turnover (job change) on average increased wages 8 to 11 percent. The wage increase was even higher for those who searched for new employment while on the job. Similarly, a study of employment and income in England, found that there was movement into a variety of occupations in response to higher wages in those occupations [49].

However, cross-sectional studies that compare the wage levels of workers who have changed jobs with the wages of comparable workers (equalizing for effects of age, sex, race, education level, and total work experience) who have not changed jobs have often concluded that job-changers tend to have lower wages. Light and McGarry [32], for example, observed a negative impact of job change on wage in a purely cross-sectional study based on data

from the NLSY. They postulated that jobs could be viewed as "experience goods" where workers will change jobs if the experience of the job is less favorable than expected.

Some researchers have suggested that cross-sectional results showing lower wages for job-changers than for job-stayers are due to adverse selection in the "used worker" market (job-changers). Greenwald [21] argues that current employers are better informed about the abilities of their employees and thus are able to concentrate their retention efforts on their better workers. Thus there is adverse selection in the market for "used" workers. Workers who quit one job to move to another are likely to be those workers who were passed over for promotion or whose previous employer was unwilling to match an alternative offer. Quitters may increase their salary, but still make less on average than those who do not change jobs. Similarly, Waldman [53] argued that: "firms other than the employer are frequently at an informational disadvantage when it comes to experienced workers." However, he argues that this effect can be somewhat attenuated when competing firms use an individual's job assignment as an imprecise signal of the individual's ability.

One of the most direct measures of adverse selection was developed by Acemoglu and Pischke [1] who investigated German apprenticeship programs. Apprenticeships in Germany are government regulated and pay salaries in excess of initial productivity. These investigators found that employees who changed jobs in the first few years (voluntary quits or laid off) after the end of the apprenticeship program earned lower wages than those who stayed with their initial company. They also found that workers who left their jobs to perform military service earned wages on average higher than either the job-changers or job-stayers on their return. They hypothesized that employers discount the value of workers' changing jobs at the end of their apprenticeship period because of perceived adverse selection. Since military draftees are not subject to this effect there is a competitive market for them that fully compensates for their expected skill level.

Countering these adverse selection effects, aspects of the new labor contract seem to imply a measure of *positive selection*. The emphasis on the employee's responsibility to maintain employability suggests that companies believe that they have numbers of current employees whom they would *not* be willing to hire on the open market. Presumably, this set of employees would not have access to voluntary job change and only those employees maintaining a current skill set would be able to find alternative job offers.

Another factor contributing to positive selection among voluntary job changers is "poaching." Essentially poaching is an approach in which firms attempt to acquire a skilled workforce by hiring workers who have previously been trained by another firm. A study of French workers found that workers with training in certain types of skills by their former employers earned a substantial wage premium if they left that employer and went immediately to another employer in the same sector [25]. This suggests that workers are receiving training that produces skills that are valued by competing firms. To cite just a couple of examples from the IT field, United Health Care reported losing "about half" of 600 new IT hires in 1997-98 to other employers [35] and a Gartner group study suggested that "Services providers like IBM, EDS and CSAA grow their NT know-how by stealing talent away from their end users with a minimum 35 (pay) percent increase" [10].

The specificity of skill needs in IT is also an important factor that may contribute to poaching behavior. Moore and Burke [40] suggest that, "At any given time within the IT profession some skill-sets are more marketable than others. In today's environment, skills associated with say, network and database management (such as in Oracle database administration) and with enterprise resource planning (ERP) systems (such as those in people-soft and SAP) are in demand." The sets of high-demand skills also tend to change rapidly. As Memishi [38] notes "workers proficient in Novell were in huge demand about five years ago and today that's not a problem. There are multiple skill sets and so if something new comes down the pike and people aren't trained in that application, that's when there's a shortage."

Another factor influencing wages of job-stayers versus job-changers is seniority. Topel [50] found that job seniority does cause wages to increase significantly (about a 25 percent wage increase per 10 years additional tenure) among workers with equal experience in an industry. This result suggests that workers do acquire job-specific skills on the job and that they are paid for at least a portion of their enhanced productivity. However, Abraham and Farber [1] note that workers who find good, high-paying jobs are less likely to pursue other opportunities and that this may explain the observed returns to tenure.

In another study based upon the NLSY data, Keith and McWilliams [29] found voluntary mobility to have a positive effect on wages in a model where a seniority measure was also included. However, since seniority is negatively correlated with job turnover, the overall impact of job change on the level of wages is not certain based upon this study.

