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FIRM-SPECIFIC KNOWLEDGE RESOURCES AND COMPETITIVE ADVANTAGE: THE ROLES OF ECONOMIC- AND RELATIONSHIP-BASED EMPLOYEE GOVERNANCE MECHANISMS

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The resource-based view of the firm emphasizes the role of firm-specific resources, especially firm-specific knowledge resources, in helping a firm to achieve sustainable competitive advantage. However, the deployment of firm-specific knowledge often requires key employees to make specialized human capital investments that are not easily redeployable to other settings. Thus, in the absence of effective safeguards and trust building devices, employees with foresight may be reluctant to make such specialized investments. This study explores both economic- and relationship-based governance mechanisms that might mitigate this underinvestment problem. Effective use of these governance mechanisms enables a firm to obtain greater performance from its efforts to deploy firm-specific knowledge resources. Empirical results further support these key arguments. Copyright © 2009 John Wiley & Sons, Ltd.

INTRODUCTION

According to the resource-based view of the firm, a firm's ability to achieve and sustain a competitive advantage is directly related to the strength of 'isolating mechanisms' that protect the firm's valuable and rare resources from imitation by rivals (Mahoney and Pandian, 1992; Rumelt, 1984). An important isolating mechanism is the firm-specificity of resources. Resources with such a feature are not easily tradable or redeployable outside the firm (Dierickx and Cool, 1989), making it difficult for rivals to imitate them. Resource- and knowledge-based research generally maintains that among the types of firm-specific resources examined, firm-specific *knowledge* has the greatest potential to serve as a source of sustainable competitive advantage (Coff, 1997; Grant, 1996; Kogut and Zander, 1992).

A firm's knowledge base is the information inputs, know-how, and capabilities that organizational members draw on when searching for innovative solutions (Dosi, 1988). Firm-specific knowledge often results from a search for, and accumulation of, new solutions that build upon

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a firm's established knowledge base (Cohen and Levinthal, 1989; Nelson and Winter, 1982; Teece, 1986). Such firm-specific knowledge may include the ability to operate and maintain customized equipment and familiarity with specialized practices for developing and manu-facturing unique products (Døving and Nordhaug, 2002).

However, rarely can a firm automatically achieve superior economic performance from its firm-specific knowledge resources. Instead, a firm usually requires its key employees to make complementary investments in human capital in the process of absorbing and deploying firm-specific knowledge. When a firm's rent-generating knowledge resources are to a large extent firm-specific, the human capital investments required of its employees are also likely to increase in specificity. Similar to other types of firm-specific investments, the employees' firm-specific human capital is imperfectly redeployable, or is valued less in the external labor market than within the firm (Williamson, 1985). As a result, in the absence of complete contracting, the employees' investments give the firm opportunities to hold employees up *ex post* (through, for example, lower compensation and extended work hours). Thus, key employees with foresight might be reluctant to make such firm-specific investments that would place them in a weak bargaining position. Without effective safeguards and/or substantial trust between the firm and its key employees, a firm might not be able to realize the potential economic rents that can be generated from its firm-specific knowledge resources (Cornell and Shapiro, 1987).

This scenario can be illustrated by the example of Intel employees. In 1970, Intel planned to invest in developing the first semiconductor DRAM (dynamic random access memory), the 1 kilobit '1103.' Despite the economic attractiveness of the project, however, Intel's engineers were seriously concerned about the potential negative consequences of developing knowledge and skills specific to DRAM technology. According to Gordon Moore, then CEO of Intel, 'There was a lot of resistance to semiconductor technology on the part of the core memory engineers. The engineers didn't embrace the 1103 until they realized that it wouldn't make their skills irrelevant' (Cogan and Burgelman, 1989: 2–3). The Intel example shows that while firm-specific knowledge can generate competitive advantage for a firm, it is also likely to give rise to key employees' reluctance to invest in the necessary firm-specific human capital because such investment can put them in a potentially vulnerable position. Thus, a firm needs to adopt effective employee governance mechanisms to reduce its key employees' concerns and align their goals with those of the firm.

This study considers two such governance mechanisms: economic-based mechanisms such as employee stock ownership, and relationship-based mechanisms such as long-term firm-employee relationships, and makes two interrelated arguments. First, a firm's governance system is endogenous to its resource composition: the higher a firm's level of firm-specific knowledge resources, the greater the need to adopt economic- and relationship-based employee governance mechanisms. Second, effective use of such governance mechanisms enables a firm to achieve better economic performance from its firm-specific knowledge resources.

The existence of, and the solution to, employee governance problems are, thus, critically important for explaining the economic rents generated by firm-specific knowledge resources. Accordingly, this study attempts to contribute to both employee governance and resource-based literatures. *First,* this study emphasizes a contingency view of employee governance in which governance mechanisms are endogenous to the nature of firm resource composition, such as the heterogeneity of its knowledge assets. *Second,* this study contributes to the resource-based theory by emphasizing that firm-specific knowledge can only influence *potential* economic rents. The governance of employees who deploy such knowledge in the value creating process moderates the *de facto* rents generated by the firm. Indeed, the next generation of resource-based theory needs to place more emphasis on the logic that *a firm's resource base and the effectiveness of its governance system jointly influence its economic performance* (Gottschalg and Zollo, 2007; Kim and Mahoney, 2005; Makadok, 2003).

