MICHIGAN
ROSS SCHOOL OF BUSINESS

Working Paper

Returns to Managerial and Technical Competencies of IT Professionals: An Empirical Analysis

Sunil Mithas
Stephen M. Ross School of Business
at the University of Michigan

M. S. Krishnan
Stephen M. Ross School of Business
at the University of Michigan

Ross School of Business Working Paper Series
Working Paper No. 888
September 2004

24 September 2004 Version

Returns to Managerial and Technical Competencies of IT Professionals: An Empirical Analysis

Sunil Mithas (smithas@bus.umich.edu)
Business Information Technology
Ross School of Business
University of Michigan
701, Tappan Street
Ann Arbor, MI 48109-1234
Phone: 734-763-8290
Fax: 734-936-0279

M. S. Krishnan (mskrish@umich.edu)
Michael R. and Mary Kay Hallman e-Business Fellow
Professor and Area Chair
Business Information Technology
Ross School of Business
University of Michigan
701 Tappan Street
Ann Arbor, MI 48109-1234
Phone: 734 763-6749
Fax: 734 936-0279

Acknowledgements: We are grateful to InformationWeek for providing the necessary salary data for this research. In particular, we would like to thank Bob Evans, Rusty Weston, Lisa Smith, Stephanie Stahl, Helen D'Antoni and Brian Gillooly for sharing their insights and for their valuable support. We thank Narayan Ramasubbu for going through the manuscript carefully and providing insightful comments; all the remaining errors are ours. We also thank Eli Dragolov for her excellent research. Financial support for this study was provided in part by the Michael R. and Mary Kay Hallman fellowship at the Michigan Business School.

Returns to Managerial and Technical Competencies of IT Professionals: An Empirical Analysis

Abstract

In this study, we examine the effect of managerial and technical competencies of information technology (IT) professionals on their salaries. Based on a large nationally representative dataset of more than 55,000 IT professionals in the U.S. for the period 1999-2002, we find that both managerial and technical competencies have a significant effect on salaries of IT professionals. In contrast with findings of previous studies, we find that compared to firms in other industries, firms in the IT industry pay a significant amount of premium to IT professionals. Our results also show that IT professionals in the non-profit and governmental sector receive less compensation compared to their counterparts in the for-profit sectors of the economy. Similar to the dotcom effect for abnormal returns in stock markets, we observe a pronounced dotcom effect in salaries of IT professionals during the 1999-2002 period. Our findings provide evidence of pronounced wage inequalities on the basis of gender and male IT professionals receive 7.8% more in total compensation than their female counterparts. Finally, we estimate the causal effect of MBA education on the salaries of IT professionals using a matching estimator and demonstrate how bounding such a matching estimator provides an assessment of sensitivity of estimated causal effects with respect to selection due to unobservable factors.

Keywords: IT professionals, Managerial Competencies, Business education, Technical Competencies, Compensation, Human Capital.

1.0 INTRODUCTION

IT professionals are among the knowledge workers spearheading the white heat of the technological trajectory of a modern economy. With the digitization of business processes, firms are increasingly relying on the managerial and technical competencies of their IT professionals to design and execute IT enabled business processes that provide a competitive advantage in the marketplace. As a part of their efforts to attract and retain talented IT professionals, firms deploy a wide variety of human resource practices. Compensation schemes form an important element of any such human resource strategy to attract and retain IT professionals. Ferratt, Agarwal, Moore and Brown (1999) argue that compensation is the most important reason for loss of valuable employees. Since managers are expected to deliver more value with reduced IT budgets, competition among firms for attracting and retaining the best IT talent continues to be just as fierce now as it was during the frenzy of the dotcom boom in the late nineties. For example, the 2003 survey of Society for Information Management (SIM) and Conference Board places attracting, developing and retaining IT professionals among top four concerns of CIOs and other IT executives (Luftman and McLean 2004).

Although there is a wide agreement that managerial and technical competencies of IT professionals are important for their career outcomes and success, our understanding of how firms value or price managerial or technical competencies of IT professionals is limited. While compensation structure of CEOs and senior executives has attracted the attention of researchers, empirical research on the determinants of IT professionals' compensation is relatively scant (Anderson, Banker and Ravindran 2000; Ang, Slaughter and Ng 2002; Talmor and Wallace 1998). Even though U.S. is the largest producer and consumer of IT related products and services and employs a substantial proportion of the global IT force, there is a paucity of research in understanding the drivers of IT professionals' compensation in the US market.

In this research, we study the determinants of compensation of IT executives across a broad spectrum of hierarchical levels for U.S. firms. We use a large dataset of information technology professionals in the U.S. to estimate returns to managerial and technical competencies in terms of total annual compensation. Besides studying the human capital determinants of compensation, we also study the institutional determinants of compensation such as firm size and industry sector. Additionally, our results inform the recent debate about value of MBA education and provide a robust assessment of the returns from an MBA degree to IT professionals. We estimate the causal effect of MBA education on the salaries of IT professionals using a matching estimator and demonstrate how bounding such a matching estimator provides an assessment of sensitivity of estimated causal effects with respect to selection due to unobservable factors.

This study extends previous research in two important ways. First, we use a nationally representative dataset of more than 55,000 IT professionals in the U.S. for the period 1999-2002 covering both senior and middle level IT executives. This is in contrast to previous studies focusing only on top executives or junior levels of IT professionals (Anderson, Banker and Ravindran 2000; Ang, Slaughter and Ng 2002; Talmor and Wallace 1998). We consider both the individual and institutional determinants of compensation of IT professionals to get realistic estimates of returns to education and experience. Second, from a methodological perspective, our analysis focuses on establishing the causal effect of human capital on compensation by considering observed and unobserved selection factors that have not been explicitly considered before. In undertaking this causal analysis, we use the insights from recent research at the confluence of econometrics and statistics and illustrate how management science researchers can use these newer techniques.

The rest of the paper continues as follows. Section 2 reviews the background literature and develops hypotheses. Sections 3 and 4 discuss the methodology and present the results. Section 5 provides concluding remarks and outlines the directions for future research.

2.0 LITERATURE REVIEW AND THEORY

Prior research has used economic and sociological theories to explain wage differentials among workers. Whereas economic theories focus on human capital endowments (Mincer 1970; Mincer 1997; Mincer and Polachek 1974) and agency relations (Anderson, Banker and Ravindran 2000; Stroh et al. 1996); sociological approaches focus on institution related factors such as institutional size, unionization, profit-orientation, and turbulence (Kalleberg and Van Buren 1996). Besides sociological and economic explanations, researchers have also proposed an extension of the core competence theory in strategic management to explain wage differentials across industry sectors. For example, based on the core competency theory, Ang, Slaughter and Ng (2002) posit more returns to IT education and IT experience in information intensive firms and industries.

Although there is copious empirical research showing returns to education and computer use, much of the empirical work is based on surveys of non-IT workers and with few references to IT professionals or the IT industry. For example, Talmor and Wallace (1998) use the ExecComp dataset to compare CEO compensation during 1992-1995 for the computer and non-computer industries. They focus largely on firm related determinants of CEO compensation because ExecComp does not contain human capital related variables for top executives. Anderson, Banker and Ravindran (2000) also use the ExecComp dataset to study the industry and firm level determinants of compensation of the top five executives of IT and non-IT U.S. firms for the 1992-96 period. Because of limitations of the ExecComp dataset, they also do not consider human capital endowments such as education or experience of executives in their compensation models.

Ang, Slaughter and Ng (2002) extend compensation research to cover junior and middle level IT professionals belonging to 39 institutions in Singapore. They consider both human capital and institutional determinants of compensation. Their study offers several insights by considering the cross level interactions among the individual and institutional factors for the first time. Both Anderson, Banker and Ravindran (2000) and Ang, Slaughter and Ng (2002) provide a good review of academic literature on the determinants of compensation and hence for brevity sake we refer the readers to these papers for additional background literature on compensation. In their concluding remarks, Ang, Slaughter and Ng (2002) observe that future research should *"…explore the effects of other human capital attributes (e.g. technical skills or managerial competencies) … in determining compensation (p. 1443)."* This study fills that gap by examining the returns to managerial and technical competencies for IT professionals in the U.S. context.