Overall, theoretical models and past empirical results do not provide a clear-cut prediction as to the effects of job change on the wage level. Most evidence suggests that in purely cross-sectional studies with no ability to measure seniority on the job (as will be the case for our analysis); wage rates of job changers have tended to fall

7

below those of job-stayers. However, *the new labor contract research suggests that this is changing and that positive selection factors, including incentives for poaching those workers with the most highly desired skill-sets, may begin to outweigh the adverse selection factors leading to higher wages among job-changers.*

CPS Survey Data

The empirical component of this study is based upon data from the Current Population Survey (CPS). The CPS is jointly sponsored by the Census Bureau and the Bureau of Labor Statistics. This survey is housing unit based. Therefore, if a household changes its residence, the members of that household drop from the survey and the new occupants of the housing unit are surveyed. Thus, only job changes not involving changes in residence are included in this study. Households and their resident individuals are in the survey for four months (months 1 through 4), then they are out of the survey rotation for 8 months, and finally they are surveyed for another 4 months (months 5 through 8). Workers are asked questions about their wages only in months 4 and 8 in the survey. The data set used is based upon individual data for the 4th and/or 8th months in the survey plus data measuring voluntary job change over the previous 3 months – a flag that is set to one if the individual reported changing employers in any of the preceding 3 months and is set to 0 otherwise. Individuals are included in our survey data only if that same individual was observed in the survey throughout months 1 through 4 or throughout months 5 through 8.

The data set used in this analysis covers a three year period (April 1998 through March 2001). Also the data set is restricted to individuals 25 years of age and above, working full time, and reporting weekly earnings of at least $150. This allows us to focus the analysis on full-time paid employment of workers who have completed their initial formal education.

Most of the variables used are standard demographic and economic variables whose meanings are well understood. The wage variable used is an average weekly wage estimate compiled by the CPS by converting wage values reported over differing time periods (hourly, monthly, annually, etc.) to a weekly bases (and, if necessary constructing values) using a standard procedure [52]. This wage is top-coded at $2881.61, or approximately $150,000 per year. Following Autor, Katz and Kreuger [4], top coded wages are reported as 1.5 times the top code value or $4322.42 per week. In the analyses that follow, less than two percent of any of the groups studied had top coded values.

Comparison of IT workers with workers in other professions is the major focus of this study. The detailed occupation code of workers was used to separate IT workers from other business and technical professionals. Codes 64, Computer Systems Analysis and Scientists and 229 Computer Programmers have been identified as IT professions. Professional workers and technicians in all other non health-care related fields were identified as the base group of other comparable professional workers.

Data identifying the industry in which a worker is employed is also of interest. Industry code 732 Computer and Data Processing Services is the industry category that includes software and computer consulting services companies. Arguably, firms in this industry tend to provide their employees with more access to new technology and provide workers with greater professional growth opportunities than companies that are not in computer related industries. Comparison of IT workers in this IT related industry with IT workers in less IT focused industries will allow us to determine whether this industry has distinct wage and turnover behavior.

<center>**EMPIRICAL RESULTS**</center>

Descriptive statistics for a number of qualitatively measured demographic characteristics that might be expected to impact wage and voluntary labor turnover rates are presented in Table 1. The education level of IT workers appears to be somewhat higher than that of other technical occupations and management related occupations. Just over one-third of IT workers are employed specifically in the Computer services industry, which constitutes a very minor component of employment in the other occupation categories. Workers in other technical occupations tend to be concentrated in manufacturing industries, while workers in management related occupations are more heavily represented in services and government. IT workers tend to be more concentrated in large cities than workers in the other two categories. Finally, female workers are much more prevalent in the management related occupations than in the IT and other technical occupation groups, whereas, Black and Hispanic workers are about equally represented across the three occupation categories, but are underrepresented across all of these occupation groups relative to their prevalence in the general population.

Table 1: Distribution Of Demographic Variables

	IS Related Occupations		Other Technical Occupations		Management Related Occupations	
	Count	Percentage	Count	Percentage	Count	Percentage
EDUCATION LEVEL						
High School or Less	401	6.90%	1701	14.33%	2200	17.75%
Some College	818	14.07%	1945	16.39%	2356	19.00%
Associates Degree	656	11.28%	1665	14.03%	1288	10.39%
Bachelors Degree	2873	49.42%	4612	38.86%	5116	41.27%
Masters or Higher	1066	18.34%	1946	16.40%	1437	11.59%
INDUSTRY						
Manufacturing	1142	19.64%	5260	44.32%	2108	17.00%
Trans., Utilities & Finance	1109	19.07%	1810	15.25%	3438	27.73%
Wholesale & Retail Trade	360	6.19%	392	3.30%	1303	10.51%
Computer Services	1941	33.38%	363	3.06%	186	1.50%
Other Services & Govt.	1262	21.71%	4044	34.07%	5362	43.25%
CITY SIZE						
Small (<500,000)	1256	21.60%	3860	32.52%	3939	31.77%
Medium (500,000-5,000,000)	2294	39.46%	4508	37.98%	4598	37.09%
Large (>500,000)	2264	38.94%	3501	29.50%	3860	31.14%
FEMALE AND MINORITY STATUS						
Female	1692	29.10%	2670	22.50%	7251	58.49%
Black	369	6.35%	622	5.24%	1037	8.36%
Hispanic	182	3.13%	538	4.53%	537	4.33%
TOTAL COUNT	5814		11869		12397	

