FIRM-SPECIFIC HUMAN CAPITAL AND COMPENSATION-ORGANIZATIONAL TENURE PROFILES: AN ARCHIVAL ANALYSIS OF SALARY DATA FOR IT PROFESSIONALS

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We examine determinants of IT compensation using archival salary data from 2,251 IT professionals in Singapore. Consistent with human capital theory, we find that professionals in IT jobs requiring more firm-specific human capital are paid more than those in jobs requiring less firm-specific human capital. Moreover, compensation increases with organizational tenure at an increasing rate for professionals in higher firm-specific human capital IT jobs, but at a decreasing rate for those in lower firm-specific human capital IT jobs. Our results reveal firm-specific human capital as a primary determinant of compensation and a moderator of IT compensation-organizational tenure profiles. © *2007 Wiley Periodicals, Inc.*

INTRODUCTION

Over the last decade, the transformation to a knowledge-based economy has increased the demand for professionals who are highly skilled in the development and support of information technology and systems (IT). Although growth slowed in the high-tech industry in the early 2000s, particularly in the United States, the demand for skilled IT professionals is rebounding and is projected to increase later in the decade (Brown, 2004). According to the president of the Information Technology Association of America (ITAA; 2002), "a sluggish job market today could turn off many prospective information systems and computer science students, resulting in rampant IT talent shortages a few years down the road." Hecker (2005) estimates that for the period 2002–2014, computer-related occupations are projected to add more than 1.8 million jobs to the labor market, causing IT to be one of the fastest-growing occupational sectors.

In an environment with significant fluctuations in the demand and supply of IT professionals, compensation emerges as

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an important lever for organizations in recruiting and retaining skilled IT employees (ITAA, 2004). In response to imbalances in the IT labor market, the starting salary for IT professionals increased at unprecedented rates, particularly during the late 1990s. However, although we know that new hires in IT have experienced increasing compensation, less is known about the compensation for IT job incumbents, particularly those who have stayed with their current organizations. Do incumbents receive corresponding increases in compensation for their tenure at a particular organization?

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It is important to explore the relationship between compensation and organizational tenure in IT for several reasons. The relationship between seniority and earnings is integral to understanding compensation, employment, and careers in a profession. Rising compensation with tenure can reflect returns on joint training investments by both the employer and the employee or returns on maintaining long-term relationships between workers and employers. On the other hand, falling compensation with tenure implies that compensation growth over a career depends less on worker-firm relationships and more on workers' own efforts to continually develop marketable productive competencies and monitor opportunities available in the external labor market. Thus, examining the compensation-tenure relationship addresses a fundamental question about the structure of earnings over careers within the IT profession. As highlighted by the ITAA (2004, p. 3), it is important for IT professionals to be "stewards of their own careers," and "understanding the trends and directions shaping the IT workforce is one of the best ways to launch or sustain an information technology career." Hence, compensation-organizational tenure profiles have implications for both IT human resource managers and IT professionals.

Classical human capital theory (Becker, 1975; Mincer, 1970) suggests that compensation rises with organizational tenure to reflect increases in the worker's competence from the accumulation of on-the-job experience. However, given the rapid technological advancements in IT, it is possible that IT skills can become obsolete very quickly if not continuously updated (Joseph & Ang, 2002; Pazy, 1996). A rapid erosion of skills suggests that compensation may not necessarily rise with organizational tenure in IT, as employees who stay in a particular job for too long may find their skills becoming obsolete. On the other hand, the business and managerial competencies needed to successfully implement information systems and technology in a particular organization are acquired through on-the-job experience, which suggests that the value of firm-specific human capital could increase with organizational tenure for IT professionals.

This study examines whether compensation increases with organizational tenure for IT professionals. Measuring the level of firm-specific human capital required for different IT jobs, we evaluate how the firm specificity of different job types affects the salaries of 2,251 IT professionals working in information systems development and infrastructure jobs.

Theory and Hypotheses

Human capital theory offers a cogent explanation for the relationship between tenure and compensation (i.e., the compensation-tenure profile) (Topel, 1991). Human capital embodies an individual's productive competencies that result from natural ability, education, training, and experience (Becker, 1975). Accordingly, human capital theory suggests that compensation is positively associated with organizational tenure because tenure reflects the level of human capital accumulated over the period of employment (Becker & Lindsay, 1994; Parent, 2002; Topel, 1991).

Empirical studies on the compensation-tenure relationship have been conducted primarily in the field of labor economics. How-

ever, research to date has not shown consistent evidence of this relationship. Altonji and Shakotko (1987) and Abraham and Farber (1987), for example, found the effect of tenure on compensation to be almost insignificant, whereas others (e.g., Goldsmith & Veum, 2002; Jacobsen & Levin, 2002; Topel, 1991) found strong, positive tenure effects on compensation. It is thus recognized that compensation dynamics are more complicated and variegated than the simple presumption that compensation monotonically increases with job tenure (Munasinghe & O'Flaherty, 2005).

Researchers have attempted to examine the complexity of compensation dynamics by accounting for other factors such as the impact of external labor market conditions including the market distribution of external wage offers (Munasinghe & O'Flaherty, 2005), or exogenous worker displacements from larger firms (Bingley & Westergaard-Nielsen, 2003). Some researchers have speculated that certain firms with more firm-specific capital involved will adopt more aggressive techniques for retaining their workers (Coleman, 1998; Farber, 1999). In this study, we extend previous research from a firm-level explanation to a job-level explanation for differential patterns in compensation-tenure profiles. Specifically, we examine the economic returns to tenure in IT by positing that returns to tenure could differ for jobs requiring different levels of firm-specific human capital.

Human Capital and Compensation-Tenure Profiles in IT

Human capital theory identifies two types of human capital: general and specific (Becker, 1975). General human capital increases the individual's productivity to many firms. In contrast, firm-specific human capital increases the individual's productivity exclusively to a particular firm. Human capital theory therefore suggests that the growth of compensation with organizational tenure (the duration of an individual's employment at a particular organization) is attributed to the individual's share of investments in firm-specific skills (Parent, 2002). That is, individuals raise the value of their firm-specific human capital through on-the-job experience over time, subsequently enhancing their productivity to their firms.

In IT, both general and specific human capital are very important and necessary (Ives & Olson, 1981; D. M. S. Lee, Trauth, & Farwell, 1995; Nakayama & Sutcliffe, 2001). IT jobs are complex, requiring knowledge of difficult, abstract technical concepts such as data modeling, database design, process engineering, information architectures, network design, and software design theory (Feeny & Wilcocks, 1998; D. M. S. Lee et al., 1995; Todd, McKeen, & Gallupe, 1995). Such IT knowledge and skills are generally transferable from firm to firm. However, due to the fast rate of change in IT, where new generations of the technology can emerge every 18 months, the value of this human capital could rapidly erode over time absent further investment in learning new skills (Glass, 2000). This potential for erosion of technical human capital with organizational tenure is an interesting feature of the IT profession.