2.1 Technical and Managerial Competencies Among IT Professionals

Rapid technological changes and the need for an agile response to emerging business opportunities make it imperative for firms to better understand the appropriate bundle and composition of IT human capital. Agarwal (2001) argues that IT human capital encompasses "accumulated stock of tacit and explicit knowledge about IT that is resident not only within individuals who might typically be considered IT professionals, but also in other organizational members whose primary roles are outside the IT function (p. xiv)." While organizational members outside the typical IT function are important for success of IT projects, the focus of this study is on IT human capital represented by IT professionals' capabilities.

Although one can conceptualize multiple ways of classifying critical competencies required by IT professionals, at a broad level, such competencies comprise of two major dimensions: technical competencies and business management competencies (Bharadwaj 2000; Lee, Trauth and Farwell 1995; Nunamaker, Couger and Davis 1982; Smaltz, Agarwal and Sambamurthy 2004). Significant amount of theoretical and conceptual literature in information systems argues about the importance of IT professionals to have technical and managerial competencies for executing and enabling the IT infrastructure capability of firms (Luftman, Lewis and Oldach 1993; Ross, Beath and Goodhue 1996). Mata et al. (1995) argue that a synergistic combination of technical and managerial competencies among IT professionals of a firm has the potential to provide it with a sustained competitive advantage. Recent work by Bharadwaj (2000) and Sambamurthy et al. (2003) extends this line of reasoning and underscores the need for managing and nurturing appropriate technical and business skills of IT professionals to improve IT competence of firms for long–term success .

2.1.1 Returns to Technical Competencies

Human capital theory provides an explanation for the differences in the compensation of workers on account of their human capital endowments such as experience and education (Becker 1975; Mincer 1997). In the context of IT professionals, researchers have argued that technical competencies related to IT are essentially skill based competencies with action orientation and such competencies are acquired largely through learning by doing (Ang, Slaughter and Ng 2002; Koh et al. 2004; Tesluk and Jacobs 1998). In other words, the technical competencies of IT professionals are reflected in their on- the- job IT experience. While this line of reasoning does not deny the importance of knowledge and conceptual skills imparted in technical IT related educational programs, it suggests that the labor market may value technical competence obtained through practical work experience much more than the academic certification.

Outside the domain of IS research, the onset of IT induced growth in the economy has led some economists to argue that computer usage or computer skills were a powerful determinant of earnings in the eighties and nineties. Krueger (1993)'s seminal work deals with the issue of return on computer skills and argues that computers may have been responsible for changes in the wage structure of the economy. This work has sparked off other studies that support or argue with this reasoning (Autor, Katz and Krueger 1998; DiNardo and Pischke 1997). Krueger (1993) found that workers using computers at work earned 10 to 15 percent higher wages compared to similar workers not using computers. Although DiNardo and Pischke (1997) also report similar wage differences, they provide an alternative explanation of Krueger's findings and suggest that returns to computer usage may be driven by non-random assignment of computers to more able workers who would be paid higher wages anyway. In other words, despite a positive association between increased computer usage and higher wages, concerns remain whether returns to computer usage are a treatment effect or if they merely capture the omitted worker heterogeneity.

It is important to note that the debate on returns to computer usage has so far employed datasets of non-IT professionals such as secretaries and other office workers. Since IT professionals are the heaviest users of computers in course of their work and if computer skills are indeed the ones that are associated with higher wages, we would expect higher IT experience to be associated with higher wages. Besides the generic IT experience of an employee, IT experience at a particular firm may have an independent effect on employee productivity. This is because employees having tacit knowledge of a firm's IT infrastructure and understanding of the unique needs of customers of the firm are likely to be more productive (Josefek and Kauffman 1999). For example, knowledge of the legacy systems of a firm and how they exchange data among each other is valuable in the context of a specific employer. Previous research provides justification for the critical importance of specificity of experience at a particular firm and of these tacit skills and knowledge. Finally, since IT professionals are primarily hired for the IT or technical competence and this expertise is more likely to be valued in the IT industry (Ang, Slaughter and Ng 2002), we posit that returns to IT experience will be higher in the IT industry. Based on the above discussion, we propose the following hypotheses.

H1a: Greater technical competencies of IT professionals are associated with higher total compensation.

H1b: Greater experience at the current firm is associated with higher total compensation.

H1c: The returns to IT experience will be greater for IT professionals who work in the IT industry.

2.1.2 Returns to Managerial Competencies for IT Professionals

Whereas both technical and managerial competencies are important in their own right for a successful performance in IT jobs, research findings suggest that, over time, the relative importance of managerial competencies has increased significantly (Kakabadse and Korac-Kakabadse 2000; Lee, Trauth and Farwell 1995). Ever increasing competitive intensity is fueling the demand for executives with a good grounding in managerial competencies for applying technology in a given business context. Organizations spend more than two trillion dollars annually worldwide on business education and training with more than $ 800 billion spent in the U.S. alone (Friga, Bettis and Sullivan 2003; The Economist 2004a). Not long ago, most executives used to acquire managerial competencies over time through learning by doing. However, there is a popular belief that a management degree provides a career advantage to those who invest in acquiring managerial competencies by going through the rigor of an MBA program. The proliferation of business schools and the availability of a wide array of customized MBA programs have been successful in fulfilling the growing industry demand for MBA executives in all functional areas. MBA degrees accounted for 11% of all graduate degrees in

1971 while the comparable figure for 1997 is 23%, an increase of more than 100% over this period. In terms of absolute numbers, the U.S. alone produced more than 100,000 MBAs in 2000, compared to a figure of only 5000 in 1961. While the absolute number of MBA graduates has increased, recent controversy on the value of business education raises doubts whether monetary and time investments in MBA education are worthwhile (Pfeffer and Fong 2003).

Prior research has identified various dimensions of human capital and provided evidence in support of positive returns to higher education (Ashenfelter and Krueger 1994). With specific regard to managerial competencies, Gerhart (1990), based on his study of starting and current salaries of exempt employees hired between 1976 and 1986 by a large private firm, found that MBAs tend to earn significantly more than BA degree holders. In information systems research, a wide body of academic and practitioner literature provides support for the effect of managerial competencies among IT professionals on their career prospects. Previous research has documented the need for IT professionals to acquire management knowledge and competencies (Smaltz, Agarwal and Sambamurthy 2004). Lee, Trauth and Farwell (1995) were among early researchers to document an industry demand for IT professionals with a strong background in business. IT professionals recognize the need for complementing their technical skills with an understanding of various business functions and processes and many do come back to business schools for getting an MBA degree to fill gaps in their business knowledge. Bharadwaj (2000) argues that managerial competencies are important in coordinating the multifaceted activities associated with successful implementation of IT systems and for integration of IT and business planning. Ferratt and Agarwal (1996) reviewed the literature on the effectiveness of management education and development programs in the context of IT professionals and concluded that longer management development programs are more effective than short duration management development programs. Based on this line of argument and consistent with previous research, we posit that IT professionals with business degree are likely to be more valuable for firms and firms are therefore likely to reward such professionals in the form of higher compensation.

H2: A Business degree has higher returns compared to any other master level degree.

