DURATION OF IT HUMAN CAPITAL EMPLOYMENT

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Abstract

Investment in information technology (**IT**) and the strategic benefits derived from successful systems are critical to the large, modern enterprise. Delivering these systems requires talented information systems (**IS**) professionals and the human capital assets they bring to an employment relationship. However, these relationships frequently fail at inopportune times, to the detriment of the employing firm. This raises questions about how long a firm and an individual can expect an IT employment relationship will last. The questions are made more significant by the large investment and uncertain recovery period associated with skills employed in a technologically dynamic environment. Drawing on the theory of human capital from economics (e.g., Becker, 1962), we develop an explanation for the duration of employment among IS professionals. We perform empirical tests of related hypothesis using a *duration model with time-varying covariates* and observations on over 600 IS professionals. The results suggest that the duration of an employment relationship can be explained in terms of the content of the IT human capital involved, the equity of the employment relationship and other organizational factors.

Keywords: Duration analysis, economic analysis, human capital, IS professionals, IT human capital, retention, retention policies, separation, workforce retention, IT workforce.

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1. INTRODUCTION

Recent research highlights the role that investments in new information technologies (**ITs**) play in creating business value and executing business strategy (Brynjolfsson and Hitt 1998; Dewan and Kraemer 1998). Yet in competitive markets, a firm's ability to earn an adequate return on strategic IT investments critically depends on the capabilities of the human elements present for information systems design, development, deployment, and management. Capable IT professionals are in short supply economy-wide, however.

Illustrating this shortfall in IT professionals, the Information Technology Association of America (**ITAA**) publishes an annual "state of the IT workforce" study on nation-wide trends. Its February 1998 study estimated that in 1997, for a national workforce of 3.3 million programmers, systems analysts and computer engineers, some 346,000 positions were open (ITAA 1998). A 1997 CIO Magazine survey of 316 U.S. companies with revenues of $2.6 billion or more estimated IS staff turnover reveals the same problem, though its estimate was somewhat higher at about 14.5% average turnover in a smaller sample of firms (Fabris 1998). We define "turnover" as *a firm-level measure of worker replacement during some period* – annually, in this case. See Table 1.

Table 1. IS Turnover Rates by Firm Size

Firm's Staff Size	Annualized Turnover Rate
< 50	14.7%
50-99	19.7%
100-199	16.0%
200-499	10.4%
500+	12.4%
Average	14.5%

Source: Adapted from Fabris, P. "Desperate Times, Creative Measures," *CIO Magazine*, January 1, 1998 (http://www.cio.com/archive/010198_over.html).

Thus, for every 10 to 15 employees at mid-size and larger companies in the U.S., one information systems (**IS**) position is unfilled. The 1997 shortfall was more than 190,000 workers (ITAA 1997), indicating the significant recent growth in the supply and demand gap. Clearly, the demand for technical professionals continues to grow, and is unlikely to be reduced any time soon (Fabris 1998, Petersen and Forcier 1998).

This level of turnover greatly reduces most firms' abilities to deliver software projects on time and on budget, too. For example, the 1997 CIO Magazine survey also identified the transaction costs of hiring to fill various kinds of gaps in IS staffs at the responding firms (Fabris 1998). The survey's results indicated that it took more than six months to fill an experienced IS staff position, and the non-salary average cost to a firm was on the order of $19,000, a significant budgetary disruption. (See Table 2.) No wonder senior managers in the IS function have begun to express desperation about their "IT human capital."

Table 2. Costs of Filling IS Staff Vacancies in 1997

IS Staff Type	Months to Fill Position	Non-Salary Cost to Fill Position
Executive Mgmt	7.6	$30,277
Experienced Staff	6.2	$19,219
Entry-Level Staff	3.8	$ 9,777

Source: Fabris, P. "Desperate Times, Creative Measures," *CIO Magazine*, January 1, 1998 (http://www.cio.com/archive/010198_over.html).

In this research, we will focus on this essential link in the IT value chain: *IT human capital*. Consistent with Nobel Prize-winning economist Gary Becker's book, *Human Capital* (Becker 1962), we define "IT human capital" as *the stock of knowledge, skills, and abilities embedded in an IT professional that results from natural endowment and relevant education, and training-related investment activities that occur over time*. To distinguish human capital from the physical that most firms employ in production, Becker wrote that "you cannot separate a person from his or her knowledge, skills, health, or values the way it is possible to move financial and physical assets while the owner stays put" (Becker, 19xx, p. xxx). From this perspective, IT human capital is an economic asset in which individuals and firms can invest, however, the investment stays with the person rather than with the organization.

As organizations scramble to leverage new technologies, changes in the skills and knowledge required by firms employing IT professionals also changes. According to a recent Gartner Group study, IS departments spend 65% of their recruiting efforts finding people with technical skills, and about 35% finding people with business and IT management skills (Fields 1998). Gartner Group estimates that by 2003 the emphasis will change significantly, so that more firms will move to outsource more of their IT labor. The result is an environment in which firms and individuals must make investment decisions to develop and apply the competencies necessary for success – both for today and for the future.

This creates opportunities for those with relevant skills. But it also makes skill set development a challenge for individuals who are employed, just as staff retention is a critical issue for employers. We address these issues in the context of *human capital theory*, a theoretical perspective that views investment in a workforce as a capital investment (Becker 1962; Becker 1995; Becker, Murphy, and Tamura 1990). Economics treats various issues of IT human capital: models of human capital investment (Glomm and Ravikumar 1992, Hashimoto 1981, Keane and Wolpin 1997), separation decisions (Johnson 1978; Parsons 1986), and employee mobility (Katz and Ziderman 1990).

In prior research on the problem of the separation and retention of IT professionals, we applied human capital theory occupations (Josefek and Kauffman 1998). In this work, we defined "separation" as *an employee-initiated severing of the employment relationship*. We found evidence to suggest that IT human capital is different from human capital in less dynamic and less knowledge-intensive when it comes to separation decisionmaking. Technical and computer professionals may value opportunities to learn about new technologies and to advance their technical skills in a manner that is not seen elsewhere among the less technical workforce. We also learned that the separation of IT professionals from the firms that employed them was consistent with the active management of human capital assets by their owners, the employees.

Our prior results also provide motivation for understanding the impact and value of controlling relevant covariates on the duration of IT employment. We define "duration" relative to IT employment as *the length of time that passes from the time an employee begins with a firm up to the time that they choose to separate from the firm.* Duration of employment becomes a significant issue relative to staff retention. Consider the comments of James R. Kinney, VP and CIO of Kraft Foods, Inc. of Northfield, Illinois and president of the Society for Information Management:

> *"It used to be that people who stayed with us eight to ten years would usually remain here for their whole careers. [But, a growing percentage of those workers are leaving.] Just about all the CIOs I have talked to say the same thing,"* (Fabris 1998)

Kraft's turnover rate ranges from 6% to 8%, low by the standards reported by CIO Magazine's and the ITAA's studies. But signing bonuses, higher salaries (Becker, Murphy, and Tamura 1990)), and new opportunities to improve an IT professional's technical knowledge all create pressures to separate.

Existing IS research, however, does not consider IT human capital or IT human capital theory as a factor in separation, turnover or retention. On the other hand, the existing economics

literature addresses human capital and human capital theory as it relates to broad classes of workers (e.g., all workers, or perhaps differentiating between professional and other labor). The economics literature also reports research into some sub-classes of employees (e.g., nurses), but none considers IT human capital. As we explore and report conditions for IT human capital separation from the firm, we uncover aspects that seem to make the labor of the IT professional different from that of other classes and categories of labor.

Motivated by human capital theory, we view IT professionals' decisions to remain with or separate from a firm in utility maximization terms, given a particular skill set, and opportunities within the firm and a market context. This perspective enables us to derive hypotheses that suggest different impacts for IT skill characteristics and other factors that may bear on separation and the duration of employment. In particular, we address the following questions:

- How long can the firm expect the IT employment relationship to last?
- To what extent do factors that are significant to separation affect IT employment duration? Why do they operate in the manner that they do?
- What implications do these factors and IT employment duration have for employment policy and retention-related interventions?

