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Natalia Levina, Mingdi Xin,

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Research Note

Comparing IT Workers' Compensation Across Country Contexts: Demographic, Human Capital, and Institutional Factors

Natalia Levina, Mingdi Xin
Stern School of Business, New York University, Information Systems Group/IOMS, 44 West Fourth Street, New York, New York 10012 {nlevina@stern.nyu.edu, mxin@stern.nyu.edu}

As the IT workforce becomes global, it is increasingly important to understand the factors affecting IT workers' compensation in labor markets distributed across the globe. Ang et al. (2002) published the first in-depth analysis of compensation for IT professionals juxtaposing human capital endowment (education and experience) and institutional determinants (firm's size, industry, and sector) of compensation in the Singaporean economy. In this paper, we explore the influence of particular national economies on IT workers' compensation. We draw on research into the roots of wage differentials in labor economics and build on the Ang et al. research to present a multilevel analysis of IT workers' compensation in the United States, analyzing the U.S. Bureau of Labor Statistics' Current Population Survey (CPS) data for 1997, 2001, and 2003.

We find that, while institutional differences in Singapore mattered only in conjunction with individual factors, in the U.S. institutional differences had a direct effect on IT workers' wages. As tightness of IT labor supply decreased in the United States in the early 2000s, the influence of a firm's size on wages became more pronounced. Also, female IT workers and workers without a college degree fared worse than their male and college-educated counterparts as the IT job market slowed down.

We suggest that factors such as presence of job search friction, diversity in the educational system, geographical differences in cost of living, labor mobility, and shortages in IT labor supply vis-à-vis demand help explain the differences among countries. We conclude by outlining the implications of these findings for IT workers, firms, and policy makers.

Key words: management of IT human resources; compensation; hierarchical linear modeling
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Introduction

With the rise of information technology (IT) in the second half of the 20th century, IT workers have become essential to the productivity and profitability of the information economy. In 2004, despite the technology sector's economic downturn and an increase in the use of offshore IT resources, the U.S. Department of Labor predicted that computer system analysts and scientists would experience above-average employment growth rates (greater than 21% a year) for the next 10 years (Department of Labor [DOL] 2004). Since 1999, for example, computer science researcher salaries had risen by 5.6% per year (Arora et al. 2006). At the same time, salaries of computer support personnel and programmers have barely maintained pace with the rate of inflation (Arora et al. 2006). As sourcing of IT work becomes more global, shifting demand for IT labor within the United States and to other countries, it becomes increasingly important to understand the factors that shape IT workers' compensation in a particular economic context.

Recently, Ang et al. (2002) (henceforth ASN) published the first in-depth analysis of compensation structure in the IT sector using data from Singapore's economy. Their analysis juxtaposed human capital endowment (education and experience) and institutional determinants of compensation (firm size, industry, and sector). In this paper, we will broaden their investigation to understand how IT compensation structures vary from one country to the next. To do so, we will build on ASN's work by conducting a multilevel analysis of IT worker compensation in the United States. We will also consider how U.S. compensation structures have changed over time by comparing U.S. data from 1997 (the year that the ASN data were collected) with 2001 and 2003 data. We will conclude this paper by discussing the implications of our results for IT workers in diverse socioeconomic settings, as well as for firms and policy makers.

Background

The ASN study draws on prior research in human resource (HR) management to develop hypotheses pertaining to individual, institutional, and cross-level determinants of compensation. Prior studies of compensation have largely focused on studying compensation strategies at a single level of analysis (typically either at the level of the individual or institution). The ASN study theorizes and models the interaction effect of the individual- and institutional-level determinants (i.e., the cross-level interactions) (ASN, p. 1428). The authors' three-level hypotheses are summarized in Table 1. To test these hypotheses, ASN used archival salary data on 1,576 IT professionals across 39 institutions in Singapore. The cross-level hypotheses are tested using recent advances in hierarchical linear modeling (HLM) (Hofmann 1997).

The results show that, in Singapore, compensation was directly determined by education and experience in the workforce (human capital endowments), but was not directly determined by institutional factors. Institutional differences, however, do have a moderating effect, with information-intensive firms paying more to IT professionals who have more education or IT-specific education, and with large institutions paying more than small institutions to IT professionals who have more education. Finally, for-profit institutions pay more than not-for-profit institutions to IT professionals who have more education or IT-specific education.

Table 1 ASN Findings

Individual level		
Hypothesis 1A	IT compensation is positively related to education.	Supported
Hypothesis 1B	IT compensation is positively related to experience.	Supported
Institutional level		
Hypothesis 2A	IT compensation is higher in larger than in smaller institutions.	Not supported
Hypothesis 2B	IT compensation is higher in for-profit than in not-for-profit institutions.	Not supported
Hypothesis 2C	IT compensation is higher in information-intensive than in noninformation-intensive institutions.	Not supported
Cross-level		
Hypothesis 3A	Compensation is higher in larger than in smaller institutions for IT professionals with more education.	Supported
Hypothesis 3B	Compensation is higher in larger than in smaller institutions for IT professionals with more experience.	Not supported
Hypothesis 4A	Compensation is higher in for-profit than in not-for-profit institutions for IT professionals with more education.	Supported
Hypothesis 4B	Compensation is higher in for-profit than in not-for-profit institutions for IT professionals with more experience.	Not supported
Hypothesis 5A	Compensation is higher in information-intensive than in noninformation-intensive institutions for IT professionals with more education.	Supported
Hypothesis 5B	Compensation is higher in information-intensive than in noninformation-intensive institutions for IT professionals with more experience.	Not supported

The ASN study made a significant contribution to our understanding of this phenomenon. At the same time, the authors acknowledged the limitations inherent in the specificity of the Singaporean context:

> Although the IT labor market context may be similar in other settings, the institutional context could be different. ... Obviously, such findings must be validated in other settings, and extension of our ideas to other institutional contexts is essential. (ASN, p. 1443)

For example, country-specific factors such as government regulation of compensation, unemployment policies, unionization rates, and labor mobility influence compensation structures (Blau and Kahn 1986, Erdil and Yetkiner 2001). In what follows, we draw on labor economic theories that may help explain the differences in IT compensation structures across the Singaporean and U.S. contexts. We then evaluate these differences empirically.

Differences in Institutional and Human Capital Impacts: United States vs. Singapore

Prior theories for wage differentials across industries and firms of different sizes have fallen into two categories. The differences can arise when different types of firms have different compensation policies (or institutional effects), or when higher-paying firms employ workers who are more productive due to factors that are not captured by the observed variables (Mortensen 2003). Studies have suggested that both factors are equally important in explaining the inter-industry and inter-firm wage differentials (Abowd, Finer, et al. 1999, Abowd, Kramarz, et al. 1999).

ASN focused on three institutional factors—firm size, sector, and industry—in explaining IT workers' wage structure. ASN argued that larger institutions can offer higher levels of compensation because (1) they have higher market power and a higher rate of return on capital, (2) they face greater complexity and need workers who have greater expertise (i.e., the human capital of the workers they employ is different, but the human capital variables do not show this difference), and (3) it is more difficult to monitor workers' performance in larger institutions and higher wages provide greater incentives to perform (this is the so-called "efficiency wage" theory) (ASN, p. 1429). ASN argued that not-for-profit institutions pay lower wages due to (1) "institutional rigidity" (they are slower to adjust wages according to the market factors), (2) workers' desires to contribute to not-for-profit firms' causes, and (3) nonmonetary perquisites (perks) offered by not-for-profits (p. 1430). Finally, ASN argued that information-intensive firms offer higher wages to IT workers because such workers bring a higher rate of return for these firms as compared to similar workers in other industries (p. 1430).