2.2 Importance of Institutional Context in Determining Compensation

Economic and sociological theories acknowledge the role of institutional context as a determinant of worker compensation. Bartel and Lichtenberg (1987), based on their industry level study, show that the relative demand for educated workers declines as the age of plant and equipment increases. They advance two reasons for such a finding about the importance of educated workers in technology environments. First, the degree of uncertainty declines as the experience with a technology increases. Thus, in the early stages, when technological uncertainties are high, firms tend to hire more educated workers. Second, there are intrinsic differences among highly educated versus less educated workers in how they handle their job and the speed with which they learn and such differences can be particularly critical in uncertain environments. In the context of IT industry, since firms in the IT industry are more likely to employ newer technologies and plants, they need a higher proportion of technical and educated employees in their workforce. In addition, because of scarce supply of technical and highly educated employees particularly during the growth phase of an industry, higher industry demand is likely to result in higher wages offered to such professionals. Finally, since IT industry requires executives with an understanding of the strategic role of IT, IT professionals are more likely to be valued by firms in the IT industry. As such, we expect that compensation for IT executives in the IT industry will be higher than that prevailing in non-IT industries. Likewise, IT executives at the dotcom firms are also likely to have higher compensation compared to traditional firms because dotcom firms face significant uncertainty in their business processes and IT has a strategic role in most dotcom firms. Thus,

H3a: IT professionals in the IT industry have higher levels of total compensation than the executives in non-IT industry.

H3b: IT professionals in dotcom firms will have higher levels of total compensation than the executives in non-dotcom firms.

While economic theories explain part of the institutional differences in compensation, neoinstitutional theories provide a complementary perspective on such institutional differences. Instead of attributing compensation differences to economic factors, neoinstitutional theories explain labor market segmentation on the basis of profit orientation (Gerhart and Milkovich 1990) and institution size (Kalleberg and Van Buren 1996). With specific reference to profit orientation, empirical evidence indicates lower salaries in the non-profit sectors compared to the for-profit sectors of the economy (Preston 1989; Roomkin and Weisbrod 1999). Researchers have advanced three explanations for such differences in compensation: greater institutional rigidity in non-profit sectors, donation of labor by employees recognizing the lower ability of non-profits to compensate their employees to the extent for-profit firms can and non-monetary considerations such as less stressful and more flexible work environment offered by non-profits (Handy and Katz 1998; Pfeffer and Baron 1988; Ruhm and Borkoski 2000). In addition, the role of IT in the non-profit sector is often viewed as a support function as opposed to a strategic role in the for-profit sector. Based on these arguments, we posit that IT professionals working in non-profit and government sectors will have lower levels of salary compared to IT professionals in for-profit sectors.

H3c: IT professionals will have lower levels of total compensation in non-profit firms compared to IT executives in for-profit firms.

Besides the above focal variables, we identify and control for other relevant variables in our models of compensation for IT executives: gender, age, number of hours worked, occupational title of the respondent and region, and institution size.

3.0 RESEARCH DESIGN AND METHODOLOGY

The U.S. is the largest producer of IT related products in the world and is the biggest labor market for IT professionals. The data used in this study comes from four National Surveys for the period 1999-2002 conducted by Information Week, a leading and widely circulated IT publication in the U.S. Information Week is a reliable source of information, and previous academic studies have used data from Information Week surveys (Bharadwaj, Bharadwaj and Konsynski 1999; Rai, Patnayakuni and Patnayakuni 1997; Santhanam and Hartono 2003). The salary surveys during 1999-2002 covered more than 55000 IT professionals of age 18-70. The salary surveys contain information on total compensation of respondents, demographics of respondents, human capital related variables, and institutional variables. We used similar and comparable questions across the years to construct the variables used in this study.

3.1 Variable Definition

Dependent Variable

Total Compensation (totcompcy99): We measure total compensation of IT professionals by adding their base pay, bonus and stock options. We converted the nominal dollar value of compensation in each year to 1999 dollars by deflating salary figures for 1999 through 2002 using annual CPI for urban consumers computed by the Bureau of Labor Statistics (BLS).

Independent Variables

Age of the respondent was measured in number of years.

A set of dummy variables measure the highest educational degree of the respondent: *edubach* denotes the Bachelor's degree, *edumaster* denotes a Master's degree other than an MBA, *edusomecoll* denotes some college education, and *eduphd* denotes the PhD degree.

Managerial competency of a respondent is measured by whether he or she has an MBA degree or not (*edumba*=1 if respondent has MBA degree, 0 otherwise).

Technical competency is measured by a respondent's IT experience (*itexp*) in number of years.

Tenure at the current firm (*currcoexp*) is measured in number of years.

The variable *male* indicates the gender of the respondent (male=1, female=0).

Organization size (*empno*) is a bracketed variable indicating a range for the number of employees in the respondent's firm (1=less than 100, 2=101-1000, 3=1001-10000, 4= more than 10000).

A set of dummy variables are used to denote a respondent's industry sector: *npg* is 1 for non-profits and governmental organizations and 0 otherwise, *itind* is 1 for IT vendors and service providers including telecommunications and 0 otherwise, *dotcom* is a dichotomous dummy variable coded as 1 if the respondent works with a dotcom type of firm and 0 otherwise.

Hours Worked (*hrsperwkcy*) measures the average number of hours per week put in by the respondent.

In our analyses, we controlled for the year of the surveys by putting dummies for each year of the salary survey (*d2000, d2001, d2002*) excluding the year 1999 to avoid a singular matrix. We also used dummies for the region (at the level of U.S. state) and job titles to check the robustness of our results as we report in our sensitivity analyses.

Table 1 provides descriptive statistics for the variables used in this study. IT professionals in our surveys have about 13 years of IT experience, 85% are male, 45% have Bachelor's degree, 6.5% have MBA degrees, 13% have Master's degree, 1.6% have a PhD degree.

---Insert Table 1 about here---

3.2 Empirical Models

We begin by specifying a standard cross-sectional earnings model to include a dummy variable (say M) indicating whether an individual has an MBA degree. Let X and Z represent a vector of observed characteristics associated with the respondent and the institutional context respectively, and let W represent the annual salary of the respondent. Consistent with previous research, we use the following log-linear specification for estimating our models,

$$\ln W_i = M_i \alpha + X_i \beta + Z_i \gamma + + \varepsilon_i \quad (1)$$

where α, β, and γ are the parameters to be estimated and ε is the error term associated with observation i.

4.0 RESULTS AND DISCUSSION

Table 2 reports the results of fitting equation (1) by OLS with varying set of covariates X and Z. As shown in Table 2, the explanatory power of our models is reasonable as reflected by the overall R squared values. For all the regression models shown in Table 2, we performed several diagnostic checks to ascertain the stability of our results. We tested for multi-collinearity by computing variance inflation factors (VIF) (Belsley, Kuh and Welsch 1980). The highest VIF in our models was lower than the threshold specified in literature, indicating that multi-collinearity is not a serious concern in our analysis. We also calculated Hat values to check for leverage and studentized residuals to detect outlying cases. Our analysis of measures of influence (DFbetas and Cook's distance) did not suggest a presence of influential observations in our sample.

We next discuss the results of the models shown in Table 2.

---Insert Table 2 about here---

4.1 Results: Returns to Managerial Competencies

In column (1) of Table 2, variables representing education dummies such as MBA, Master, and Bachelor's degrees are entered with year dummies. The coefficient of MBA provides a naïve assessment (without controlling for any differences in human capital or institutional setting attributes) of the compensation difference between IT professionals with an MBA degree and the reference group of IT professionals with a high school degree (the high school category includes associate degree holders or professionals with any IT trade related training after high school). Instead of comparing with a reference group of high school graduates, a more meaningful comparison of MBA professional's salary might be with respect to an executive with an equivalent Master' degree. Hence, we calculate the MBA wage premium by calculating the difference in coefficients of MBA and Master and obtain an estimate of wage differential due to having an MBA degree of the magnitude of 22.1 percent [100*exp (0.49)-100*exp (0.35)].

Results in column (2) of Table 2 show returns to an MBA education when we include several covariates relating to human capital endowments and respondent demographics in the regression equation. Predictably, including these covariates reduces the MBA wage premium compared to an equivalent Master's degree from 22.1 percent to 16.3 percent. After including institution related covariates shown in the wage regression in column (3) of Table 2, the MBA premium reduces to about 14.6 percent. This wage premium is quite close to the Connolly's (2003) estimate of 13.8 percent return on MBA education based on a comparison of before and after MBA salaries.