Age is measured in individual years in the CPS data set. Figure 2 shows the distribution of employment by age grouped in 5-year age ranges and compared across occupation groups. Clearly the proportion of workers in the age groups up to age 40 is substantially higher in IT related occupations, than in the other occupational categories. Figure 3 provides a similar analysis focusing only on IT industry workers, but separating those in the computer services industry from IT workers in all other industries. Here we see a still more pronounced bulge of employees in the age ranges below the age of 40.
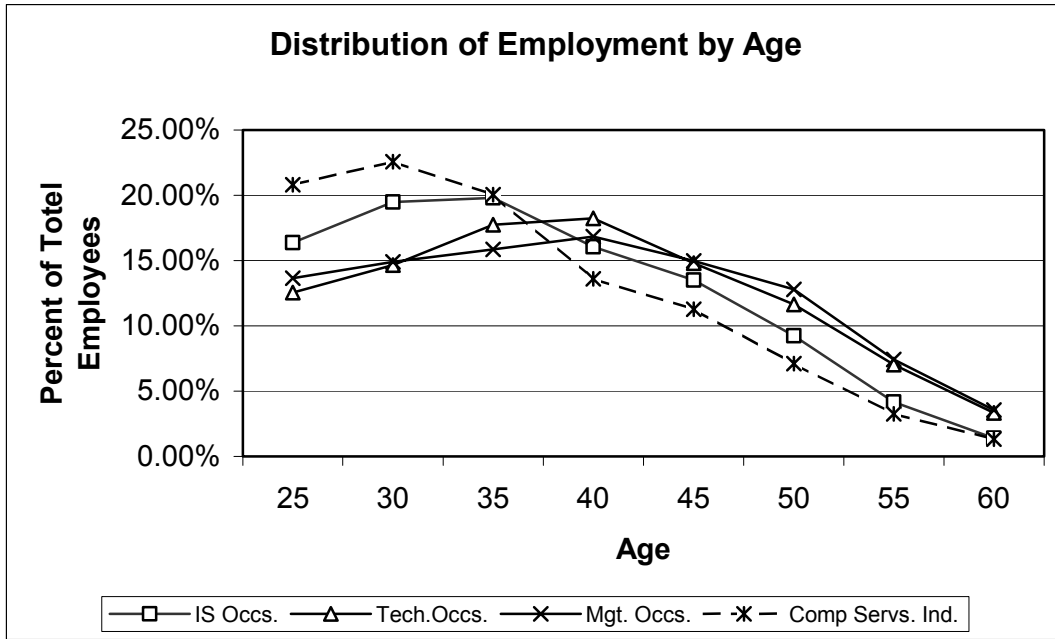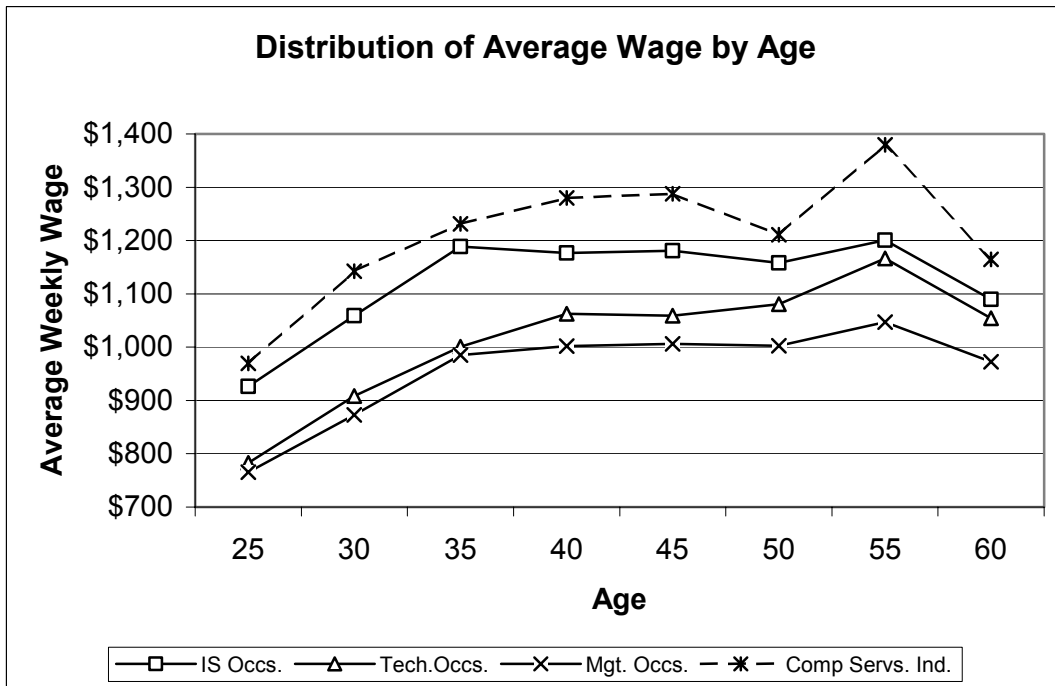
Figure 2

Distribution of Employment by Age

Percent of Totel Employees vs **Age**

Legend: —□— IS Occs. —△— Tech.Occs. —✕— Mgt. Occs. – ✳ – Comp Servs. Ind.