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At the same time, the application of IT to a specific organization's business problems involves a high degree of tacit knowledge about organizational systems, structures, members, and procedures, and tacit skills about handling people and negotiating organizational politics. This knowledge and associated skills mostly are firm-specific and are best acquired through experience at the particular organization (Nakayama & Sutcliffe, 2001; Schenk, Vitalari, & Davis, 1998; Stinchcombe & Heimer, 1988). For example, to determine the IT strategies of an organization, or to lead IT projects involving many parts of the organization, IT professionals need to have knowledge of their firm's corporate strategy in relation to its industry, the decision-making processes and biases of the management, the organizational structure,

and other business processes and procedures (Levinson, 1988). To effectively manage IT projects and to communicate with users about their requirements, IT professionals also require skills to manage interpersonal relationships within the organization and to plan, organize and delegate tasks and projects (C. K. Lee, 2005). The IT professional also must learn to build relationships with different groups of individuals within the corporation, including diverse users from different functional departments (e.g., finance, marketing, accounting, production), as well as with peers, superiors, and specific vendors that offer IT services and products to the organization. Such skills and knowledge are very much specific to a firm, are less transferable from firm to firm, and are acquired with work experience and organizational tenure (Kim & Lerch, 1997).

As skills often are a primary focus of job evaluations, jobs that require higher levels of firm-specific skills are often more highly compensated, controlling for job level.

Jobs as Embodiments of Firm-Specific Capital

Different IT jobs require different extents of firm-specific human capital. An IT job such as an application programmer requires less firm-specific human capital as the knowledge and skills relevant to job performance (e.g., proficiency in programming languages) are applicable across organizations. In contrast, an IT job such as a systems analyst requires more firm-specific human capital as the knowledge and skills relevant to job performance (e.g., building and sustaining effective relationships with certain users in functional units) are more relevant to a particular organization (Ang & Slaughter, 2000; D. M. S. Lee et al., 1995; Nakayama & Sutcliffe, 2001).

Compensation for different jobs in organizations is determined by external labor markets and internal managerial decisions, typically in the form of job evaluation (Campion & Berger, 1990). Job evaluation is a formal procedure that determines the value or "worth" of a job within an organization's overall pay structure (Figart, 2001). Job evaluations typically are based on a quantitative evaluation system that considers compensable factors. Four key categories of compensable factors are skills (e.g., years of education, degree of firm-specific skills required); effort (primarily physical); responsibility for machinery, money, or people; and working conditions (Figart, 2001). A key attribute of job evaluation is that it focuses on determining a rate for a job, rather than determining the compensation for a particular person (Figart, 2001).

As skills often are a primary focus of job evaluations, jobs that require higher levels of firm-specific skills are often more highly compensated, controlling for job level (Cappelli & Cascio, 1991). This differentiation occurs due to the costs of replacing workers whose jobs require a high level of firm-specific human capital. According to human capital theory, firms have to invest in developing firm-specific human capital since there is no market for such firm-specific skills elsewhere, and job applicants cannot know the job requirements or prepare for them in advance (Becker, 1975). The potential cost of replacing and retraining such workers with firm-specific skills if they do leave is thus very great; hence, firms offer higher compensation to such employees to prevent them from leaving (Cappelli & Cascio, 1991).

Moreover, employees do not have an incentive to invest in developing human capital that is not transferable to other firms (Schoones & Bernhardt, 1998). To provide incentives for employees to develop firm-specific human capital such as that required to build effective relationships with users, a firm must provide inducements in the form of higher pay for jobs that require more firm-specific skills (Prendergast, 1993). Thus:

H1: Controlling for job level, individuals in IT jobs that require higher levels of firm-specific human capital are paid more, for a given level of organizational tenure, than those in IT jobs requiring lower levels of firm-specific human capital.

Our next two hypotheses focus on the rate of change in compensation with organizational tenure for jobs varying in firm skills specificity. Human capital theory implies that compensation rises with organizational tenure to reflect increases in the worker's human capital from on-the-job experience (Topel, 1991). In a job requiring a high level of firm-specific skills, an IT professional's firm-specific human capital will continue to increase over time with job experience. With longer tenure, IT professionals develop greater firm-specific knowledge and skills by deepening and improving existing relationships and developing new relationships with other organizational members or even with external constituents such as vendors and trading partners. IT professionals also become more knowledgeable about tactics for negotiating organizational politics and bureaucracies, and this enables them to work more effectively. Finally, as IT professionals work for a longer period with the organization, they gain more knowledge about the business processes and strategies of the organization, which in turn facilitates their work, especially since their job typically requires a large extent of such knowledge about the organization.

Such development of firm-specific skills, of course, does not automatically come with tenure if IT professionals do not actively learn from their experiences. Nevertheless, in a job that requires a high level of firm-specific skills, opportunities exist for IT professionals to develop such firm-specific skills on the job, through learning by doing (Argote, 1999). The learning from experience, therefore, is expected to help IT professionals to develop firm-specific skills.

The increase in firm-specific human capital will enable IT professionals in a job requiring a high level of firm-specific skills to be even more effective. Such IT professionals thus become even more costly to replace over time and, correspondingly, the firm is more willing to continuously increase compensation for incumbents of IT jobs that require more firm-specific human capital. Hence:

H2: Controlling for job level, compensation increases at an increasing rate with organizational tenure for individuals in IT jobs with higher levels of firm-specific human capital.

By contrast, in a job requiring less firm-specific human capital, an IT professional's human capital will increase initially because the professional needs time to adjust and adapt the skills and knowledge to a new environment, which is consistent with classical human capital theory. However, prior empirical research finds that human capital that is less firm-specific tends to erode with age and tenure (Allen & de Grip, 2005; Dalton & Thompson, 1971; Fossum & Arvey, 1986; Shearer & Steger, 1975) if professionals do not keep their skills up-to-date.

With longer tenure, IT professionals develop greater firm-specific knowledge and skills by deepening and improving existing relationships and developing new relationships with other organizational members or even with external constituents such as vendors and trading partners.

According to human capital theory, a firm is unwilling to invest in increasing the general human capital of employees because the firm cannot reap the benefits from the investment when the employees leave the firm and transfer the general human capital to another firm. In IT, organizations could be reluctant to train their IT professionals for fear that up-to-date human capital will make these professionals more attractive in the external labor market.

In addition to firms' reluctance to develop the general human capital of employees, there are varied reasons why we would expect to see the erosion of human capital with age and tenure in IT. First, workers tend to experience decreasing levels of motivation as they grow older because of the difficulties in having to unlearn what they have specialized in for a long time (Larwood, Rodkin, & Judson, 2001). Second, older workers are less likely to be recommended for training compared to equally qualified younger individuals as a result of employers' perceptions that they are difficult to train, or are not inter-

ested in receiving training (Chiu, Chan, Snape, & Redman, 2001; Taylor & Walker, 1998). Third, and more important, with increasing tenure and repetition of tasks in a job, unused skills and knowledge are forgotten. Over time, older or longer-tenured individuals are able to maintain a core of skill competencies allowing them to function at an acceptable level so long as the job does not change (Larwood et al., 2001).