A potential caveat in the above finding is that the model in column (3) does not include dummies for the job titles. However, it may be argued that an MBA degree may enable IT professionals to qualify for better paying jobs at higher levels and therefore including dummies for job titles in wage regressions may underestimate the true returns to MBA degree. Nonetheless, we check the sensitivity of our results by including such controls. After including the dummies for job titles in the model shown in column (4), we still obtain a sizable pay premium for MBAs of about 8.2 percent. We go a step further and in column (5), we control for the location of IT professionals by entering state dummies and despite specifying such an extensive model, the MBA wage premium remains largely unchanged at 8.2 percent. In order to provide an easy interpretation of our results in dollar terms, we also estimate wage regression in column 6 of Table 2 with total compensation (1999 dollars) as the dependent variable. The results in column 6 indicate that MBAs earn approximately 7000 dollars more than a Master's degree holder.

While the above models were estimated with an extensive set of human capital covariates such as age, education and experience, one can't rule out the possibility of unobserved heterogeneity. After all, returns on an MBA degree may vary depending on the innate ability of students and the type of school one graduates from (Jaschik 2004). One way to account for potential heterogeneity is to include proxy measures for ability in the above regression models. Researchers have used parental background, grades or achievement scores as indicators of ability. In this study, for our sensitivity analysis, we use a variable that provides a labor market assessment of employees' ability. If IT professionals are valued by the labor market, then the headhunter contact in the previous six months should provide an indication of the ability of employees. We find that even after controlling for the frequency of headhunter contacts in the last six months, the estimates of returns on MBA remain essentially the same at about 8.4 percent (model not shown). This sensitivity analysis provides an indication of the robustness of returns on MBA estimated earlier.

In our analyses so far, we have compared the salary of an IT professional with an MBA degree to the salary of an IT professional with an equivalent Master's degree to provide a conservative estimate of wage premiums associated with an MBA. An alternative comparison group for IT professionals with an MBA may be a Bachelor's degree holder with two more years of experience. Such a comparison based on results in column 5 indicates that having an MBA degree provides 11.2 percent more salary compared to having a Bachelor's degree with two extra years of IT experience.

4.2 Returns to IT Experience and Firm Tenure

The results in Table 2 (column 5) also show that one extra year of IT experience is associated with an increase of 1.4 percent in total compensation. This return of 1.4 percent on IT experience provides a convenient benchmark to compare the returns on MBA education of about 8.2 percent in column 5 of Table 2. While two years of IT experience give a salary advantage of 2.8 percent, spending these two years in acquiring an MBA degree are associated with a salary advantage of about three times of that i.e. 8.2 percent. Even though we have not factored the direct costs of doing an MBA, such as tuition and other expenses in our calculations, the substantial difference in returns on an MBA degree vis-à-vis two extra years of IT experience provides a favorable assessment of the benefits of having an MBA degree. Our findings indicate that, labor market values IT professionals with an MBA degree much more than an IT professional without an MBA degree but with two extra years of IT experience.

We next compare the returns to IT experience in our dataset with those reported in previous research based on American and German data of non-IT office workers in the late 80s and early 90s. Following DiNardo and Pischke (1997), we interpret the coefficient of IT experience as a treatment effect for one extra year of computer skills and knowledge controlling for all other background variables. We find that our calculated return of 1.4 percent is much lower than the ones estimated by Krueger (1993) of about 15-20 percent based on American data for the period 1984-1989 and comparable but somewhat lower returns estimated by DiNardo and Pischke (1997) based on German data for the periods 1979, 1985-86 and 1991-1992. Besides differences in sample composition, one potential explanation for such a large difference in returns about a decade later may be that since 1992, computer skills may have become more readily available leading to a decline in returns from such skills.

In contrast to IT experience, job experience at the current firm (after controlling for total IT experience) does not seem to have an incremental value towards compensation. This suggests that firms do not put a monetary value on employee investments in firm specific experience. This result is consistent with a widely prevalent notion that job hopping is necessary for salary growth and may explain the high turnover of IT professionals (Chabrow 2004; Shachtman 2000). If their current firm does not place a value on the firm specific experience, IT professionals have a good reason to switch to other employers. This result is also consistent with findings of Stroh et al. (1996) who do not find returns to experience in terms of variable pay. However, this findings does raise some theoretical issues because much of the literature argues about the importance of firm specific IT skills in tailoring IT systems to a company's specific needs and views firm specific IT skills as an important component of the IT capability of firms (Bharadwaj 2000; Bharadwaj, Sambamurthy and Zmud 2002; Mata, Fuerst and Barney 1995).

There may be two explanations for our finding of no returns from tenure at a current firm. First, although firms understand the need for encouraging employees to invest in firm specific IT competence, they may not have aligned their compensation strategy with their IT strategy (Prahalad and Krishnan 2002). Second, in contrast with the academic belief about the role and importance of firm specific IT skills, firms themselves place a low value on such specific skills and there may be a need for modifying our theoretical frameworks to incorporate this empirical reality. There is a need for future research to unravel these alternative explanations.

4.3 Effect of Institutional Setting on Compensation

As regards the effect of employer characteristics on compensation of employees, we find that firms in the IT industry pay 9.4 percent more wages to their employees than non-IT firms. Our results are consistent with Gibbons and Katz (1992) and Bartel and Sicherman (1999) in that they also found evidence of an industry wage premium after controlling for human capital variables. However, in contrast, Anderson, Banker and Ravindran (2000) reported that after controlling for performance and other factors, the average level of pay for top five executives in the IT industry were not higher than in other industries. One reason for a difference in these findings may be due to differences in the occupation levels of executives. While we focus on IT professionals at middle and senior levels in our study, Anderson et al. focus on top five executives who may have much greater mobility across industry sectors. One would expect that any pay differentials in the salaries of top executives will be arbitraged away over a period of time in an economy as developed as that of the U.S. However, this may not be true for IT professionals in our sample because of the shortage of IT professionals in the economy between 1999 to 2001 and a rising demand for professionals in the IT industry associated with the stock market power of firms in IT and related industries allowed them to pay substantial premiums to their IT professionals to retain them.

An interesting finding of our study is that similar to IT firms, dotcom firms pay significantly higher wages (9.6 percent more) to their employees compared to traditional brick and mortar firms. This pattern of ‘abnormal’ salaries in dotcom firms is reminiscent of the phenomenon of the dotcom effect with respect to abnormal stock market returns reported by Subramani and Walden (2001). Consistent with previous studies, we also find that IT employees in the non-profit and governmental sector earn less salary compared to their counterparts in for-profit sectors of the U.S. economy.

4.4 Gender Inequality in Compensation

Our findings also indicate that female IT professionals earn about 7.8 percent less than men even after controlling for age, job level, education, work experience and other institutional factors. Although this finding is consistent with the results reported by Truman and Baroudi (1994) based on 1989-93 data, it is disconcerting to note that apparent wage differential due to gender has not decreased with passage of time. While our study does not establish that wage differentials among male and female IT professionals are on account of systematic gender discrimination by employers, persistent gaps in salaries attributable to gender in this study as well as in previous studies should serve as a wake up call for understanding the determinants of salary gulf between males and females. Several lawsuits, and many of them in the information intensive sectors such as financial services, involving millions of dollars of settlement illustrate the prevalence of inequalities in pay, promotions, hiring and training based on race, age and gender (The Economist 2004b). These cases point to the need for continual re-examination of success of the Equal Pay Act of 1963 and the Civil Rights Act of 1964 to assess the fairness of human resource management practices of large corporations. Our results point to the need for senior managers to take a critical look at their human resource policies in managing their IT professionals to assess the reasons for such wage inequalities because left unchecked, these inequalities not only vitiate the work place environment, they also expose corporations to avoidable lawsuits, bad publicity and punitive damages. In particular, there is a need for future research to examine the reasons for systematic wage gaps among males and females in the IT departments.