The relevance of firm size for compensation has repeatedly been affirmed in a global economic context. Research in the United States (Lester 1967, Mellow 1982), Japan (Idson 1992), Europe (Loveman and Sengenberger 1991), and Peru (Schaffner 1998), for example, has demonstrated that larger firms tend to offer higher levels of compensation. U.S. labor market data have also affirmed the presence of wage differences between industries (Osburn 2000), as well as compensation differences in the for-profit versus not-for-profit sectors (Preston 1989). The lack of support for the hypotheses (2A–2C) in the ASN study, however, suggests that a more detailed theoretical evaluation may be required to fully understand the impact of institutional factors on IT industry compensation.

Job search theory (Mortensen 2003) may prove particularly useful in this regard. This theory suggests that institutional influences on compensation are heavily dependent on the presence of search friction in labor markets (Mortensen 2003). In such markets, more productive (i.e., large or information-intensive) firms pay higher wages and invest more in their recruiting efforts because they have more to lose if an informed worker rejects their offer. That is, if workers are perfectly informed (i.e., no search friction), institutional factors will not influence compensation. However, if there *is* friction, institutional factors will prove to be relevant (Burdett and Mortensen 1998, Pissarides 2000).

We suggest that search friction is likely to be lower in Singapore than in the United States. This is likely attributable in large part to geographic and demographic differences between the two countries. Singapore is a small island, with a land mass approximately 3.5 times the size of Washington, D.C., and a total population of about 4 million. In a city-state such as Singapore, the information networks among IT professionals are likely to be stronger, rendering information about job opportunities much more accessible.

Additional factors that supplement the search friction explanation have to do with geographical variations in wages. In some countries (such as the United States), the cost of living varies widely between regions. Given that information-intensive industries such as the financial services sector and the IT industry tend to cluster in particular regions (Baptista and Swann 1999, Nachum 2000), one would expect more pronounced industry effects in the United States. Moreover, all three institutional influences may be stronger in larger economies if workers are simply less willing to move for higher wages (Hoynes 2000).

In addition, strong governmental influence on compensation may serve to reduce institutional effects (Blau and Kahn 1986), especially the differences between for-profit and not-for-profit firms. In Singapore, employment is heavily influenced by government-linked companies (DOL 2003). The government has also set up a National Wage Council advising companies on proper wage policies. For example, during the Asian recession, the National Wage Council recommended that wages have a higher variable component that would allow firms to pay workers based on year-end results; many organizations responded accordingly by implementing performance-based compensation practices (U.S. Embassy of Singapore 2001).[1]

Finally, institutional compensation differences can also be attributed to unobservable differences in worker characteristics (Murphy and Topel 1987, Osborn et al. 1998). For example, information-intensive firms may try to hire better-trained IT workers with the same formal education. Unobservable discrepancies in the quality of worker education, however, are likely to be more pronounced in the United States than Singapore. There are only three local universities in Singapore, only two of which have academic programs in computer science.[2] Since graduates from the same university are likely to receive similar training, educational background is likely to be an accurate indicator of an IT worker's technical expertise. Conversely, in the United States, there are hundreds of universities and colleges offering technical degrees on all levels, and as such, training content and quality varies significantly between institutions. Thus, controlling for educational level in Singapore is likely to leave fewer unobservable worker characteristics, leading to less institutional wage difference, than would be achieved by doing the same with data from the United States. Given all of these considerations, we would expect

Hypotheses 2A–2C *will be supported in the U.S. context.*

The predictions ASN offered with respect to cross-level effects of human capital endowments and institutional factors on compensation suggested that more productive firms will be willing to pay a premium wage for IT workers with higher levels of human capital (ASN, p. 1431). We would expect these predications to be supported in the United States.

Hypotheses 3A–5B *will be supported in the U.S. context.*

Differences in Gender Impacts: United States vs. Singapore

Although the ASN study included gender as a control variable in determining compensation, the authors found no significant gender-based differences. This is surprising, especially given that prior research has demonstrated significant gender-based differences in pay in the Singaporean workforce in general (i.e., not specific to IT workers) (Lee and Pow 1999, DOL 2003). It is possible, however, that the Singaporean government is now making headway in its attempt to minimize the gender gap by encouraging women to pursue higher education (DOL 2003).[3]

Another explanation for this finding may have to do with the impact of the mandatory Singaporean military service for men on compensation, which gives women a two-year head start in their careers while their male counterparts are fulfilling their service obligation. Some studies report that among young Singaporean females, the gender gap in compensation has been reversed, with women under 19 years of age earning wages that are 38% higher than men at the same age level (Hua and Long 1997). In the overall Singaporean labor force, however, there is a pronounced decrease in women's wages compared to

[1] It should be noted that influences on compensation structure such as high rates of unionization that are prevalent in European countries and that may lead to dampened institutional effects typically do not apply as broadly to either the United States or Singapore, both of which have approximately 16% unionization density—among the lowest in the world (Blau and Kahn 1986, DOL 2003).

[2] See http://www.singaporeedu.gov.sg/htm/sis/sis0207.htm for information about Singapore's system of higher education.

[3] We also hypothesized that the absence of a gender gap was a function of women being more equally represented in the Singaporean IT workforce insofar as they constituted approximately 50% of the ASN sample. This was not the case, however. According to the Singaporean Ministry of Manpower, women represent about 22% of engineering, IT, and physical sciences professionals. In our U.S. data set, which is a random sample of the U.S. population, women represented about 30% of IT professionals in the occupational groups we studied.

men's, and the wage gap widens as women age (Hua and Long 1997). Interestingly, this finding is consistent with the results attained by labor economists in many countries (Blau and Kahn 2000).

In the U.S. labor force, for example, there is almost no gender gap with respect to wage in the young adult age group (18 to 24-year-olds). The gap develops and becomes larger as workers age—reaching 24% on average (Blau and Kahn 2000). This phenomenon is typically attributed to women temporarily dropping out of the workforce for family reasons, as well as to difficulties in advancing into managerial positions (Mincer and Polachek 1974, Becker 1985). As a second-order effect, in anticipating their loss of experience, women often tend to underinvest in job-related training and skills (Becker 1985). We also note that the ASN data reflect a relatively young labor force with an average of seven years of IT work experience, thus potentially explaining the smaller gender gap. We propose that

Hypothesis 6A. *Compensation for male IT workers is higher than for female IT workers in the United States.*

Hypothesis 6B. *Compensation difference between male and female IT workers ("the gender wage gap") is absent or smaller for younger workers.*

Longitudinal Effects in the United States

Finally, the ASN study noted that the supply shortage in the IT labor market in Singapore in the late 1990s might have had a significant effect on the findings. A similar shortage was observed in the United States during the late 1990s (National Research Council [NRC] 2001). The shortage in the labor supply eased in the early 2000s as a result of the burst of the dot-com bubbles and the increased prevalence of the offshoring of IT services. For example, the unemployment rate among IT professionals has increased from 1.2% in 1997 (the lowest rate since 1983) to 5.7% in 2002 (the highest rate since 1983) (Montes 2003). Moreover, the U.S. Department of Labor no longer predicts growth in the computer programming sector for the period of 2002 through 2012, indicating that the labor shortage for less-skilled IT workers (programmers as opposed to system analysts) has been eased (DOL 2004).[4]

[4] Growth is still predicted for the systems analysis occupation, however.