Singapore provides an ideal setting in which to study compensation-tenure profiles for IT professionals. Well known for its nationwide strategic plan, the "IT2000 Vision," Singapore has leveraged IT for national competitive advantage.

It is important to note that general human capital need not necessarily erode with organizational tenure, especially when IT professionals are continually updating and developing deep knowledge of a select set of skills and when the organization stays current with the latest technology releases. However, we acknowledge the persistent concern of IT professionals that deep knowledge acquired from working on a specific technology or system (especially if it is legacy and proprietary in nature) does not necessarily translate readily to marketable skills.

This observation is consistent with Farmer and Campbell (1997), who found that IT professionals often work within a very narrow scope of technology and application systems domains. They state that due to overspecialization, IT professionals can become frustrated and concerned that they are competent to conduct their specific job only. As Farmer and Campbell (1997, p. 129) note:

> This may be compounded by a feeling that their competence even in that job is slipping away as the pace of technological change races inexorably on and they perceive themselves as failing to keep up.

In sum, the value of human capital that is less firm-specific diminishes with organizational tenure. Thus, we expect compensation to rise more slowly with organizational tenure in IT jobs that require little firm-specific human capital. That is:

H3: Controlling for job level, compensation increases with organizational tenure, but at a decreasing rate for individuals in IT jobs with lower levels of firm-specific human capital.

Method

Research Setting and Data

To evaluate our hypotheses, we examine annual salary data collected for 2,251 IT professionals across 43 organizations in Singapore. Singapore provides an ideal setting in which to study compensation-tenure profiles for IT professionals. Well known for its nationwide strategic plan, the "IT2000 Vision," Singapore has leveraged IT for national competitive advantage. As part of the vision, the Singapore government has the goal of becoming an IT leader and has implemented significant economic incentives to attract major IT companies to the country. These incentives have led to increased demand for IT labor such that there are shortages of qualified IT professionals (Ang, Slaughter, & Ng, 2002). Thus, Singapore has a highly competitive IT labor market. However, because the country is small and its population is not as diversified as the United States or Europe, it is less heterogeneous. Further, there is less reliance on importing foreign workers in Singapore, due to country-size limitations. In addition, organizations in Singapore are very consistent in their definition of IT jobs. These factors result in a competitive IT labor market but with better controls than in the United States or Europe, mitigating the heterogeneity problems that have plagued prior research on compensation-tenure profiles.

The Information Technology Management Association (ITMA), the premier IT association in Singapore, provided the salary data. Members of the ITMA include major IT users representing both public- and private-sector organizations in industries such as financial

services, manufacturing, retailing, and transportation. Data were obtained from the top IT executive or CIO (Chief Information Officer) as well as HR specialists of ITMA member organizations. CIOs provided information on company background and demographic characteristics of the IT department. HR specialists provided salary information for all IT professionals in each organization. Forty-three organizations participated in the ITMA Salary Study, representing almost half of the ITMA member organizations. A chi-square analysis based on organization size and sector revealed no significant respondent bias, as the 43 organizations are representative of the ITMA population in terms of size ($\chi^2 = 2.041$, $p > .10$) and sector ($\chi^2 = 1.699$, $p > .10$).

IT Job Families

We examined two basic job families for IT professionals: systems development and IT infrastructure. An IT job family defines a group of hierarchically interrelated jobs in IT (Chesebrough & Davis, 1983). In the systems development job family, the primary job categories include application development manager, project manager, systems analyst, and application programmer. IT infrastructure job categories include infrastructure manager, technical specialist, systems administrator, and computer operator. Based on the job descriptions, we classified various jobs into job categories that represent the primary tasks performed. For example, in the systems development job family, Internet programmer, Web developer, enterprise resource planning (ERP) developer or engineer, and software engineer all are classified as application programmers since the primary task in these jobs involves writing, testing, and implementing software code. An example in the infrastructure job family is the technical specialist, a category that includes database specialist, data analyst or architect, systems architect, network specialist, wireless specialist, operating systems specialist, and security specialist. These specialists all perform jobs that involve designing and implementing particular aspects of an organization's technical IT infrastructure. Table I provides detailed descriptions of the jobs in the systems development and IT infrastructure job families, respectively.

Measures

Skills Specificity

To measure the level of skills specificity of each job category, we asked a panel of 15 experts to rate the extent to which individuals in each job category (1) require knowledge about their company and skills that are relatively unique to their company; (2) must make a substantive investment in acquiring company-specific knowledge and in developing skills that are tailored to the particular needs of their company; and (3) require extensive knowledge and skills that are specific to their company. These measures were adapted from Ang and Straub (1998). The experts who conducted the ratings included nine IT faculty members with postgraduate degrees in IT and an average of 11.63 years of working experience in the IT industry and six IT industry professionals with an average of 11.57 years of working experience in the IT industry. Fourteen out of the 15 experts had college education, and nine of the experts were male. The mean age of the 15 experts was 39.1 years.

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To examine agreement in the expert ratings of firm-specific knowledge requirements for each job category, we examined the R_{wg} (interrater agreement of a group of judges) (James, Demaree, & Wolf, 1984) and the Cronbach's alpha (reliability of the items) for each job category. Table II shows the results of this analysis. R_{wg} indicates convergence among raters on variables associated with a component

TABLE I Job Category Descriptions

Position	Job Description
	SYSTEMS DEVELOPMENT JOB FAMILY
Applications Development Manager (AM)	Plans and oversees multiple projects and project managers. Works with senior management to determine systems development strategy and standards. Administers department budget and reviews project managers.
Project Manager (PM)	Plans and oversees the development and support of one or more projects. Coordinates resources, schedules, and communications for applications development projects. Develops project schedules and assigns tasks for applications development projects.
Systems Analyst (SA)	Works directly with management and users to analyze, specify, and design business applications. Serves as contact with user groups and systems management.
Applications Programmer (AP)	Develops detailed functional, system, and program specifications. Codes and maintains business applications on particular hardware/software platforms.
	IT INFRASTRUCTURE JOB FAMILY
Infrastructure Manager (IM)	Plans, manages, and coordinates all matters related to IT hardware, software, systems, data, network, and telecommunications infrastructure.
Technical Specialist (TS)	Designs and manages specific aspects of the IT infrastructure such as hardware, operating systems, communication systems, Internet applications, database management systems, or networks, etc.
Systems Administrator (AD)	Installs operating systems, software, database management systems software, compilers, and utilities. Monitors and tunes systems software, peripherals, and networks. Installs new users, creates batch administration scripts, and runs systems backups. Resolves systems problems.
Computer Operator (CO)	Performs tasks associated with operational computing and peripheral equipment in accordance with the workload, services, priorities, and deadlines as defined in the daily production/testing schedule.