The other variables in Table 2 also provide useful insights. For example, coefficients of year dummies indicate that, after controlling for human capital and institutional factors, salaries of IT professionals continued to grow in real terms in the 1999-2002 period. It is interesting to find that on average, IT professionals with a PhD earn more than those with an MBA or Master’s degree and this provides further evidence in support of returns to education. Likewise, the coefficient of hours of work per week in our models indicates more pay associated with more hours of work put in by IT professionals.

4.5 An Alternative Estimate of Returns to MBA Education Using a Causal Framework

While the preceding econometric analysis provides support for the hypothesized effect of an MBA degree on the salary of IT professionals, the nature of observational data raises concerns about the causal interpretation of our findings. Do returns to MBA degree reflect an estimate treatment effect or do they merely capture the omitted worker heterogeneity? Can we attribute the salary differences between MBA and non-MBA IT professionals to MBA degree alone? In other words, assessing the benefits of a treatment like an MBA degree is difficult because we do not observe the performance of MBAs had they not acquired the degree and vice versa.

Selection bias due to correlation between *observed* characteristics of a subject and the subject's treatment status can be addressed by a matching technique. We use a matching estimator based on a propensity score to calculate the treatment effect. We also demonstrate use of a procedure suggested by Rosenbaum (1995) to bound the matching estimator to evaluate the uncertainty of the estimated treatment effect due to selection on *unobservables*. We calculate the lower and upper bounds for different values of unobserved selection bias for the test statistics under the null hypothesis of a no treatment effect.

We begin by assuming that selection on unobservables is ignorable i.e. we assume that selection bias is only due to correlation between observed subject characteristics and a subject's treatment status where treatment here refers to presence or absence of an MBA degree. Table 3 provides descriptive statistics for the profiles of IT professionals with MBA degrees versus those in a comparison group without MBA degrees. Rows 1a through 10a in Table 3 show that compared to non-MBA professionals, MBAs are older with greater IT and firm experience, more likely to work longer hours and with larger firms and less likely to work in non-profit and government sectors. Arguably, these observed characteristics may be related to a subject's propensity to acquire an MBA degree.

---Insert Table 3 about here---

We, therefore, estimate a logit model for selection into MBA status using all observed characteristics of a respondent as covariates in the selection equation. The chi-squared test in the selection model is significant compared to a model with no explanatory variables[1]. Thus, IT professionals with an MBA differ significantly from those not having an MBA degree with respect to observable characteristics. We, thus, reject the hypothesis of random assignment of MBA status among IT professionals. Favorable characteristics like ability to put in longer hours and greater IT experience significantly increase the probability of one's acquiring an MBA degree because such professionals may benefit more from acquiring an MBA degree or such professionals may have better awareness of the potential benefits from an MBA given their profile and experience. In either case, the analysis thus far seems consistent with the hypothesis of self-selection by professionals into MBA status based on their expectation of higher perceived benefits from an MBA education.

4.5.1 Returns to MBA Assuming Selection on *Observable* Characteristics

The propensity score defined as $\pi_i(x_i)=Pr(D_i=1|x_i)$, is the conditional probability that a subject with X=x will be in the treatment group. In this research, we have calculated the propensity score based on the logit model reported earlier. Based on these propensity scores, we plotted the distribution of treatment and control subjects in our sample (Figure not shown due to space constraints). In an experimental study, one would have an approximately equal number of treatment and control subjects in each group. However, as is common in other observational studies, we observe that subjects in treatment (i.e. MBAs) are over represented in groups with higher probability of obtaining an MBA degree and that control (or non-MBA) subjects are over represented in groups with lower probabilities of obtaining an MBA degree. This is not surprising

[1] Results of sensitivity analysis not shown due to space constraints but are available from authors on request.

given that the logit model is successful in explaining the observed selection into the treatment (i.e. MBA) group.

The matching technique tries to distribute the mean value of x equally between MBA and non-MBA subjects, so the estimated treatment effect has no bias due to mean x. Table 3 shows the reduction in bias achieved through matching on x. The mean x after matching on observed x in Table 3 (see Rows 1b through 10b) is much closer among treatment and control groups compared to that before matching.

Panel A in Table 4 shows the difference in mean performance outcomes for MBA and non-MBA subjects. This is the effect given that we have taken into account selection bias due to a correlation between observed variables (used in the selection equation) and the treatment variable. The overall treatment effect is positive and significantly different from zero for total compensation. After matching on the propensity score and thereby adjusting for the observed characteristics, we find that the average MBA effect is $ 20988 in 1999 dollars (see ATT in Panel A of Table 4). This estimate is slightly higher than the salary difference between MBA and High School of $19122 (1999 dollars) found using regression analysis (see column 6 of Table 2) but much lower than the $ 27181 difference (refer Panel A of Table 4) in the unadjusted average total compensation between MBA and non-MBA subjects.

---Insert Table 4 about here---

4.5.2 Returns to MBA Assuming Selection on *Unobservable* Characteristics

The analysis in the previous section assumed that treatment and control groups are different because they differ on the *observed* variables in the data set. However, once we account for the observed variables by calculating propensity score, potential outcome is independent of the treatment assignment. More formally, this is equivalent to assuming that $(y_1, y_0) \perp d|x$ where d denotes treatment status and $\perp$ denotes independence (Dehejia 1999). If treatment and control groups differ on *unobserved* measures, a positive association between treatment status and performance outcome would not necessarily represent a causal effect. Given that we have already accounted for selection bias due to *observed characteristics*, sensitivity analysis provides an assessment of robustness of treatment effects due to factors not observed in the data. Since it is not possible to estimate the magnitude of selection bias due to unobservable factors with non-experimental data, we calculate the upper and lower bounds on the test statistics used to test the null hypothesis of the no treatment effect for different values of unobserved selection bias (Rosenbaum 1995).

Assume that the probability of selection into the treatment group is given by the following model:

$$\pi_i (x_i)=\Pr(D_i =1|x_i)= F (\beta x_i+\gamma u_i) \quad (3)$$

where x_i is the observed vector of background variables for subject i, u_i is an unobserved variable, and γ is the effect of u_i on the probability of participating in a treatment. If we assume that F is the logistic distribution, the odds that a subject is in the treatment group can be written as:

$$\pi_i /(1- \pi_i)=\exp (\beta x_i+\gamma u_i) \quad (4)$$

Comparing two subjects within a stratum, with common support and equal distribution of x, the odds ratio (relative odds) of receiving the treatment (after some simplification) may be written as:

$$[\pi_i /(1- \pi_i)]/ [\pi_j /(1- \pi_j)]=\exp [\gamma (u_i–u_j)] \quad (5)$$

where i and j are two different subjects within a stratum. The x vector cancels out assuming that it is equally distributed for all subjects within each stratum. Assuming that unobserved variable u is a binary variable, we can rewrite the above equation as:

$$1/ \Gamma \leq [\pi_i /(1- \pi_i)]/ [\pi_j /(1- \pi_j)] \leq \Gamma \quad (6)$$

where $\Gamma= \exp(\gamma)$. If unobserved variables have no effect on the probability of getting into the treatment group (i.e. $\gamma=0$) or if there are no differences in unobserved variables [i.e. $(u_i–u_j)=0$] then there is no unobserved selection bias and the odds ratio will be exp(0)=1. In that case, controlling for observed selection would produce an unbiased estimate of the treatment effect. In contrast, a value of $\exp(\gamma)=2$ implies that two subjects who appear similar on the x vector differ in their relative odds of participation by a factor of two. In the sensitivity analysis, we evaluate how inferences about the treatment effect will be altered by changing the values of γ and (u_i-u_j). If changes in the neighborhood of $\exp(\gamma)=1$ change the inference about the treatment effect, then the estimated treatment effects are said to be sensitive to unobserved selection bias. However, if a large value of $\exp(\gamma)$ does not alter inferences about the treatment effect, the study is not sensitive to selection bias. Note that sensitivity analysis does not indicate whether biases are present or what their magnitudes are. It only informs us about the magnitude of biases that, if present, might alter our inference.