BACKGROUND AND HYPOTHESIS DEVELOPMENT

Firm-specific resources and the potential for sustainable competitive advantage

The resource-based view of the firm considers firms as bundles of heterogeneous resources that include tangible and intangible assets, operational processes, and products (Amit and Schoemaker,

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1993). Among these, knowledge is often considered a firm's most important resource (Grant, 1996; Kogut and Zander, 1992). Firm knowledge can be broadly classified as either firm-specific or general. If a firm pursues new knowledge close to its existing knowledge base and with specific applications to its own business setting, the firm is likely to develop firm-specific knowledge, which is more useful to the firm and has less applicability across firm boundaries (Helfat, 1994; Pavitt, 1991). Alternatively, some firms may emphasize the development of general knowledge, which is more often built upon the knowledge available in the market and is less specialized to these firms' own settings. Different knowledge accumulation and development strategies result in key differences among firms in terms of the degree of firm-specificity of their knowledge resources.

Although both firm-specific and general knowledge resources are critical for firm operations, accumulating firm-specific resources is generally associated with higher risk, since the economic value of such resources is ultimately influenced by exogenous factors such as market conditions (Barney, 2001; Bowman and Ambrosini, 2000; Priem and Butler, 2001). Once firm-specific resources prove valuable in the market, however, the rarity and inimitability associated with firm-specific resources enable such resources to play a more strategic role than general resources. Due to the idiosyncrasies in firm contexts, rival firms seeking to appropriate value through imitating another firm's firm-specific knowledge must gain access not only to the knowledge itself, but also to the organizational routines and complementary resources supporting its deployment. This character of firm-specific knowledge has been described by Helfat (1994), who emphasizes that firm-specific R&D activities, as key inputs to firm-specific knowledge, are difficult for other firms to imitate:

> The outcome of firm-specific R&D can prove difficult for other firms to imitate, if they do not have access to the assets to which the R&D was applied. Additionally, the firm-specific nature of the R&D process further impedes imitation: when the R&D process has an important tacit element, it is difficult for others outside of the firm to replicate the process. If the firm has superior and difficult to replicate dynamic routines to support new process and product development, other firms may be left playing catch up, for example, by trying to reverse engineer products once another firm has introduced them. Essentially, the difficulty of imitating (or finding effective substitutes for) other firms' R&D processes or outcomes retards the diffusion of technical knowledge across firms. This in turn enhances appropriability, since direct competition between firms in R&D is reduced (Helfat, 1994: 175).

In contrast, although general knowledge resources have lower risk associated with their value, they are less rare and more subject to ready imitation by other firms. This makes them an unlikely source of sustainable competitive advantage. So despite the risk associated with developing firm-specific knowledge resources, firms seeking to gain and sustain competitive advantage often find it crucial to do so through, for example, investing in firm-specific R&D (Helfat, 1994).

Firm-specific knowledge resources and employee governance mechanisms

Firm-specific knowledge resources alone often do not automatically lead to superior economic performance. Instead, a firm often requires its key employees to make complementary human capital investments crucial to absorbing and applying firm-specific knowledge. Thus, it is of strategic importance for the firm to encourage key employees to invest in such firm-specific human capital.

Becker's (1964) human capital theory provides an early exposition of employee invest-ments in specific human capital. Because firm-specific human capital has, by definition, limited economic value in alternative settings, employees whose human capital has a substantial firm-specific component are constrained in their transactions with the focal firm. Moreover, writing and enforcing contracts associated with firm-specific knowledge and human capital investments are generally difficult (Hart, 1995; Tirole, 1988; Williamson, 1975). As a result, employees' investment in firm-specific human capital likely leaves them vulnerable to opportunistic behavior or the potential for holdup by the firm (Klein, Crawford, and Alchian, 1978; Schelling, 1960;

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Williamson, 1985).[1] For example, a firm '. . .may be tempted to exaggerate financial difficulties in order to justify paying lower wages to workers' (Milgrom and Roberts, 1992: 334).

If employees rationally expect that their firm may hold them up in the future, this expectation will have a direct negative effect on their current incentives to make specific human capital investments (Hart, 1995; Williamson, 1985). They will be inclined to underinvest unless they are ensured via some effective forms that such opportunistic behavior by the firm will not ensue (Shleifer and Summers, 1988; Titman, 1984). Thus, firm-specificity in a firm's knowledge resources is a double-edged sword. On the one hand, firm-specific knowledge is crucial for a firm's gaining and sustaining competitive advantage; on the other hand, such knowledge induces concerns among the firm's employees about economic appropriation.

It then follows that when it is critical for a firm to enlist its key employees to make firm-specific human capital investments, the firm may need to promise not to hold up the employees *ex post*. However, previous studies have shown that such simple promises are generally unreliable—after the employees have made their specific investments, the firm has an incentive to engage in economic holdup and break its promises (Kydland and Prescott, 1977; Laffont and Tirole, 1988). The employees may be aware of this possibility and decline to make specific investments in the first place. Without credible economic safeguards and/or sufficient trust, employees will be reluctant to commit to firm-specific investments in skills that have low redeployability in other firms; instead, they will prefer to invest in more generic skills that can be applied elsewhere.

This study focuses on two general types of employee governance mechanisms that can help firms mitigate their employees' reluctance to make firm-specific human capital investments: an economic-based governance mechanism, and a relationship-based mechanism. The former mechanism is intended to secure employees' economic gains against *ex post* value appropriation; the latter mechanism focuses on fostering trust between the firm and its employees.

Economic-based governance mechanism: employee stock ownership

As an important human resource management practice, employee stock ownership has received considerable research attention (Blair, 1995; Kruse and Blasi, 1997). For example, a wide range of reasons have been proposed to explain firms' adoption of employee stock ownership, including providing employee benefits, inducing employee effort, fulfilling management's philosophical commitment to shared ownership, gaining tax advantages, and financing capital acquisitions (Klein, 1987; Kruse and Blasi, 1997).