(where a value of 1 indicates complete agreement). All R_{wg} scores computed in this analysis resulted in positive scores greater than 0.70 (ranging from 0.76 to 0.88), suggesting a high level of agreement between the raters in their assessment of the level of firm specificity for each job category (James, Demaree, & Wolf, 1993). The Cronbach's alphas of item reliability range from 0.74 to 0.97, suggesting that the three items measuring the level of firm specificity for each job category have a high level of reliability. Thus, we created a measure of the level of firm skills specificity for each job category (SKILLS SPECIFICITY) by averaging the ratings of the three items by the 15 expert raters for the respective job category. Table II also shows the means and standard deviations for the firm-specificity ratings of each job.

In the systems development job family, the application development manager is rated to require the highest level of firm-specific knowledge, followed by the systems analyst, and then the project manager. The applications programmer is rated to require the lowest level of firm-specific knowledge. In the IT infrastructure job family, the infrastructure manager is rated to require the

TABLE II Expert Ratings of Firm Skills Specificity for Each Job Category (n = 15 raters, J = 3 items)

Job Type	R_{wg}	Cronbach's Alpha	Mean Rating	S.D. of Ratings
Applications Manager (AM)	0.81	0.88	5.289	1.326
Project Manager (PM)	0.82	0.83	4.644	1.294
Systems Analyst (SA)	0.81	0.89	5.111	1.333
Applications Programmer (AP)	0.82	0.96	3.533	1.290
Infrastructure Manager (IM)	0.81	0.76	4.956	1.331
Technical Specialist (TS)	0.80	0.94	3.156	1.357
System Administrator (AD)	0.76	0.85	3.733	1.429
Computer Operator (CO)	0.88	0.74	2.133	1.075

highest level of firm-specific knowledge (comparable to the firm-specific knowledge requirements of the project manager in the systems development job family). While the systems administrator was rated to require a higher level of firm-specific knowledge compared to the technical specialist, the ratings for these two job categories were close to that of the application programmer. The computer operator was rated to require the lowest level of firm-specific knowledge among all of the IT job categories.

Compensation was measured as the sum of base compensation (i.e., the 12-month salary of an individual) plus bonuses for the year (COMPENSATION). Organizational tenure is measured as a continuous variable that assesses the number of years an IT professional has worked in the company (ORGANIZATIONAL TENURE) as of the time of the study. Employees with less than one year of tenure were scored as having zero years of tenure. Similarly, those whose tenure was more than one year but less than two years were coded as having one year of tenure, and so on.

Control Variables

We control for other variables that prior research has suggested are likely to influence compensation, including level of education (GRADUATE), modeled as a dummy variable with 1 representing college graduates and 0 representing noncollege graduates; gender (GENDER), modeled as a dummy variable where 1 represents males and 0 represents females; organization sector (ORGANIZATION SECTOR), modeled as a dummy variable where 1 represents for-profit sector firms and 0 represents not-for-profit sector firms; and organization size (ORGANIZATION SIZE), modeled as the natural logarithm of the total number of employees in the firm to correct for skewness in the variable's distribution. We also control for job level (JOB LEVEL) using a variable to represent the implicit hierarchy of progression within each IT job family. The levels of this variable correspond to the job categories shown and described in Table I. For the systems development job family, application programmer is at level 1, followed by systems analyst at level 2, then project manager at level 3, and the application development manager at level 4. For the infrastructure job family, the computer operator is at level 1, followed by systems administrator at level 2, then technical specialist at level 3, and the infrastructure manager at level 4.

Models and Analysis

While the systems development and IT infrastructure job families are related and considered to be part of the same occupational group, a different skill set is required in the career progression within each job family. The ranking of job levels is clear within a job family but is much less obvious across job families. For example, a technical specialist or system administrator is clearly ranked higher in terms of job level than a computer operator in the IT infrastructure job family. However, it is

not apparent how a technical specialist and system administrator should be ranked relative to application programmer, systems analyst, or project manager. It is therefore much more difficult to control for job levels if we combine both job families together into one data set for analysis given that we cannot determine how jobs within the IT infrastructure family are ranked vis-à-vis those within the systems development family. In addition, pooling the job families together requires homogeneity of variance in the dependent variables and similar means and standard deviations of the independent variables; these requirements are not met in our data. Hence, we conducted separate analyses for the systems development and IT infrastructure job families. We estimated the following model for each job family:

We expect a nonlinear compensation-tenure relationship because different IT jobs have varying levels of firm-specific human capital and thus have different compensation change rates with organizational tenure.

$$ln\ (\text{COMPENSATION}) = \beta_0 + \beta_1\text{GRADUATE} + \beta_2\text{GENDER} + \beta_3\text{ORGANIZATION SECTOR} + \beta_4\text{ORGANIZATION SIZE} + \beta_5\text{JOB LEVEL} + \beta_6\text{SKILLS SPECIFICITY} + \beta_7\text{ORGANIZATIONAL TENURE} + \beta_8\text{ORGANIZATIONAL TENURE}^2 + \beta_9\text{SKILLS SPECIFICITY} * \text{ORGANIZATIONAL TENURE} + \beta_{10}\text{SKILLS SPECIFICITY} * \text{ORGANIZATIONAL TENURE}^2 + \varepsilon$$

The normal distribution of residuals is a critical assumption for regression. In our analysis, the histogram and normal probability plots of the residuals indicated that the residuals were highly skewed, a violation of the normality assumption (the assumption of normally distributed residuals is rejected by the Kolmogorov-Smirnov test of normality for both systems development, $Z = 3.342$, $p < 0.01$, and IT infrastructure, $Z = 2.502$, $p < 0.01$). We thus used the natural logarithm of compensation in our models and analysis to achieve a more symmetrical distribution of the error terms (Box & Cox, 1964). Residuals were normally distributed after these transformations (Kolmogorov-Smirnov test of normality: $Z = 1.599$, $p > 0.05$ for systems development and $Z = 0.868$, $p > 0.10$ for IT infrastructure). Also, every variable was standardized to its Z-score before entering it into the analysis to ease interpretation of estimated coefficients (as each variable is measured using a different unit scale) and to mitigate potential collinearity between the main effects of firm skills specificity and organizational tenure and their interactions (Aiken & West, 1991).

We expect a nonlinear compensation-tenure relationship because different IT jobs have varying levels of firm-specific human capital and thus have different compensation change rates with organizational tenure. Modeling the compensation-tenure relationship as nonlinear is also consistent with the literature in labor economics (e.g., Mincer, 1974). The natural logarithm of the dependent variable implies that the coefficient for organizational tenure represents proportionate (percentage) changes in compensation with changes in tenure; the quadratic terms for organizational tenure capture the nonlinearity effect; and the interaction terms for skills specificity and organizational tenure capture the differences in average compensation and in the change in compensation with organizational tenure across different levels of firm-specific human capital for the IT jobs.