Figure 3

Distribution of Average Wage by Age

Average Weekly Wage vs **Age**

Legend: —□— IS Occs. —△— Tech.Occs. —✕— Mgt. Occs. – ✳ – Comp Servs. Ind.

Figures 4 and 5 show the distribution of average wage across the age ranges and occupation groups. Average wages for workers in IT occupations tend to be higher than those for the other occupational categories, particularly in the early age ranges. For all occupations average wages tend to rise rapidly with age before 40 and then level off substantially. This pattern is particularly pronounced for workers in the IT industry. Figure 5 suggests that wages are particularly strong across all age groups for IT workers in the computer services industry. Overall

Figures 4 and 5 suggest that the relationship between age and wages is nonlinear. In the regression analyses that follow both age and the square of age are included in order to capture this non-linearity.
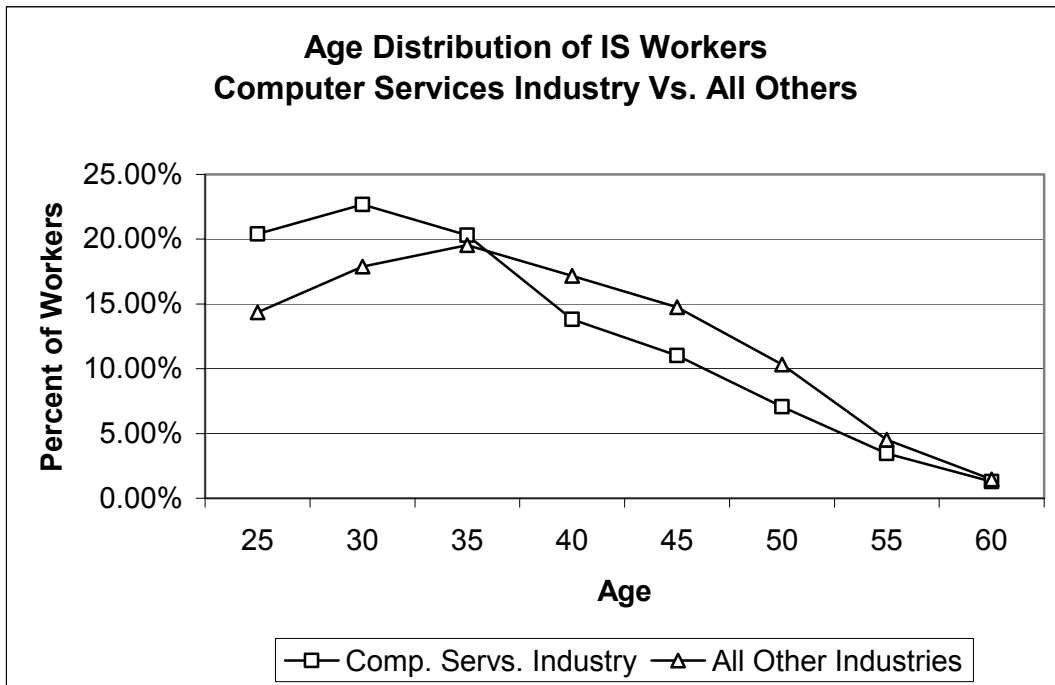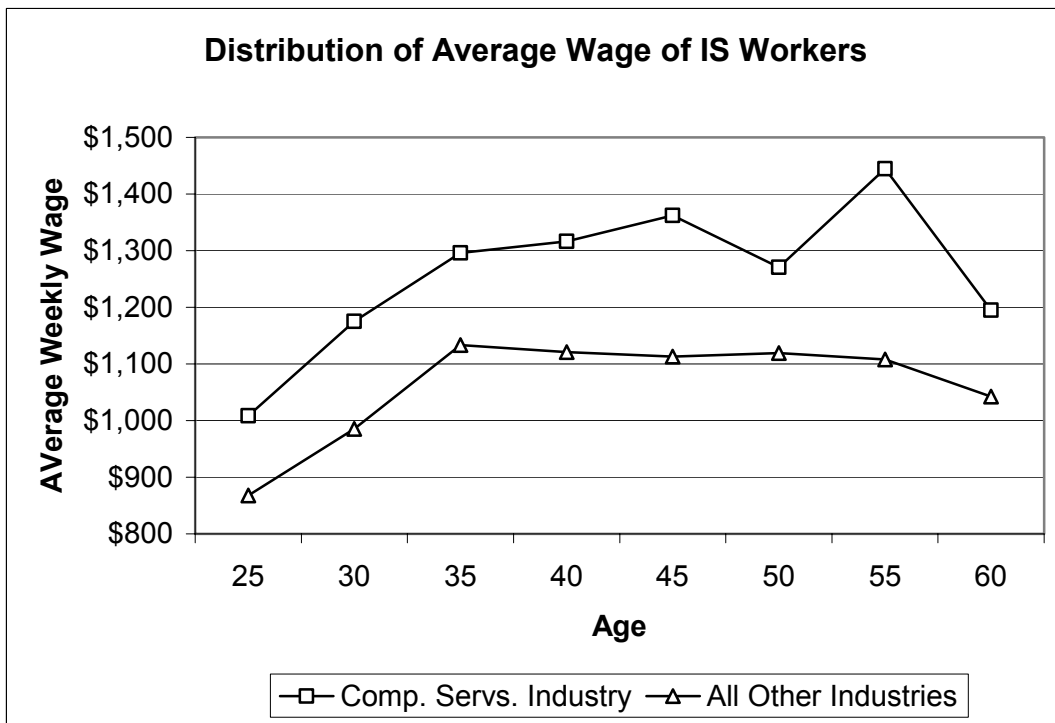
Figure 4