The current study builds on, but departs from, this research literature by considering a strategic situation in which stock ownership may be particularly relevant to inducing employee effort: namely, when the firm relies on firm-specific knowledge resources to achieve sustainable competitive advantage and thus requires key employees to make substantial firm-specific human capital investments. In this setting, concerns about firm-level holdup and employee underinvestment issues are especially prominent, and accordingly effective governance solutions to employee underinvestment are most needed.

The idea of using employee stock ownership as an economic-based governance solution to employee underinvestment problems is built upon property rights theory (Barzel, 1989; Demsetz, 1967; Libecap, 1989), which maintains that ownership rights are instrumental in allocating resources toward their highest economically valued uses, making these ownership rights crucial to achieving operating efficiency. Based on this view, employees will be more willing to invest in specialized human capital if they are able to effectively avoid holdup by the firm, and thus appropriate a fair share of the rents generated from these investments.

A particular feature of firm-specific knowledge resources and employees' accompanying human capital investments is the often ambiguous nature of ownership (Coase, 1960; Milgrom and Roberts, 1992). In general, employment contracts that govern exchanges of employee services are costly to write and enforce (Coase, 1937; Klein, 1980) and therefore are typically incomplete (Hart, 1995).

[1] Although there are cases where employees may hold up the firm by, for example, threatening to resign from some projects or even leave the firm, generally speaking, the firm has more bargaining power in such a bilateral monopoly situation. So the risk of holdup often affects employees more severely than the firm (Glick and Feuer, 1984; Rock and Wachter, 1999).

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The uncontracted dimensions of the exchange, which are in essence property rights or ownership rights, are the 'residual rights of control' (Grossman and Hart, 1986; Hart and Moore, 1990). When these residual rights of control do not accrue to the transacting party who invested in the resource, this party has less incentive to devote the full effort needed to maximize the rent-generating potential of the resource. Thus, the residual rights or ownership of resources involved in a transaction should go to the party whose firm-specific investments have the most influence over the resources, but are the most difficult to contract over (Grossman and Hart, 1986; Rajan and Zingales, 1998). Specifically, when the key resource involved is firm-specific knowledge, granting some equity ownership to the key employees who must absorb and deploy such knowledge becomes economically desirable. Such equity ownership provides key employees greater power to bargain *ex post* over the economic rents generated from the deployment of firm-specific knowledge assets.

In addition, firms can also use employee stock ownership to serve as a control mechanism suitable to resource compositions characterized by high levels of firm-specific knowledge resources, where the behavior of the key employees in absorbing and deploying firm-specific knowledge is often difficult to observe and measure. The employer's insufficient knowledge of the transformation process, or imperfect task programmability, may force reliance on outcome control—as opposed to behavior control—to induce cooperative effort among the firm's key employees (Eisenhardt, 1985; Ouchi, 1980). Linking the financial reward of key employees to the firm's economic performance through granting key employees equity ownership is likely to best align the firm's interests with those of the key employees (Shleifer and Vishny, 1997). In sum, employee stock ownership provides both a measure of residual control and a vehicle for profit-sharing to encourage productive effort.

Granting key employees such ownership rights directly, however, is costly to the firm. In addition to the direct reduction of the share of the economic profit accrued to the firm, other shareholders' investment incentives are lessened because they will gain only a fraction of the marginal product for the full marginal cost of their investment (Roberts and Van den Steen, 2000). Meanwhile, employee stock ownership can potentially give rise to dysfunctional behavioral responses from the employees due to potential mismatches between employees' and employers' time horizons and risk preferences (Miller, 1992). For example, because employees with stock ownership often hold an undiversified investment portfolio, their potential aversion to the downside risks of financial difficulty or bankruptcy may reduce their incentives to invest in firm-specific human capital. In addition, employee equity ownership may not fully safeguard against employees shirking if value distribution is not fine-tuned to individual performance (Holmstrom, 1982). Moreover, while equity ownership gives employees more opportunities to participate in the firm's decision-making process, greater involvement of employees may also lead to administrative inefficiency (Blasi, Kruse, and Bernstein, 2003). Therefore, as Kruse and Blasi (1997) emphasize, in order for employee ownership to serve as an effective mechanism of governance, firms need to give attention to '... the circumstances in which employee ownership is implemented, the history of employee relations in the company, and other company policies that may support or work against positive effects of employee ownership' (Kruse and Blasi, 1997: 114).

Due to these costs and downside risks associated with employee stock ownership, firms often find it necessary to use extra caution when considering adopting such policies, unless employee concern for firm opportunistic behavior is severe and the employee underinvestment problem is critical. Thus, when a firm has a high level of firm-specific knowledge, where the concern for employee underinvestment is likely to be the greatest, the firm is more likely to grant its key employees ownership rights. Therefore,

> *Hypothesis 1: Everything else equal, a firm's level of firm-specific knowledge resources is positively associated with its use of employee stock ownership as a governance mechanism.*

Relationship-based governance mechanism: firm-employee relationships

Building trusting relationships with key employees may also serve as a governance mechanism that a firm can adopt to encourage employees to

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make specialized human capital investment accompanying firm-specific knowledge resources. Since employees' concerns about holdup by the firm may be based on perceptions that the firm is in a position to unfairly expropriate their investments in firm-specific human capital, the firm's efforts to build trust may help reduce the threat of such perceptions. Although it may generally be difficult for employees to trust a firm's simple promise not to engage in unfair expropriation *ex post*, the employees may be more willing to commit if the firm shows its trustworthiness through practices that can help build its reputation as a fair and caring employer (Barney and Hansen, 1994; Rousseau, 1995; Zaheer, McEvily, and Perrone, 1998).