According to ASN, "when labor supply exceeds demand, the institutions possess relatively greater bargaining power vis-à-vis workers and can exercise differentiating compensation strategies to attract and retain workers, resulting in institutional effects on compensation" (ASN, p. 1440). Overall, we propose that

Hypothesis 7. *Institutional factors will have a stronger influence on compensation as IT labor supply becomes more abundant vis-à-vis IT labor demand.*

Economic downturn is also likely to affect the return to education among IT workers. Prior studies in the United States have shown that changes in labor demand lead to more pronounced changes in employment rates and wages for non-whites, younger persons, and those with lower education levels, especially among women (Bound and Holzer 1993, Hoynes 2000). There are several explanations for these phenomena: (1) These historically disadvantaged groups experience lower mobility rates and therefore are often unable to move to pursue better opportunities. (2) They would rather tolerate a loss of income than risk temporary unemployment. (3) These groups tend to be employed in sectors and occupations associated with a greater potential for layoffs (Hoynes 2000).

In relation to IT workers, these explanations suggest that a loss of employment and earnings is likely to be of greater concern for workers with lower education and for women. This is because the drop in IT industry labor demand after the dot-com market correction and the concomitant increase in offshoring fundamentally altered the nature of employment in the IT sector, producing deleterious impacts in some markets, sectors, and regions, while retaining or even creating earning opportunities in other areas (Aggarwal et al. 2006). IT workers with lower levels of education were likely to suffer considerably because their jobs were typically among the first to go offshore or to be eliminated in downsizing (Aggarwal et al. 2006). Women in IT were also more likely to suffer than were other groups because of their relatively restricted geographical mobility. Prior research, however, shows that because of the rapid pace of skill obsolescence in IT, young workers do not constitute a disadvantaged group, as they often do in other industry contexts (Levina et al. 2003).

Hypothesis 8. *Education will play a more significant role in compensation as IT labor supply becomes more abundant vis-à-vis IT labor demand.*

Hypothesis 9. *The gender wage gap will become wider as IT labor supply becomes more abundant vis-à-vis IT labor demand.*

Our empirical work uses the innovative multilevel model developed by ASN to analyze the U.S. Current Population Survey (CPS) data set so as to understand the following:

1. How do individual, institutional, and cross-level effects differ in the United States?
2. Does the gender-based wage gap among IT workers differ in the United States?
3. How have the determinants of wages changed over the seven-year period from 1997–2003 in the United States?

Method

The ASN study was based on Singapore IT professional's salary data in 1997. For consistency, the current investigation uses the U.S. 1998 CPS March Supplement data set, which refers to data in the previous year (i.e., 1997). CPS monthly survey data is collected by the U.S. government from a random sample of 5% of the U.S. workforce (about 60,000 households in 2002) by interviewers who visit individual household and survey respondents (DOL 2005).[5] The CPS monthly survey uses a rotation sample scheme that follows a 4-8-4 pattern. A housing unit is interviewed for four consecutive months, excluded from the sample for the next eight months, interviewed for the next four months, then retired from the sample permanently. The rotation scheme is designed so that outgoing housing units are replaced by housing units with similar characteristics (Census Bureau 2002).[6]

In addition to the 1997 data, we use CPS 2002 and 2004 data to investigate the trends in compensation for the years 2001 and 2003, respectively. For the sake of parsimony, we limited our longitudinal investigation to these two years. The year 2001 was chosen because it was associated with the reported decrease in demand for IT workers after the dot-com bubble burst (Information Technology Association of America (ITAA) 2002), while 2003 was the most recent year for which CPS data were released.[7]

We define our sample as employed workers in IT-related occupations. (For a more detailed definition, see Table 2.) In July 2001, additional funding from the U.S. Congress allowed CPS to expand its sample size. Accordingly, our data set increased from 422 in 1998 (referring to data in 1997) to 769 in 2002 (referring to data in 2001). Since 2003, CPS has enhanced its occupational categorizations with more detailed definitions, thus leading to a slight change in our sample size from 769 to 913. Unfortunately, the new job categorization schema has a many-to-many relationship to the previous schema. As such, it is impossible to back-code the data and construct a sample on the basis of consistent job categories. The appendix describes the sample in more detail, along with the relevant descriptive statistics.

The ASN hierarchical model shown in Figure 1 includes eight main variables. Given the limitations of the CPS data set, there are slight differences in defining variables in the current study as compared to the original. The variables have been selected, however, to be as close to the initial definitions as possible. (See Table 2 for a comparison.) In measuring compensation, we used the only variable measuring compensation that was available in CPS (income from wages and salary) deflated by the year's consumer price index (2003 = 100). ASN used two variables (base and total compensation), but there were no significant differences in results from using one or the other variable.

[5] Since we wanted to conduct a longitudinal analysis, we sought to use an existing longitudinal data set, of which CPS is the best available. While we could have collected original data that more closely approximated the ASN data set, we could not ensure the comparability of that set to the CPS data set available for 1997 (the year of ASN data).

[6] Due to CPS's sampling strategy, only half of the households in the March sample of the previous year are still in the March sample in the current year, and are wholly absent in the following year. Hence, we are unable to compare data for the same individual over a long period of time, which is required for a growth model. Nevertheless, the representative sample allows our results to reflect general trends in the U.S. economy.

[7] There is also some concern that for two consecutive years the CPS data may have up to 50% sample overlap, which is not the case if a year is skipped.

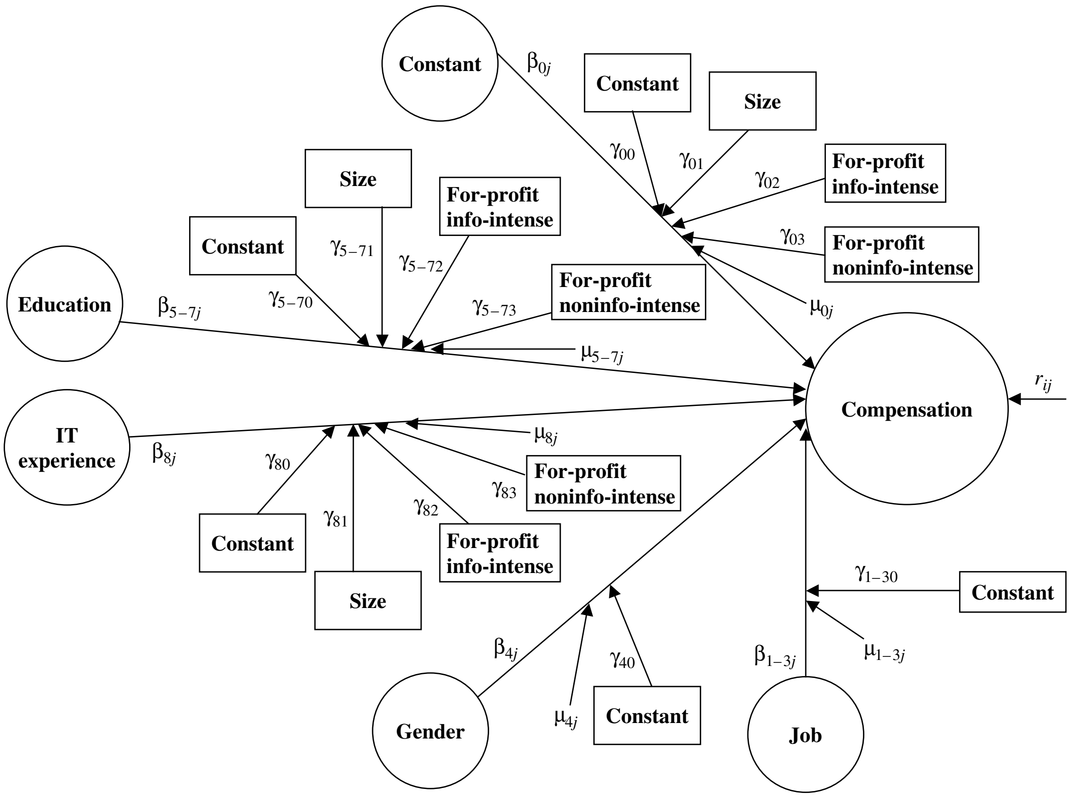
Table 2 Comparison of Variable Definitions

