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I propose that perceptions of the employment game held by organization members are determinants of cooperative knowledge sharing and subsequently firm performance. I analyze survey data gathered from high-tech workers using both regression and path analysis techniques.

The results from this study offer new insights into methods for measuring both the connections between knowledge work and firm performance and the perceptions critical for fostering collaborative knowledge work in high tech firms. Results of the study show a significant relationship between the game theory construct of reciprocity, knowledge building behavior and firm performance. The mediation model was weakly supported but shows potential usefulness for further research in the field of strategic human resource management.

Keywords

research, practice, firm, performance, human resource, technology, management, employee, game, work

Comments

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The Relationship Between Employee Perceptions of the Employment Game and Their Perceptions of Cooperative Knowledge Behavior in High Tech Firms

Edward William Rogers

Working Paper 00 – 15



The Relationship Between Employee Perceptions of the Employment Game and Their Perceptions of Cooperative Knowledge Behavior in High Tech Firms

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This paper has not undergone formal review or approval of the faculty of the ILR School. It is intended to make results of Center research available to others interested in preliminary form to encourage discussion and suggestions.

Abstract

The relationship between knowledge sharing and organizational performance for high-technology start-up companies is not well understood. Using game theory and the concept of competitive advantage through human resource management, I examine employee perceptions of the employment game relating to cooperative knowledge behavior and firm performance as an entry point into researching organizational knowledge utilization. I draw upon classical game theory to develop four measures of perceptions critical to game playing and apply these to organizational situations via a survey instrument.

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Introduction

A whole new consulting industry has been born around the related topics of knowledge management, intellectual property, and organizational learning as just a sample of top books of the last decade will reveal.

- “The Fifth Discipline,” by Senge, 1990
- “The Global Learning Organization,” by Marquardt and Reynolds, 1994
- “The Knowledge Creating Company,” by Nonaka and Takeuchi, 1995
- “Intellectual Capital,” by Stewart, 1997
- “If Only We Knew What We Know,” by O’Dell and Grayson, 1998
- “Working Knowledge,” by Davenport and Prusak, 1998

In the faster pace of technological and scientifically based innovation characteristic of high technology firms, knowledge utilization needs to be as intentional, methodical, and effective, as the utilization of other organization resources. However, there is scant empirical research linking established organizational theory to knowledge use in organizations. This study attempts to address that need by applying the fundamentals of game theory to high tech start-up knowledge sharing.

The sharing of knowledge is a fundamental competitive element of cooperative enterprise for firms in the knowledge economy. In order to understand the organizational determinants of knowledge use, I examine the knowledge production process using game theory. Game theory has a rich heritage in organizational analysis serving as the foundation for a large portion of the literature on cooperation and strategic decision analysis. I use game theory to model internal cooperation among rational actor employees and a cooperative employment relationship between a firm and its members. As exploratory research, I focus on the high tech start-up sector where knowledge is considered a critical production resource.

Three questions emerge from this approach.

1. The theoretical question is why do people choose to cooperate and make seemingly irrational decisions about participating in high tech start-up ventures which require cooperative behavior yet possess many of the features of classic N-person social dilemmas?

2. The practical question is how can entrepreneurs and investors benefit by understanding the mechanisms of knowledge sharing to design and manage high tech start-up firms to maximize knowledge utilization and production?
3. The research question is how can the dynamics of knowledge sharing be studied at the organizational level using insights from game theory into individual organizational member perceptions about employment?

The focus of this study is on the last of these questions as an attempt to establish new measures and demonstrate the fundamental relationships predicted by game theory in workplace dynamics. Thus, I draw directly from classical game theory four dimensions relevant and critical to cooperation in the workplace and seek to use them for organizational research. I then test these measures in a set of hypotheses relating to how they may be predicted to interact with other organizational measures for cooperative behavior and firm performance.

With the importance of human capital to the success of high tech start-up ventures, HRM has a critical role to play in sustaining the balance between free-thinking to achieve high levels of productivity and focus on the innovation problems at hand. Knowledge utilization requires people to process their collective knowledge towards producing output in knowledge intensive work. Like untapped oil reserves, static intellectual capital is not value producing. Some high tech start-up firms seem able to establish the culture that facilitates open sharing and high levels of effort such as SAS Institute in North Carolina. Other firms bid high for talent in the labor market and still struggle to retain top performers such as Disney's attempt to build an internal capability in computer animation only to lose many key players to small start ups.

One practical management way of dealing with the knowledge and people question is to keep them together. So, whole high tech projects may be bought, sold or spun off taking the knowledge talent with it. A good example is the way IBM purchased Lotus Development Corporation¹. IBM could have licensed the technology, formed a partnership or some other alternative. Instead they bought the whole operation in toto. This did not prevent many top Lotus people from leaving after the takeover bringing into question both the wisdom of the purchase and the credibility of the future of Lotus products. These resource management issues surrounding high tech employment make it an interesting and dynamic environment to study cooperative knowledge sharing in organizations by combining research approaches to focus on the human interactive nature of knowledge production work.

¹ The acquisition was widely reported in the press. For one account of it with similar insights see "Leading with Knowledge," by Richard Huseman and Jon Goodman, SAGE , 1999.

For a high tech firm, however, it is both the risk of failure (financial loss) and the risk of self-generating obsolescence that provide the potential for abnormal financial returns by pursuing a course of Schumpeterian innovation (Barney & Baysinger, 1990). History shows that a technology strategy and a dynamic market environment combine to create these unique corporate entities at the intersection of capitalism, property rights, and the established rule of law (Schumpeter, 1934). This research does not consider macro-social, economic or political levels but the population of firms from which I sample is defined by these historical artifacts.

Risk from the environment penetrates the high tech organization and affects the nature of the enterprise as well as the workers. Large established firms have traditionally offered a high degree of insulation to their workers from marketplace risk though this has changed much in recent years with reengineering and the redefinition of the psychological contract (Rousseau, 1995). As companies have become leaner and more closely attuned to market dynamics, more risk has filtered through organizational boundaries directly impacting employees.

High Technology Workers

Three characteristics stand out from work describing the high tech worker: 1) a high level of education, 2) a strong preference for independence, and 3) a professional orientation rather than an organization focus (Mohrman & Von Glinow, 1990; Resnick-West & Von Glinow, 1990; Turbin & Rosse, 1990). These characteristics were abundantly clear in the open ended comments of my survey instrument. Many expressed their love of their work (advanced technical work), their disdain for organizational dysfunction and a desire to work for themselves if possible some day.