Age Distribution of IS Workers
Computer Services Industry Vs. All Others

Figure 5

Distribution of Average Wage of IS Workers

We have not yet presented data about the rates of voluntary job change. Since these rates are one of the principal targets of our analysis, we present the job change data in Table 2 along with results of a statistical test of whether the proportions are equal across occupation groups. Table 2 shows that the 3 month rate of voluntary job change is between 1 and 1.5 percent higher for IT occupations than that for other technical workers and for management professions and these differences are statistically significant (based upon separate comparisons of IT worker to each of the other occupation groups). In table 3 similar statistics are presented with a breakdown of the turnover rate of workers in the computer services industry versus all other industries, as well as a breakdown of IT versus other professional occupations. It is clear that job turnover in the computer services industry much higher than the average across other industries for both IT workers and other professional workers. It appears that all of the difference in job change rates found in Table 2 is due to the strong prevalence of IT workers in the computer services industry. Within industry comparisons between IT workers and other professional occupations showed no significant difference in the rate of job change. IT professionals working in the computer services industry experienced a job change rate of 9.22 percent over the three month observation period, but employees from other professions working in the computer services industry experienced an even higher, 10.2 percent, job change rate. In all other industries, IT professionals experienced a job change rate of 5.37 percent compared to 5.23 percent for other professions.

Table 2: Three Month Job Change Rate It Vs Other Occupations

Value	Information Technology Professions	Other Technical Professions	Management Professions
No Job Change	5427	11254	11716
Job Change	387	615	681
Percent Changing Jobs	6.66%	5.18%	5.49%
Test for = Proportions (Z-Value)		-3.98 **	3.11 **

** Significant at .05 level.

**Table 3: Three Month Job Change Rate Computer Service Industry Vs
Other Industries (In It And Other Occupations)**

Information Technology Occupations

Value	Computer Services Industry	All Other Industries
No Job Change	1762	3665
Job Change	179	208
Percent Changing Jobs	9.22%	5.37%
Test for = Proportions (Z-Value)		-5.56**

Other Technical and Management Occupations

Value	Computer Services Industry	All Other Industries
No Job Change	493	22477
Job Change	56	1240
Percent Changing Jobs	10.20%	5.23%
Test for = Proportions (Z-Value)		-5.12**

** Significant at .05 level.

   Table 4 presents regression results for determinants of the rate of job change. Job change is a dichotomous variable. A worker either changed jobs over the prior 3 months (1) or did not change jobs in the prior 3 months (0). For a number of reasons, standard linear regression is not appropriate when using a dichotomous dependent variable. Most prominently, the error term cannot be normally distributed. The logit function is a commonly used method that produces maximum likelihood estimates for equations with dichotomous dependent variables [20]. The Logit function essentially makes the log of the odds ratio (the ratio of the probabilities of the two outcomes of a dichotomous variable) the dependent variable and performs a "standard" linear regression on this transformed value. In our case the odds ratio is the probability of changing jobs divided by the probability of not changing jobs. This is illustrated in equation 1 where ln is the natural logarithm, p_{jc} is the probability of changing jobs, a is an intercept term X is a vector of independent variables, B is a vector of coefficients on those variables and e is the error term. Taking the antilog of equation 1 yields equation 2.

   1. $\ln(p_{jc}/(1 - p_{jc})) = \mathbf{a} + \mathbf{B}X + e$
   2. $p_{jc}/(1 - p_{jc}) = \exp\mathbf{a} \times \exp\mathbf{B} \times \exp X \times \exp e$

   The B coefficients in equation 2 can be interpreted as percentage changes in the odds-ratio of the dependent variable, and this interpretation is appropriate for the coefficients of Table 4.