To analyze our models, we use hierarchical moderated regression (Cohen & Cohen, 1983), first estimating a model with the control variables, then adding the main effects, and finally adding the interactive and quadratic effects.[1] Although the ordinary-least-squares (OLS) assumption of normality of residuals is met in both models, White's test (1980) rejects the null hypothesis of homoscedasticity. Thus, we employed weighted least squares, using a general weighting procedure to correct for heteroscedasticity in the models (Greene, 2000). We found no collinearity problems in the models, as the variance inflation factors and condition indices were well below the commonly accepted cutoff levels (condition index = 5.339

and average VIF = 2.448 in systems development; condition index = 4.954 and average VIF = 2.354 in IT infrastructure). The existence of outliers was not relevant to the results of the estimation. Application of the Belsely, Kuh, and Welsch (1980) procedures detected three outliers in the systems development model and two outliers in the IT infrastructure model. However, the results did not change materially when the analyses were conducted without the outlying observations; thus, we report the results with all observations included.

Results

Tables III and IV display descriptive statistics and the correlation matrices for the variables in our models for systems development and IT infrastructure, respectively. The results from the hierarchical estimation of our models are reported in Tables V and VI. As shown in these tables, our control variables alone explain significant variation in compensation (58.4% for systems development and 53.4% for IT infrastructure). In both models, adding the main effects for skills specificity (i.e., extent of firm-specific human capital in the job) and organizational tenure explains significant incremental variation in compensation (R^2 change = 9.3%, F = 210.04, p < 0.001 for systems development and R^2 change = 13.7%, F = 161.75, p < 0.001 for IT infrastructure). Finally, adding the interaction and quadratic effects to the models explains significant incremental variance in compensation (R^2 change = 1.6%, F = 24.69, p < 0.001 for systems development and R^2 change = 2.1%, F = 17.98, p < 0.001 for IT infrastructure).

Our first hypothesis posited that the higher the level of firm-specific human capital required by the job, the greater the compensation of the individual in that job, all else equal. We find that Hypothesis 1 is supported: an individual in a job that requires a higher level of firm skills specificity receives a higher level of compensation for a given level of organizational tenure (β_6 = 0.032, z = 3.556, p < 0.001 for systems development and β_6 = 0.079, z = 4.158, p < 0.001 for IT infrastructure).

The second and third hypotheses posit that compensation increases with organizational tenure, and that the rate of increase depends on the level of firm skills specificity. To examine these hypotheses, we need to establish whether compensation does in fact increase with organizational tenure. To do this, we compute the first derivative by differentiating the compensation equation with respect to organizational tenure, yielding: {1} ∂ *ln* Compensation / ∂YRCOY = β_7 + 2*β_8YRCOY + β_9SKILLS SPECIFICITY +

TABLE III Descriptive Statistics and Correlation Matrix (Systems Development Jobs)

	Mean	S.D.	1	2	3	4	5	6	7
1. Compensation	3.86	0.40	-						
2. Skills Specificity	4.04	0.78	.69**	-					
3. Organizational Tenure	5.54	5.96	.52**	.41**	-				
4. Job Level	2.33	1.15	.75**	.83**	.42**	-			
5. Graduate	0.77	0.42	.18**	.14**	–.21**	.15**	-		
6. Gender	0.51	0.50	–.02	.03	–.14**	–.03	.14**	-	
7. Organization Sector	0.56	0.50	.08	.03	–.03	.02	–.12**	–.03	-
8. Organization Size	0.22	0.42	–.03	–.14**	–.07**	–.02	.06*	.04	–.19**

Notes: N = 1,471. *p < .05; **p < .01. Coding: Graduate: 1 = college graduate, 0 = nongraduate; Sector: 1 = private, 0 = public; Gender: 1 = male, 0 = female. Pearson correlations are reported between pairs of continuous variables, Spearman correlations between pairs of noncontinuous and continuous variables, and Phi correlations between pairs of noncontinuous variables. Means and standard deviations are provided for nonstandardized variables.

TABLE IV Descriptive Statistics and Correlation Matrix (IT Infrastructure Jobs)

	Mean	S.D.	1	2	3	4	5	6	7
1. Compensation	3.52	0.50	-						
2. Skills Specificity	2.91	0.83	.58**	-					
3. Organizational Tenure	6.32	6.56	.28**	–.09*	-				
4. Job Level	2.20	1.02	.69**	.83**	–.11**	-			
5. Graduate	0.36	0.48	.59**	.46**	–.18**	.62**	-		
6. Gender	0.61	0.49	–.03	.11**	–.22**	.13**	.09*	-	
7. Organization Sector	0.64	0.48	–.06	–.15**	–.06	–.06	–.08*	.15**	-
8. Organization Size	0.18	0.39	–.06	.21**	–.24**	.14**	–.01	.14**	.12**

Notes: N =780. * $p < .05$; ** $p < .01$. Coding: Graduate: 1 = college graduate, 0 = nongraduate; Sector: 1 = private, 0 = public; Gender: 1 = male, 0 = female. Pearson correlations are reported between pairs of continuous variables, Spearman correlations between pairs of noncontinuous and continuous variables, and Phi correlations between pairs of noncontinuous variables. Means and standard deviations are provided for nonstandardized variables.

$2*\beta_{10}$YRCOY*SKILLS SPECIFICITY. Since both YRCOY and SKILLS SPECIFICITY are in expression {1}, we chose different levels for each of these variables—low (one standard deviation below the mean) average, and high (one standard deviation above the mean)—and computed the result of expression {1} for those different values. We found that the result of expression {1} is positive for *all* values of YRCOY and SKILL SPECIFICITY, indicating that compensation increases with organizational tenure, at all levels of tenure and skill specificity.

Given that compensation does increase with organizational tenure, our next step is to determine whether compensation is increasing at an increasing rate with organizational tenure for high levels of skills specificity as posited in Hypothesis 2, and whether compensation is increasing at a decreasing rate with organizational tenure for low levels of skills specificity as posited in Hypothesis 3. To do this, we obtain the second derivative by differentiating expression {1} again, with respect to organizational tenure, yielding: {2} ∂^2 ln Compensation / ∂YRCOY^2 = $2*\beta_8$ + $2*\beta_{10}$*SKILLS SPECIFICITY.

Based on expression {2}, when skills specificity is high (one standard deviation above the mean) we find that Hypothesis 2 is supported for systems development, where the rate of change is positive = 0.023, but not for IT infrastructure, where the rate of change is negative = –0.352. By contrast, we find that Hypothesis 3 is supported for both systems development and IT infrastructure. The range of change is negative (–0.124 and –0.104) for systems development and IT infrastructure, respectively, when skills specificity is low (one standard deviation below the mean).