Because of these concerns, high tech workers present many challenges to the traditional role of human resources in managing employees. High tech workers face additional social dilemmas among themselves regarding their participation in the ventures and projects of the firm. Since high tech workers manage their own careers to maximize their own personal knowledge value, they face a dilemma of sharing some of their knowledge with their colleagues in the course of their research and development projects. This dilemma is in some ways like the traditional prisoner's dilemma drawn from classical game theory.

The dilemma may be seen on two levels. First employee-to-firm and second employee-to-employee. With respect to the firm, the employee has a dilemma since the firm's success is in part determined by his own effort yet his market value is determined by how much individual knowledge he accumulates. At the individual level, every employee is most likely also an owner through stock plans so that he is both an agent and a principal at the same time. The workers

face each other in a kind of prisoner's dilemma where they each want the others to cooperate (share their knowledge freely) while it is in each person's private interest to not share any of their own knowledge. They are then free to appropriate everyone else's knowledge without any cost. This individual level of dilemma is often overlooked in organizational research because it is not easily observable, is not addressed by any official firm practice, and it may not be socially acceptable to admit to peer monitoring in many cases since it may be perceived as a violation of trust.

Traditional strategic responses to resource shortages or weak power relationships such as vertical integration are not possible with human resources (Diaz & Gomez-Mejia, 1997). In-house training programs eventually confront the 'public good' dilemma as employees are able to take training acquired and apply it within some other firm to their own personal advantage. Another firm will presumably pay the worker for the added value of the training received from the first firm. This represents a loss of investment by the training firm and an appropriation by the employee.

The relative high market power enjoyed by high tech workers is precisely what makes the social dilemmas facing high tech start-up organizations so poignant. The workers do have alternatives to organizational participation besides collective action (labor market restriction) such as taking a higher paying job at another firm (Das & Bhadury, 1997). Considering that they have alternatives, including the opportunity to form their own venture, combined with the fact that they do choose to cooperate in high tech firms means that some organizing efficiencies (vs. the spot labor market) are being captured by these high tech start up firms.

The model of these interactions begins with several general assumptions based on the preceding discussion. The typical high tech start-up firm has a need to introduce structures to the organization in the interest of efficiency and knowledge utilization. It would benefit most from its high tech workers if they all cooperated fully on any given project. Yet, the firm faces an externally institutionalized sector within which the firm must define its own necessary structure (i.e. it's options for structures are limited). Within the firm, workers choose cooperative knowledge behavior when their individual rational choices might otherwise guide them to non-cooperation. They may have made rational choices about their viable alternatives to working in the firm and in so doing reached a semi-stable position vis-à-vis the firm and their fellow employees. My approach is to try to model some of the determinants of their cooperative knowledge behavior from a game theory perspective in order to frame appropriate research questions to address these and other perplexing aspects of high tech knowledge work and ultimately investigate how they relate to firm performance. While not proposing a new theory of

the firm, I augment current theory of the firm with the unique attributes of knowledge as a resource for production.

Knowledge as a Firm Resource

Knowledge poses a problem for organizations that rely on traditional management approaches based on resource models of land, labor and capital. If indeed knowledge has become the most critical resource to attain and sustain a competitive advantage, then its unique characteristics and especially those that distinguish it from the usual set of resources firms consider in strategic choices need to be carefully understood and addressed by organizational researchers and practitioners.

The first and most important attribute of knowledge is that it is intimately associated with the carrier or human host. Codified knowledge (patents, databases, formulae, procedures, etc.) are valuable but not the real essence of competitive advantage in knowledge work because they can be exchanged in the market for a price. Only the dynamic knowledge resources that reside in human intellect are knowledge components able to deliver sustainable competitive advantage to innovative firms. These dynamic knowledge components are embedded or contextual in nature and cannot be easily separated from their human hosts (Weiss, 1998). Even if they are captured, very often their value is greatly reduced in the process or the knowledge becomes common and so also loses its firm specific value. Processes used to capture other types of resources (enclose it within the organizational boundaries to control its use) might actually diminish the value of knowledge resources.

Knowledge is also not always transferable. It is hard to put a price on knowledge before it is captured in an innovative product. This makes it hard even for firms to know what knowledge they possess or to value it though some companies have tried, notably Skandia (See the Economist, 6/12/99 and Skandia' Supplement to the Annual Report, 1994). Much organizational knowledge is completely uncatalogued and often invisible to the organization (O'Dell & Grayson, 1998). In response there has been a rush of consulting efforts to manage knowledge by first helping firms to identify what knowledge they actually have either by uncovering tacit organizational knowledge or capturing knowledge in databases. Most of the major consulting houses have been busy in the last few years building knowledge bases containing cross-referenced links about who knows what in the organization. These attempts to leverage the corporate organizational knowledge have met with mixed results in terms of more efficient knowledge utilization (Watts Sussman, 1998).

Finally, knowledge is not directly controllable. Codified parts may be kept under lock and key but once it is used, its use cannot be completely controlled. Since the most valuable (dynamic) knowledge exists in human intellects, to control that knowledge requires controlling the humans of the firm. This is where knowledge management meets human resource management. The most valuable knowledge assets are really managed through managing the people who directly control the development and deployment of those assets. In addition, firm knowledge productivity is intricately tied to personal perceptions those individuals hold about the knowledge, the firm, its goals for use of the knowledge, societal norms, personal preferences and values. Consider the change in motivation techniques employed by the research lab on a top scientist compared with how that scientist is motivated when captured by some evil villain who desires to utilize the scientist's knowledge to mischievous ends. The contrast has provided fodder for a steady stream of movies and books.

Consider the US effort to develop a nuclear bomb. Concerned over Germany's head start in rocket technology and nuclear weapons, the US managed to import enough German scientists to staff a bomb making effort. However, they faced the problem of a reverse transfer of any knowledge developed in the US back to Germany. Two strategies were deployed to mitigate that possibility. First, the scientists were sequestered in isolated research labs with minimal contact with outside people. Second, the project was fragmented so that no one person could walk out the door with enough knowledge to make a bomb.

I cast the strategic management of human resources in knowledge intensive firms such as high-tech start-ups as the attempt to maximize knowledge acquisition, creation and sharing while minimizing knowledge shirking, hoarding and appropriation. This model assumes that it is in the best interest of the firm to maximize knowledge building activities and minimize knowledge limiting activities on the basis that knowledge utilization is dependent on these two sets of behaviors. This framework sets the stage for application of the resource-based view of the firm to the organizational resource of knowledge.

The Resource Based View of the Firm and attending notions of competitive advantage through human capital (Wright, McMahan & McWilliams, 1994) have led to the notion that the knowledge assets held by the employees are the most valuable part of the firm. If so, then the HR department along with the rest of the support departments should be strategically aligned with the needs and goals of those assets holders (Schuler & Jackson, 1987). Before looking at how these approaches may yield understanding of the high tech start-up phenomena, it is necessary to review how human resources have come to take such a preeminent place in organizational strategic formulations and planning.