Panel B of Table 4 provides the p-values from Wilcoxon sign-rank tests for the average treatment effect on treated (ATT) while setting different values of $\exp(\gamma)$. At each $\exp(\gamma)$, we calculate a hypothetical significance level 'p-critical' which represents the bound on the significance level of the treatment effect in the case of endogenous self-selection into treatment status. Table 4 shows that the total compensation of IT professionals is sensitive to unobserved selection bias if we allow treatment and controls to differ as much as 250 percent in terms of unobserved characteristics which must be considered a very large difference given that we have already adjusted for several key observed background characteristics in our selection model. If subjects with a high value of u are over represented in the treatment group, then the estimated treatment effect of $20988 in total compensation overestimates the true treatment effect. If those who have a low value of u are over represented in the treatment group, then the estimated treatment effect of $20988 underestimates the true treatment effect and the true treatment effect is highly significant. It is important to realize here that the analyses presented here represent the worst-case scenario. The confidence intervals for the effect of an MBA on total compensation will include zero only if (1) an unobserved variable caused the odds ratio of treatment assignment to differ between treatment and control groups by 2.5, and (2) the effect of this unobserved variable was so strong as to perfectly determine the effect attributed to the treatment for the treatment or control case in each pair of matched cases in the data. If confounding variable had a strong effect on treatment assignment but only a weak effect on the outcome variable, then the confidence interval for the outcome such as total compensation will not contain zero.

5. CONCLUSION

In this study, we examined the effect of managerial and technical competencies on the salaries of IT professionals. Based on a large nationally representative dataset of IT professionals in the U.S. for the period 1999-2002, we find that both business and technical competencies have a significant effect on the salaries of IT professionals. In contrast with findings of a previous study of the top five executives of IT versus non-IT industries (Anderson, Banker and Ravindran 2000), we find that the IT industry pays a significant amount of premium to IT professionals at all levels of the hierarchical spectrum. On the other hand, IT professionals in non-profit and governmental sectors receive less compensation compared to their counterparts in for-profit sectors of the economy. Similar to the dotcom effect in abnormal returns reported by Subramani and Walden (2001), we also observe a pronounced dotcom effect in the salaries of IT professionals during the 1999-2002 period. This study finds evidence of wage inequalities on the basis of gender.

This study makes several important contributions. Ours is the first study of the compensation of IT professionals across a hierarchical spectrum in the U.S. This study complements other studies that have examined compensation of top executives in IT industries in the U.S. (Anderson, Banker and Ravindran 2000; Talmor and Wallace 1998) and compensation of non-managerial IT professionals in Singapore (Ang, Slaughter and Ng 2002). Together, these studies provide a complementary perspective on compensation practices relating to IT professionals and the IT industry. Second, from a methodological perspective, our analysis uses recent econometric and statistical advances that use matching techniques to estimate causal effects and demonstrate how bounding a matching estimator provides an assessment of estimated causal effects due to selection on unobservable factors. We believe that this approach provides a robust method for assessing the sensitivity of causal interpretation of research findings and is a useful tool with many potential applications in research involving management science. By illustrating the use of this emerging technique in the context of our substantive questions, we hope to have provided a template for future applications of this technique. Third, our analysis provides a robust assessment of returns to management education for IT professionals. This contribution is especially significant in light of the ongoing controversy on whether having a management education has an impact on the salaries of executives (Connolly 2003; Pfeffer and Fong 2002; Pfeffer and Fong 2003).

While this study contributes to a better understanding of compensation of IT professionals in general and in the U.S. context in particular, we identify several promising areas for future research in this stream of literature. These may overcome some of the limitations of this study. First, this study focused on the effect of managerial and technical competencies on the total compensation of IT professionals in the U.S. It would be interesting to extend this research to uncover the determinants of various individual elements of compensation such as bonus, stock options, and fringe benefits and how these elements in turn have an influence on overall job satisfaction and retention of employees. Second, in order to achieve generalizability, this study relied on an archival data of a large cross-section of IT professionals in the U.S. A useful extension of this research may be to do a panel study of a smaller group of IT professionals to study the evolution of managerial and IT competencies and how such evolution affects their compensation and other career outcomes such as promotions and annual raises. Such a panel study may also try to uncover the perceptual dimensions of discrimination, if any, on the basis of race, gender or age and the underlying reasons for them. While our study provides evidence on wage inequality, attributing such wage inequalities to discrimination requires much harder evidence. Besides, the full extent of discrimination may not reflect in wages or promotions and as such, perceptions of executives need to be studied to influence managerial policies relating to this important issue. Third, there is an opportunity to undertake a cross-national study of compensation of IT professionals to uncover reasons for apparent differences in compensation practices. As a start, there is a need for collaborative research by pooling the data of individual studies on a common set of variables and employing multiple level hierarchical analysis to uncover national or cultural determinants of compensation such as the relative importance of human capital and status (or job title) related factors. Finally, future research should explore other determinants of career success such as innovativeness and the customer orientation of IT professionals (Chabrow 2002; Murphy 2004), competencies that are becoming increasingly critical for competitive success.

Table 1: Descriptive Statistics and Correlations (N=55162)

	Variable	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	lntotcompcy99	11	0.45	0	16	1.00																	
2	eduphd	0.016	0.13	0	1	0.08	1.00																
3	edumba	0.065	0.25	0	1	0.17	-0.03	1.00															
4	edumaster	0.13	0.34	0	1	0.13	-0.05	-0.10	1.00														
5	edubach	0.45	0.5	0	1	0.05	-0.11	-0.24	-0.35	1.00													
6	edusomecoll	0.16	0.37	0	1	-0.11	-0.06	-0.11	-0.17	-0.39	1.00												
7	d2000	0.29	0.45	0	1	0.06	0.01	0.00	0.00	0.00	0.01	1.00											
8	d2001	0.14	0.35	0	1	0.00	0.01	0.00	-0.01	0.00	0.00	-0.26	1.00										
9	d2002	0.24	0.43	0	1.00	0.01	0.00	0.02	0.02	0.00	-0.01	-0.36	-0.23	1									
10	itexp	13	8.3	0	45	0.38	0.03	0.06	0.05	-0.04	-0.01	-0.01	-0.01	0.08	1.00								
11	currcoexp	6.5	6.8	0	50	0.09	0.02	0.02	0.01	-0.01	-0.01	-0.01	-0.03	0.06	0.38	1.00							
12	hrsperwkcy	48	7.4	35	90	0.27	0.03	0.05	0.02	-0.03	0.02	-0.01	-0.02	-0.01	0.08	-0.02	1.00						
13	age	40	9.1	18	70	0.23	0.10	0.07	0.12	-0.09	-0.04	-0.01	-0.01	0.09	0.66	0.42	0.03	1.00					
14	male	0.85	0.35	0	1	0.10	0.02	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.04	-0.04	0.06	-0.02	1.00				
15	empno	2.7	1	1	4	0.18	-0.01	0.07	0.04	0.03	-0.06	0.01	0.00	0.00	0.14	0.20	-0.04	0.10	0.00	1.00			
16	npg	0.12	0.32	0	1	-0.13	0.01	-0.04	0.02	-0.02	0.00	-0.01	-0.01	0.00	0.06	0.11	-0.11	0.13	-0.04	-0.04	1.00		
17	itind	0.22	0.41	0	1	0.16	-0.01	0.00	0.03	0.02	-0.01	0.07	0.02	-0.04	-0.04	-0.12	0.07	-0.10	0.04	-0.03	-0.19	1.00	
18	dotcomint	0.058	0.23	0	1	0.07	0.02	-0.01	0.01	0.00	0.01	0.00	0.03	-0.05	-0.07	-0.12	0.09	-0.09	0.01	-0.17	-0.07	0.20	1
19	itind_itexp	2.6	6.2	0	45	0.24	0.01	0.02	0.04	-0.01	-0.01	0.05	0.01	0.00	0.24	0.00	0.09	0.11	0.05	0.02	-0.15	0.80	0.12