We answer these questions by leveraging theory and methods from multiple disciplines, including our own previous work. Our focus in this paper is on the failure of an employment relationship due to separation. We perform empirical tests of hypotheses as part of ongoing research at a multidivisional organization operating as a set of loosely federated independent divisions. These divisions employ more than 700 IT professionals. The nature of their business operations and human resource policies closely parallel those of large IT-intensive firms across the U.S. economy.

2. RELEVANT THEORY

Three literatures provide relevant insights into the failure of an IT employment relationship: economics, management, and information systems. Each contributes to our understanding of the behavior of IT professionals as they make choices about separation, yet none offers a completely satisfactory explanation for what we have observed in the marketplace.

2.1. The Economics of Human Capital

Human capital theory (Parsons 1986) posits that individuals invest time and resources in knowledge and skill development to acquire productivity-enhancing skills. The resulting capital

asset gives an individual productive capacity to leverage in an employment relationship and earn a market wage. Rational agents in the workforce decide among alternate investment and employment actions, and seek optimal levels of productivity consistent with their individual goals.

Nevertheless, as firms and individuals pursue relationships, each is constrained by imperfect information and asymmetric information. Consequently, good skill-to-position matches require some experimentation; both firms and individuals test the relationships they engage in for value. This motivates a theory of job search (Mortensen 1986) in which individuals search for appropriate matches. It also lays the groundwork for theories of job matching (Sicherman and Galor 1990) and occupational choice (McCall 1991). The theories explain job and occupational changes as a search for a more appropriate match between an individual's human capital and her employer or occupation.

These theories offer sound economic reasoning for separation behavior as an individual seeks to maximize return on investment in human capital over the course of her working life: She will do so subject to information and resource constraints. Managerial actions and policy also influence individual employment-related behavior. For example, the nature of a position may constrain the value that an individual can create for the firm. This limits return on capital for anyone employed in that position.

2.2. Management and Information Systems Perspectives

The management and IS literatures establish the importance of IT human capital. Members of the firm's IT workforce make up a pool of human capital that, when appropriately deployed, is a resource capable of creating value and delivering competitive advantage. Barney (Barney 1991) and others (Ross, Beath, and Goodhue 1996) interpret the well known resource-based theory of the firm and emphasize the importance of value-producing resources that are rare, difficult to imitate, and not vulnerable to substitution. Upon meeting these criteria, IT human capital becomes a critical strategic asset capable of delivering competitive advantage (Josefek Jr. and Kauffman 1997)).

Explanatory factors addressed by the management and IS literatures include a variety of individual and task considerations. These include individual demographics, job and career satisfaction, job type, task characteristics, attitudes toward the organization, intention to separate, and role stressors, such as ambiguity, conflict, or boundary spanning (Baroudi 1985; Igbaria, Meredith, and Smith 1994). The management literature also addresses organization level factors like presence of a union and industry (Cotton and Tuttle 1986). Much of this literature employs

path analysis of cross-sectional survey data to identify turnover correlates and assess their relative influence. Intention to leave an employer is the common dependent variable.

2.3. Other Considerations: Pressure to Separate and Relationship Equity

In addition to IT human capital, individual, and organizational characteristics, two other aspects of separation deserve attention: relationship equity and pressure to separate. Individuals and firms monitor their respective contributions to, and benefits derived from, the employment relationship. "Employment relationship equity" refers to *the net benefit derived by each party to the employment relationship*. When the net benefit is negative for either the employer or the employee, the relationship is inequitable. This differs from the way we often think about employment relationships and the equality of treatment or equality of benefit distribution. Instead, this approach tests whether the relationship is equitable by considering the benefit received and the costs borne by each party.

As we have seen in the prior literature, several factors affect the likelihood of separation: human capital, relationship equity, individual characteristics, and organizational characteristics. The impact of any single factor may not be sufficient to cause separation, even when exerting its maximum effect. Instead, each causal factor contributes to some level of "pressure to separate." *Pressure to separate, in the IT employment context, is akin to disutility or dissatisfaction*, depending upon the referent literature chosen. When the pressure to separate reaches some critical threshold, separation will occur. We call this the "separation threshold" (Josefek. and Kauffman 1998). Separation will not occur until the pressure exceeds the separation threshold. This is likely to be true regardless of level of pressure necessary to cause a specific individual to separate. Individuals are likely to vary in the level of pressure they can withstand before concluding that leaving the employer is their best option.

2.4. The Employment Duration Problem

Earning a return on an asset depends largely upon two factors: the magnitude of value the asset creates during each period of its life and the life of the asset. After establishing the value-creating capability of an asset, the next relevant issue is the useful life of the asset. From the point of view of human capital theory, earlier investments in human capital are consistent with greater returns in an employee's limited life span, although they involve significant opportunity costs. In our present context, however, our concern is about the length of an employment relationship – its duration – irrespective of when the relationship began. This is a particularly important consideration since investments in knowledge, skills, and abilities of workforce participants, i.e., investments in IT human capital, create assets that are owned by the individual, not by the firm.

Asset characteristics and the nature of their application largely determine potential return. Consequently, we expect the dynamic nature of IT human capital – especially in today's market context – to affect IT workforce behavior. For example, as firms adopt new technologies, the nature of work and skills necessary to achieve individual productivity change. Human capital previously valued for its productive capacity depreciates and, absent investment in new skills and knowledge, an individual's value to the firm decreases. The result is a growing mismatch between the individual and the tasks associated with a changing job description. The likelihood for separation increases, as a result.

The relevant theory suggests that separation behavior within the IT workforce ought to be consistent with the active management of human capital by people who own it. By active management, we mean to indicate that over time employees assess the level of utility (or disutility) they experience in the context of their employment relationship with a firm. Being satisfied in one period may or may not have a bearing on the employee's level of satisfaction with the employment relationship in a subsequent period. Consequently, we expect to be able to detect employees' responses *as a population* to changes in observable factors that influence likelihood to separate in the business and technology landscape, the employment relationship, and employment policy. Actual separation may not occur immediately, but pressure to separate will build until it reaches some threshold and separation becomes the most attractive alternative. An employee who separates from the firm crosses the "separation threshold" in utility terms relative to her employment relationship with the firm.

2.5. Evaluative Approaches

Separation behavior among IT professionals is the result of a utility maximizing decision involving two potential actions – to separate or to stay – that characterize an employee's choice set relative to the employment relationship. The decision making process incorporates a set of primary drivers, moderating factors, and time. In prior research, we identified the relevant set of primary drivers as IT human capital characteristics and relationship equity (Josefek and Kauffman 1999). IT human capital characteristics tend to be unobservable in a direct sense. Consequently, our approach to the specification of these characteristics has been to identify different kinds of skill set clusters that relate to specific jobs and families of jobs commonly seen in IS operations. This approach, in our view, provides sufficient analytical power to address IT human capital characteristics, even though the reader should view this approach as being only *second best.*

To understand better our perspective with respect to the identification of IT human capital characteristics, the reader should consider the following scenario. Imagine an

organization in which some IT professionals are highly skilled with hardware or programming languages. Others in the organization may be more highly skilled with business processes, managing end-user relationships, and creating systems concepts that facilitate business strategy. By subdividing dominant skill categories among IT professionals to an appropriate level, we can address the extent and direction of effect that each skill set group has on separation. The natural starting points, in our view, for such subdivisions among IT professionals is with respect to application development, infrastructure development, project management, project consulting, and IS project-related business-side expertise.[1]

In a similar vein, varying levels of organizational granularity – employee-to-manager, work group, project, and division within the firm – may provide insights into the moderating effects of organizational characteristics. One would logically hypothesize that "the specific organization won't matter," because there is no theory that predicts that any given part of an organization ought to be a better place to work than any other part. But invariably organization does indeed matter. The result is that some organizations – for whatever observable or unobservable reasons – create greater pressure for their employees to separate, and this is often reflected in their current and historical rates of turnover to some extent.