The research literature has often considered the firm-employee relationship as an exchange of trust and commitment (Blau, 1964; Etzioni, 1961; Mowday, Porter, and Steers, 1982). When employees consistently receive favorable treatment from their firm, they are likely to develop a sense of trust that the firm will not take advantage of their vulnerability *ex post* and thus are more likely to reciprocate the favorable treatment by engaging in firm-specific human capital investments (Gouldner, 1960). Further, employees form perceptions of the extent to which they are valued and cared about; and they use such perceptions as a basis for evaluating the degree of commitment they will provide to the firm (Vandenberghe *et al*., 2007). Research has also generally shown that relational governance is associated with greater employee cooperation and trust, which in turn reduces employee concerns about holdup by the firm and increases employees' acceptance of the firm's goals as close to their goals. For example, Ouchi (1980) maintains that in clan organizations: 'a variety of social mechanisms reduces differences between individual and organizational goals and produces a strong sense of community' (Ouchi, 1980: 136). The shared values embedded in well-functioning firm-employee relationships often inspire key employees to self-enforce their psychological contracts with the firm and to devote sufficient effort to cooperation.

Nevertheless, the development and maintenance of relational governance are costly because they often require substantial long-term investment by the firm in various human resource practices, such as recruitment benefits and training, team-based performance appraisal, and long-term employment policies (Collins and Smith, 2006). This cost factor implies that the use of relational governance is more beneficial when substantial exchange hazards are present, as in the context of firms with high levels of firm-specific knowledge resources. Therefore,

> *Hypothesis 2: Everything else equal, a firm's level of firm-specific knowledge resources is positively associated with the extent to which it places emphasis on establishing good relationships with its key employees.*

Employee governance and performance advantage based on firm-specific knowledge

Although firm-specific knowledge resources are a potential source of a firm's superior economic performance, if employees' concerns for holdup by the firm lead to a tendency for underinvestment in firm-specific human capital, the firm's *actual* economic performance may diverge substantially from its potential (Kim and Mahoney, 2005). Thus, both explicit and implicit governance mechanisms, such as employee stock ownership and firm-employee relationships, can be important in influencing the performance impact of firm-specific knowledge (Gottschalg and Zollo, 2007; Wang and Barney, 2006). Consistent with this view, some researchers have recognized organizational capabilities and motivation as two key drivers for firm competitive behavior, and consequently firm-level economic performance (Chen, 1996; Gimeno, 1999). These two different but coexisting drivers *jointly* influence the economic outcome of the firm.

Viewed in this way, the current resource-based theory of the firm focuses primarily on the *potential* of a firm's resources—especially firm-specific knowledge-based resources—for generating economic rents. What has been far less examined from this perspective is the willingness of a firm's key employees to deploy these firm-specific resources. Indeed, the governance of key employees who actually deploy and utilize a firm's resources toward productive uses moderates the *de facto* economic rents generated by the firm. Therefore, to better explain and predict how superior firm-level resources bring sustainable competitive advantage, we need to simultaneously consider a firm's resource base and the effectiveness of its governance system (Makadok, 2003).

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To reduce the gap between potential economic rents and *de facto* economic rents, a firm must mitigate its employees' tendency to underinvest in firm-specific human capital and align their economic interests with those of the firm. Otherwise, the capability for firm-specific knowledge to deliver superior economic performance will be substantially compromised. Put differently, a key barrier to the realization of economic rent based on firm-specific knowledge resources is employees' underinvestment in firm-specific human capital; and employee governance mechanisms need to incorporate appropriate solutions to the employee underinvestment problem. Hypotheses 1 and 2 suggest that an effective governance system for a firm with a high level of firm-specific knowledge resources will more likely grant key employees equity ownership and/or build trusting relationships with them. This logic suggests that there should be an interaction effect between firm-specific knowledge resources and employee governance mechanisms on firm-level economic performance. A firm's governance system might be considered analogous to a valve, the inappropriate functioning of which will hinder the flow of firm-specific knowledge resources toward full realization of economic rents. Therefore, the following are hypothesized:

Hypothesis 3a: Everything else equal, the relationship between the level of firm-specific knowledge resources and firm-level economic performance is positively moderated by employee stock ownership.
Hypothesis 3b: Everything else equal, the relationship between the level of firm-specific knowledge resources and firm-level economic performance is positively moderated by firm-employee relationships.

It should be noted however that unlike firm-employee relationships, employee stock ownership often influences employee incentives in a more complex manner (Kruse and Blasi, 1997). While employee equity ownership directly addresses employees' concerns about holdup by ensuring them bargaining power concerning *ex post* rent appropriation, it may not fully safeguard against employees' shirking behavior, which often occurs when value distribution is not fine-tuned to individual performance. This shirking or free-rider problem can be especially severe if key employees need to work in a group. Such a problem is sometimes referred to as the '1/N problem.' With N employees in a company or a group, each employee will get an average of only 1/N of any extra economic surplus generated by their better performance (Holmstrom, 1982). Furthermore, when a firm or a team is large, the contribution of a particular employee to team output often cannot be precisely measured and rewarded accordingly (Alchian and Demsetz, 1972). Therefore, in such settings, purely economic incentives can give rise to dysfunctional behavioral responses (Miller, 1992). So employee stock ownership may be less effective in resolving the underinvestment problem in large firms. Such a limitation of employee ownership-based governance is captured in the following hypothesis:

Hypothesis 4: The moderating role of employee stock ownership in the relationship between the level of firm-specific knowledge resources and firm-level economic performance will be weaker in larger firms.