Table 2: Parameter Estimates For Effect of MBA Education on Total Compensation of IT Professionals for 1999-2002 Period

Dependent Variable	Natural Log of Total Compensation (1999 Dollars)					Total Compensation (1999 Dollars)
	(1)	(2)	(3)	(4)	(5)	(6)
eduphd	0.478*** (0.000)	0.409*** (0.000)	0.396*** (0.000)	0.284*** (0.000)	0.258*** (0.000)	28,568.066*** (0.000)
edumba	0.491*** (0.000)	0.421*** (0.000)	0.388*** (0.000)	0.257*** (0.000)	0.244*** (0.000)	19,122.263*** (0.000)
edumaster	0.346*** (0.000)	0.307*** (0.000)	0.283*** (0.000)	0.192*** (0.000)	0.177*** (0.000)	12,229.183*** (0.000)
edubach	0.220*** (0.000)	0.211*** (0.000)	0.194*** (0.000)	0.133*** (0.000)	0.128*** (0.000)	8,273.833*** (0.000)
edusomecoll	0.082*** (0.000)	0.062*** (0.000)	0.058*** (0.000)	0.047*** (0.000)	0.042*** (0.000)	1,328.562 (0.151)
d2000	0.075*** (0.000)	0.075*** (0.000)	0.063*** (0.000)	0.059*** (0.000)	0.052*** (0.000)	8,770.391*** (0.000)
d2001	0.035*** (0.000)	0.035*** (0.000)	0.026*** (0.000)	0.024*** (0.000)	0.015*** (0.001)	1,479.066* (0.086)
d2002	0.038*** (0.000)	0.016*** (0.000)	0.017*** (0.000)	0.013*** (0.001)	0.007* (0.075)	1,650.766** (0.024)
itexp		0.021*** (0.000)	0.019*** (0.000)	0.013*** (0.000)	0.014*** (0.000)	1,002.360*** (0.000)
currcoexp		-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-312.082*** (0.000)
hrsperwkcy		0.014*** (0.000)	0.013*** (0.000)	0.006*** (0.000)	0.006*** (0.000)	698.408*** (0.000)
age		-0.002*** (0.000)	-0.001*** (0.000)	-0.001*** (0.001)	-0.001*** (0.000)	-133.472*** (0.002)
male		0.085*** (0.000)	0.077*** (0.000)	0.072*** (0.000)	0.075*** (0.000)	4,950.220*** (0.000)
empno			0.053*** (0.000)	0.076*** (0.000)	0.074*** (0.000)	5,420.568*** (0.000)
npg			-0.119*** (0.000)	-0.098*** (0.000)	-0.101*** (0.000)	-8,249.705*** (0.000)
itind			0.099*** (0.000)	0.104*** (0.000)	0.090*** (0.000)	1,680.449 (0.166)
dotcomint			0.119*** (0.000)	0.110*** (0.000)	0.092*** (0.000)	16,717.238*** (0.000)
itind_itexp (Interaction term)			0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	689.011*** (0.000)
Occupational Dummies			No	Yes	Yes	Yes
State Dummies			No	No	Yes	Yes
Constant	10.912*** (0.000)	10.047*** (0.000)	9.917*** (0.000)	10.193*** (0.000)	9.893*** (0.000)	-23,593.958** (0.012)
Observations	55162	55162	55162	55162	55162	55162
R-squared	0.099	0.285	0.326	0.447	0.487	0.166

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Bias reduction due to Matching

	Variable	Sample	Mean Treated	Mean Control
1a	itexp	Unmatched	14.57	12.40
1b		Matched	14.57	13.29
2a	currcoexp	Unmatched	6.93	6.45
2b		Matched	6.93	6.69
3a	hrsperwkcy	Unmatched	49.55	48.15
3b		Matched	49.55	48.72
4a	age	Unmatched	41.93	39.53
4b		Matched	41.93	40.50
5a	male	Unmatched	0.85	0.85
5b		Matched	0.85	0.85
6a	empno	Unmatched	2.95	2.65
6b		Matched	2.95	2.77
7a	npg	Unmatched	0.08	0.12
7b		Matched	0.08	0.10
8a	itind	Unmatched	0.21	0.22
8b		Matched	0.21	0.21
9a	dotcomint	Unmatched	0.05	0.06
9b		Matched	0.05	0.06
10a	itind_itexp (Interaction term)	Unmatched	3.01	2.54
10b		Matched	3.01	2.74

Note: Unmatched rows show raw summary statistics before matching each treated subject with a counterfactual control subject using kernel matching.

Table 4. Estimating the Returns to MBA Using a Matching Estimator

Panel A: Overall Treatment Effect on Treated

Variable	Sample	Treated	Controls	Difference
Total Compensation in 1999 Dollars	Unmatched	103035	75854	27181
	ATT[1]	103035	82047	20988

Panel B: Sensitivity[2] Analysis for Effect of MBA on Compensation

Gamma	Significance Level
1	0.000
1.25	0.000
1.5	0.000
1.75	0.000
2	0.000
2.25	0.000
2.5	0.184

Notes: [1]Kernel matching using Gaussian Kernel. Out of 55162 IT employees, only 55041 had common support. We lose 121 observations during matching because one of the U.S. states in our dataset did not have any IT professional with an MBA degree. Among these 55041 professionals, 3586 had an MBA degree while 51455 did not have an MBA degree.

[2]Sensitivity analysis is done for ATT (average treatment effect on treated i.e. on IT professionals with MBA degree).

References

Agarwal, R. "Editor's Comments," *MIS Quarterly* (25:4) 2001, pp xiv-xv.

Anderson, M.C., Banker, R.D., and Ravindran, S. "Executive compensation in the Information Technology industry," *Management Science* (46:4) 2000, pp 530-547.

Ang, S., Slaughter, S.A., and Ng, K.Y. "Human Capital and Institutional Determinants of Information Technology Compensation: Modeling Multilevel and Cross-Level Interactions," *Management Science* (48:11) 2002, pp 1427-1445.

Autor, D.H., Katz, L.F., and Krueger, A.B. "Computing inequality: Have computers changed the labor market?," *Quarterly Journal of Economics* (113:4) 1998, pp 1169-1213.

Bartel, A.P., and Lichtenberg, F.R. "The comparative advantage of educated workers in implementing new technology," *Review of Economics and Statistics* (LXIX:February) 1987, pp 1-11.

Bartel, A.P., and Sicherman, N. "Technological change and wages: An interindustry analysis," *Journal of Political Economy* (107:2) 1999, pp 285-325.

Becker, G. *Human Capital* University of Chicago Press, Chicago, IL, 1975.

Belsley, D.A., Kuh, E., and Welsch, R.E. *Regression Diagnostics: Identifying influential data and sources of collinearity* John Wiley & Sons, New York, 1980.

Bharadwaj, A. "A Resource based perspective on information technology capability and firm performance: An empirical investigation," *MIS Quarterly* (24:1) 2000, pp 169-196.

Bharadwaj, A.S., Bharadwaj, S.G., and Konsynski, B.R. "Information technology effects on firm performance as measured by Tobin's q," *Management Science* (45:7) 1999, pp 1008-1024.

Bharadwaj, A.S., Sambamurthy, V., and Zmud, R.W. "Firmwide IT Capability: An Empirical Examination of the Construct and its Links to Performance," in: *Working Paper*, 2002.

Chabrow, E. "Keep 'Em Happy," in: *InformationWeek (Issue 907, 23 September 2002)*, http://www.informationweek.com/story/IWK20020920S0037, 2002, pp. 20-22.

Chabrow, E. "Solid money, worried minds," in: *InformationWeek*, 2004, pp. 30-42.

Connolly, M. "The end of the MBA as we knew it?," *Academy of Management Learning and Education* (December) 2003, pp 365-367.