The primary determinants of relationship equity include an individual's contribution to the firm evaluated on the basis on her performance in the relationship, and the firm's contribution to the individual measured in the form of her compensation. However, neither is sufficient to determine equity. *Instead, one must consider compensation in light of performance – and performance in light of compensation.* For example, a programmer who is paid below the market rate for programmers and below the level of her co-workers may well be in an equitable

[1] Our approach is consistent with that discussed by Field (1998), who cites the importance of identifying and filling various kinds of roles in IS organizations. Field also suggests that other approaches are possible, too, and we agree. For example, the Stamford, Connecticut.-based Meta Group Inc. has taken a different tack regarding the definition of IS-related skill sets that is reminiscent of Fred Brook's proposal in *The Mythical Man Month* (Brooks 1995) based on what he learned about the development of IBM mainframe computing architectures in the 1970s. The Meta Group defines several different roles that IS staff members can play, each of which is indicative of a somewhat different kind of human capital. They include the "engineer," who takes a systematic approach to analyzing project problems. The "urban planner" keys on scalable IT architecture and keeping a project on track relative to IT strategy. The "architect" is the designer of the effective IT organization consistent with corporate principles. The "psychologist" aims to reduce the gaps in communications among divergent business cultures to improve the likelihood of project and system success. And, finally, the "soccer player" responds to the changing nature of a project, including its scope creep, budget changes and so on, to keep things on track to completion.

Cambridge, Massachusetts-based Forrester Research offers a somewhat different interpretation, but one that is again consistent with the identification of different kinds of IT human capital. They include "the marine, the inventor, the ambassador and the professor," each of which is descriptive of the different kinds of non-technical roles that must be filled for an IT project to succeed.

relationship if her contribution is equally sub-standard. What is important is the extent and magnitude of the gap between her performance-adjusted compensation and her actual compensation.

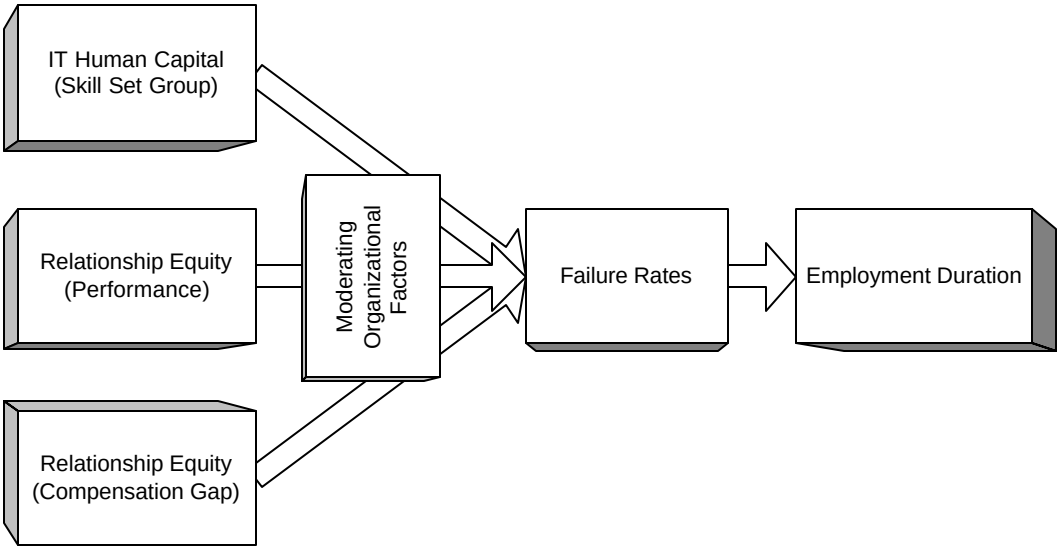
Time enters the separation and retention process in an interesting way. We know from the second law of thermodynamics that disintegration is an undeniable consequence of time. The only way to stave it off is to work to avoid it. So it is with employment relationships: they tend to dissolve over time, unless the employee and the employer manage the quality of the employment relationship. Therefore, we argue that over time, one expects the failure rate of the employment relationship to increase. On the other hand, experienced managers know that turnover tends to be the greatest among employees in their first two years of employment. This observation argues for a decreasing failure rate over time. But how do these facts relate to what we might observe for a real organization's turnover? Is the failure rate of the employment relationship across a population of employees increasing, on average, over time? Do employment relationships exhibit entropy in this respect? Or is the failure rate decreasing, on average, as Kraft Inc.'s CIO indicated had been the case until recently at his firm among IT professionals.

In the current research, we are interested in the duration of IT employment and, consequently, in the failure rate and whether it is upward sloping across time. One can think of employment duration as the counterpart to cumulative probability of separation. It is also possible to think of employment duration in terms of cumulative probabilities of separation and retention relative to an entire workforce. In the remainder of this paper, we will illustrate this latter perspective, and show how it relates to individual assessments of whether separation is an employee's best option at some point in time.

3. CONSTRUCTS AND HYPOTHESES DEVELOPMENT

Our research questions take aim at the core of IT employment duration and the factors that affect duration. Specifically, we focus on the combined direct effects of IT human capital skill set groups, relationship equity (as a function of performance and compensation information), and the moderating influence that different organizations have on IT employment relationship failure rates across time. The failure rates, by virtue of their relationship with survival, determine employment duration. Figure 1 illustrates the relationship among the constructs. (See Figure 1.)

Figure 1. Key Drivers of Separation and Duration in the IT Employment Relationship



In this section, we explain the specific skill set groups that underlie IT human capital, the elements of the relationship equity construct, and the role of organizational factors and time.

3.1. IT Human Capital and Skill Set Groups

The economics literature addresses both general and specific human capital. *Specific human capital* is of value to only a single employer. *General human capital*, however, offers value to more than one employer. As one might expect, individuals who have a high ratio of specific to general human capital are more likely to remain with their employer; no firm other than their current employer will have a use for their dominant skills. In contrast, individuals whose general human capital dominates their specific human capital have no such constraint; their dominant skills are valued across companies, and possibly even across industries. If the human capital of IT professionals behaves in a similar fashion, we should see those with intensely technology-focused human capital exhibiting higher separation rates than those who have a more business-focused orientation.

Consider, for example, a group of applications programmers with strong C++ skills and a group of analysts with strong process, user management, and communication skills. Individuals in both groups have a mix of specific and general IT human capital. However, the programmers are likely to have human capital dominated by intensely technology-focused skills (Katz and Ziderman 1990), whereas the analysts derive much of their value from knowledge of the people and processes employed by their firm (specific human capital). Consequently, one would expect to observe a lower rate of separation among the analysts.

The following specific skill set groups provide a reasonable balance between detail and parsimony:

- applications – programming and systems analysis skills
- architecture – architectural analysis and integration skills
- business – business analysis skills
- operations – media handling and distribution skills
- technical management – technical project management skills

The applications, architecture, and technical management skill set groups reflect a greater technology focus than do the business and operations skill set groups.

As organizations adopt new technologies, skills within these skill set groups often undergo rapid devaluation. Recognizing this phenomenon, we expect to observe behavior that is highly consistent with active human capital management by IT professionals. In particular, we expect to see groups of IT professionals with greater technology-focus tending to exhibit higher separation rates, as they seek to maximize their return on investment during an uncertain, and perhaps very short, recovery period.

3.2. Relationship Equity

Relationship equity rests upon the premise that an employer and its employees are partners to employment relationships because, by doing so, they are better off than they would be otherwise. Either may independently sever the relationship if it no longer provides a sufficient level of benefit. This is true even in the presence of contracts or other agreements to the contrary, though ending the relationship may then be costly. Consequently, we expect that as the net benefit of engaging in the relationship drops increasingly below zero while other alternatives are available, the observed rate of separation will increase.

Individual performance and compensation provide workable starting points from which to evaluate the net benefits that accrue to the employee and employer. These constructs form a foundation for exchange between employer and employee. As performance and compensation become increasingly disproportionate, the resulting inequity will increase and separation rates will rise. From the firm's perspective, as an individual's performance declines, the firm receives less. If we assume that compensation is a function of expected performance, then lesser performance reduces the net benefit derived by the firm. From the individual's perspective, as compensation declines relative to performance and earning potential at market rates, the net benefit of remaining in the relationship also decreases. The validity of these relationships among performance, compensation, and market rates is reinforced by the typical firm requirement for formal performance evaluations by managers in conjunction with compensation adjustments.

3.3. Organization

Organizational characteristics undoubtedly have some effect on separation behavior. For years, IBM and AT&T were known for the durability of their employment relationships relative to other companies. Regardless of the specific causal factors, there can be little doubt that characteristics of each organization (e.g., compensation levels, work environment quality, human resources management practices and organizational culture) affected employment duration across their respective workforces. That no firm can impose employment on an individual suggests organizational characteristics have a moderating effect, rather than direct effect on separation behavior. The direction and magnitude of the relative moderating effect depends upon the specific organizations in the comparison set. Consequently, there can be no *a priori* expectation about the impact a given organization will have on separation behavior.