	Definition in the ASN study	Definition in the current study for the 1997 and 2001 data	Definition in the current study for the 2003 data
Compensation	Base compensation: 12-month salary for an individual, together with any guaranteed bonus for that year. Total compensation: Base compensation plus variable portion of salary.	Total income from wage and salary a worker earned in the prior year, e.g., 1997 for 1998 data set (approximates base compensation). Variable pay data were not available.	The same as that in 1997 and 2001 CPS data.
Size of the employer	A continuous variable that is the natural logarithm of the number of employees in the institution.	A continuous variable with 1 indicating firms with size 1–50, 2 for 51–99, 3 for 100–499, 4 for 500–999, and 5 for 1,000 employees or more.	The same as that in 1997 and 2001 CPS data.
For-profit info-intense (FP-II)/noninfo-intense (FP-NII)	Information and financial services industries are defined as FP-II; manufacturing, oil production, aerospace, and transportation industries are defined as FP-NII; utilities, educational, government, and charitable institutions are defined as not-for-profit industries as reference group.	Information and financial services industries are defined as FP-II; manufacturing, oil production, aerospace, transportation, and utilities industries are defined as FP-NII; educational, government, and charitable institutions are defined as not-for-profit industries as reference group.	The same as that in 1997 and 2001 CPS data.
Education	Three dummy variables: Edu1 bachelor's degree, IT major; Edu2 indicates bachelor's degree, non-IT major; Edu3 indicates associate's degree, IT major. The associate degree recipients with non-IT major are defined as a reference group.	One dummy variable: Ed1 indicates bachelor's degree and the associate degree recipients defined as a reference group.	The same as that in 1997 and 2001 CPS data.
IT experience	Reported IT working experience in the survey.	Approximated by age-6-years of education.	The same as that in 1997 and 2001 CPS data.
Gender	Male vs. female.	Male vs. female.	Male vs. female.
Job	Three job-level dummy variables representing project-leader, senior-analyst, and systems-analyst, with programmers as the base group.	Two occupation dummy variables representing computer system analysts and scientists with programmers as the base group.	Seven occupation dummy variables for computer and IS managers, computer scientists and system analysts, computer software engineers, computer support specialists, database administrators, network and computer systems administrators, and network systems and data communication analysts with programmers as the base group.

Next, the firm size variable is not continuous in the CPS data set, with four specific categories defined (see Table 2). We created a continuous variable for firm size (see Table 2). In terms of industry definitions, we used the same variable definition as the original study, except that we classified the utilities industry as a for-profit industry in the United States, whereas it is defined as not-for-profit in Singapore.[8] A significant difference in variable definitions concerns the lack of reporting of the IT-specific education and experience in the CPS data set. Taking this into consideration, we used the standard labor-economic approach and approximated experience using age-6-years of education (Willis 1999). Finally, in the Singaporean data, the project leader and senior analyst job categories were

[8] Classifying the utilities industry as a not-for-profit industry makes no difference for the hypothesis testing results, although this may be due to the small sample of IT workers in the utilities industry in the CPS data. (See the appendix for a detailed description of the sample distribution.)

Figure 1 **Statistical Model**



Note. From ASN (p. 1433). Reprinted by permission. Copyright [2002] INFORMS. From Ang, S., S. Slaughter, K. Y. Ng. 2002. Human capital and institutional determinants of information technology compensation: Modeling multilevel and cross-level interactions. *Management Sci.* **48**(11) 1427–1445. The Institute for Operations Research and the Management Sciences, 7240 Parkway Drive, Suite 310, Hanover, Maryland 21076, USA.

reported separately, whereas in the CPS data set, these categories were separated only in the 2003 data, but not in the 1997 and 2001 data. Additional job categories were also added in 2003, which were included in the current analysis. We believe the differences in variable definitions will diminish only slightly the comparability of results.

The following equations represent the cross-level model estimated in both studies. Because the number of occupations changed in 2003 in our study, we list two models that differ from each other only in terms of the number of occupation dummy variables. Table 3 shows how each hypothesis was tested.

The original model was estimated using full maximum likelihood, empirical Bayes procedures, and the Expectation Maximization (EM) algorithm in HLM (Bryk and Raudenbush 1992) and reported random coefficient specification of the model (ASN, p. 1434). Although our analysis used a different software package, LIMDEP 8.0 (Greene 2003), it implemented the same statistical model for estimating cross-level hypotheses. Despite the fact that the tests showed no signs of multicollinearity, we chose to center the data in order to follow ASN's methods as closely as possible.

Individual-Level Model

CPS1997 or 2001

$$COMPENSATION_{ij} = \beta_{0j} + \beta_{1j}\cdot(GENDER_{ij}) + \beta_{2j}\cdot(EDUCATION_{ij}) + \beta_{3j}\cdot(EXPERIENCE_{ij}) + \beta_{4j}\cdot(JOB_{ij}) + r_{ij}.$$

CPS2002–2003

$$COMPENSATION_{ij} = \beta_{0j} + \beta_{1j}\cdot(GENDER_{ij}) + \beta_{2j}\cdot(EDUCATION_{ij})$$

Table 3 Hypothesis Testing

		Test
Individual level		
Hypothesis 1A	IT compensation is positively related to education.	$\gamma_{20} = 0$
Hypothesis 1B	IT compensation is positively related to experience.	$\gamma_{30} = 0$
Institutional level		
Hypothesis 2A	IT compensation is higher in larger than in smaller institutions.	$\gamma_{01} = 0$
Hypothesis 2B	IT compensation is higher in for-profit than in not-for-profit institutions.	$\gamma_{02} + \gamma_{03} = 0$
Hypothesis 2C	IT compensation is higher in information-intensive than in noninformation-intensive institutions.	$\gamma_{02} - \gamma_{03} = 0$
Cross-level		
Hypothesis 3A	Compensation is higher in larger than in smaller institutions for IT professionals with more education.	$\gamma_{21} = 0$
Hypothesis 3B	Compensation is higher in larger than in smaller institutions for IT professionals with more experience.	$\gamma_{31} = 0$
Hypothesis 4A	Compensation is higher in for-profit than in not-for-profit institutions for IT professionals with more education.	$\gamma_{22} + \gamma_{23} = 0$
Hypothesis 4B	Compensation is higher in for-profit than in not-for-profit institutions for IT professionals with more experience.	$\gamma_{32} + \gamma_{33} = 0$
Hypothesis 5A	Compensation is higher in information-intensive than in noninformation-intensive institutions for IT professionals with more education.	$\gamma_{22} - \gamma_{23} = 0$
Hypothesis 5B	Compensation is higher in information-intensive than in noninformation-intensive institutions for IT professionals with more experience.	$\gamma_{32} - \gamma_{33} = 0$
Hypothesis 6A	Compensation is lower for female than for male IT workers.	$\gamma_{10} = 0$
Hypothesis 6B	The gender wage gap is absent or smaller for younger IT workers.	$\gamma_{10} = 0$ for IT workers with fewer than 12 years of experience*
Hypothesis 7	Institutional determinants will have a stronger influence on compensation as IT labor supply becomes more abundant vis-à-vis IT labor demand.	γ_{01} increases over time $\gamma_{02} + \gamma_{03}$ increases over time $\gamma_{02} - \gamma_{03}$ increases over time
Hypothesis 8	Education will play a more significant role in compensation as IT labor supply becomes more abundant vis-à-vis IT labor demand.	γ_{20} increases over time
Hypothesis 9	The gender wage gap will become wider as IT labor supply becomes more abundant vis-à-vis IT labor demand.	γ_{10} decreases over time