The intensification of knowledge work has shifted the Human Resource Management (HRM) activities closer to the “production line” since that line may be thought of as being entirely within the confines of the human skills of the organization. HRM activities are no longer peripheral staff items of interest, they are directly related to the most valuable assets of the organization and hence directly related to the ability of the organization to successfully achieve its goals (Harrigan & Dalmia, 1991; Stewart, 1991). Another way of looking at this transformation is that knowledge workers are much more an integral part of their work rather than implements of the work process. Their designs, thoughts, and insights are the raw material used in creating a piece of knowledge work, similar to craftsmen in a professional guild hundreds of years ago. This trend has impacted manufacturing to move from “mindless” assembly line structures to “mindful” group work centers and high performance work systems (Becker & Huselid, 1998; Guest, 1997; Warrick, 1990). The knowledge and the knowledge worker are not supporting units on the production line, they are the production line. In supporting knowledge work systems and high performance work designs, HRM, becomes an important value-added organizational function directly involved in the production process.

To produce economic gain from its knowledge resources embedded in its human capital, an organization must leverage its knowledge effectively and efficiently into knowledge-laden products of value in the marketplace. The shift to knowledge as the critical organizational resource has led to an increased awareness of the human capital of an organization (Becker, 1964). The focus on a firm's human capital has in turn pushed Human Resource Management (HRM) researchers to seek explicit connections between activities of HRM and economic organizational outcomes. Much of the Strategic Human Resource Management (SHRM) research attempts to connect HRM and firm outcomes by correlating deployment of HRM practices or systems with firm performance (Arthur, 1994; Becker & Huselid, 1998).

One of the reasons for the apparent weakness of these models is the poor operation of performance as Rogers and Wright (1998) pointed out. A more fundamental weakness of SHRM models may be the lack of explanatory linkages. Researchers have neglected to specify the mechanisms through which HRM affects organizational performance. Rogers and Boswell (1998) suggested the development of a construct for Knowledge Utilization as a mediating variable in the link between HRM and organizational performance. Knowledge utilization was defined as the capability to transform knowledge through knowledge sharing, integration, and application into products of economic value. Measures for such a construct still need to be developed and the model is still untested. One of the goals here is to build a theoretical foundation for further empirical investigation of knowledge utilization.

To use a resource based view of competitive advantage based on human capital, the input and outputs of human capital must be measurable as well as some utilization rate. Defining these measures has been a heated topic at conferences and in the popular business press for several years. Since knowledge is a key if not the critical resource, not only input and output measures need to be defined, but a utilization function for it needs to be developed (Rogers & Boswell, 1998). In this study, I investigate determinants of knowledge sharing as a preliminary step towards developing measures for assessing knowledge utilization directly in future research.

Recent business press books related to SHRM practices have revolved around three approaches related to knowledge in organizations:

- 1) Intellectual capital, measuring and managing what the organization knows, treating the knowledge as a valuable corporate asset (Edvinsson & Malone, 1997; Stewart, 1997),
- 2) Knowledge sharing as an organizational culture attribute (Leonard-Barton, 1990; Nonaka & Takeuchi, 1995), and
- 3) Human Capital Theory as an augment to the Resource Based View of the firm and a basis for competitive advantage (Ulrich, 1997; Pfeffer, 1997).

While all of these approaches have provided meaningful insights, none adequately addresses the nature of the game the employees play within the firm towards utilization of the knowledge they hold individually or in common.

SHRM also attempts to specify human resource activities in terms of HRM configurations, bundles, or contingencies that enhance human or intellectual capital development and leverage human resources toward competitive advantage by aligning the functional activities and policies with organizational strategies. In other words, a strategic HRM implementation would result in an increase of measured intellectual capital, an improvement in a knowledge sharing culture index, and/or an enhancement in the human capital resource base. Unfortunately, the results to date do not support such a clear or direct connection partly because research constructs for knowledge sharing, human capital and intellectual capital have not yet been established.

One thing that game theory makes clear is that how a player *perceives* the game will determine how they will play or if they are likely to cooperate regardless of the *stated* policies or practices. This notion of starting point perceptions is what formed the basis of this research into how game theory concepts can be applied to employment in knowledge intensive work. The assumption is simply that people in knowledge intensive work settings are playing employment

games. Because these games and the parameters for them are not well understood by managers or HR researchers, much of the underlying dynamic remains obscure and often ignored from research models and strategic HR planning.

Perceptions may turn out to be very important because in repeated play situations, how the players play the first round is a critical determinant of how they perceive the game and thus how they will play subsequent rounds. If the determinants of cooperation can be emphasized during organizational formation, the likelihood of building a cooperative culture will be much higher.

Some research has been conducted on framing effects in n-person prisoner's dilemma. McDaniel and Sistrunk (1991) used business students as subjects but framed the problem by giving artificial information about the intentions of other players before they played. Their experiment showed that initial frames, or perceptions of the initial game significantly influenced cooperative choices. As was later confirmed in computer simulations by Axelrod (1984), first round cooperation was often a high predictor of second round cooperation and so forth. How entrepreneurs cast the initial employment game and how first round employees perceive it may set in motion the process of developing the high levels of cooperation necessary for high tech start-ups to succeed.

Game theory deals with how rational choice actors make decisions within a set of assumptions about utility maximization, information efficiency, and relationship structures. It has relevance to SHRM since the outcome of strategic planning, including SHRM planning, is a set of choices that depend on the assumption areas critical to game theory. Game theory tries to predict the decision process that rational actors will use under different circumstances allowing for differential risk preferences, imperfectly aligned goals, and bounded rationality all of which are relevant to knowledge sharing situations in high tech firms.

One view of the design of HRM systems is as an attempt in various ways to maximize cooperation and minimize non-cooperative behavior (Coff, 1997). Thus game theory has an implied presence in HRM research from an avoidance perspective and a direct presence in organizational design and especially human resource system design. However, the specific parameters of game theory have not been tested or formally used within a knowledge-sharing context. In this light, it is reasonable to consider how game theory informs HRM research in defining the boundaries of cooperative space in organizational design. This study attempts to address this theoretical gap by formulating a test of game theoretic dimensions in a knowledge-sharing context.