3.4. Time

At any moment in time, there is some probability that an employment relationship will fail. Upon failure, we can determine the duration of employment. If the relationship does not fail, then there is some probability that it will fail during the next period, and so on, into the future. These probabilities form a distribution that reflects the failure rate across time, provided the employment relationship survives. Conceptually, it is straightforward to convert the probability of failure to the probability of survival, resulting in the firm's observed ability to retain its employees. Taking this next step, the probability of survival during successive periods yields a probability of the employment relationship surviving for a given duration.

As we previously indicated, there are arguments for both positive and negative slopes in the probability density function. Either slope indicates that separation rates may vary throughout the life of the employment relationship. However, even though we recognize the potential importance of the time that an individual has been with an organization, we make no assertion as to slope of the density function.

3.5. Hypotheses

From this discussion, four primary hypotheses emerge, each dealing with one of the core constructs in our model: human capital, relationship equity, organizational impact and the role of time:

- **Hypothesis 1 – The IT Human Capital Hypothesis.** As the intensity of technology focus increases across skill set groups, employment relationship duration decreases.
- **Hypothesis 2 – The General Relationship Equity Hypothesis.** As relationship equity decreases, employment relationship duration decreases.

- **Hypothesis 2a – The Performance Hypothesis.** As performance decreases, employment relationship duration decreases.
- **Hypothesis 2b – The Compensation Gap Hypothesis.** As the compensation gap becomes increasingly unfavorable, employment relationship duration decreases.

- **Hypothesis 3 – The Organizational Effect Hypothesis.** *A priori*, organizational factors have no effect on employment relationship duration.
- **Hypothesis 4 – The Time Hypothesis.** The length of time that an IT professional has been with the organization has no effect on the likelihood of separation from it in the next period.

We next turn to a discussion of the research context in which we will test these hypotheses, and the measurement issues that relate to our specification of the various variables that will be included in the empirical model.

4. RESEARCH CONTEXT AND DATA COLLECTION

The context of this study provided unique opportunities for conducting research on the factors that drive employment duration in an IT workforce. It also raises important issues about data collection and measurement. We next consider these issues.

4.1. Twin Cities, Inc., a Loosely-Federated Multi-Divisional Firm

Twin Cities Inc. (**TCI**), is a large, diversified services firm comprised of separate and highly autonomous divisions that operate in different industries on multiple continents. Its IT management describes the structure as a loose federation of independent organizational entities. One indicator of the degree of independence that exists within the federation is that each division has a vice president that heads the division's IT functions. In addition, each division's IT support group is different in size, mix of technologies employed, reputation, and work environment. In total, some 850 professionals, including 250 contractors, support business units operating in five different service industries around the globe. (For additional information and background on TCI, the interested reader should see Josefek and Kauffman, 1998 and 1999.)

For the most recent calendar year, TCI's management reported turnover within the IT organizations at 19%, higher than what the ITAA and the *CIO Magazine* studies that we discussed earlier have estimated. The high level of turnover is viewed as a serious threat to the organization's IT human capital base and to its organizational performance. The ten plus hours per week some IT managers must spend recruiting and retaining employees is only a small part of the real cost of this situation for TCI. Furthermore, it turns out that this is the case despite substantial investments in employee training, career development activities, retention bonuses,

and a host of other commonly prescribed and applied interventions. Senior managers agree that increasing retention is critical to the success of their operations.

Several factors provide a level of confidence about the results obtained in this research relative to the extent to which they are generalizable beyond TCI. These include divisional independence; separation by industry, technology, and work environment; and the close parallel between TCI's turnover situation and that of other large organizations across the country. Taking the elements of this description together, TCI is representative of many Fortune 500 firms, both in the size and in the scope of its business operations – and its headaches with IT.

4.2. Contextual Issues and Data Collection Choices

A number of contextual data collection issues, common to this type of research, arose during the course of our field study. Consequently, the reader will benefit from better understanding the rationale for some of the choices we made about the form of the variables in the model and how they were measured, and how data collection was conducted. There are three primary issues: the issue of observability relative to the dependent variable in the model, the measurability of certain constructs, and the manner in which some variables in the model were constructed.

Observability. As we mentioned previously, the IS literature on turnover closely parallels some of the organizational research in its focus on psychological constructs such as intention to separate and satisfaction with job or employer. While it is true that companies often conduct employee satisfaction type surveys, it is also true that respondent anonymity is an essential element of that process. In the absence of accurate individual level measurement, most IT managers have little or no basis for predicting separation or defending interventions they believe to be appropriate. To make this research more meaningful, we chose to focus data collection on readily observable elements of an employment relationship. Skill set group, division, performance rating, salary data, and observed employment duration all fall into this category; they are readily observable in most organizational environments. This increases the likelihood, to some extent, that the present research can be managerially actionable.

Measurability. The focus on observable data and the limited time from during which we can reasonably collect data within TCI places key constraints on the data set. For example, collecting data on the final duration of employment requires that the researcher wait until separation is observed. Obviously, it is not very practical to suspend analysis until every individual in the data set actually separates from the firm. Instead, we suspend observation at the end of a period that was chosen by TCI's management based on data they were willing to supply to us, and then we include information about duration as of that date. These "censored"

observations contain useful information provided the statistical methods that we employ properly address the censoring (Kalbfleisch and Prentice 1980).

The second constraint on the data set relative to our model is that some constructs are not directly measurable. For example, such is the case with the equity of the relationship: we cannot directly measure the "true" net benefit derived from the relationship by either the IT professional and the firm, even though the theory states that employees and their employer ought to be able to estimate it. However, second-best, but readily observable proxies (Kiefer 1988) give some indications of the benefits derived. Similarly, the skill set groups measure only a subset of individual IT human capital. The intent of the proxies is to realize a reasonable indicator of the latent constructs (Lawless 1982).

Variable Construction. A suitable transformation process can increase the performance of proxies and result in data that more closely approximate the underlying construct. In our data set, transformation can improve the proxies related to the equity of the employment relationship. Consider an organization that uses a five-point numeric scale. A "5" indicates stellar contributions from the employee, and "0"indicates the greatest deficiency. It is quite likely, however, that mid-range performance does not result in mid-range performance ratings (i.e., ratings with mean "3" and greater or lesser contributions distributed nicely around the mid-point). More likely, managers assign some value, say "4", to indicate performance on par, and ratings of more than "4.9" or less than "2.5" are rarely seen.[2] Since we are dealing with human performance, forcing a normal distribution with some mean and variance is appropriate given a sufficiently large sample. In the current data set, we transform an employee's performance rating by subtracting the mean and dividing by the standard deviation. This results in a standardized performance rating measure with mean zero and a normal distribution. This more meaningful proxy better approximates relative performance across individuals and is more likely to reflect their actual contribution to the firm.

Compensation equity presents a similar challenge. Here one would expect compensation to approximate mean market rates, with an adjustment upward or downward in some range, based upon individual contribution to the firm. (See Appendix A – The Relationship Between Compensation and Performance). Salary alone does not provide that though. Nor does a comparison between the employee's salary and the midpoint of an organization's salary range for a given position. So instead, we construct salary gap and percent salary gap by transforming the relevant related variables. "Salary gap" is *the difference between actual salary and performance*

[2] One is reminded of "A Prairie Home Companion," the radio show on National Public Radio hosted by Garrison Keillor, in which he describes the children of Lake Wobegon as all being "above average."

adjusted salary. Determining performance-adjusted salary requires equating mid-range performance to midpoint data for similar positions as determined during recent market salary surveys. Position-specific salary ranges and standardized performance ratings then allow for adjustment above or below the mid-point salary. The resulting "performance-adjusted salary" *approximates an equitable salary and subtraction yields the salary gap as a nominal amount.* Finally, dividing the salary gap by performance adjusted salary yields "percent salary gap": *a measure of relationship equity from the compensation perspective.*

5. METHODOLOGY

Duration modeling and duration analysis models (e.g., Kalbfleisch and Prentice 1980, Kiefer 1988) provide a natural methodology for investigating the likelihood of failure of an employment relationship. The approach provides a ready means to assess the likelihood of an employee's departure during the next period, provided she continues in the employment relationship up to the current period. The literature often refers to individual absence of failure as an instance of "survival," and duration models, more generally, as "survival models" based on their applicability in medical research. Another often-used name is "failure time models," in reference to studies of the time-to-failure of mechanical or electrical components in physical systems.