*We used the cutoff of 12 years of experience because in the ASN data the average experience was seven years. Twelve years of experience cutoff in the CPS data corresponds to an average experience of seven years.

$$+\beta_{3j} \cdot (EXPERIENCE_{ij}) + \beta_{4\text{–}10,\,j} \cdot (JOB_{ij}) + r_{ij}.$$

Institution-Level Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01} \cdot (SIZE_j) + \gamma_{02} \cdot (FP - II_j) + \gamma_{03} \cdot (FP - NII_j) + \mu_{0j}.$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21} \cdot (SIZE_j) + \gamma_{22} \cdot (FP - II_j) + \gamma_{23} \cdot (FP - NII_j) + \mu_{2j}.$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31} \cdot (SIZE_j) + \gamma_{32} \cdot (FP - II_j) + \gamma_{33} \cdot (FP - NII_j) + \mu_{3j}.$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j}.$$

$$\beta_{4j} = \gamma_{40} + \mu_{4j} \quad \text{(before 2001)}, \quad \text{or}$$

$$\beta_{4\text{–}10,\,j} = \gamma_{4\text{–}10,\,0} + \mu_{4-10,\,j} \quad \text{(after 2001)}.$$

Cross-Level Model

$$\begin{aligned} COMPENSATION_{ij} &= \gamma_{00} + \gamma_{01} \cdot (SIZE_j) + \gamma_{02} \cdot (FP - II_j) \\ &\quad + \gamma_{03} \cdot (FP - NII_j) + \gamma_{10} \cdot (GENDER_{ij}) \\ &\quad + (\gamma_{20} + \gamma_{21} \cdot (SIZE_j) + \gamma_{22} \cdot (FP - II_j) \\ &\qquad + \gamma_{23} \cdot (FP - NII_j)) \cdot (EDUCATION_{ij}) \\ &\quad + (\gamma_{30} + \gamma_{31} \cdot (SIZE_j) + \gamma_{32} \cdot (FP - II_j) \\ &\qquad + \gamma_{33} \cdot (FP - NII_j)) \cdot (EXPERIENCE_{ij}) \\ &\quad + (\gamma_{4,\,0} \text{ or } \gamma_{4-10,\,0}) \cdot (JOB_{ij}) + \mu_{0j} \\ &\quad + \mu_{1j} \cdot (GENDER_{ij}) + \mu_{2j} \cdot (EDUCATION_{ij}) \\ &\quad + \mu_{3j} \cdot (EXPERIENCE_{ij}) + (\mu_{4j} \text{ or } \mu_{4-10,\,j}) \cdot (JOB_{ij}) + r_{ij}. \end{aligned}$$

Table 4 Descriptive Statistics and Correlation

Variable	Mean (s.d.)	1	2	3	4	5	6	7	8
Descriptive statistics and correlation (Current study 1997)									
1 Natural log of salary	10.890 0.478	1							
2 Computer system analysts and scientists	0.718	0.163***	1						
3 Gender (female)	0.301	−0.095*	−0.014	1					
4 Education 1 (bachelor)	0.637	0.125***	0.064	−0.064	1				
5 Work experience	15.941 8.849	0.213***	0.034	0.061	−0.206***	1			
6 FPII	0.621	0.099**	−0.023	−0.062	−0.020	−0.177***	1		
7 FPNII	0.206	0.007	−0.045	−0.015	0.019	0.049	−0.652***	1	
8 Firm size	3.993 1.420	−0.008	0.038	0.032	0.034	0.152***	−0.348***	0.168***	1
# of observation	422								

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Results

Table 4 presents the descriptive statistics and intercorrelations between the variables in the study. Most of the correlation results are similar to the ASN study in terms of the direction (sign) and magnitude, with the exception of the FPII variable, which has a significant positive correlation with compensation. The cross-level model's results are shown in Table 5. The results from the hypotheses testing and how they compare to the original study are shown in Table 6.

In comparing the 1997 data, the direct effects of the human capital variables are supported (H1A and H1B). Moreover, the attainment of a bachelor's degree contributed to a larger average percentage increase in pay in Singapore than in the United States. Also, as hypothesized, all three institutional influences (firm size, industry, and sector of the economy) do have direct, significant effects on compensation while controlling for differences in returns to human capital variables (H2A–H2C). By and large, however, none of the cross-level effects, except for the effect of the for-profit versus not-for-profit distinction on returns to education (H4A), was supported. Additionally, we found that, contrary to our prediction, firm size appears to have negative effects on returns to experience (H3B).

With regard to the gender gap (H6A and H6B), we found a significant gender effect that was consistent with our hypotheses. Moreover, the gender gap derives primarily from the older age group. In testing H6B on IT workers with fewer than 12 years of experience (about 34 years of age), there was no significant gender wage gap (see the last column in Table 5).

In exploring longitudinal changes, we find that the influence of institutional size on pay has been growing in both significance and impact in recent years, with a particularly sizable jump noted in 2003. Other institutional factors prove significant in all years, but do not seem to exhibit a clear trend in terms of their effects. These observations provide partial support for H7. In support of H8, we find that the average return for having a bachelor's degree has been steadily increasing from about 14% to 21% during the period 1997–2003. Returns to experience have been relatively stable over this period. Finally, as hypothesized, the gender wage difference seems to be increasing in recent years, with the wage gap moving from about 9% in 1997 to about 19% in 2003.

Discussion

Our empirical analysis revealed aspects of IT labor markets that will facilitate a better understanding of the conditions experienced by IT workers and employers in the global economy. ASN argued that the Singaporean IT labor market became increasingly efficient in the late 1990s as a result of the undersupply in IT labor. Subsequently, IT workers had greater bargaining power over their employers, resulting in a