Table 4: Determinants of Job Changes Rates
(Logistic Regression Results)

	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio Test	163.0729	17	<.0001

Parameter	Estimate	Std. Error
Intercept	0.6320	0.4549
Age	0.0787	0.0215 **
Age Squared	-0.00075	0.00026 **
Education Level (Bach. Degree Base)		
High School or <	0.0152	0.0416
Some College	0.0792	0.0364 **
Associate Degree	0.0795	0.0413 *
Masters Degree or >	0.0639	0.0376 *
Industry (Services Base)		
Manufacturing	-0.1275	0.0351 **
Trans. Utilities & Finance	-0.0066	0.0348
Wholesale and Retail Trade	0.0437	0.05130
Computer Sevices Industry	0.2416	0.0469 **
City Size (Medium Size Base)		
Small (< 500,000)	-0.1029	0.0328 **
Large City (> 5,000,000)	0.0486	0.0293 *
Race and Sex (White and Male Base)		
Female	0.0160	0.0281
Black	0.0063	0.0493
Hispanic	0.0116	0.0599
Occupation (Non IT Technical Base)		
Information Technology	-0.0156	0.0385
Management	-0.00585	0.0315

** Significant at .05 level
 * Significant at .10 level

Data for all of our occupational categories were pooled into a single group for this analysis with occupation and industry groupings being treated as independent variables. (The wage rate is not included as an independent variable, since the observed job changes occur one to three month prior to the point when the weekly wage rate is reported.) The likelihood ratio test for this model shows it to be statistically significant. Individual parameter estimates and their standard errors are also shown.

Age, and the square of age are the only continuous variables in this model. They are statistically significant with opposite signs. These coefficients suggest that the odds of a worker changing jobs initially increase at a decreasing rate with age and eventually begin to decrease with age.

The remaining coefficients in Table 4 are based upon sets of dummy variables. In each category there is a base group and a set of coefficients reflecting how a worker's probability of job change is affected by belonging to some other demographic group. The base group is white male workers in non-IT related technical professions who live in cities between 500,000 and 5 million in population and work in the services and government industry sector (but not the computer services industry). The results suggest that college graduates are less likely than workers at other education levels, both higher and lower, to change jobs. Workers in manufacturing industries are significantly

less likely to change jobs and workers in the computer services industry are substantially more likely to change jobs than workers in other industries, which is consistent with the base proportions in Table 3. Not surprisingly workers in small cities are less likely to change jobs (without relocation) and workers in large cities are more likely to do so. The race and sex of workers do not appear to have a significant impact on their job change characteristics. Finally, consistent with the Table 3 results, the worker's occupation category does not significantly impact the rate of job change when the impact of working in the computer services industry is treated as a separate factor.

Some of these results seem at first counter intuitive and are inconsistent with past studies of voluntary job change. However, it must be remembered that only job changes not involving relocation are included in our sample. With respect to age, younger workers may change jobs more frequently overall (the expected result) but a higher proportion of their moves may involve relocation. Rates of job change have generally been found to decline with increases in the education level, but the markets for workers with advanced degrees may be too small to allow them to easily change jobs without relocation.

Together the results of tables 2 through 4 suggest that the higher rates of voluntary job change for workers in IT occupations are almost entirely due to the high incidence of job change in the computer services industry where over a third of IT professionals work. After allowing for the impact of age, education, and other demographic factors the rate of job change for workers in the computer services industry is substantially greater than that for the services industry in general.

Table 5 summarizes linear regression results examining the determinants of wage rates. In this case separate results for IT occupations, other technical professions, and management related professions are shown. Values for the log of weekly wage were found to be approximately normally distributed, while untransformed wage values were not. Thus, the log of weekly wage was used as the dependent variable in this analysis.

In standard linear regressions with a dependent variable that is measured in log form, coefficients can be interpreted as percentage impacts on the dependent variable in non-log form. Thus, for instance, the -.15896 coefficient for female workers in IT occupations means that, other things being equa,l average weekly wages of female workers are about 16 percent less than those of their male counterparts.