To give an intuitive view of our results, we graphed the compensation-tenure profiles for the IT professionals in systems development and IT infrastructure (Figures 1 and 2, respectively). For each job, we plotted functions for compensation against organizational tenure, holding the values for the other variables constant at their means, and using the estimated coefficients and the data range for organizational tenure from the data sample.

As these graphs illustrate, compensation increases with organizational tenure at a decreasing rate for the jobs that require lower levels of firm-specific human capital and at an increasing rate for jobs that require higher levels of firm-specific human capital. The results shown in Tables V and VI, and illustrated graphically in Figures 1 and 2, suggest that while compensation increases with organizational tenure for individuals in all IT jobs (both in systems development and in

TABLE V **Hierarchical Regression Results: Systems Development Jobs, Dependent Variable = *ln* (Compensation)**

Independent Variables	Control Variables Only	With Main Effects	With Moderated Effects
Intercept (β_0)	3.856**	3.855**	3.912**
	(0.006)	(0.005)	(0.007)
Graduate (β_1)	0.034**	0.086**	0.093**
	(0.006)	(0.005)	(0.005)
Gender (β_2)	0.000	0.010*	0.014**
	(0.006)	(0.005)	(0.005)
Organization Sector (β_3)	0.019**	0.023**	0.021**
	(0.006)	(0.005)	(0.005)
Organization Size (β_4)	0.017**	0.016**	0.014**
	(0.006)	(0.005)	(0.005)
Job Level (β_5)	0.296**	0.177**	0.176**
	(0.006)	(0.009)	(0.009)
Skills Specificity (β_6)		0.064**	0.032**
		(0.009)	(0.009)
Organizational Tenure (β_7)		0.151**	0.209**
		(0.006)	(0.009)
Organizational Tenure^2 (β_8)			–0.037**
			(0.005)
Skills Specificity * Organizational Tenure (β_9)			–0.060**
			(0.009)
Skills Specificity * Organizational Tenure^2 (β_{10})			0.024**
			(0.004)
***R*^{2}**	0.584	0.677	0.692
***R*^{2} Change**		0.093	0.016
***F* Change**		210.04**	24.69**

Notes: N = 1,471. ** p <.01, * p < .05, + <.10.

IT infrastructure), *none* of the individuals in jobs in IT infrastructure, including the infrastructure manager, experience compensation increases at an *increasing rate*. In simulating the compensation values for the graphs, we found that the level of firm-specific human capital needs to be higher than a certain threshold (a level of 5 out of 7 in our data) in order for the rate of compensation to be increasing with organizational tenure. None of the jobs in IT infrastructure, including infrastructure manager, have a level of firm-specific human capital over that threshold value.

However, in systems development, individuals in two jobs with levels of firm-specific human capital that are above the threshold value (systems analyst and application development manager) experience compensation increases at an increasing rate. Finally, in both IT job families, individuals in jobs with lower levels of firm-specific human capital (application programmer and project manager in systems development and computer operator, systems administrator, technical specialist and infrastructure manager in IT infrastructure) experience compensation increases, but at a decreasing rate. This result implies that the level of firm-specific human capital required in an IT job needs to be sufficiently high before IT professionals will experience an in-

TABLE VI **Hierarchical Regression Results: IT Infrastructure Jobs, Dependent Variable = *ln* (Compensation)**

Independent Variables	Control Variables Only	With Main Effects	With Moderated Effects
Intercept (β_0)	3.502**	3.535**	3.607**
	(0.012)	(0.010)	(0.013)
Graduate (β_1)	0.120**	0.159**	0.167**
	(0.017)	(0.014)	(0.013)
Gender (β_2)	–0.043**	–0.014	0.001
	(0.012)	(0.010)	(0.010)
Organization Sector (β_3)	–0.014	–0.001	–0.006
	(0.012)	(0.010)	(0.010)
Organization Size (β_4)	–0.045**	–0.013	–0.006
	(0.013)	(0.011)	(0.010)
Job Level (β_5)	0.283**	0.199**	0.198**
	(0.017)	(0.021)	(0.020)
Skills Specificity (β_6)		0.076**	0.079**
		(0.019)	(0.019)
Organizational Tenure (β_7)		0.216**	0.293**
		(0.012)	(0.014)
Organizational Tenure^2 (β_8)			–0.093**
			(0.012)
Skills Specificity * Organizational Tenure (β_9)			0.031*
			(0.014)
Skills Specificity * Organizational Tenure^2 (β_{10})			–0.041**
			(0.012)
***R*^{2}**	0.534	0.672	0.693
***R*^{2} Change**		0.137	0.021
***F* Change**		161.75**	17.98**

Notes: $N = 780$. ** $p < .01$, * $p < .05$, + < .10.

creasing rate of compensation with organizational tenure.

Conclusion

Drawing upon human capital theory, we posited that, all else equal, professionals in IT jobs requiring higher levels of firm-specific human capital would receive higher salaries than those in IT jobs requiring less firm-specific human capital. We found that for IT jobs with lower levels of firm-specific human capital, the erosion of such human capital over time led to progressively lower compensation increases with tenure. By contrast, for IT jobs that require more firm-specific human capital, we found that compensation increased at an increasing rate with organizational tenure to reflect the value of accumulating on-the-job experience in the firm.

Limitations

We acknowledge that our study has some limitations and that it raises several questions for future research. First, the salary data for this study were collected at one point in time. Future research could examine the impact of tenure on compensation using panel data that tracks the compensation, jobs, and organizational tenure of individuals over time. Our study also focuses on permanent employ-