Table 5 Comparison of HLM Results

ASN		Current study				
Variable	Coefficient (s.e.) 1997	Variable	Coefficient (s.e.) 1997	Coefficient (s.e.) 2001	Coefficient (s.e.) 2003	Coefficient (s.e.) 1997 (exp < 12)
Constant	10.743*** (0.025)	Constant	10.909*** (0.117E−01)	11.0004*** (0.923E−02)	11.028*** (0.823E−02)	10.776*** (1.92E−02)
Education1 (IT-grad)		ED1 (bachelor)				
—*Intercept*	0.236*** (0.036)	—*Intercept*	0.146*** (0.252E−01)	0.196** (0.198E−01)	0.214*** (0.173E−01)	0.162*** (4.61E−02)
—*Ed1 ∗ Institution size*	0.072*** (0.018)	—*ED1 ∗ Institution size*	0.231E−03 (0.157E−01)	0.003 (0.160E−01)	−0.054*** (0.146E−01)	−2.98E−02 (3.15E−02)
—*Education1 ∗ FP-II*	−0.134** (0.048)	—*ED1 ∗ FPII*	0.130* (0.730E−01)	−0.025 (0.567E−01)	−0.093* (0.495E−01)	−9.69E−02 (0.141)
—*Education1 ∗ FP-NII*	−0.331*** (0.050)	—*ED1 ∗ FPNII*	0.268*** (0.912E−01)	−0.019 (0.712E−01)	−0.183E−04 (0.578E−01)	0.289 (0.177)
Education2 (non-IT grad)						
—*Intercept*	0.248*** (0.033)					
—*Ed2 ∗ Institution size*	0.068*** (0.016)					
—*Education2 ∗ FP-II*	−0.177*** (0.038)					
—*Education2 ∗ FP-NII*	−0.359*** (0.035)					
Education3 (IT-nongrad)						
—*Intercept*	0.067*** (0.026)					
—*Ed3 ∗ Institution size*	0.032** (0.014)					
—*Education3 ∗ FP-II*	−0.101** (0.038)					
—*Education3 ∗ FP-NII*	−0.263*** (0.035)					
Experience		Experience				
—*Intercept*	0.035*** (0.003)	—*Intercept*	0.016*** (0.136E−02)	0.014*** (0.101E−02)	0.013*** (0.938E−03)	5.63E−02*** (6.79E−03)
—*Experience ∗ Institution size*	0.002 (0.001)	—*Experience ∗ Institution size*	−0.003*** (0.105E−02)	−0.002* (0.844E−03)	0.001 (0.768E−03)	−1.36E−02*** (5.19E−03)
—*Experience ∗ FP-II*	−0.002 (0.001)	—*Experience ∗ FPII*	−0.003 (0.396E−02)	−0.004 (0.281E−02)	0.001 (0.270E−02)	−1.21E−02 (2.28E−02)
—*Experience ∗ FP-NII*	−0.010 (0.005)	—*Experience ∗ FPNII*	−0.004 (0.477E−02)	−0.001 (0.342E−02)	−0.006* (0.325E−02)	−2.43E−02 (2.73E−02)
Gender (male = 1)	0.007 (0.011)	Female	−0.094*** (0.250E−01)	−0.144*** (0.206E−01)	−0.194*** (0.202E−01)	6.17E−02 (4.72E−02)
Project leader	0.520*** (0.031)	Occupation 1	0.135*** (0.258E−01)	0.052** (0.215E−01)	0.193*** (0.273E−01)	0.214*** (4.00E−02)
Senior analyst	0.357*** (0.028)	Occupation 2			−0.062** (0.242E−01)	
System analyst	0.199*** (0.022)	Occupation 3			0.115*** (0.249E−01)	
		Occupation 4			−0.244*** (0.316E−01)	
		Occupation 5			−0.018 (0.621E−01)	
		Occupation 6			−0.134*** (0.431E−01)	
		Occupation 7			−0.045 (0.324E−01)	
Institution size	−0.002 (0.017)	Institution size	0.014* (0.773E−02)	0.016** (0.726E−02)	0.049*** (0.665E−02)	9.15E−03 (1.30E−02)
FP-II (for-profit info-intensive)	0.060 (0.061)	FPII	0.249*** (0.343E−01)	0.250*** (0.297E−01)	0.224*** (0.251E−01)	0.378*** (6.11E−02)
FP-NII (for-profit noninfo-intensive)	−0.023 (0.071)	FPNII	0.182*** (0.421E−01)	0.112*** (0.348E−01)	0.178*** (0.279E−01)	0.342*** (7.38E−02)
Number of observations			422	769	913	143

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 6 Hypotheses Tests

Hypotheses	ASN 1997	Current study 1997	Current study 2001	Current study 2003
Hypothesis 1A Education	Supported	Supported ($p < 0.01$)	Supported ($p < 0.05$)	Supported ($p < 0.01$)
Hypothesis 1B Experience	Supported	Supported ($p < 0.01$)	Supported ($p < 0.01$)	Supported ($p < 0.01$)
Hypothesis 2A Institution size	Not supported	Supported ($p < 0.10$)	Supported ($p < 0.05$)	Supported ($p < 0.01$)
Hypothesis 2B For-profit vs. not-for-profit institutions	Not supported	Supported ($p < 0.05$)	Supported ($p < 0.01$)	Supported ($p < 0.01$)
Hypothesis 2C Info-intensive vs. noninfo-intensive institutions	Not supported	Supported ($p < 0.05$)	Supported ($p < 0.01$)	Supported ($p < 0.05$)
Hypothesis 3A Institution size $*$ education	Supported	Not supported ($p > 0.10$)	Not supported ($p > 0.05$)	**Not supported** ($< 0^{***}$)
Hypothesis 3B Institution size $*$ experience	Not supported	**Not supported** ($< 0^{***}$)	**Not supported** ($< 0^{*}$)	Not supported ($p > 0.10$)
Hypothesis 4A For-profit vs. not-for-profit institutions $*$ education	Supported	Supported ($p < 0.01$)	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)
Hypothesis 4B For-profit vs. not-for-profit institutions $*$ experience	Not supported	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)
Hypothesis 5A Info-intensive vs. noninfo-intensive institutions $*$ education	Supported	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)
Hypothesis 5B Info-intensive vs. noninfo-intensive institutions $*$ experience	Not supported	Not supported ($p > 0.10$)	Not supported ($p > 0.10$)	Supported ($p < 0.05$)
Hypothesis 6 Gender gap	Not supported	Supported ($p < 0.01$)	Supported ($p < 0.01$)	Supported ($p < 0.01$)
Hypothesis 7 Longitudinal influences of institutional factors	N/A	Supported for firm size, but not for information intensity or sector		
Hypothesis 8 Longitudinal influences of education	N/A	Supported		
Hypothesis 9 Longitudinal growth of the gender wage gap	N/A	Supported		

Notes. Bold represent significant results in a direction opposite to our hypothesis.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

labor market where pay was based largely on workers' qualifications rather than on institutional factors (ASN, p. 1140). As hypothesized (H2A–H2C), we found the situation to be different in the United States. Even in the late 1990s, when the U.S. IT labor market was tight,[9] institutional influences on compensation were found to be significant.

If the reason for the observed differences between the U.S. and Singaporean markets is the search friction present in the considerably larger and more complex U.S. marketplace (and, conversely, the search friction largely absent from the small and relatively transparent Singaporean market), then we would expect firm size and industry differences to be less pronounced in smaller geographical regions within the United States. To explore the validity of this proposition, we checked the effects of institutional determinants of compensation within four regions in the United States (Northeast, South, Midwest, and West). We found only the for-profit versus not-for-profit sector determinant to be consistently significant inside each region; firm size and information-intensity lost their significance within most of the regions. Although samples within each region were rather small, the results suggest that search friction in the market and geographical differences in cost of living may be key to understanding firm size and industry influences on compensation (Burdett and Mortensen

[9] We use the term *tightness* as opposed to *shortage* because the NRC report on the topic suggested that this term described the situation in late 1990s more accurately (NRC 2001).

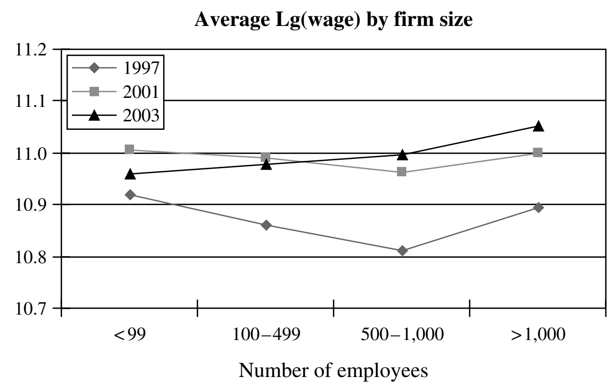
1998). Differences in compensation between for-profit and not-for-profit institutions may be better explained by institutional rigidity and other factors described in ASN (p. 1430).