DATA AND METHODS

Data and sample

Our sample was compiled from several data sources: Standard & Poor's (S&P) Compustat series, United States patent data, the U.S. Securities and Exchange Commission's (SEC) EDGAR data, and data from KLD Research and Analytics Inc. Since all of the datasets covered multiple years, we were able to construct an unbalanced panel dataset based on their overlapping periods.

We began our sample selection with the group of firms in manufacturing industries (four-digit Standard Industrial Classification [SIC] codes 2000 to 3999) that were also listed in the KLD database between 1994 and 2002. The focus on manufacturing firms enabled us to construct a sample of firms that shared some common characteristics in terms of their innovation processes, but provided sufficient variation in terms of the level of knowledge specificity across firms. The KLD data were used to construct the measure for firm-employee relationships. KLD data have been widely used in business and society research,

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and are considered to be the best data available for a comprehensive measure of corporate social relationships and stakeholder management (Hillman and Keim, 2001; Sharfman, 1996; Waddock and Graves, 1997). The data have been used to compile profiles and social ratings evaluating each company's strengths and concerns in several dimensions including community, diversity, firm-employee relations, environment, products, and so forth. We obtained our firm-employee relationships measure from the 'employee relations' dimension of the KLD data (see Appendix).

Information on employee stock ownership was collected from the SEC data. The SEC requires every registered firm to file a definitive proxy statement (DEF14-A) annually, which discloses the beneficial ownership of common stock holdings in excess of five percent. Note that for firms in which employees do not hold at least five percent collectively, this information is not reported and was thus coded as zero. Roughly 12 percent of the observations in our sample had nonzero values.[2]

The combined firm-employee relationships and employee stock ownership data were then merged with patent citation data and data from S&P's Compustat series, where we obtained our measures of firm-specific knowledge resources and firm-level economic performance respectively. Hall, Jaffe, and Trajtenberg (2001) have created a data file that contains detailed information about almost three million U.S. patents granted between 1963 and 1999, and over 16 million citations made of these patents for those granted between 1975 and 1999. Moreover, Professor Bronwyn Hall has compiled updated information on patents and their citations up to 2002.[3] Because our unit of analysis was the firm, we aggregated the patents and their citation counts to the firm level (Rosenkopf and Nerkar, 2001). After merging all the datasets and deleting observations with missing values for key variables, the final panel data contained 211 firms and 1,329 firm-year observations between 1994 and 2002. The firms were distributed within 18 two-digit and 65 three-digit SIC codes.

Measures

Firm economic performance (Tobin's Q)

Tobin's Q was employed to capture each firm's economic performance, as it reflects the market's expectations of the firm's future growth and profit potential (Lindenberg and Ross, 1981). Tobin's Q was approximated using the market-to-book ratio. The market value numerator was the year-end market value of the firm's common stock, plus the book value of its preferred stock and debt; the book value denominator was the year-end total assets figure. In addition, to be consistent with our statistical model, which shall be discussed in the next section, we conducted a log transformation of our proxy of Tobin's Q.

Firm-specificity of knowledge resources (FS)

Patent citations provide direct evidence of the path of knowledge flow and knowledge spillovers, since each patent normally identifies several others constituting the state-of-the-art technology on which it builds. It is possible to tabulate the frequency with which patents cite previous patents of the same firm and patents assigned to other firms. Previous research has used such tabulations to explore questions involving spatial diffusion (Jaffe, Trajtenberg, and Henderson, 1993), international knowledge flows (Jaffe and Trajtenberg, 1999), and spillovers from public research (Jaffe and Lerner, 1999).

Firm-specific knowledge often results from firms searching and accumulating new knowledge on the basis of their established knowledge bases (Cohen and Levinthal, 1989; Teece, 1986). If patents represent knowledge creation, and patent citations represent knowledge flows, the frequency with which a firm cites its own previous patents indicates the degree to which the firm is building upon its own knowledge base. The higher the percentage of such internal accumulation, the more likely the firm's innovative knowledge is firm-specific. This logic supports constructing a measure of firm-specific knowledge resources using patent citations. The patent citation data for 1975 to 2002 were analyzed to generate two proxies for the level of firm-specific knowledge resources. The first was the

[2] According to the latest estimate of the National Center for Employee Ownership (www.neco.org), about 15 percent to 20 percent of all public companies today have adopted employee stock ownership plans. The somewhat lower percentage of nonzero values in our sample may be because a firm had adopted employee stock ownership but the total percentage holding was below five percent, or because the percentage of firms has been growing over the years.

[3] http://elsa.berkeley.edu/~bhhall/patents.html (last accessed 20 March 2008).

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share of self-citations made, calculated by counting all citations made in a firm's new patents in a certain year that cited the firm's previous patents, then dividing this by the total number of citations made in all of the firm's new patents in that year. The second proxy was a weighted count measure calculated as follows:

$$\textit{Firm-specific knowledge} = \textit{Number of prior self-citations made (adjusted by firm size)}^{*} \textit{extent to which prior self-cited patents are subsequently cited by the focal firm}$$

The weight was added to take into account the firm-specificity of the firm's prior patented knowledge: even though a firm cites its own previous patents, if these previous patents are also widely cited by other firms (which makes the weight rather small), the degree of firm-specificity in knowledge as measured by the count of self-citations made should be discounted.