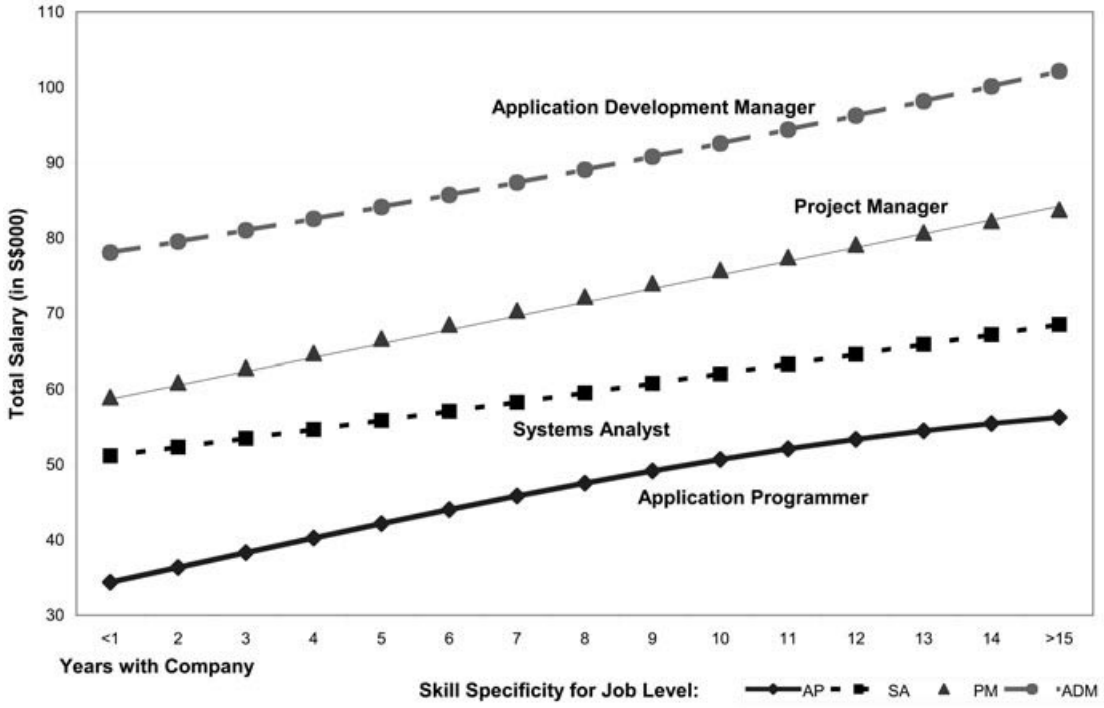

FIGURE 1. Compensation-Organizational Tenure Extrapolation by Level of Firm Skills Specificity for Systems Development Jobs

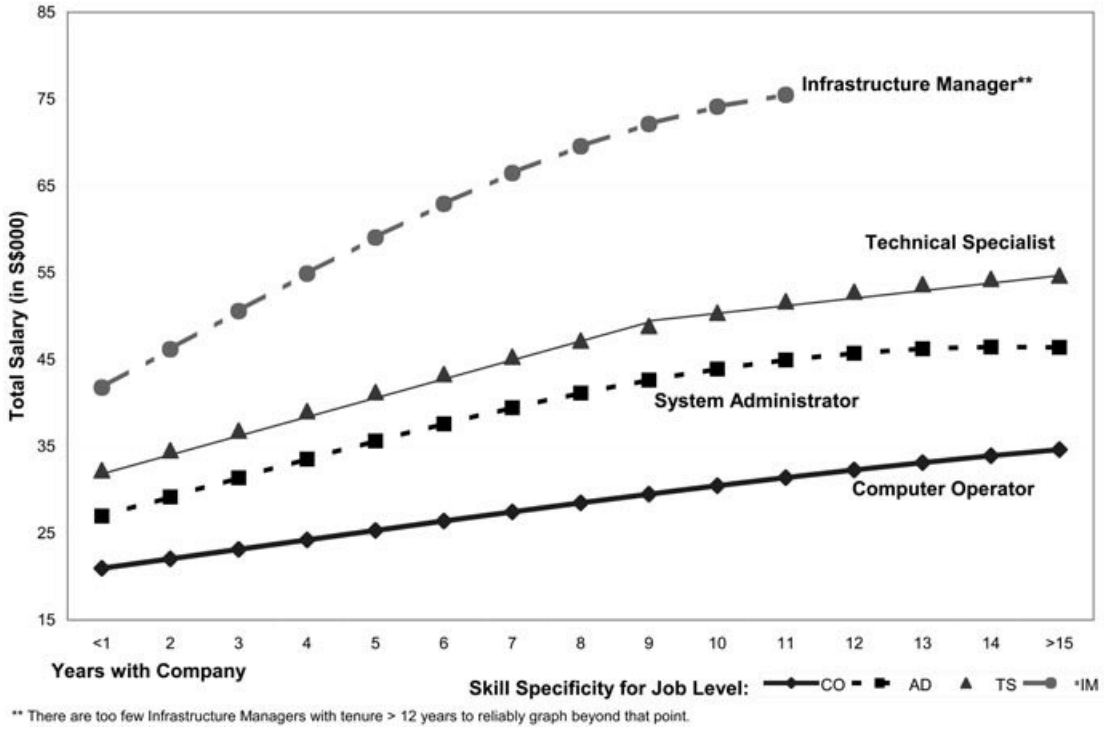

FIGURE 2. Compensation-Organizational Tenure Extrapolation by Level of Firm Skills Specificity for IT Infrastructure Jobs

ees. With the increasing prevalence of outsourcing and the use of contractors (Ho, Ang, & Straub, 2003; Koh, Ang, & Straub, 2004), future research could compare the longitudinal unfolding of the compensation of IT contractors vis-à-vis permanent employees. Longitudinal analysis would also be instructive to assess interactions between the external and internal labor market over time in influencing the compensation-tenure relationship in IT.

More significantly, our results show that the compensation change rate could differ based on the level of firm-specific human capital embodied in IT jobs. Specifically, the change rate of compensation increases with organizational tenure for IT professionals in jobs that require more firm-specific human capital, reflecting the increasing value of this firm-specific human capital.

Second, our results are based on data collected from Singapore, thereby opening up the possibility that the findings are specific to the Singapore context. There are, however, several positive aspects to studying the IT labor market in Singapore that can mitigate this limitation. First, prior research has highlighted that "although much research has been performed on managing IT employees, most of these studies have been restricted to examining North America" (Tan & Igbaria, 1994, p. 220). With increasing interest among researchers to study information systems topics in an international context, researchers have called on others to examine the human resource aspects of IT in different countries (e.g., Hunter & Beck, 2000; Tan & Igbaria, 1994). Second, Singapore is a culturally diverse nation founded as a parliamentary republic and operates based on the strategic pragmatism of a free market economy (see Schein, 1996). The latest World Economic Forum 2005–6 ranks the country sixth in its Global Competitiveness Report. Hence, Singapore operates in a free market economy, and the laws of demand and supply work in the IT labor market in Singapore, just as they would operate in the United States and Europe (Lopez-Claros, Porter, & Schwab, 2006). Also, as we have noted earlier, Singapore has a highly competitive IT labor market, akin to other nations in other parts of the world. Nevertheless, we acknowledge that although the IT labor market context in Singapore may be similar to other settings, the institutional context could be different. This is especially true regarding the country's size. Singapore is very small and not as geographically dispersed as the United States or countries in Europe. Thus, studies of compensation in Singapore may not be constrained by heterogeneity across regions or regional mobility issues otherwise present in nations with regional differences. Obviously, our findings must be validated in other settings, and extension of our ideas to other institutional contexts is essential.

Third, we did not control for job performance in our analysis, and job performance has been shown to be a major determinant of individuals' pay. Nevertheless, we do not see this as a major issue, as we collected data for *all* IT professionals in 43 companies, in different jobs. As there is a distribution of good and poor performers in each job and in each company, the potential for introducing biases by not including a control for job performance is mitigated.