5.1. The Concept of "Duration" and Time-Varying Covariates

In most studies that employ duration modeling approaches, the primary issue of interest is duration itself. How long does it take for failure to occur relative to the phenomenon that is being studied? For example, with different kinds of medical treatments for a specific diagnosis of disease, an important question arises that bears on the issue of healthcare quality: How long do patients live following exposure to different treatment alternatives? (In this case, failure occurs when a patient passes away due to the disease.) In a manufacturing system environment, the focus on duration reflects interest in the likely failure time of some system component. Subsequently, analysis may turn to the impact of alternative maintenance procedures (treatments) intended to increase the duration of uninterrupted system performance. Duration modeling can answer questions like these as well.

However, when we extend the model to broaden the focus from duration to include other factors that may affect duration, it is necessary to introduce "covariates" to the basic model. "Covariates" are *variables that one can reasonably expect are correlated with some time-specific variation in the likelihood of failure, and thus with the final duration of the employment relationship*. Very often, researchers think of such covariates as the causal factors of duration.

This emphasizes the fact that duration can be a function of a variety of things, each with a potentially orthogonal impact on the observed outcome.

In the current research, we apply a model that allows for "time-varying covariates." "Time-varying covariates" are *variables whose values change during the course of observation, and which again one can reasonably expect to be correlated with the time until failure*. Greene (1997, p. <number> characterizes "the treatment of time-varying covariates [as] a considerable complication" relative to basic duration models that focus primarily on the effects of time on the likelihood of failure.

In the material that follows, we introduce the basic elements of duration modeling to set up the specification of our empirical model. We also discuss some of the considerations that must be taken into account when assessing the quality of the fit of an estimated duration model, as well robustness issues relative to the model's estimated parameters. Next, we address "censoring" of the dependent variable, a problem common to standard regression analyses involving microeconomic data, and especially prevalent in studies involving duration analysis.

5.2 A Duration Model for IT Human Capital

Within the context of duration analysis, there are several ways to describe the elapsed time from date of hire to date of separation. We begin by assuming employment duration, T, is a continuous random variable with some distribution conditioned on a set of covariates. There are several ways to characterize the distribution of T including:

- By its cumulative failure time distribution function: the cumulative probability of separation up to some period:

$$F(t) = \int_0^t f(s)ds = \Pr(T \le t)$$

- By its probability distribution function: the probability of separation during a specified period:

$$f(t) = dF(t)/dt$$

- By the *hazard function*: the probability of separation during a specified period provided the individual remains employed to the start of that period:

$$h(t) = f(t)/(1 - F(t)) = \Pr(t \le T \le t + \Delta \mid T \ge t)$$

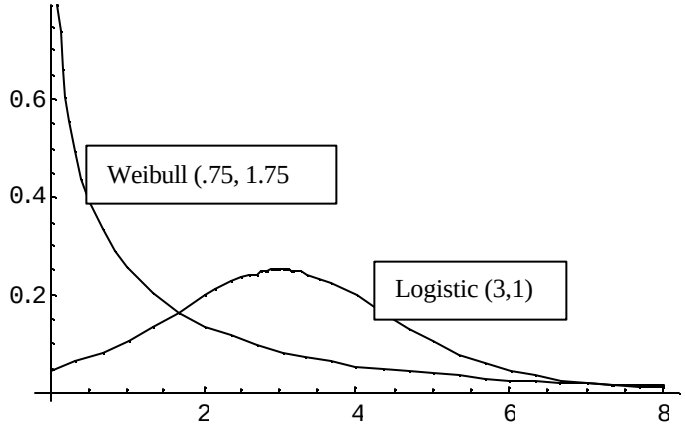
Kauffman, McAndrews, and Wang (1998) offer an exposition of duration model development and details about relationships among these functions.

In the current research we are most interested in the likelihood of separation among IT professionals who are with the firm in the current period. Consequently, it is the hazard function, and the forward-looking or hazard rate it yields, that are initially of interest. In essence, this

"hazard" is the hazard of employment relationship failure that the firm faces and the associated loss of valuable IT human capital.

As stated previously, whether probability of separation increases or decreases over time is an empirical question. Selecting an appropriate distribution for the hazard function then becomes an important consideration. Common practice, model fit with the data, and analytical value of the functional form provides. The most commonly used distributions include the exponential, Weibull and logistic distributions (Greene 1997). All are distributions for non-negative random variables and, in that respect, are suitable distributions for the time variable. However, the exponential distribution is inappropriate because it implies a time-invariant hazard rate. The Weibull distribution provides a monotonically increasing (or decreasing) hazard depending upon the value taken by a coefficient a, which we will address in a moment. The hazard rate in the logistic distribution first increases then decreases. Our approach is to illustrate the analysis using the Weibull distribution and then compare the Weibull results with results obtained given a logistic distribution. (See Figure 2.)

Figure 2. Comparison of Weibull and Logistic Distributions



<Bob – there is missing information here and also too much info. Name the axes. But remove the numbers next to Weibull and logistic, remove the numbers on the axes, and just have the distribution names. Thx>

The hazard function with time-varying covariates (Greene 1997) takes the following form under the Weibull distribution[3]:

$$h_i(t) = a\, t^{a-1} e^{-bX_{it}}$$

[3] In Greene (1997), as in Kalbfleisch and Prentice (1980), the hazard function is $lw(lt)^{w-1}$, where $l = e^{-bX_{it}}$ and $w = 1/s = a$.

In this expression, $X_i(t)$ is a matrix of explanatory variables for individual i at time t and a column of ones. $ß$ is a column vector of coefficients to be estimated for the primary explanatory variables, and a is a scalar. The scalar, a, and the exponent on time, $a-1$, together allow the hazard to be a function of time, while the time-varying covariates, X, exert their influence via the time-invariant $ß$'s. The time-varying covariates include:

- *IT human capital skill set groups*: Applications, Architecture, and Technical Management (Tech Mgmt) as binary variables.
- *Organizational characteristics*: Division 2, Division 3, and Division 4.
- *Relationship equity*: Standardized Rerformance Rate (Std Perf Rate) and % Salary Gap.

Division 1 forms the base case in the organizational factors category while the less highly technology-focused skill groups (business and operations) provide the base case for the IT human capital.

5.3. Model Specification Analysis and Fit Evaluation

Assessment methods for model specification and fit in the duration context differ to a considerable extent from methods for the standard regression model.

Residuals Analysis and Likelihood Tests. Greene (1997) points out that there are no direct counterparts to tests of regression residuals available for duration models. Other likelihood tests, such as the likelihood ratio, the Wald test, and the Lagrange multiplier tests, act as different starting points for assessing model fit. However, these tests are appropriate only in the absence of censoring, or when censoring is minimal and the life span of censored and uncensored observations is nearly identical (Lawless 1982). The solution to the problem of establishing a workable basis for assessing model fit depends upon the specific type of censoring that is observed, and the availability of appropriate tests given the type of censoring present in the data. We next discuss the mechanics of censoring.

Censoring. Censoring of the dependent variable occurs when "the exact lifetimes are known for only a portion of the individuals under study; the remainder of the lifetimes are known only to exceed certain values" (Lawless 1982, p. 31).[4] In the context of duration models, there

[4] Unfortunately, conventional regression analysis methods fail to distinguish between instances in which the dependent variable actually occurs up to some real *limit value*, as opposed to when some limit value is imposed on the range of the dependent variable due to its transformation. A good example of Type II censoring occurs in the assessment of demand for hotel rooms and airline tickets in the context of revenue yield management system use. The best measure for demand that revenue managers can use is the number of rooms or tickets sold. However, whenever a hotel sells out its rooms or an airline's seats on a given flight are entirely booked, it is usually the case that the level of demand exceeded capacity. In each case, using rooms booked or seats sold results in a censored value for the demand variable. *The implication is that there is information about the dependent variable that is lost, and thus not available for use in an*

are two types of censoring to consider: Type I and Type II (Lawless 1982). The important characteristics of Type II censoring are as follows:

- the lifetime of every censored individual must be the same at the time of the last observation; and,
- the period of the last observation must be a random variable.