Firm-employee relationships

Our measure of firm-employee relationships is based on the 'employee relations' dimension of the KLD data. The employee relations dimension has a total of seven 'strengths' (strong union relations; no layoff policy; cash profit-sharing; employee involvement; strong retirement benefits; health and safety strength; and other strengths) and three 'concerns' (poor union relations; health and safety concern; and workforce reduction). A firm's total number of 'concerns' was subtracted from its number of 'strengths' to arrive at a net score for firm-employee relationships. Note that we excluded the 'cash profit-sharing' dimension from the list, as it is a financial-based governance mechanism. These remaining items take into consideration long-term employee well-being, and therefore may serve as a reasonable proxy for firm-employee relationships.[4]

Employee stock ownership

Employee stock ownership was measured in terms of the percentage of beneficial ownership of the firm's common stock held by employees as a collective.[5] The data were extracted from the EDGAR database.

Control variables

Previous empirical studies (Hall, 2000; Hall, Jaffe, and Trajtenberg, 2005) have considered *R&D expenditure* as an innovation input and an important determinant of the intangible component of market value. To be consistent with our statistical model, we scaled each firm's yearly R&D expenditure by the firm's total assets (*RD/A*). *Patenting intensity* represents another important aspect of the knowledge resources that contribute to a firm's market value, since a firm's patents were taken as the output of the firm's investment in knowledge creation (Griliches, 1981; Hall, 2000; Hall *et al*., 2005). Patenting intensity was calculated by dividing the aggregate number of a firm's patents by its total assets (*PAT/A*).

The R&D expenditure and patenting intensity indicators were included in the equations with employee stock ownership and firm-employee relationships as dependent variables. It is reasonable to expect that firms with greater knowledge resources in general (as indicated by R&D expenditure and patenting activity) have greater difficulty measuring employee effort, and are therefore more likely to adopt the governance mechanisms under consideration.

In addition, we controlled for *firm size, firm age,* and *financial slack* in these equations. Previous

[4] 'Employee involvement' is not a pure relationship-based item, since it includes granting employees shares and options. Moreover, the 'union relations' items are geared toward lower-level employees, whereas our theoretical focus is on key knowledge workers. Thus, as a robustness test, we constructed a more conservative measure of firm-employee relationship by removing these two items. Our key empirical results remained consistent. In addition, we conducted robustness tests using a dummy measure of firm-employee relationships based on the '100 Best Places to Work For' list (http://www.greatplacetowork.com/best/list-bestusa.htm). Consistent results were again generated using this alternative measure. Details of these robustness tests are available from the authors upon request.

[5] Because of the relatively large number of zeros in this variable, we conducted a supplementary analysis coding employee stock ownership as a dummy variable (those having collective employee ownership of five percent or above were coded as one, otherwise, zero). In addition, we constructed a third measure of employee stock ownership using the 'cash profit-sharing' dimension from the KLD data. The main results with these alternative approaches were largely consistent with those of the main analysis. Details of these alternatives are available from the authors upon request.

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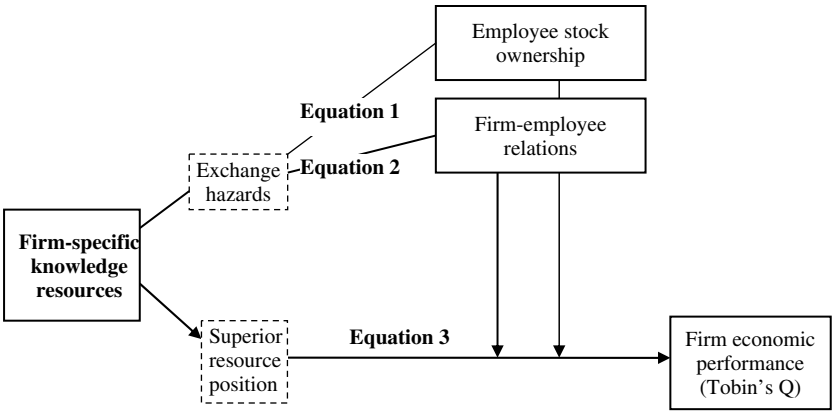

Figure 1. The conceptual model

empirical studies (Gregg and Machin, 1988; Kruse, 1996) have found that larger companies have a greater level of employee stock ownership. Firm size may also affect firm-employee relationships positively, due to the presence of economies of scale in relationship-building activities. Firm age has previously been shown to be related to the adoption of certain employee governance mechanisms (Gomez-Mejia, Larraza-Kintana, and Makri, 2003; Schulze, Lubatkin, and Dino, 2003). Financial slack may affect the extent to which a firm is willing to adopt employee stock ownership plans (Jones and Kato, 1993; Poole and Jenkins, 1990) and engage in relationship-building with its stakeholders, including employees (Waddock and Graves, 1997).

Firm size was proxied by the natural logarithm of the total number of employees in a firm. Following the methods of Bourgeois (1981) and Singh (1986), we use each firm's current ratio (current assets divided by current liabilities) to represent its financial slack. In addition, year dummies and industry dummies[6] at a three-digit SIC level were included in all of the equations to control for time and industry effects.

Estimation method

Overall model

Our hypotheses require that we empirically test a system of equations simultaneously (see Figure 1). The first and second equations were formulated to test whether the level of firm-specific knowledge resources was associated with the degree of employee stock ownership and with the cultivation of good firm-employee relationships. The third equation examined whether or not the level of firm-specific knowledge resources affects firm performance and whether the relationship between firm-specific knowledge resources and performance is moderated by employee stock ownership and firm-employee relationships.