Dehejia, R., and S Wahba "Causal Effects In Nonexperimental Studies: Reevaluating the Evaluation of Training Programs," *Journal of American Statistical Association* (94:448) 1999, pp 1053-1062.

DiNardo, J.E., and Pischke, J.S. "The returns to computer use revisited: Have pencils changed the wage structure too?," *The Quarterly Journal of Economics* (112:1) 1997, pp 291-303.

Ferratt, T.W., and Agarwal, R. "Toward managing information systems professionals better," Proceedings of the ACM Special Interest Group on Computer Personnel Research, ACM Press, Denver, Colorado, 1996, pp. 268-276.

Ferratt, T.W., Agarwal, R., Moore, J.E., and Brown, C.V. "Observations from "the front": IT executives on practices to recruit and retain information technology professionals," Proceedings of the ACM Special Interest Group on Computer Personnel Research, ACM Press, 1999, pp. 102-112.

Friga, P., Bettis, R., and Sullivan, R. "Changes in Graduate Management Education and New Business School Strategies for the 21st Century," *Academy of Management Learning and Education* (2:3) 2003.

Gerhart, B. "Gender differences in current and starting salaries: The role of performance, college major, and job title," *Industrial and Labor Relations Review* (43:4) 1990, pp 418-433.

Gerhart, B., and Milkovich, G.T. "Organizational differences in managerial compensation and financial performance," *Academy of Management Journal* (33) 1990, pp 663-691.

Gibbons, R., and Katz, L.F. "Does unmeasured ability explain inter-industry wage differentials," *Review of Economic Studies* (59:July) 1992, pp 515-535.

Handy, F., and Katz, E. "The wage differential between nonprofit institutions and corporations: Getting more by paying less," *Journal of Comparative Economics* (26) 1998, pp 246-261.
Jaschik, S. "The B-School Hierarchy (April 25, 2004)," in: *New York Times*, 2004.
Josefek, R.A.J., and Kauffman, R.J. "Five degrees of separation: A human capital model of employment related decisionmaking in the Information technology workforce," Proceedings of the 32nd Hawai International Conference on System Sciences, IEEE, Hawai, 1999, pp. 1-13.
Kakabadse, A., and Korac-Kakabadse, N. "Future role of IS/IT professionals," *The Journal of Management Development* (19:2) 2000, pp 97-154.
Kalleberg, A.L., and Van Buren, M.E. "Is bigger better? Explaining the relationship between organizational size and job rewards," *American Sociological Review* (61) 1996, pp 47-66.
Koh, S., Buk, C., Lee, S., Yen, D.C., and Havelka, D. "The relationship between information technology professionals' skill requirements and career stage in the e-commerce era: An empirical study," *Journal of Global Information Management* (12:1) 2004, pp 68-82.
Krueger, A.B. "How computers have changed the wage structure: Evidence from microdata, 1984-1989," *Quarterly Journal of Electronic Commerce* (108:1) 1993, pp 33-60.
Lee, D.M.S., Trauth, E.M., and Farwell, D.W. "Critical skills and knowledge requirements of IS professionals: A joint academic/industry investigation," *MIS Quarterly* (September) 1995, pp 313-340.
Luftman, J.N., Lewis, P.R., and Oldach, S.H. "Transforming the enterprise: The alignment of business and information technology strategies," *IBM Systems Journal* (32:1) 1993, pp 198-221.
Luftman, J.N., and McLean, E.R. "Key issues for IT executives," *MIS Quarterly Executive* (3:2) 2004, pp 89-104.
Mata, F.J., Fuerst, W.L., and Barney, J.B. "Information Technology and Sustained Competitive Advantage: A Resource -Based Analysis," *MIS Quarterly* (December) 1995, pp 487-505.
Mincer, J. "The distribution of labor incomes," *Journal of Economic Literature* (8) 1970, pp 1-26.
Mincer, J. "The production of human capital and the life cycle of earnings: Variations on a theme," *Journal of Labor Economics* (15:1) 1997, pp S26-S47.
Mincer, J., and Polachek, S. "Family investments in human capital: Earnings of women," *Journal of Political Economy* (82) 1974, pp S76-S108.
Murphy, C. "Where the opportunity is," in: *InformationWeek*, 2004, pp. 45-50.
Nunamaker, J.F., Couger, J.D., and Davis, G.B. "Information systems curriculum recommendations for the 80s: Undergraduate and graduate programs," *Communications of the ACM* (25:11) 1982, pp 781-805.
Pfeffer, J., and Baron, J. "Taking the workers back out: Recent trends in the structuring of employment," in: *Research in Organizational Behavior,* B.M. Staw and L.L. Cummings (eds.), Jai Press, Greenwich, CT, 1988, pp. 257-303.
Pfeffer, J., and Fong, C. "The end of business schools? Less success than meets the eye," *Academy of Management Learning and Education* (1) 2002, pp 78-96.
Pfeffer, J., and Fong, C. "Assessing Business Schools: A Reply to Connolly," *Academy of Management Learning and Education* (December) 2003, pp 368-370.
Prahalad, C.K., and Krishnan, M.S. "The dynamic synchronization of strategy and information technology," *Sloan Management Review* (Summer) 2002, pp 24-33.
Preston, A.E. "The non-profit worker in a for-profit world," *Journal of Labor Economics* (7:4) 1989, pp 438-463.
Rai, A., Patnayakuni, R., and Patnayakuni, N. "Technology investment and business performance," *Communications of the ACM* (40:7) 1997, pp 89-97.
Roomkin, M.J., and Weisbrod, B.A. "Managerial compensation and incentives in for-profit and nonprofit hospitals," *Journal of Law, Economics and Organization* (15:3) 1999, pp 750-781.

Rosenbaum, P. *Observational Studies* Springer-Verlag, New York, 1995.
Ross, J.W., Beath, C.M., and Goodhue, D.L. "Develop Long-term Competitiveness through Information Technology Assets," *Sloan Management Review* (38:1) 1996, pp 31-42.
Ruhm, C., and Borkoski, C. "Compensation in the non-profit sector," in: *National Bureau of Economic Research (NBER)*, Cambridge, MA, 2000.
Sambamurthy, V., Bharadwaj, A.S., and Grover, V. "Shaping Agility through Digital Options: Reconceptualizing the Role of IT in Contemporary Firms.," *MIS Quarterly* (27:2) 2003, pp 237-263.
Santhanam, R., and Hartono, E. "Issues in linking information technology capability to firm performance," *MIS Quarterly* (27:1), March 2003, pp 125-153.
Shachtman, N. "IT pros find job-hopping pays," in: *InformationWeek (Issue June 26, 2000)*, http://www.informationweek.com/792/jobhop.htm, 2000.
Smaltz, D., Agarwal, R., and Sambamurthy, V. "An empirical analysis of the antecedents of CIO role effectiveness," Proceedings of AIS Special Interest Group on IS Leadership 2004, Athens, Georgia, 2004, pp. 1-18.
Stroh, L.K., Brett, J.M., Baumann, J.P., and Reilly, A.H. "Agency theory and variable pay compensation strategies," *Academy of Management Journal* (39) 1996, pp 751-767.
Subramani, M., and Walden, E. "The impact of e-commerce announcements on the market value of firms," *Information Systems Research* (12:2) 2001, pp 135-154.
Talmor, E., and Wallace, J.S. "Computer industry executives: An analysis of the new barons' compensation," *Information Systems Research* (9:4) 1998, pp 398-414.
Tesluk, P.E., and Jacobs, R.R. "Toward an integrated model of work experience," *Personnel Psychology* (51) 1998, pp 321-355.
The Economist "But can you teach it?," in: *The Economist (May 22, 2004)*, 2004a, pp. 61-63.
The Economist "A woman's place is in the courtroom," in: *The Economist (July 14, 2004)*, 2004b.
Truman, G.E., and Baroudi, J.J. "Gender differences in the information systems managerial ranks: An assessment of potential discriminatory practices," *MIS Quarterly* (June) 1994, pp 129-142.