Some attempts at directly using game theory have been made in organizational research. Pfeffer's (1997) discussion of best practices implies a reduction of social dilemmas through adoption of a mutually reinforcing package of HR practices. This is in essence an indirect appeal to minimize the effects predicted by game theory. Coff (1997) makes a series of propositions about the potential for what he terms 'management dilemmas' in human asset management. His basic argument is that the very same activities that tend to make employees valuable assets to the firm (enhancing the human capital of the firm) also tend to increase the moral hazards in the system because of the inherent linkage between the asset value and the employee's individual value. This investment in the individual (skills or knowledge) gives the employee options and payoff choices not available in non-strategic HR practice environments. Coff's model is a useful attempt to examine the underlying theory behind the resource based view of the firm but there is no empirical evidence as of yet to support his propositions.

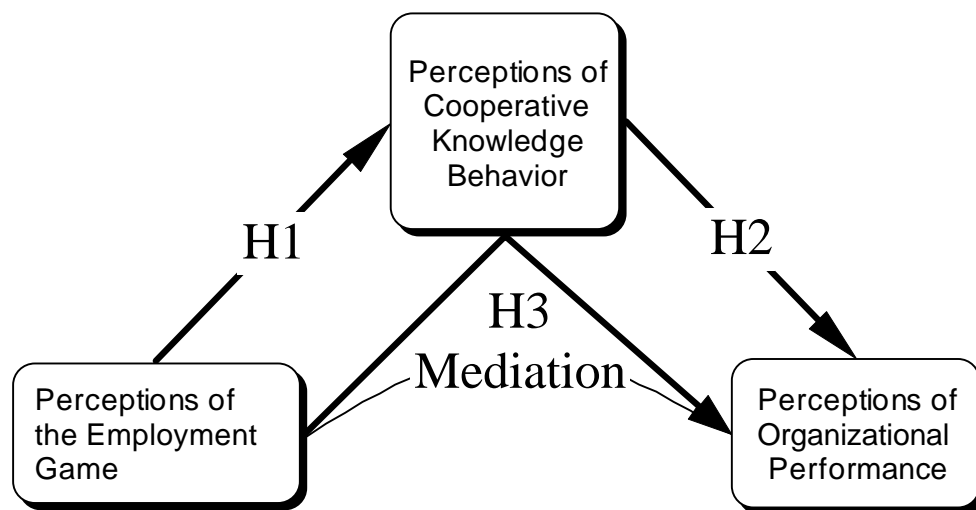
In an earlier piece, Hill (1990) examined the aspects of market mechanisms on repeated iterations of employee interactions and opportunism. Hill used a game theory model to predict that opportunism is overstated in TCE theory because it ignores basic game theory research that shows that actors who behave opportunistically are punished by marketplace governance systems (Axelrod, 1984). It would be reasonable to expect the same kind of behavior in the labor marketplace. If Hill is right, then TCE and the RBV approaches overstate opportunism and subsequent models that predict internal employment systems will be more efficient than external labor markets. Unfortunately, this model has also not yet been tested empirically. My study extends these attempts at using game theory directly in organizational research by applying four critical elements of game theory to the employment relationship in high tech firms.

For a high tech firm to succeed, high tech workers must choose to collaborate to some degree and thus achieve some measure of cooperative outcome. Since a high tech worker possesses knowledge (similar to the prisoner who possesses valuable knowledge) and they face a skewed payoff matrix not dissimilar to the prisoner's dilemma, this paradox could be described as the "Employee's Dilemma. For the employee, hoarding knowledge is to keep valuable knowledge assets available only to oneself, without making them available for use by the group through an open sharing of knowledge. Unless the actors have the opportunity to form coalitions among themselves (and then coalitions of coalitions until they reach a two player scenario), the uncoordinated individual interests will always have a non-cooperative expected outcome (Colman, 1995).

Research Hypotheses

There are three fundamental hypotheses for this study. First, employee perceptions of the employment game are correlated with their perceptions of cooperative knowledge behavior. Second, employee perceptions of cooperative knowledge behavior within the firm are correlated with firm performance. The third hypothesis tests the mediation effects of Cooperative Knowledge Behavior on the relationship between the game theory dimensions and performance. Game theory claims that what the other prisoner intends to do is not as important as what the first prisoner thinks is likely for the second prisoner to do. Translating this to organizational studies means that the employee perceptions of their organizational game may be a critical determinant of their cooperative behavior (Sparrow, 1998). The conceptual model is presented in Figure 1.

Figure 1
Conceptual Model



I have constructed a scale of perceived knowledge sharing behaviors including both positive (knowledge building) and negative (withholding of effort) which I attempt to link to the four game theory dimensions. To connect perceptions along the game theory dimensions with cooperative knowledge behavior I propose the following main hypothesis as:

H1: A higher perception of knowledge sharing behavior will be correlated with perceptions of higher non-zero-sum, higher reciprocity, higher longevity and lower monetary utility.

To relate the connection between employee perceptions of behavior and firm performance, I test a second hypothesis that investigates the relationship between the knowledge cooperation behavior and perceived firm performance. This hypothesis is specified as follows:

H2: A higher perception of cooperative knowledge behavior evidenced by more acquiring, creating, or sharing and less hoarding, shirking or appropriating of knowledge, will be correlated with a higher perception of firm performance.

Finally, I perform a mediating test on the whole model to investigate the indirect effects of the game theory dimensions on performance through the knowledge cooperative behavior. This test is expressed in hypothesis 3 as follows:

H3: Perceptions of knowledge sharing behavior will have a mediating effect on the relationship between perceptions of non-zero-sum, reciprocity, longevity and monetary utility on performance.

Description of Sample

Using personal contacts and networks, start-up firms were contacted directly by the researcher either by telephone or e-mail. After the purpose and scope of the study were explained to the CEO or other top executive, they were invited to participate in the study by having their employees fill out the survey instrument. By working through over one hundred firms this way, 30 firms agreed to answer the survey and 13 actually filled out some responses on-line. One firm had only two observations and was dropped. One firm that agreed to participate later withdrew because of the sensitive nature of the questions. The other firms that failed to follow through with the survey all cited their extreme busy schedules and lack of time for surveys even though they were interested in the study and it's potential usefulness for their organizations.

The respondents to the survey were all employees of high tech firms. All of the firms have a high degree of knowledge intensive work as reported from discussions with the CEO of each firm. Several firms declined to participate based on the fact that they were primarily manufacturing facilities with little design or research focus. Some declined because they felt they were more service oriented (engineering design consultants for example). The firms have a range of educational levels but all work in areas considered as technology plays though some are software and some are hardware oriented. An open comment question asked "What company would you like to work for if you could?" The answers to this question (those who filled

it out) also gave an indication that the participants considered themselves to be high tech workers. The companies they mentioned were mostly well known high tech firms, generally successful or of a high profile (CISCO for example received many nominations).