For example, suppose that a test to determine the expected life of mechanical parts ends after 28 of 100 parts fail. The design of the study pre-specifies that 72 parts will be censored in the period that the 28th part fails. In this case, the censored duration values equal a single value. Consequently, when the study ends, 72 working parts will have the same, censored lifetime.

In contrast, Type I censoring occurs when the full life span of an individual part is known only if the observed life span is less than some critical value. In the general case, the critical value may vary by individual. However, if the critical value is the same for all individuals, the data are said to be "singly" Type I-censored. For example, suppose again that some test of mechanical parts will end on a pre-specified date in the future. Only those parts that fail before that given date will be uncensored. In this case, the censoring that occurs is Type I. However, by placing all the parts in service at the same time, the critical value will be the same for every part. When this is the case, the censoring is "singly" Type I.

Assessing Model Fit Based Upon Censoring Type. If the data are Type II-censored, then modifying the usual likelihood test may produce suitable test statistics. (The interested reader should see Lawless (1982), pp. 31-44 and 431-470 for additional details.) However, established test statistics for Type I data do not exist, so far as we can tell. Unfortunately, the data set we use in this research is Type I-censored: employment duration is censored for all employees who remain with the firm at the end of the study period; otherwise, the data are uncensored.

Another aspect of the procedures that are available for assessing duration model fit relates to the choice of the distribution for the hazard function in the empirical model. We follow the convention in the labor economics literature and employ the Weibull distribution (e.g., Lancaster (1979), Solon (1985), Dynarski and Sheffrin (1987)). However, this creates a dilemma also. Lawless (1982) indicates that there has been little research on assessment of the goodness of fit for duration models with a "Weibull hazard" or distribution of elapsed times to separation. He nevertheless recommends that three types of tests be considered. One is useful when data are

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econometric mode . Greene (1997) also provides useful coverage of the general issues involved with respect to censored data.

uncensored. A second is useful when the data are Type II-censored. The last handles Type I-censoring – our case – but is not particularly robust.

Instead of model fit, one may also consider model stability and parameter robustness. To do this, it is appropriate to examine the assumption that is made about the distribution of the "elapsed times to failure," for example, as we have seen in Kauffman and Wang (1998) and Sinha and Chandrashekaran (1992), relative to the overall robustness of the model's estimated coefficients. In the absence of appropriate tests that are available for assessing the fit of an econometric model with the data used to estimate it, another approach is to consider alternative distributions for the hazard. For example, the logistic or normal distributions might be substituted for the Weibull distribution – provided the intuition of doing this achieves an appropriate match with the situation that is being modeled.[5] We discuss this issue further in the following section, when we present the results.

6. RESULTS AND INTERPRETATION

We next turn to a discussion of the econometric results of our duration model, as they relate to the hypotheses we specified. To kick off this discussion, we first provide the reader with some background information on the interpretation of the estimation results of a duration model.

6.1. Interpreting the Estimation Results of a Duration Model

Interpreting the parameter estimates for significant variables in a duration model is relatively straightforward. Let us begin by considering the hazard function itself, $h_i(t) = at^{a-1} * e^{-bX_i(t)}$. By inspection, when a is greater than one, the hazard rate increases with time via at^{a-1}. If a is less than one, then the hazard rate decreases with time. When a is nearly equal to one, however, the model suggests that time has no effect on the hazard rate. The exponent on *e* (the exponential value 2.718…) affects the hazard rate by increasing or decreasing the hazard based upon the values of (possibly time-varying) covariates without regard to the period. Note that the negative sign on *ß* reverses the usual intuition about the effects of the estimated coefficients. If $ß_x X_{it}$ is positive and greater than one, then the impact of the *i*th variable X at time *t* is to reduce the hazard rate. The likelihood of separation is lessened. If, however, the

[5] The reader should note that we have *not* included the exponential distribution of elapsed times to separation among the admissible set of assumed distributions, even though this distribution is often seen in the empirical literature that examines various kinds of duration phenomena. The reason if that assuming an exponential distribution implies a *time-invariant underlying hazard*, which would inappropriate in our case. The intuition that we have developed in our field study of TCI Inc., and the employment-related literatures we have read, suggest that the hazard rate *ought* to vary over time, even though we cannot hypothesize the manner of its variation. A time-invariant hazard is assumed when $h(t) = g$ and $1 - F(t) = e^{-gt}$, in lieu of $h(t) = gat^{a-1}$ and $1 - F(t) = exp(-gt^a)$, with $g > 0$ and $a > 0$, as we used to define the Weibull hazard.

estimated coefficient is negative or less than one, then hazard rate increases; likewise, if it is near to equals one, then the covariate will have no effect (because e^{-1} equals one).

The values of the variables in our data set are such that the signs on the coefficients are opposite from the effect the variable has on the hazard rate – unless the value of the estimated coefficient is on the interval [0,1). Consider this for a moment, we know that a negative coefficient implies the variable increases the hazard rate, yet coefficients on the interval [0,1) have the same effect as a negative coefficient, even though they are non-negative. With this intuition in mind, we hope the reader better appreciates the care that is necessary in interpreting the results presented in Table 3.[6]

6.2. Estimation Results and Modeling Issues

Prior to carrying out the econometrics on the data, we performed a number of checks to ensure that there were no major defects with the data. These included the usual checks for pair-wise correlation and multicollinearity, identification of potential outliers and instances of incomplete entries on an employee, and evaluation of whether there were enough observations per cell for the model to converge and yield results.[7]

Table 3 shows maximum likelihood estimates from LIMDEP 7.0 (Greene 1998), based upon 2,471 observations on 628 IT professionals over a 21-month period. (See Table 3.)

[6] Again, we stress that there are some subtleties here that are not often associated with the usual interpretation of ordinary least squares regression. For this reason, it may be worthwhile for a reader who is unfamiliar with duration modeling to review the intuition we present before attempting to sort out our results. Unfortunately, nowhere in the textbooks and articles that most graduate students in Information Systems read about statistical analysis of data will such a "compiled version" of this intuition be found. Instead, it is necessary to work with the primary sources on duration modeling, and then develop one's intuition by working with the data. A good statistical package for this purpose – and the one we used for this analysis is William Greene's LIMDEP 7.0, which offers a number of routines for duration modeling, and mechanisms to incorporate different assumptions about the hazard function.

[7] We earlier determined that it would be appropriate to eliminate one division whose data no longer figures in our analysis in any way. The reasons for this were twofold: *first*, the data exhibited insufficient variation to suggest that our model would be explanatory of what was happening in that division; and, *second*, there were two few data points on employees in that division to enable the model to compute an Organizational Variables coefficient (Division 2, Division 3, Division 4). Thus, it was dropped from consideration.

Table 3. Maximum Likelihood Estimation Results for the Duration Model, Weibull Hazard

Variable Name	Estimated Coefficient	Standard Errors	t-ratio	P-value
Constant	7.1581	0.32813	21.8149	0.0000***
IT Human Capital Variables:				
Tech Mgmt	-1.0980	0.33181	-3.3092	0.0009***
Architecture	-1.0608	0.29764	-3.5639	0.0004***
Applications	-1.2111	0.29196	-4.1482	0.0000***
Organizational Characteristics Variables:				
Division 2	0.4528	0.61498	0.7363	0.4616
Division 3	-0.2976	0.23030	-1.2922	0.1963
Division 4	-0.4357	0.21020	-2.0726	0.0382**
Relationship Equity Variables:				
Std Perf Rate	0.3606	0.09496	3.7964	0.0001***
% Salary Gap	-0.5289	0.68362	-0.7736	0.4392
Hazard Rate Variable:				
a	1.1856	0.13066	9.0739	0.0000***

Note 1: ** means "significant at the .05 level" *** means "significant at the .01 level"

Note 2: The reader should recognize that the estimated value of *a* is not produced directly by LIMDEP when it estimates a duration model. Instead, what happens is that it estimates another value, *w*, which in the model's terms is the inverse of *a*. A different, but proportional standard error results, while the t-statistic and the significance level of the estimated coefficient are retained.

Note 3: The reader also should note that there are two "base cases" in this analysis. The base case for the "Skill Set Group" is *Business/Operations*, indicating that their skills tend to be more business and operations-focused than IT-focused. The base case for the "Organization Characteristics" variable is *Division 1*. In each case, the intent is to identify a variable's effect on estimated duration relative to its base case.