The lack of support for the cross-level hypotheses between institutional factors and education (H3A, H4A, and H5A) may have roots in the unobservable variations in worker quality (Murphy and Topel 1987), which are more pronounced in the United States, as we have argued before. If education level is a noisy signal of workers' abilities in the United States, then firms that set differential wage policies are likely to put less weight on this criterion. Instead, these firms may choose to set such policies based on more specific criteria, such as knowledge of certain computer languages or training in systems development, or both.

The lack of the support for the cross-level hypotheses H4B (for-profit institutions pay more for experience) and H5B (info-intensive institutions pay more for experience) may also be related to unobservable worker characteristics in the U.S. data set. Incidentally, there was no support found for these hypotheses in the ASN study, either. Given that IT skills become obsolete rather quickly (Slaughter and Ang 1996), experience beyond a certain number of years (e.g., five years) may translate into outdated skills. Thus, information-intensive or for-profit firms might be willing to set differential wage policies based on specific dimensions of the experience, such as paying more for experience with popular programming languages or business analysis experience, but not for accumulated general experience (Brandel 2007).

The negative cross-level effect between institution size and experience (H3B) calls for further investigation. Prior labor economic studies suggest that due to increasing returns to utilization of human capital, large firms invest in specially trained employees whose internal value to the firm exceeds their external value in an outside labor market (Oi 1983, Rosen 1983). Such workers would have a harder time switching jobs, and, thus, may suffer in compensation. On the other hand, small firms tend to use general-purpose equipment and employ workers with broadly applicable human capital. During the period of IT labor tightness in 1997, with more firms competing for the expertise of these generalists, they may well be able to achieve a higher return to experience than specialists in large firms.

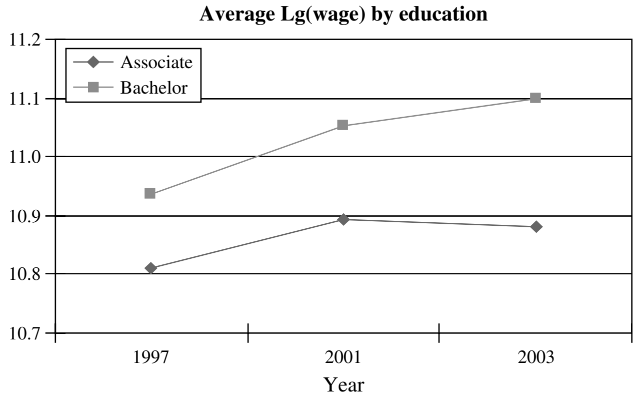
Figure 2 **Interaction Between Firm Size and Year on Average Lg(wage)**



In interpreting how the structure of IT workers' compensation has changed over time, there are a number of important observations. First, firm size was a stronger determinant of compensation in later years than in earlier years. Adding to our hypothesized explanation, we also note that large firms are less affected than small firms by business cycles (Broersma and Gautier 1997), and hence have more power to exercise differential compensation to attract and retain IT workers. As indicated in Figure 2, during a period of IT labor tightness in 1997, smaller firms were compensating IT workers, on average, more than were their medium-sized counterparts. Moreover, the negative cross-level effect of institution size with experience becomes positive and insignificant in 2003. The easing up of IT labor shortage and the post-2001 economic downturn drove down the wage premium that smaller firms pay for experienced IT workers. Finally, we found no change in the influence of information intensity and sector on compensation over the period examined. This may be attributed to such firms suffering as much, if not more, from the downturn in the IT sector than did their noninformation-intensive and not-for-profit counterparts.

The support for Hypothesis 8 corroborates prior statements that highly educated workers fared well during the IT downturn of the early 2000s (Aggarwal et al. 2006). Figure 3 illustrates that their wages went up in 2003 despite increased offshoring and the bursting of the dot-com bubble, while the wages of associate degree holders went down.

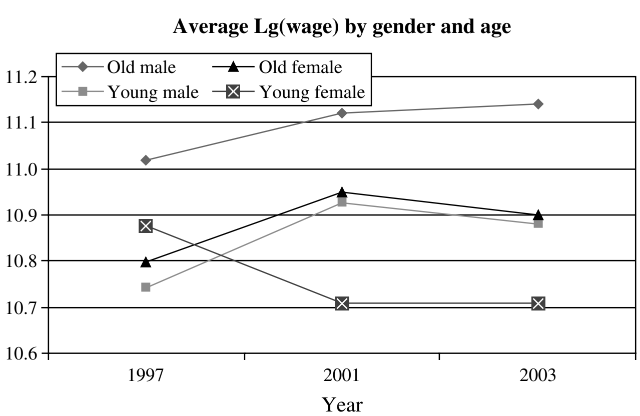
Figure 3 Interaction Between Individual Education and Year on Average Lg(wage)



Our findings with respect to the gender wage gap among IT workers are largely consistent with other accounts of challenges experienced by female IT workers in the United States (Trauth et al. 2005) and in other countries such as Israel (Bamberger et al. 1995). The increase in the gender wage gap as the IT labor shortage diminished is consistent with labor economists' findings that women are more affected by economic downturns than men are (Hoynes 2000). Moreover, a significant gender wage gap was present even among younger IT professionals with fewer than 12 years of experience in 2003.

The fact that we found that the gap was significant in 2003, even for younger women (see Figure 4), suggests that restricted mobility, as opposed to lack of experience and underinvestment in job-related training, may be a key explanation for the gender wage gap during economic downturns. During such periods, good jobs tend to reshuffle geographically (Aggarwal et al. 2006), and women, often bound by family obligations, are less likely to move in pursuit of these jobs.

Figure 4 Interaction Between Individual Gender/Age and Year on Average Lg(wage)



While we took necessary steps to enable a valid comparison with the ASN study, some limitations should be noted. CPS lacks data on IT-related working experience and IT-related education. We had to use the total years of education and approximate workers' experience by age-6-years of education in our model. Also, based on the nationwide survey, our data are likely to include a larger range of institutions than the ASN study. In 2003, the data also accounted for a wider range of IT professional occupations. Both of these factors could have introduced higher variance.

Moreover, awarding employees stock options is a more common practice in the United States than in Singapore. The CPS data set did not have information regarding stock options as part of compensation. Nevertheless, the inclusion of the stock option data, were it available, would have been likely to further support the influence of intuitional factors on compensation because information-intensive, larger, and for-profit firms are more likely to use options-based compensation strategies than are others (Liebeskind 2000, Yang et al. 2003). Finally, CPS's data are self-reported by workers, while ASN data comes from the employers. Further studies based on more precise measures and detailed data sets are needed to address these limitations.

Conclusions and Implications

Our study contributes to the literature on IT workers in three ways. First, it provides a deeper understanding of how country contexts influence IT workers' compensation structure. Specifically, factors such as search friction in the labor market, variability in the education system, tightness of the labor supply vis-à-vis demand, geographical differences in cost of living, and labor mobility shape which determinants of compensation influence wage structure, as well as the extent of their influence. Second, to the best of our knowledge, this study represents the first in-depth, cross-level empirical analysis of compensation for IT professionals in the United States. It builds on the theory of compensation proposed in ASN and tested in the Singaporean context, and adds to the studies of IT management compensation in the United States (Talmor and Wallace 1998, Anderson et al. 2000). Third, it provides the first glimpse at certain longitudinal trends in IT workers' compensation as the labor supply becomes more abundant vis-à-vis labor demand. As proposed by ASN, when labor shortages lessen, the influence of institutional factors on compensation, particularly firm size, becomes more acute. At the same time, wages of IT workers with lower education and women are most profoundly affected.