Of the firms that participated, the percentage of employees who filled out the survey ranged from 100% (two firms) to 10% (two firms). Generally the larger the firm, the lower the percentage of employees that responded. From twelve companies a total of 166 people responded, thirteen of them were CEO/founders of their respective firms, which were not included in the main sample. This left 153 usable responses with which to construct a covariance matrix for use in the SEM analysis.

Method of Analysis

This study aims to investigate a new application of game theory to a complex model of interactive variables including latent variables not before clearly used. This makes structural equation modeling a good choice for analysis of the results to test for the statistical strength of the constructs proposed and the general fit of the relationships suggested by the overall model.

Structural equation modeling (SEM) allows for item covariance and reliability to be accounted for while still testing for an overall fit of the modeled relationships. Direction may be indicated by an arrow on the diagram but in reality only covariance is being tested. SEM models allow for simple covariance representation which is closer to what is actually being examined than might be represented in a multiple regression result that tends to imply an predictive concept to the analysis.

A covariance type of model also estimates indirect effects (covariance weights) that help in determining whether the model represents an acceptable representation of the data. In assessing the overall fit of the model, several fit statistics are commonly used with SEM analyses. The most common are Chi² (with appropriate degrees of freedom and a corresponding probability value), a goodness of fit (GFI) and an adjusted goodness of fit (AGFI) which accounts for the effect of sample size on GFI. The main effects of the study are examined using AMOS software to model and test the factors and hypotheses using standard SEM techniques (Bollen, 1989; Hoyle, 1995; Maruyama, 1997). Standard regression analysis was also performed using STATA for each of the hypotheses including the factor analysis. Each of the measures was constructed of multi-item scales. These scales were analyzed with confirmatory factor analysis methods including varimax rotations to investigate the factor loading for both convergent and discriminatory validity. In addition the factor models were examined for identification in the structural equation modeling before any of the measures were fitted into the hypothetical structural models.

Game Theory Measures

The four factors based on game theory (Non-Zero-Sum, Reciprocity, Longevity and Utility) all had four or more items in the survey instrument. Factor analysis of each set of items was used to reduce each measure to four items. These sixteen items plus the four for performance were analyzed together and cross-loading items eliminated as much as possible. NZERO retained three items and the other three factors were reduced to two items for the final measures. (Cronbach's alpha NZEROS = 0.841, RECIP = 0.784, LONG = 0.767, UTIL = 0.603.)

To investigate the discriminatory validity of the four measures, the four factor model and a one factor model were compared for overall fit (Schwab, 1980). The one factor model did not achieve minimization and the fit estimated was much worse than the four factor model ($\text{Chi}^2 = 372 / \text{df} = 28, p = .000$; $\text{GFI} = .561$ and $\text{AGFI} = .295$). While not a completely exhaustive test (all possible factor structures were not tested) the four-factor model was retained as a better fit of the data and more consistent with game theory considerations.

Cooperative Knowledge Behavior Measures

For measures of Cooperative Knowledge Behavior, the 12 survey items loaded onto five distinct factors with minimal cross loading on the performance factor items. The two items on knowledge creating were split with one loading with the two items on knowledge acquisition and one loading with the items on knowledge sharing. Upon rereading the items, the concept of 'newness' seemed strong in the first three items and the concept of 'combination' in the second group. The first factor was named Knowledge Building (KBUILD alpha = 0.820) and the second Knowledge Sharing (KSHARE alpha = 0.799).

On the negative side, one hoarding item loaded weakly on several factors and so was dropped. The other hoarding item loaded by itself but was dropped from the analysis since it was a single item measure. The items for KnSHIRK (alpha = .730) and KnAPPRO (alpha = .696) loaded on to each factor and were retained as defined. Thus for Cooperative Knowledge Sharing, there were four dimensions measured in the final model after the confirmatory factor analysis.

A one-factor model for cooperative knowledge behavior was also tested in AMOS to check for discriminatory validity of the four retained measures. The one factor model was a much poorer fit of the data ($\text{Chi}^2 = 206, \text{df} = 36, p = .000$; $\text{GFI} = .770$ and $\text{AGFI} = .649$). While not a formal test of all possible factor models, the four factors were retained as confirmed in the factor analysis and indicated by intuitive definitions of positive and negative behaviors and prior research in this area (Kidwell, 1993).

Performance Measure

Four items were used on the survey to capture a construct for perceived organizational performance. The four items were analyzed as one factor for performance (Cronbach's alpha = 0.760). Since none of the four performance items loaded heavily on either any of the game theory measures or the cooperative knowledge behavior measures, all four items were retained in the performance factor PERF.

Part of the theoretical predictions included directionality for the effect of these game theory dimension on cooperative behavior and also for behavior on performance. The measurement scales were coded so that all effects would be in the positive direction as much as possible. Thus survey items were reverse coded in some cases to make the scale indicate a positive relationship with the dependent variable.

Each of the three hypotheses was tested using standard regression analysis in STATA using the factor scores generated in the factor analysis. Without prior research directly testing these measures, standard levels of significance (p values) are reported for generally acceptable levels of significance as well as F-values for the overall regression model.

Each hypothesis was also tested using a path analysis framework in AMOS using the covariance matrix of the relevant items. All of the SEM models used the covariance matrix since covariance analysis is more robust than relying on correlation data alone for SEM analysis (Hoyle, 1995). The AMOS models were constructed based on the confirmatory factor analysis done previously which identified the most unique items for each measure.

Control Variables

AGE, RACE, EDUCLVL, GENDER, and FIRM were included in all of the regression models to investigate possible biases from sample characteristics along these dimensions. In addition, a one-item measure of job satisfaction (JOBSAT) was included in all models to test for divergence in construct strength between job satisfaction and the measures used in this study.

All of the perception questions were scored on a 6-point scale of agreement except JOBSAT, which was a six-point scale of satisfaction. Normality tests (Shapiro-Wilks test for normal data) were run on the data with only the measure for KnAPPRO failing the test ($p > .05$). RACE and EDUCLVL were not significant in any of the models. AGE showed a significant relationship to KnBUILD and KnSHARE but not to the negative measures of knowledge behavior. That older employees perceived more positive cooperative knowledge behavior is not unexpected from the fact that they may have more skill, more relationships or experience at organizational social skills to be able to achieve that type of behavior. JOBSAT was only

significant with KnSHARE ($p=.019$) but was highly significant in relation to performance (PERFORM) as would be expected from prior research in the HR field.

Since the demographic control variables did not show unexpected significance with any of the variables of interest in the study, they were not included in the SEM analyses to simplify the tests of overall model fit. The one item job satisfaction was included in the structural equation models to allow for the significant covariance revealed in the regression and because of possible conflict with variables under study.