Table 5: Determinants of Log Wage Rate Across Occupations

Variable	Information Systems Occupations		Other Technical Occupations		Management Occupations	
Observations	5813		11783		12386	
Adjusted R-Square	0.1833		0.2799		0.2822	
	Parameter Estimate	Std. Error	Parameter Estimate	Std. Error	Parameter Estimate	Std. Error
Intercept	5.43964	0.10453 **	5.61670	0.06925 **	5.62659	0.06829 **
Age	0.06788	0.00522 **	0.05227	0.00332 **	0.05131	0.00328 **
Age Squared	-0.00073	0.00006 **	-0.00051	0.00004 **	-0.00053	0.00004 **
Month	0.00397	0.00054 **	0.00333	0.00039 **	0.00395	0.00038 **
Education Level (Bach. Degree Base)						
High School or <	-0.27048	0.02237 **	-0.37738	0.01215 **	-0.30675	0.01134 **
Some College	-0.19804	0.01660 **	-0.25708	0.01147 **	-0.24375	0.01097 **
Associate Degree	-0.16726	0.01820 **	-0.26005	0.01211 **	-0.25583	0.01351 **
Masters Degree or >	0.07959	0.01515 **	0.11004	0.01142 **	0.15588	0.01286 **
Industry (Services Base)						
Manufacturing	-0.00159	0.01451	0.07786	0.00875 **	0.05393	0.01100 **
Trans. Utilities & Finance	-0.01323	0.01463	0.10698	0.01178 **	0.04671	0.00934 **
Wholesale and Retail Trade	-0.00879	0.02328	-0.02975	0.02212	-0.06161	0.01328 **
City Size (Medium Size Base)						
Small (< 500,000)	-0.13145	0.01478 **	-0.08511	0.00927 **	-0.12754	0.00935 **
Large City (> 5,000,000)	0.08849	0.01246 **	0.08529	0.00951 **	0.11648	0.00941 **
Race and Sex (White and Male Base)						
Female	-0.15896	0.01214 **	-0.24555	0.00960 **	-0.23889	0.00811 **
Black	-0.17494	0.02270 **	-0.16250	0.01748 **	-0.13547	0.01413 **
Hispanic	-0.07429	0.03167 **	-0.07187	0.01867 **	-0.07267	0.01844 **
Job Change	0.05381	0.02206 **	-0.01617	0.01741	-0.02448	0.01688

The regression model is statistically significant for each occupation group. Adjusted R-Square values are modest suggesting, not surprisingly, that there are many factors influencing individual wage rates which are outside the scope of the broad set of demographic factors available for this study.

The age and age squared coefficients are similar across the occupation groups and reflect a pattern of wage rates increasing at a decreasing rate in younger age levels and decreasing in absolute terms for older workers. The somewhat larger magnitudes (in an absolute sense) of these coefficients among workers in IT occupations means that wages are expected to rise more rapidly with age initially, but that this rate of growth will also drop off more rapidly as age increases.

The month variable is an index that begins with a value of 1 in April of 1998 and increases by one for each month thereafter. It is designed to capture the general time trend of wages. This rate is about 0.4 percent per month or 4.8 percent per year for workers in IT occupations. The rate for management occupations is almost identical, while that of other technical occupations is slightly, but not significantly lower.

The Education level parameters suggest that the wage premiums for increased education are systematically (and in many cases significantly) lower for IT occupations than for the other technical and management occupations.

This may suggest that formal education is less important, relative to subsequent on-the-job and nonacademic training and experience among IT professionals.

Industry differences are less pronounced for IT workers than for the other occupations. However, it should be noted that the services and government sector (the base sector in this analysis) includes the computer services industry that has a large number of highly paid IT workers. This industry will be examined in detail in Table 6 below.

City size has consistent effects across the occupation groups - workers in small cities on average earn less while workers in large cities earn more. The wage penalty for living in a small city is somewhat smaller for non-IT technical occupations.

The wages of women and minorities are systematically lower across all of the occupational categories. The wage differential for female IT workers is significantly smaller than that for the other two occupation categories, while the wage rate differential for Blacks is a bit larger than that for management related professions.

Finally, the job change parameter shows that workers who had changed jobs in the previous three months earned slightly less than those not changing jobs among both management and non-IT professional occupations. Neither of these coefficients was statistically significant. For IT related occupations, on the other hand, job changers on average earned just over 5 percent more than those who had not changed jobs and this difference was statistically significant.

The results indicate that workers in IT occupations could expect a premium for changing jobs that was not present in other occupations. At the same time, the rate of increase in wages over time was not significantly greater for IT occupations. Together these results show a substantial incentive for job change among workers in IT occupations. Perhaps positive selection factors, including poaching effects, were on balance more important than adverse selection factors among job changers in IT occupations. This would account for the combination of a wage premium for job changers with very little increase in the overall wage trend.

In Table 6, we further break down the data, for workers in IT occupations only, to see if the wage determinants in the computer services industry differ from those for other industries. Results suggest that wages of workers in the computer services industry tend to rise more rapidly with age initially, but to fall of more quickly at older ages. With respect to the effect of job change on wage, job changers in the computer services industry gained a premium of 5.8 percent while IT workers in other industries gained about 4 percent. However, the job change coefficient was not significantly different from zero for either group. The time trend of wages for workers in the computer services industry is a bit stronger than that for IT workers in other industries – 5.6 percent versus 4 percent. The wage premium for bachelor's degree holder versus those with lower education level is larger for computer services industry workers, but the wage premium for master's degrees and above is smaller for this group. With respect to city size, the wage penalty for working in a small versus a mid-sized city is larger for workers in the computer services industry, but the wage premium for working in a large versus medium sized city is smaller. Hispanic workers suffer a somewhat larger wage penalty among workers in the computer services industry, while there is little difference across industries in the wage disadvantage of female and black workers. It is also notable that, when computer service industry workers are excluded, wages of other IT workers are higher in all of the other industry sectors than they are in the remaining service sector industries. Overall, the results in Table 6 suggest that factors affecting wage rates of IT professionals in the computer services industry do not differ substantially from the factors affecting IT professional's wages in other industries.