First-stage equations:

$$\begin{aligned} Employee\ Ownership &= \alpha_0' \\ &+ \beta_1' Lagged\ Employee\ Ownership \\ &+ \beta_2' FS + \beta_3' Employee\ Relations \\ &+ \beta_4' RD/A + \beta_5' PAT/A + \beta_6' Size + \beta_7' Age \\ &+ \beta_8' Slack + \beta_9' Other\ Controls + \varepsilon' \\ Employee\ Relations &= \alpha_0'' \\ &+ \beta_1'' Lagged Employee\ Relations \\ &+ \beta_2'' FS + \beta_3'' Employee\ Ownership \\ &+ \beta''_4 RD/A + \beta''_5 PAT/A + \beta''_6 Size \\ &+ \beta''_7 Age + \beta''_8 Slack \\ &+ \beta''_9 Other\ Controls + \varepsilon'' \end{aligned}$$

Second-stage equation[7]:

$$\log Q = \alpha_0 + \beta_1 RD/A + \beta_2 PAT/A + \beta_3 FS$$

[6] We conducted additional tests by running the regressions based on individual industries. The results were largely consistent with those of the analyses with industry controls. Details are available from the authors upon request.

[7] Please see the subsection below for the detailed derivation of the second-stage equation.

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$$+ \beta_4 Employee\ Ownership$$
$$+ \beta_5 Employee\ Relations$$
$$+ \beta_6 Size + \gamma_7 FS^*\ Employee\ Ownership$$
$$+ \gamma_8 FS^*\ Employee\ Relations$$
$$+ \delta_9 FS^*\ Employee\ Ownership^*\ Size + \varepsilon$$

Specifying and testing the third equation independently would introduce significantly biased estimates due to the endogeneity of the employee stock ownership and firm-employee relationship variables (Hamilton and Nickerson, 2003). Thus, the equations were tested using a series of two-stage models that considered the endogeneity of governance mechanisms. Two-stage least squares (2SLS) analysis is a popular approach for estimating simultaneous equations (Greene, 2002; Kennedy, 1998). A 2SLS estimation combines all exogenous variables in the first-stage equation (but not in the second-stage equation) to create a combined variable to act as a 'best' instrumental variable. In this analysis, the exogenous variables were the lagged employee governance variables, firm age, and financial slack. The first-stage tests had employee stock ownership and firm-employee relationships as the dependent variables. New variables were obtained by regressing the first-stage models. The second-stage equation has firm-level economic performance (Tobin's Q) as the dependent variable. We then used as regressors the newly estimated employee stock ownership, firm-employee relationships, their interactions with firm-specific knowledge resources, and other factors that were thought to affect Tobin's Q.

The second-stage performance equation

Following the pioneering work of Waugh (1928) and Griliches (1961), and subsequent studies (Griliches, 1981; Hall, 2000; Hall *et al.*, 2005), we determined the economic returns on firm-specific knowledge resources using the hedonic regression method, which regresses a firm's market value against bundles of resources that compose the firm, including measures relating to intangible resources such as knowledge and innovations. This approach is often used when no direct economic valuation of a resource is available and the resource can only be valued when bundled with other resources of the firm.

We thus followed the basic approach employed in the market valuation literature that relates the market value of a company to the economic value of its tangible assets and various measures of its intangible assets (Griliches, 1981; Hall, 2000). Specifically, MV_i was defined as the market value of company i. The assets of the firm were regarded as made up of two parts: physical or tangible assets that are recorded and are measured as part of the total assets of the firm, and knowledge or intangible assets that largely go unrecorded and do not appear in the accounts as part of the total assets. The recorded economic value of the tangible assets was represented by A_i, and the corresponding measures of the economic value of the intangible assets were represented by K_i. The model was

$$MV_i = q(A_i + \gamma K_i)^{\sigma} \tag{1}$$

Taking the logarithms of both sides,

$$\log MV_i = \log q + \sigma \log A_i + \sigma \log(1 + \gamma K_i/A_i) \tag{2}$$

where $\log(1 + \gamma K_i/A_i)$ is generally approximated by $\gamma K_i/A_i$ in the literature (Hall *et al.*, 2005). γ measures the shadow value of knowledge assets relative to the tangible assets of the firm. σ is unity if returns to scale are constant, which should be the case in a cross-sectional setting. $\log A_i$, the log of book assets, can then be moved to the left side of the equation:

$$\log(MV_i/A_i) = \log q + \gamma K_i/A_i. \tag{3}$$

Since Tobin's Q is defined as a firm's market value relative to the replacement value of its assets, and the replacement value is approximately the value of the tangible assets of the firm, MV_i/A_i, the ratio of a firm's market value to the value of its tangible assets is in fact Tobin's Q. Therefore, the above equation can be estimated with the logarithm of the conventional Tobin's Q (Q_i) as the dependent variable, as we did here. Therefore, the estimation model becomes:

$$\log Q_i = \log q + \gamma K_i/A_i + \varepsilon_i \tag{4}$$

where ε_i is a normally distributed error term.