Summary of Results

Game Perceptions Related to Cooperative Behavior Perceptions

The regressions indicate a significant positive relationship for RECIPROCITY with KnBUILD ($\beta = .48$, $p = .000$) and KnSHARE ($\beta = .46$, $p = .000$) and a significant negative relationship with KnSHIRK ($\beta = -.31$, $p = .002$). LONGEVITY showed a significant negative relationship with both KnSHIRK ($\beta = -.217$, $p = .010$) and KnAPPRO ($\beta = -.361$, $p = .000$) which were in the direction predicted (longer commitment means less shirking behavior). UTILITY was weakly related ($p=.076$) to KnBUILD but in a positive direction which was opposite of that predicted in Hypothesis 1. Only NZEROS failed to register significance on any of the cooperative behavior measures in the multiple regression equations. NZEROS was significant in simple regression on KnBUILD with the control variables but loses significance when in the full model with any of the other three game theory measures. Overall, the regression results provide weak to moderate support for Hypothesis 1 that game theory perceptions are related to cooperative knowledge behavior within the firm.

The structural equation test model was designed to test all possible covariance links between the eight measures (4 game theory and 4 knowledge behavior). This means the model has 12 covariance links among similar measures (6 within each group) and 16 covariance links across measures. Since the two measurement models had acceptable fit statistics, the regression weights (factor loading) and within set covariance were fixed from the measurement models in the comparative test model. This method fixes the more parsimonious models and allows a more direct analysis of the covariance across the different constructs without forcing the recalculation of the covariance and regression weights within each factor set.

The fit statistics for the overall model indicate an acceptable fit with $\chi^2 = 168$ ($df = 150$) and a probability of $p = .150$. The GFI and AGFI were .90 and .88 respectively. These levels are in the range of acceptable fit and indicate that the model is explaining a significant amount of the covariance among the measures.

The path analysis shows clearly the strength of the covariance between RECIP and knowledge behaviors. (RECIP with KnBuild, KnShare, and KnSHIRK all $p < .001$). The significance pattern is similar to the regression results with the addition that NZEROS is significant with both KnBUILD ($p = .04$) and KnSHARE ($p = .000$). UTILITY is also significant with all four types of knowledge behavior though all in the opposite direction from that predicted by Hypothesis 1. All but three of the links are significant above the $p < .05$ level. Only KnAPPRO with NZEROSUM was not significant at all ($p = .138$).

The four strongest covariance links were the same four identified by the regression analysis, namely RECIP with KnBUILD (beta = .523, $p = .000$), RECIP with KnSHARE (beta = .413, $p = .000$), UTILITY with KnBUILD (beta = .319, $p = .000$) and LONGVITY with KnAPPRO (beta = .245, $p = .000$).

The SEM analysis shows significant and strong covariance weights. Utility is significantly related but not in the predicted direction. This is a surprising result given the basis of game theory. The utility construct should be closely examined in future research efforts and perhaps compared with alternative types of utility instead of the one dimensional measure on monetary compensation used here. The utility factor also had the lowest factor alpha score, which may indicate problems with the way this factor was constructed.

The overall model fit was good ($\text{Chi}^2 = 167.7$, $df = 150$, $p = .15$, $GFI = .90$ and $AGFI = .88$) which are in the range of acceptable fit for these type of models. Four error term covariance links were added to stabilize the model. These are interpreted as data specific item covariance that when specifically accounted for (allowing it to be estimated in the model) allows the latent variable covariance relationships to be seen more clearly (Maruyama, 1997).

The results for Hypothesis 1 show strong support for reciprocity being highly correlated with Knowledge Building Behavior. This lends support to the notion put forward in the theoretical framework of this study that how people perceive the game may in part determine how they will play the game. The other game theory measures did not show strong support for this relationship.

Utility, which was conceived of as a preference for monetary compensation showed an unexpected positive relationship with KnBUILD and negative relationship with KnSHIRK. This result is consistent in sign across the models. Game theory would suggest that the more attention players give to quantified personal payoffs, the more likely they are to not cooperate but act opportunistically. The result here provides opportunity for more research into the relationship between monetary incentives and cooperation to explore just how and when a focus

on monetary compensation enhances cooperation and when it may lead to excessive individual competition and hurt cooperation.

Perceptions of Cooperative Behavior Related to Perceptions of Firm Performance

The regression analysis for hypothesis 2 regressed firm performance on each of the four cooperative knowledge behavior measures. KnBUILD (beta = .191, $p = .01$) was the only one of the four Knowledge Behavior factors to show a significant relationship to the performance factor in the regression analyses.

JOBSAT was very strongly related to performance as was expected. An interesting side result is that even with JOBSAT controlled for, KnBUILD is still a significant predictor of performance. This demonstrates that at least this measure of cooperative knowledge behavior is capturing a different construct than what might be embedded in job satisfaction. Independent regression models (one for each of the four cooperative knowledge behaviors) revealed significance for KnBUILD (beta = .241, $p = .000$) and also KnSHIRK (beta = -.232, $p = .003$) but neither KnSHARE nor KnAPPRO. Overall, the regression results provide weak support for hypothesis 2 though the support is strong for the one measure of KnBUILD. Subsequent analysis of cooperative knowledge behavior used only this one significant measure for testing mediation effects in Hypothesis 3.

The path analysis reveals a strong relationship for three of the knowledge behavior measures with Performance. Only KnAPPRO was not significant at the .05 level. The directionality of all four is in the correct direction indicating that KnBUILD and KnSHARE are positively related to PERFORM and KnSHIRK and KnAPPRO are negatively related to PERFORM. The test statistics for the full model are $\text{Chi}^2 = 104.5$ ($df = 90$, $p = .14$, $\text{GFI} = .92$ and $\text{AGFI} = .89$). The structural equation results give strong support for Hypothesis 2 that Cooperative Knowledge Behavior is related to perceptions of firm performance.

The results from the path analysis give much stronger support than the regression results for hypothesis 2. One reason for inconsistent regression results may be due to multi-collinearity of the independent variables. An examination of the variance inflation factors for all of the variables in the regression model did not reveal any one variable with a high VIF (all were less than 2 where a value of 10 is considered to indicate multi-collinearity) but the mean VIF was above 1. A mean VIF over 1 can indicate that among all the variables together there is enough multi-collinearity to inflate the variance and bias the results. This may explain somewhat, the lack of support in the regression test for the relationships suggested in hypothesis 2 that were more strongly detected in the SEM analysis.

All of the cooperative knowledge behavioral measures were significantly correlated with performance in simple bi-variate correlation analysis but only KnBUILD and KnSHIRK were significant in the regression analysis. Thus there is weak support for the notion that the amount of perceived cooperative knowledge behavior is related to the performance of the firm. This relationship was assumed to be a strong one so the weak results are surprising. The weakness of the relationship may be due to one or more of the limitations outlined below, particularly the possibility of poorly defined measures for these behaviors or social sensitivity on the part of the respondents in answering some of the questions.