Contributions to Research

Notwithstanding the potential limitations highlighted above, our study makes several contributions to research, and has several implications for both HR managers and IT professionals. Our study contributes to human capital theory by examining not only the relationship between compensation and tenure, but also, and more important, the moderating influence of firm skills specificity on the rate of change in compensation as it relates to tenure. Our results confirm the tenets of classical human theory within the IT field, in that compensation does rise with organizational tenure, all else being equal. More significantly, our results show that the compensation change rate could differ based on the level of firm-specific human capital embodied in IT jobs. Specifically, the change rate of compensation increases with organizational tenure for IT professionals in jobs that require more firm-specific human capital, reflecting the increasing value of this

firm-specific human capital. Our results imply that IT professionals in jobs requiring more firm-specific human capital (such as application development manager) receive proportionately greater compensation increases with organizational tenure to reflect returns on their investments in a long-term relationship with a firm. On the other hand, IT professionals in jobs requiring less firm-specific human capital (such as application programmer or technical specialist) may need to continually invest in developing marketable and productive technical competencies to experience compensation increases.

Much of the prior empirical research on compensation has focused on a single job category, primarily on executives and managers (e.g., Gerhart & Milkovich, 1990; Stroth, Brett, Baumann, & Reilly, 1996; Tosi & Gomez-Mejia, 1989). Other research has examined compensation across a wide array of jobs in many different professions but has not been able to examine compensation-tenure profiles within specific professions due to insufficient sample size (e.g., Topel, 1991). As such, none of the prior studies has examined the relationship between compensation and organizational tenure within one occupation for jobs that require different levels of firm-specific human capital. Our study demonstrates that different jobs within an occupation could require different competencies, some of which are more general and can be applied in many firms and others that are more specific to a particular firm. Thus, to understand whether compensation policies are influenced by the specificity of the human capital embodied in different jobs as predicted by human capital theory, it is necessary to measure the firm skills specificity of the jobs and to examine how the level of firm skills specificity relates to the compensation-tenure profiles for the jobs.

Implications for Practice

Prior research has highlighted the significant role of compensation in individuals' decisions to enter and remain within an occupation (McLean, 1996). In terms of implications for practice, this study highlights several key insights for managers and individual IT professionals.

Our results show that organizations value and are willing to pay more for jobs requiring higher levels of firm skills specificity. Consistent with the findings of prior research (e.g., D. M. S. Lee et al., 1995; Vitalari, 1985), we found that jobs requiring higher levels of firm-specific skills tend to be the managerial positions, whereas jobs requiring higher levels of general skills tend to be the technical IT jobs. The rewards to staying in an organization are significantly higher for IT professionals in managerial positions that require more firm-specific human capital, compared to IT professionals in positions that require more technical general human capital. This suggests that there may be a path of upward mobility across several jobs within a job family (e.g., from an applications programmer to a systems analyst, or from a project manager to an applications development manager). Due to the path of upward mobility across jobs within a job family, part of the tenure of an applications development manager in a company may be time spent in a position like a systems analyst. Hence, IT professionals can start accumulating firm-specific capital even when they are in jobs that require more technical general human capital. However, it is likely that individuals obtain the most opportunities to accumulate firm-specific capital when they are in jobs requiring high levels of firm skills specificity.

As a first step, HR managers could formally verbalize to IT employees that building firm-specific capital should be a professional goal, especially if individuals wish to progress to managerial jobs that require such firm-specific skills.

There are thus several actions that HR managers can take based on our results. As a first step, HR managers could formally verbalize to IT employees that building firm-specific capital should be a professional goal, especially if individuals wish to progress to managerial jobs that require such firm-specific skills. It is important that HR managers explain specifically how these efforts will be rewarded in terms of compensation and advancement. Second, HR managers may wish to design pro-

grams to help IT professionals develop firm-specific knowledge. This may not be through formal classroom programs, but rather through programs like mentoring schemes, where newer employees can be mentored by employees with more tenure in the firm (Hobday, 2000). Finally, the fact that the pay for jobs requiring higher levels of firm-specific human capital increases at an increasing rate suggests that organizations should be proactive in managing turnover of personnel in those IT jobs so as to retain the firm-specific human capital of the job incumbents.

Given the reluctance of organizations to invest in general training of their IT staff, the onus lies on IT professionals to constantly upgrade and develop their general IT competencies in order to stay relevant to the organization and to the profession. Thus, IT professionals may need to invest in reskilling themselves in state-of-the-art IT competencies in order to sustain their market value.

Our study also has implications for HR managers in helping them to determine effective compensation strategies for IT professionals. As highlighted by prior research, variance occurs in the wage practices adopted for different jobs within firms (Cappelli & Cascio, 1991). Our study suggests that jobs requiring a higher level of firm skill specificity typically operate within the internal labor market, whereas jobs requiring a higher level of general human capital typically operate within the external market. This result implies that managers should weight compensable factors that reflect firm-specific skills higher in job evaluations, thus placing jobs that require more firm-specific capital higher in the pay structure. When designing compensation for jobs requiring technical general human capital like applications programmer and technical specialists, HR managers may need to focus more on analyzing the prevailing compensation rates in the external labor market.

Our findings also have implications for IT professionals who want to better manage their career paths. IT researchers generally distinguish the career paths of IT professionals into two types: technical or managerial (Crepeau, Crook, Goslar, & McMurtrey, 1992; Ginzberg & Baroudi, 1988). Technical career paths occur when IT professionals hold a series of IT technical jobs during their careers. Managerial career paths occur when IT professionals begin their careers in IT technical jobs and then move into IT supervisory or managerial positions. Our study shows that, controlling for organizational tenure, average compensation is higher for professionals in IT jobs that require higher levels of firm-specific human capital, and that these jobs tend to be managerial in orientation. This suggests that individuals who choose to go into such jobs in IT tend to achieve greater career success, in terms of average compensation, than individuals who choose to stay in jobs with lower levels of firm-specific human capital.

These results appear to dispel the romanticism of a dual-career path for the IT professional. IT professionals who stay in technical positions and choose not to progress to managerial positions may find that their pay-rate growth decelerates with increased organizational tenure. On the other hand, their peers who take the managerial path may find their pay-rate growth accelerating with organizational tenure. Individuals who wish to stay on a technical career path may do better by keeping their technical general skills updated and marketable, and operate in the external labor market by moving to organizations that require and value their technical general skills. There may be a real threat of obsolescence for IT professionals with general IT competencies if they remain within a single firm and do not upgrade their IT skills and gain exposure to technical jobs in other organizations. The "state of the practice" in computing is continually changing, and most practitioners have knowledge of only a narrow set of technologies (Glass, 2000). However, given the reluctance of organizations to invest in general training of their IT staff, the onus lies on IT professionals to constantly upgrade and develop their general IT competencies in order to stay relevant to the organization and to the profession. Thus, IT professionals may need to invest in reskilling themselves in state-of-the-art IT competencies in order to sustain their market value.

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Note

1. As a robustness check, we estimated our models using generalized least squares (Greene, 2000) to accommodate the possibility that residuals may not be independent, but rather correlated across individuals within an organization. The results are consistent with those from the OLS estimation.

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