Table 6: Determinants of Log Wage Rate of Workers in IT Occupations
(Computer Services Industry Vs All Other Industries)

	All Other Industries		Computer Services Industry	
Observations	3872		1940	
Adjusted R-Square	0.2009		0.155	
	Parameter Estimate	Std. Error	Parameter Estimate	Std. Error
Intercept	5.42152	0.12238 **	5.29579	0.19433 **
Age	0.06399	0.00607**	0.07688	0.00976**
Age Squared	-0.00068	0.00007**	-0.00082	0.00012**
Job Change	0.03688	0.02819	0.05861	0.03563
Month	0.00336	0.00062**	0.00475	0.00104**
Education Level (Bach. Degree Base)				
High School or <	-0.23423	0.02446**	-0.34835	0.04863**
Some College	-0.19243	0.01887**	-0.18578	0.03257**
Associate Degree	-0.14452	0.02055**	-0.20132	0.03613**
Masters Degree or >	0.10454	0.01808**	0.04312	0.02689
Industry (Services Base)				
Manufacturing	0.08097	0.01633**		
Trans. Utilities & Finance	0.07108	0.01642**		
Wholesale and Retail Trade	0.07563	0.02377**		
City Size (Medium Size Base)				
Small (< 500,000)	-0.10100	0.01649**	-0.15897	0.03092**
Large City (> 5,000,000)	0.10261	0.01470**	0.05502	0.02270**
Race and Sex (White and Male Base)				
Female	-0.15457	0.01379**	-0.13975	0.02411**
Black	-0.16580	0.02616**	-0.16004	0.04320**
Hispanic	-0.05514	0.03596	-0.12964	0.06222**

** Significant at .05 level
 * Significant at .10 level.

CONCLUSIONS

This paper has examined alternative theories of the impact of training and skills on the structure of wages and voluntary job change. Human capital theory suggests that firms can only afford to pay for firm-specific training. However, the dynamics of the IT market suggest that firms are often forced to pay the direct costs of specialized training that has a very competitive market. The new labor contract model suggests that firms should view such training as a cost of attracting more able employees. By providing frequent opportunities for performance appraisal and salary adjustments, the firm can recoup a sufficient return on this enhanced ability to recoup its training costs, although job change rates are expected to be higher overall due to the highly competitive skill sets developed.

Job satisfaction surveys within the IT industry have found that IT workers are generally more satisfied with their jobs when they have access to learning new skills. However, this greater job satisfaction may not translate into longer retention, if the skills learned have a highly competitive market.

Generally, the empirical results presented here support the concepts of the new labor contract and suggest that IT workers, or at least IT workers in the computer services industry, may be on the leading edge of the movement to this form of relationship between employees and employers. The higher rate of voluntary job change

among computer service industry workers and the positive returns to job change among IT workers (suggesting a predominance of positive selection factors among job changers) are both compatible with new labor contract ideas that: neither workers nor employers desire career length relationships and that the employer is expected to provide opportunities for training and skill development.

The nature of available data has imposed major limitations on the hypotheses that could be developed and the conclusions that could be drawn in this study. The ideal data set for the analyses presented here should: follow workers if they relocate due to job change, provide estimates of the wage before and after job changes, track cumulative job changes over a longer period of time, and provide data about specific skills developed and training provided on the job. The costs of developing such an ideal data set at large scale may be prohibitive, but it should be possible to test the impact of some of these elements through survey research and the use of other predefined data sources.

It is also important to examine the responsiveness of the high-tech labor market across the business cycle. This study covered a time period that was predominantly part of an economic boom. If the new labor contract is rooted in changes that are making skills more generally-valued and less firm specific, firms will have less incentive to retain skilled workers through economic downturns, since the ability to share in the returns of firm-specifically trained workers skills during good times provides incentives for employers to retain them during recessions.

Finally, this paper and the literature it reviews suggest that the process of skill development in the new economy is important area for future research. If skills are indeed becoming more generally-valued, who will pay for them and how will they be provided? Will firms be less willing to bear the costs of obtaining these skills (as economic theory suggests)? If the individual must bear all, or nearly all, of the costs of acquiring skills will there be substantial under-investment in these skills? What is the role of the higher education community in the provision of these skills and the re-skilling of workers as technology advances? All of these are important questions that need to be addressed as we work to understand the implications of the changes in work relationships implied by the new labor contract.

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