The relationship of cooperative behavior to firm financial performance is assumed by most managers of high tech firms. They spend money and time on programs trying to encourage open cooperation among their employees. To support further research in this field, better measures need to be designed and validated in order to capture the true effect of this relationship in order to investigate the antecedents or causal organizational components. This study has confirmed that there are different dimensions to cooperative knowledge behavior and that some may be more linked to performance than others. In particular, KnBUILD was more important than KnSHARE and KnSHIRK more important than KnAPPRO. Further research should continue to parse out these differences and investigate which ones in particular are related to organizational design characteristics and to firm performance.

The Mediation Effect of Perceptions of Cooperative Knowledge Behavior

To test for the mediation effect of cooperative knowledge behavior and the indirect effect of game theory perceptions on firm performance, three regressions are required (Baron & Kenny, 1986). First, the single construct factor for KnBUILD was regressed on the four game theory measures simply to demonstrate significance of this relationship. KnBUILD was selected as the one behavioral factor to use since it had shown the strongest relationship to performance in the previous regression and path analyses. Second, performance was regressed on each of the four game theory measures. Finally, performance was regressed on the four game theory measures with KnBUILD included to capture the mediation effect of KnBUILD on the primary relationship between the game theory measures and performance.

In the regression results utility continued to score in the reverse direction of that which was predicted. The other variables all had correct signs for their effect. The results here provide weak support for hypothesis 3 with reciprocity showing the largest coefficient and the strongest indication of a mediation effect with a reduction in the beta of 25% from the direct model.

To test the path model for hypothesis 3, the measurement models for the game theory measures and performance were used from the previous tests. Only the KnBUILD measure was

used for cooperative knowledge behavior, as it was the only measure significant from hypothesis 2.

The structural model tested for significance of the implied regression coefficients among the six latent variables. The covariance and regression weights among the game theory measures were fixed from the measurement model to allow for a direct model to model comparison. Due to their lack of significance, the control variables were not included in the path diagram. JOBSAT was included because it had a potential mediation effect. To test for mediation, two models were compared, one with and one without the KnBUILD construct included. The path analysis confirmed weak support for hypothesis 3.

Conclusions

Game theory has a long and colorful history of application in social science and organizational research. This study has attempted to bring some of the core elements of game theory directly into current research models for organizational studies and in particular the field of strategic human resource management. The significance and internal strength of the game theory measures used here warrant further investigation using these types of measures in real organizations. The measures clearly need refinement and further validation, particularly to confirm their divergence from other organizational measures such as internal equity and trust. They were shown to be significantly different from Job Satisfaction, strongly related to firm performance and weakly related to some elements of cooperative knowledge behavior.

The mediation effect of cooperative knowledge behavior on the relationship of the game theory perception on performance was weak. Only reciprocity showed a small significant mediation effect. For the application of game theory to high tech employment, some mechanism of action between perceptions of the game and firm performance must be included in the model. Since game theory purports to predict or explain sources of cooperative behavior and since cooperative behavior is assumed to enhance performance this was the logical choice for this study.

The lack of support for a mediation effect is therefore surprising even within the limitations of this study. One explanation is that the perceptions may be more related to a sense of fairness or equity which then translates into harder work effort which may or may not entail cooperation. Other missing variables may be part of the problem here as well. To investigate this relationship further, one approach would be to find situations where cooperation is clearly strong and then conduct a broad analysis of possible perceived causes of that cooperation.

These perceived causes from known situations of high cooperation could then be tested in a project similar to this one for verification across a wide variance of cooperation levels.

This study may have failed to detect a strong mediation effect in part because of too many other unknown variables. One way to detect an effect is to reduce variance on other dimensions in order to isolate it more clearly. In this study, I used six different aspects of cooperative behavior to try to capture as much richness about perceptions of this behavior as possible. The fact that two of the measures did not survive factor analysis may indicate that these measures need further refinement before use in complex models such as this. It is possible that other aspects of cooperation not measured here may be more important than those included in the model or that participants did not fully understand or grasp the distinctness of the measures used here even though they were given definitions as guides on the survey.

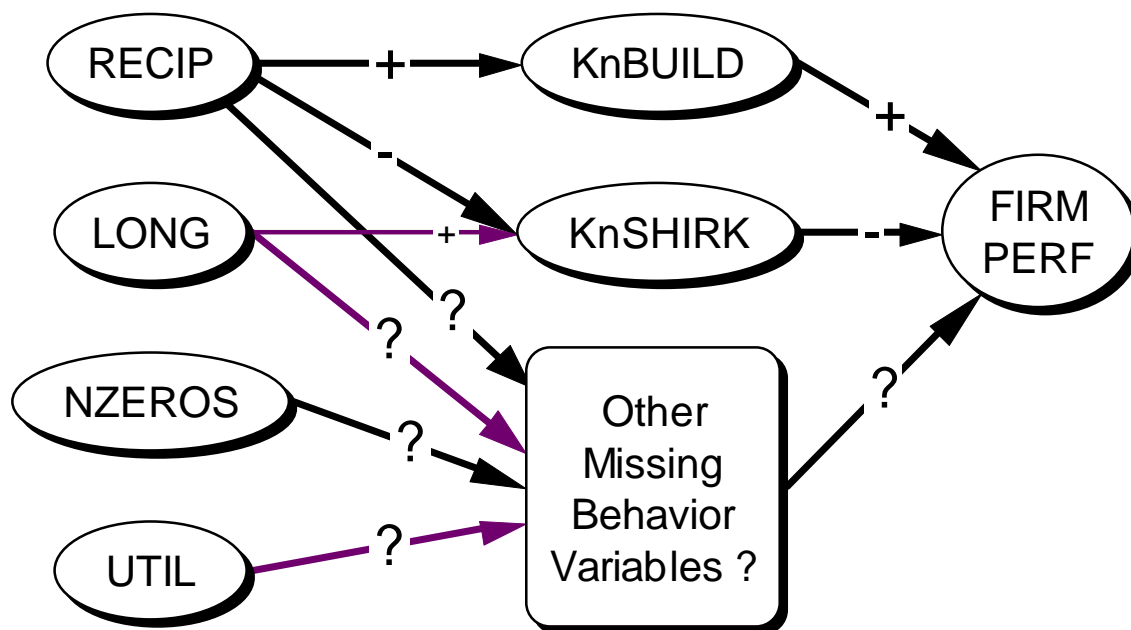
In reference to the overall conceptual model, the strongest support lies along lines from reciprocity to knowledge building to performance. Further research into this relationship to uncover the directionality and strength of each link is warranted. The significance of reciprocity is an important validation of a key concept of game theory in predicting cooperative outcomes. Reciprocity is a key determinant of cooperation in a broad range of game theory research. In addition to its significance in game theory, reciprocity, as measured here, has the potential to inform the research on organizational trust. It plays an important role in the trust research where reciprocity is described as a determinant of the mutual trust that entails from an experienced relationship.