As we mentioned earlier in the paper, there are enough complications associated with the use of a duration model that it becomes difficult to formally test various aspects of model fit. Nevertheless, even without some evaluation of fit, one can get a sense from the significance levels of the variables in the model that it has discovered a means in the independent variables to explain some of the variance of the dependent variable, the duration of elapsed times to employment separation.

What is interesting in this instance is that one can make a powerful argument regarding causality that is qualitatively different from other situations in which causality is an issue in the IS literature.[8] All too often the question of causality is clouded by the fact that an hypothesized outcome can be interpreted as having a potentially causal relationship with some condition which

[8] See, for example, Brynjolfsson and Hitt (1998), Duliba, Kauffman and Lucas (1998) and Weill (1990). Each considers causality between IT investments and the impacts most observers believe ought to follow on account of them. The contexts are IT investments among U.S. industry sectors, airline computer reservation systems investments, and IT investments in the value manufacturing industry, respectively.

is hypothesized to precede it. For example, this is the case with IT investment: over the years there has been debate about whether the investments cause value or just the opposite – that high levels of organizational performance cause IT investments. In the case we are examining, however, we don't have the possibility of this problem. Once an employment relationship is broken, resulting in separation, the observation will be removed from the data set. In addition, in no other period can this outcome be observed.

On the other hand, even though there is a basis to assert causality, there may still be a concern as to whether the estimation results are robust to different assumptions about the distribution of the elapsed times to separation. To diagnose whether there might be a problem, we performed a second MLE estimation using a logistic distribution for the elapsed times to separation and compared it with the results of the Weibull hazard-based duration model. (See Table 4.)

Table 4. Maximum Likelihood Estimation Results for the Duration Model, Logistic Hazard

Variable Name	Estimated Coefficient	Standard Error	t-ratio	P-value
Constant	6.7487	.3248	20.781	.0000***
IT Human Capital Variables:				
Tech Mgmt	-1.0470	.3287	-3.185	.0014***
Architecture	-1.0471	.2875	-3.643	.0003***
Applications	-1.2538	.2788	-4.498	.0000***
Organizational Characteristics Variables:				
Division 2	.4901	.5528	.887	.3753
Division 3	-.1885	.2475	-.762	.4463
Division 4	-.31626	.2185	-1.447	.1479
Relationship Equity Variables:				
Std Perf Rate	.3459	.0953	3.630	.0003***
% Salary Gap	-.4740	.6871	-.690	.4902
Hazard Rate Variable:				
a	1.3647	.1602	8.518	0.0000***
Note 1: ** means "significant at the .05 level" *** means "significant at the .01 level"				

Qualitatively, the major effects we saw earlier are retained, and the signs of the estimated coefficients are consistent. The only difference worth noting is that the significance of the "Organization Effect" variable, *Division 4*, no longer reaches either the 5% or the 10% confidence levels, suggesting that the related null hypothesis cannot be rejected. This increases our confidence that the results of the duration model estimated with a Weibull hazard are relatively robust to possible mis-specification of the underlying distribution.

6.3. Interpretation

The results we obtained are generally consistent with our four main hypotheses. As expected, *a* exceeds one, so the hazard rate increases across time; IT professionals are increasingly likely to leave an organization the longer they have been with it. The sign and magnitude of the constant indicate a general propensity to stay with the organization in the next period, however. Negative and similar coefficients on the model variables *Tech Mgmt*, *Architecture*, and *Applications* indicate a similarly greater likelihood of separation in the next period among individuals who possess technology-focused skills. Their less technology-focused associates who form the base case are less likely to separate in the next period. There are some shifts in hazard rate attributable to organizational differences, the lack of significant coefficients on two variables not withstanding in the Weibull hazard model.

The results pertaining to *Standardized Performance Rate (Std Perf Rate)* present an interesting picture. The related Relationship Equity hypothesis suggests that once some threshold is met, underpaid individuals will separate in search of a more favorable relationship. Similarly, those who are overpaid will stay once they realize they cannot improve their position by separating. The estimated coefficient on *Standard Performance Rate* indicates that lesser performance implies greater likelihood of separation in the next period. This is consistent with the theory that we had in mind.

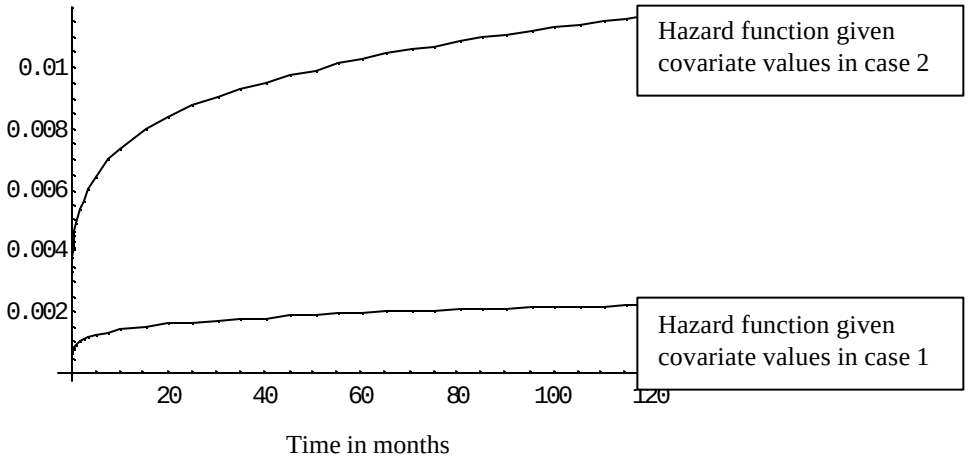
However, the coefficient on *% Salary Gap* came out slightly negative and was not significant. Currently, we are pursuing several possible explanations in our ongoing research. One possible alternative explanation is that there is an *inertia effect* that may motivate some individuals to stay with the organization despite substantial under-compensation. The compensation structure at TCI parallels that found in many large organizations in that pay cuts are rare. Furthermore, it is likely that a substantially under-compensated individual was under-compensated from the time he was initially initial hired. If that was acceptable to the individual then, it is likely that inertia may keep the individual from improving their situation by separating from the firm.

Other factors may affect individuals in the midrange. The slightly over-compensated employee may believe that she has a good deal now, but could do even better with a change. The slightly under compensated employee may be holding out the hope that he will be rewarded in the near term. In each case, it is the expectation of a slightly better future state that drives their behavior, something that our present model does not recognize. We discuss a third possible interpretation in the Conclusion of this paper. Further evaluation of these alternative explanations requires stratification of our data along the under-compensation and over-compensation continuum.

6.4. An Interpretive Illustration

By plotting the hazard function under alternative scenarios, we can see the impact of specific covariates on the hazard rate. Consider two contrasting cases. In Case 1 all of the model variables have a value of zero. This is consistent with an individual with a predominantly business-focused skill set (e.g. a business analyst), working in Division 2, delivering midrange performance, and receiving a salary at the midpoint of the salary range. Case 2 represents the hazard function for an individual with a technical management skill set, working in Division 1, performing one standard deviation below the mean, and compensated appropriately below the midpoint. See Figure 3. The plots graphically illustrate the impact that variation in covariate values can have on the hazard rate.

Figure 3. Plot of the Hazard Function for Individuals with Different Covariate Values



For both individuals, we note that the hazard rate is upward sloping, indicating that each is increasingly likely to leave the firm over time. Notice the contrast, however. The employee characterized by Case 2 not only has a higher initial likelihood of departing relative to the Case 1 employee. But the picture that emerges is that the likelihood of separation goes up considerably faster earlier in the employment relationship than the Case 1 employee. The technology-focused employee who possesses greater technology-related general human capital is more likely to depart.

7. CONCLUSION

The research reported in this paper introduces previously untapped economic theory – *the theory of human capital* – to address specific questions about the employment decisions made by IT professionals. The theory that we develop suggests that it may be appropriate to begin to take a

variety of new approaches to improve our understanding of IT professionals' decisionmaking. Our prior single-period binomial logit model for assessing IT professionals' decisionmaking relative to separating from or staying with the firm illustrates one such empirical approach to building new theory in this area (Kauffman and Josefek 1999). The current research strengthens our case further, by extending the prior work to include a multi-period assessment with a panel data duration model.