Our findings have important implications for IT workers, firms, and government policy makers. The importance of institutional factors in setting compensation levels suggests that IT workers should pay considerable attention to firm and industry characteristics in their career planning. These factors, along with having a college education, can influence wages significantly, especially in periods of economic transition or downturn when jobs become scarce.

In general, choosing a large firm may be more advantageous if workers consider the possibility of future bust periods. However, betting on long-term, cross-level effects may be risky, as these effects are not stable over time. Finally, female IT workers, especially older women, may have to give more consideration to the possibility of finding alternative, higher-paying jobs during down times, rather than holding on to existing jobs with lower salaries.

Employers may also want to reflect on institutional trends as part of an overarching process of strategic planning. Does it make sense for a firm to compensate a particular type of IT worker at a greater rate than their counterparts in other sectors or in firms of different sizes? When compensation is tied to the retention of valuable skills, this strategy is likely to be effective. However, in many other situations it might not be. In spite of the fact that one of the central premises of institutional theory holds that much, if not most, institutional practice goes unexamined, careful reflection on this study's findings may significantly improve recruitment and compensation practices in the IT industry.

Anecdotal reports we received from CIOs in the information-intensive financial services sector indicate that IT workers in the sector came to expect a high premium in compensation during the late 1990s without regard for the actual scope of their tasks or responsibilities. Thus, it seems that a network administrator who performs, in essence, the same tasks whether he works in a financial services industry or in noninformation-intensive industry often receives a significant salary premium with little justification. Given that the IT labor shortage has eased in recent years, firms may gain strategic cost advantages by reexamining their compensation policies. Since institutional norms in local labor markets take longer to change, firms may decide to source IT work from those global labor markets in which there are fewer expectations of premium wages associated with institutional characteristics (e.g., to Singapore).

With regard to government policy, our exploration of longitudinal trends in compensation suggests that the maintenance of lucrative employment in the IT sector during periods of economic downturn is critically dependent on workers obtaining college educations. Policy makers may want to consider providing college financial aid to IT workers without bachelor's degrees during economic downturns. Moreover, if governments want to seriously address the gender wage gap, they must focus on mediating the compensation deficits often experienced by older women. Programs that help women invest in job-related training later in life, or that help older women relocate to pursue higher-paying jobs, may be useful in addressing the gender-based wage gap.

This study opens a number of opportunities for future research. First, it is very important to explore IT compensation determinants in other geographical contexts as IT employment becomes global. Our analysis suggests that regions with lower search friction, more homogenous education systems, and a more consistent cost of living than the United States will likely experience less influence of institutional factors in the determination of IT industry compensation.

Singapore is likely to represent an extreme example here as a virtual city-state. Taiwan might offer an interesting point for comparison. Because Taiwan is relatively small and perhaps less connected in terms of IT workers' information networks, search friction there might be higher than in Singapore, even while the other two factors remain similar to Singapore.

West European IT labor markets might be quite similar to the United States in terms of search friction and cost-of-living differences. However, the influence of institutional factors, as well as a gender wage gap due to higher levels of unionization among the Western European IT workforce, may prove to be smaller in such an environment.

Finally, emergent IT labor markets such as those in India, China, and Russia may be similar to the United States in terms of the variability in the cost of living and quality of education, but, at the same time, may be similar to Singapore in the late 1990s in terms of the shortage of qualified workers in these countries vis-à-vis growth in IT labor demand. Also, in these markets, different institutional factors such as foreign versus domestic ownership of enterprises might play a more influential role in compensation. Other factors that should be considered in these markets are the firms' age and growth rates: younger firms and rapidly growing firms are often hungrier for talent than are others. Moreover, because these markets are newer, experienced IT professionals are harder to find in these markets than they are to find in the United States. As such, we would suspect that workers' experience will play a greater role in compensation in these economies.

Second, some of the contradictory findings regarding the cross-level effects call for a closer examination of the characteristics of individual workers, firms, and jobs. For example, to further understand the surprising negative cross-level effects between firm size and education in 2003, one might examine which kinds of smaller firms pay more to employees with more education. Are these firms in the IT industry? Are these firms in certain geographical areas? To explore this further, we need a better understanding and measure of how firms' need for certain IT skill sets vary by industry. In this regard, IT service and product firms might prove to be quite different from other information-intensive firms (Levina et al. 2003).

Third, the paper may be extended by explicitly modeling the unemployment rate in the IT profession. Here we suggested that a higher unemployment rate is positively related to the increased influence of institutional factors and return to years of education on compensation. A new aggregate-level model could be built to examine these relations. (See Mincer 1993 for an example of one such model.)

Finally, the paper does not directly deal with the inflow of foreign labor as a way of addressing the IT labor shortage. Initially, we considered the impact of availability of foreign labor for explaining the differences between Singapore and the United States, but in 1997, both countries were using foreign labor similarly as a means of addressing tightness in the domestic IT labor supply. Singapore is known for its liberal foreign labor and immigration policies (Yeoh 2007). While these policies are much stricter in the United States at the current juncture, U.S. policies regarding H-1B and L-1 temporary work visas were also quite liberal in the 1990s (Ellis and Lowell 2003). Thus, we estimate that both countries had roughly 13% of nonresidents working in the IT profession (Singapore Department of Statistics 2001, DOL 2005). In general, however, countries differ with regard to their foreign labor laws, and by increasing the supply of qualified workers in a country or tapping into offshore service delivery, such differences will have an impact on compensation. This critical variable merits further theoretical and empirical analysis.

The questions and issues addressed in the current study will continue to be important to IT workers and firms, especially as the IT profession continues to become more global in scope and reach. As Pulitzer Prize–winning journalist Thomas Friedman contended in *The World Is Flat: A Brief History of the Twenty-First Century*—it is no longer enough to ask where a country or a company fits in the global economy: one must also ask where each individual professional fits (Friedman 2005).

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Appendix. CPS Sample Description

Variables	1997 *N*	1997 %	1997 Avg. wage	2001 *N*	2001 %	2001 Avg. wage	2003 *N*	2003 %	2003 Avg. wage
Industry									
Information services (SIC 732)	174	41.23	67,079	369	47.98	72,731	362	39.65	71,751
Financial services (SIC 700–711)	59	13.98	55,267	112	14.56	69,643	179	19.61	68,132
Manufacturing, oil production, aerospace, and transportation (SIC 100–432)	109	25.83	55,755	162	21.07	62,453	208	22.78	70,874
Utilities (SIC 450–470)	7	1.66	64,087	7	0.91	73,909	13	1.42	68,884
Educational, government, and charitable institutions (842–851, 880, 901–932)	73	17.30	49,539	119	15.47	55,635	151	16.54	55,974
Firm size									
Firm size (1–99)	78	18.48	69,031	160	20.81	72,478	161	17.63	68,313
Firm size (100–499)	60	14.22	57,844	103	13.39	67,208	124	13.58	64,711
Firm size (500–999)	27	6.40	52,284	39	5.07	65,435	56	6.13	65,880
Firm size (1,000+)	257	60.90	57,619	467	60.73	66,001	572	62.65	69,138
Sector									
For-profit	349	82.70	61,485	650	84.53	69,651	762	83.46	70,613
Non-for-profit	73	17.30	49,539	119	15.47	55,635	151	16.54	55,974
Total	422		59,419	769		67,482	913		68,192

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