The second most likely route of investigation would be along the lines of longevity to knowledge shirking to performance. Though weaker, these links also show promise. The concept of longevity to the organization is not measured by the expected years of tenure (an item that was included but rejected for lack of factor stability). Expected tenure can have many different causes such as the one participant who commented that they would love to get another job but their family would never leave so "I am stuck here forever."

Rather than the question of how long an employee expects to work for one firm, I tried to focus the concept of longevity on the expected value of a long-term relationship with the firm. Thus the longevity question items I used inquired about the value of maintaining a relationship with the firm over time. Longevity is related to the notion of commitment and this measure may shed further light on important aspects of organizational commitment and its relationship to performance in addition to its potential usefulness in further game theory research in organizations. Based on these observations a revised model for further research is presented in figure 2.

This study has demonstrated that in addition to notions of fairness and general job satisfaction, other perceptions of the work place are important. Foremost among those studied here is the concept of reciprocity. Reciprocity can be thought of as the notion that personal actions matter. Good actions are rewarded and bad actions are punished. Without the sense that reciprocity is being enforced, bad behavior becomes tempting (at no cost) and good behavior may be viewed as wasted (no reward). The items on the survey were very clear about this concept and one reason it scored so strongly may be because this concept was easier to grasp than some of the other game theory dimensions. The question items also obliquely refer to hypothetical situations (someone sharing and getting a reward, someone loafing and getting fired) that could bring to mind specific stories or examples and help the participants respond more distinctly than to the other question items.

Figure 2 Revised Research Model



Reciprocity is a core element of game theory for predicting cooperation both in simulated games (Axelrod, 1997) and laboratory studies with live subjects. Komorita, Hilty, & Parks, 1991). In both cases, where reciprocity was perceived or developed in the course of play, the outcomes were more cooperative. This study has shown that it is possible to measure the perception of reciprocity and in a limited fashion how it relates to performance through enhanced cooperative knowledge behavior.

For the field of Strategic Human Resource Management, the idea that perceptions of the game are important indicators of success may open up new avenues of inquiry for investigating the use of HR practices. For example, a HR practice in the area of compensation may result in an increase in job satisfaction or a reduction in turnover yet not show a positive change in performance. It is possible to explain such results with this new model because the adoption of HR practices may not have changed the perception of the employment game in a direction or magnitude needed to increase performance. For example, a monetary incentive system such as long-term vesting of stock options may reduce turnover and increase job satisfaction but adversely affect reciprocity. Since the bonus is not tied to individual performance, shirking may actually increase and lead to a decrease in performance. Such nuances could be detected by using the measures established in this study to uncover these more complex relationships.

The complex constructs used here often require question items of a socially sensitive nature. This type of question, though typical for socially sensitive topics, is probably also necessary for uncovering the view of the game inside the workplace that is separate from what the individual thinks the game should be. Confusion over actual (perceptions of what is) vs. normative (notions of what I should do) have been a constant source of confusion in this type of organizational research. The measures used here provide a productive way to help avoid some of the individual normative bias in organizational research by tapping into the individual's perception of the group's behavior.

Another question implicit in this research is how to distinguish between perceptions of behavior and actual behavior. It is clear from the arguments raised here that employee perceptions of both the nature of the game and the behavior of others is important to their own decisions to share or hoard their own knowledge. The question remains of how to connect those perceptions with actual behavior and how to measure actual behavior. It is acknowledged that perceptions of behavior, even if consistent across a group, still may not be actual behavior nor be reflected in actual performance of the firm.

Two other important facets of organizational research need to be included in future studies in this area: the time connection between perceptions and behavior since game theory implies that today's perception will affect tomorrow's decision (to cooperate or not) there is an inherent time factor and the meaning of performance as related to a person's perception of performance. If stock performance is measured, then market standard comparisons can be made, but if 'success' is measured perceptually, then it is important to be clear what success means as it means different things to different people (Rogers & Wright, 1998).

The field of Strategic Human Resource Management has struggled with formulating a foundation of theory that allows meaningful inquiry into the workings of the employment game in the workplace. This application of game theory shows promise of new ways of measuring employee perceptions, how important these perceptions are to perceptions of behavior and performance and indicates future research approaches that might help clarify ambiguity surrounding cooperation and motivation. This study shows that these perceptions are related within a firm. Game theory already tells us that these types of perceptions are related to cooperation.

Implications for Practice

The implications for managers from this study are that perceptions matter. Most managers already know that and certainly practice it widely, especially with regard to customers and public stakeholders. This study opens up the possibility of shedding some empirical light on the perceptions of employees toward the organization and how much those perceptions matter. The kind of possibilities that become conceivable for managers is interesting. For example, during the downsizing era of the 80s companies routinely counted the cost of payroll, benefits, and bureaucracy but had no way of counting the cost of decline in morale, changes in employee perceptions, or the adoption of a new psychological contract. Measurement scales that capture perceptions of the changing game of work from the employees perspective could begin to quantify these hidden costs of downsizing without having to wait until after the completion of the merger to assess the cost in human capital.

Large companies could use this kind of perceptual information to build asset models of their human capital. By quantifying and correlating behavioral standards with performance, the perceptions underlying the behaviors could be used to project the value of strategic decisions by assessing how they would affect perceptions of current employees. Thus potential mergers could be evaluated by including an assessment of the cost to human capital in the way of changed employee perceptions.

Measures and models like that put forward here could help fledgling CEOs and their VC's by guiding them to know which workplace perceptions are worth paying attention to and how to detect them before they grow widespread enough to negatively affect behavior. For example, a HR practice such as a company gym, that might be heralded as improving productivity might not be capable of showing productivity increases for months or years. However, introducing the gym might show an immediate change in perceptions of the game as captured by these game theory measures. Then the HR practice could be evaluated on the

likelihood of its contributing to increased performance through the mechanism of increasing cooperative behavior instead of simply through general job satisfaction.

Game theory is a parsimonious way to examine decision making and behavior in thinking beings. Work is fundamentally a human interactive experience. Research and practical models for the future will benefit from the dynamic capabilities of game theory in understanding the way people perceive the employment game and how they play it. This study has demonstrated new ways of applying game theory to current employment issues of cooperative knowledge work in the high tech industry.

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