With these methods we have been able to uncover a number of hypothesized, but previously untested relationships between IT professionals' separation decisions and four potential drivers of their decisions. These include: the kind and extent of human capital they possess; the degree to which their employment relationship with the firm is an equitable one; the organizational environment within which the employment relationship ensues, and the time over which pressure to separate may build.

Our results provide evidence to support three of our four core hypotheses. *First,* a*s the intensity of technology focus increases across multiple IT related-skill set groups, the duration of the employment relationship that a firm will have with an IT professional is likely to decrease.* This provides evidence that suggests that there may be differences in the nature of IT-intensive human capital relative to less IT-intensive human capital, assuming that market conditions are appropriately controlled. IT professionals whose human capital is highly technology-intensive have a higher probability of separation than do those with a greater business focus.

This result is consistent with human capital theory: IT professionals with a greater investment in the business processes of an organization are less likely to leave their employer because they will lose the return on valuable firm-specific human capital. It is also worth examining in other organizational contexts to see if it holds. Still, we caution the reader to note that our use of a single multi-divisional firm creates a basis for a reasonable critique of this work: with a single organization delivering its results, this research may lack of the level of external validity that many researchers would like to see. However, we have argued that Twin Cities, Inc. is likely to be representative of large Fortune 500 firms in the U.S. And, to the extent that our goal is conduct exploratory research that builds new theory, we think our approach is a reasonable one.

*Second, we confirmed only one of two hypotheses regarding relationship equity. O*ur findings on the Performance Hypothesis were consistent with our expectations. Our next step with respect to this hypothesis will be to work towards identifying that level of performance rating which results in palpable pressure to separate. Our Compensation Gap hypothesis did not pan out as expected though. It was not significant in duration models with the Weibull or the

logistic hazard. We uncovered anecdotal evidence in our field study suggesting that with a negative 10% to 20% compensation gap (compensation less than the population mean adjusted for performance), the pressure an employee feels to separate is considerable. But, Fabris (1998) points to an alternative explanation for what might be going on – one that our present model doe not accommodate. In the "hot markets" for IT professionals that we have seen the last several years, many experienced employees are able to move and earn a 20% premium over their current salary – irrespective of whether their work reflects lowest quartile or highest quartile performance.

In addition to the two explanations we offered earlier, one other alternative explanation is possible that may explain our model's inability to confirm the Relationship Equity hypothesis for *% Salary Gap*. For example, let us make an analogy between sports stars and IT professionals. During the last decade, we have seen the market for sports talent soar (especially baseball these last few weeks, with numerous players signing free agent deals that will net them anywhere from $10 million to $14 million a year over the next five years). At that level of performance, the best athletes – the franchise players – are more "market commodities" than they are employees. Their capabilities are truly mobile, and the market recognizes that, and compensates them to indemnify against having to bear separation costs. It may also be that way to some extent for the most capable IT professionals, even those who are compensated much above the mean on a performance-adjusted basis. Now, with this sort of scenario in mind, that would mean that the effect that we expect to see for relationship equity may not be symmetric: even though under-compensated employees may feel pressure to separate at some compensation level, the best people may always be "testing the waters." We certainly see this in the academic arena, for example. Thus, perhaps our model fails in this respect because we have not taken into account pressure to separate relative to relationship equity that is due to forces that are *external* to the firm. This is a subject for future research that will lead to the refinement of the present model.

Third, we confirmed what we expected to be the case: irrespective of their origins, organizational factors can be expected to have an effect on the duration of the employment relationship. (Actually, the null form of the "organization hypothesis" was rejected with our data.) Our model suggested that one of four divisions at Twin Cities Inc. involved a different enough environment so that it was a significant modifier for the overall hazard rate. If all else in the model were equal, this one organization would observe somewhat different employment relationship separation behavior compared to the firm's other divisions. This suggests one very important conclusion: no single organization-wide policy instrument is likely to be capable of

creating the same amount of leverage – and by the same token, the same observed effects – in improving retention.

Finally, we confirmed that time seems to play a role in expected employment relationship duration: we rejected the "time hypothesis" that the length of time that an IT professional has been with the organization has no effect on the likelihood of separation from it in the next period. This result tells us something about the slope of the hazard function for elapsed time to separation that we did not know in any definitive way before. Our interviews with human resources professionals, discussions with IT professionals who have recently been in the market, articles we have read and surveys we track in industry-related secondary source materials (such as the ITAA and the CIO studies, among other things) all point to what the model is telling us. IT professionals, once they go to work for a firm, are increasingly likely to leave over time.

One thing is clear from our research: today's market for IS professionals seems to place great weight on the qualities of an IT professional's *technology-related general human capital.* This creates a mandate for IT professionals: develop your technology-related general human capital, if you want to be market-mobile and take advantage of opportunities for higher compensation – or else. This perspective creates considerable challenges for firms which seek organizational and workforce continuity, and high levels of performance from the IT professionals they employ. At the firm level, the mandate is quite different: it is to develop appropriate organization-focused specific human capital and then compensate it well enough so as to overcome pressures to separate that are driven by the potential returns to general human capital in the marketplace. William Sanders, Chief Information Officer of Honeywell, Inc., characterized this mandate in another way in a recent speech to an audience of industry executives: "Once you hire an IT professional, make sure to love them to death." No doubt Sanders, and other CIOs in organizations that depend on high performance information systems solutions to enable their business strategy are faced with a similar dilemma: "Love your IT professionals or they *will* leave you."

In future research, we aim to expand this line of inquiry by formulating models that can more carefully gauge *pre-separation pressure to separate*. Doing so creates the opportunity to build a "retention intervention tool set" for management. It should not only identify when a valued employee is dangerously close to her separation threshold (based on a duration-driven estimated likelihood to separate, for example), but enable the application of targeted and pre-specified human resources policies that improve the likelihood of retention. Specifying the employment relationship and estimating separation likelihoods over time also enables us to track another new construct: the *employment relationship utility (or value) trajectory*. Human resource

managers and CIOs alike know that retaining a valuable workforce does not always boil down to dollars. Instead, it would be nice to be able to apply some policies, including but not limited to salary adjustments, for which the employee's post-treatment utility can be observed. Perhaps through these efforts, we can toward solving a widely recognized problem – "You can't manage what you can't measure" – and thereby assist IT organizations in improving their ability to retain the best talent.

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Appendix A --The Relationship Between Compensation and Performance

In this paper, our interpretation of the relationship between employee compensation and performance is founded on the research literature. It is also based on what we have learned about organizational practices with respect to these issues in our field study at Twin Cities, Inc., and what evidence we have gleaned from other relevant secondary sources we could find. In this case, however, we think it is appropriate to share somewhat more information to show a concrete instance of specific support for the approach we have taken in measurement, as a means to help the reader to develop confidence that our choice was appropriate.

To do this, we include the following excerpt from the University of California at Berkeley's current "Guide to Managing Human Resources" (as of Fall 1998). This document explains the relationship between *employee performance* and *position in the salary range*. The "Salary Placement Guidelines" shown below apply to the broad salary ranges, which do not have steps and which allow managers to appoint employees at a specific whole dollar amount. This approach reflects a standard policy for compensation management that is often implemented across large organizations, and that is similar to what we have seen at our research site.

Salary Placement Guidelines

- *The **first quartile of the range** (from the minimum up to halfway to the midpoint of the range) of each salary grade is usually intended for individuals who are new to the grade, are in a **learning** situation, and/or do not have substantial experience in the new position.*

- *The **second quartile** of the range is intended for employees who have gained experience and skill and who are **becoming more proficient** in the position for which they were hired. They **generally meet expectations** in their given positions.*

- *The **midpoint of the range** is the approximate average salary at which most of the experienced, seasoned, professional staff members in a title will cluster, usually after being in the position for several years. This point is intended for those employees who are fully experienced and **consistently meet expectations** in their position.*

- *The **third quartile** is typically reserved for experienced employees who **frequently exceed expectations**.*

- *The **fourth quartile** of the range is normally reserved for individuals who are **consistently exceptional performers** and who have extensive experience.*

Note: The foregoing material has been adapted from "The Guide to Managing Human Resources," University of California, Berkeley, last updated November 1998 (http://hrweb.berkeley.edu/GUIDE/Gd-comp1.htm). We have highlighted text that illustrates quartile-based performance assessment, and the associated definitions of performance.