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On the basis of the model shown above, we came up with its expanded version:

$$\log Q = \alpha_0 + \beta_1 RD/A + \beta_2 PAT/A + \beta_3 FS + \gamma_4 FS^* \ Employee \ Ownership + \gamma_5 FS^* \ Employee \ Relations + \delta_6 FS^* \ Employee \ Ownership^* \ Size + \varepsilon \quad (5)$$

Equation (5) is the second-stage equation, which was estimated in this study. The β coefficients refer to intangible assets including both general and firm-specific knowledge assets: the ratio of R&D to total assets (β_1), the ratio of patent counts to total assets (β_2), and the level of firm-specific knowledge assets (β_3). The γ coefficients refer to the variables hypothesized to affect market value through motivating employees to cooperate with the firm, including interactions of the level of firm-specific knowledge assets with employee stock ownership (γ_4) and with firm-employee relationships (γ_5). The δ parameter incorporates any three-way interaction among firm size, employee stock ownership, and firm-specific knowledge, taking into consideration the extent to which the moderating effect of employee stock ownership also depends on firm size (as specified in Hypothesis 4).

To address concerns about autocorrelation and the unobserved heterogeneity that are likely to be present when estimating a panel dataset, we applied the standard techniques of panel data analysis. Hausman's (1978) test was conducted to determine the appropriate estimation method. The results demonstrated significant correlations between the error terms and the regressors, suggesting that firm fixed-effects models should be preferred over random-effects models in this statistical analysis. We thus applied 2SLS with fixed effects to test the models. In particular, this was implemented by reshaping the second-stage variables into difference form, and then using Proc Syslin within SAS to do 2SLS on the differenced variables.

RESULTS

Table 1 shows the descriptive statistics and correlation matrix for the main variables. The two measures of the level of firm-specific knowledge resources (share of self-citations made and the weighted number of self-citations made) were highly correlated. In addition, both measures were positively correlated with the performance measure, logged Tobin's Q. Consistent with our expectations, both measures of firm-specific knowledge showed significant, positive correlations with the measures of the two employee governance mechanisms: 'employee stock ownership' and 'firm-employee relationships' (except that the correlation between weighted number of self-cites and employee stock ownership were not significant). R&D spending and patenting intensity were also positively correlated with logged Tobin's Q, as would be expected.

Table 1. Descriptive statistics and correlation matrix

Variables	Mean	s. d.	1	2	3	4	5	6	7	8	9
1. Log (Tobin's Q)	0.77	0.56									
Firm-specific knowledge resources											
2. Share of self-cites	0.10	0.14	0.15*								
3. Weighted number of self-cites ($\times 10^{-2}$)	0.22	0.46	0.08*	0.33*							
4. Employee stock ownership	1.32	4.08	0.02	0.07*	0.01						
5. Firm-employee relationships	0.19	1.12	0.21*	0.19*	0.20*	−0.05					
6. R&D intensity	0.05	0.04	0.39*	0.10*	0.16*	−0.04	0.20*				
7. Patenting intensity	0.06	0.15	0.13*	0.21*	0.20*	−0.03	0.15*	0.28*			
7. Firm size	8.45	1.38	−0.04	0.04	0.22*	0.18*	0.08*	−0.09	0.29*		
9. Firm age	23.36	13.73	−0.00	0.03	−0.02	0.03	0.07*	0.01	−0.03	0.39*	
10. Financial slack	0.03	0.09	0.39*	0.01	0.03	−0.03	0.15*	0.07*	−0.06*	−0.09*	−0.19*

N = 1329.
* $p < 0.05$.

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Table 2. The determinants of employee stock ownership and firm-employee relationships: results from first-stage models with firm fixed effect

Labels	DV: Employee stock ownership		DV: Firm-employee relationships	
	Model 1	Model 2	Model 3	Model 4
Lagged DV	0.74***	0.74***	0.81***	0.81***
	(0.02)	(0.02)	(0.02)	(0.02)
Firm-specific knowledge resources				
Share of self-cites	3.41**		2.55***	
	(1.25)		(0.35)	
Weighted number of self-cites ($\times 10^{-2}$)		0.04+		0.09***
		(0.02)		(0.02)
Employee stock ownership			−0.03**	−0.03**
			(0.01)	(0.01)
Firm-employee relationships	−0.32**	−0.27*		
	(0.11)	(0.11)		
R&D intensity	1.77	1.59	3.15***	3.07**
	(3.98)	(4.16)	(1.01)	(1.12)
Patenting intensity	1.98	1,23	2.35	1.99
	(8.23)	(7.95)	(3.55)	(2.78)
Firm size	0.44***	0.42***	0.10*	0.09*
	(0.11)	(0.11)	(0.04)	(0.04)
Firm age	0.00	0.00	0.01*	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)
Financial slack	0.49	0.68	1.77***	1.80***
	(1.57)	(1.61)	(0.49)	(0.49)
R^2	0.68	0.67	0.79	0.79

N = 1329.
Standard errors are shown in parentheses.
Industry and year dummies are included but not reported.
Significant at the $^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ level.

Table 2 shows the empirical results of the first-stage models, which included regressions of employee stock ownership and firm-employee relationships against factors thought to affect the extent to which a firm adopts the employee governance mechanisms.

The empirical results from the first-stage analysis are largely consistent with the prediction of Hypotheses 1 and 2, which indicate that firms with higher levels of firm-specific knowledge resources were more likely to adopt appropriate governance mechanisms to align key employees' efforts with the interests of the firm. Employee stock ownership was found to be positively associated with both measures of firm-specific knowledge resources (Models 1 and 2), although the relationship was only marginally significant when the weighted number of self-cites was used as the firm-specific knowledge measure (Model 2). Consistent patterns are also found in the equations with firm-employee relationships as the dependent variable. The coefficients on both measures of firm-specific knowledge resources were positive and statistically significant (Models 3 and 4). Thus, we found support for both Hypothesis 1 and Hypothesis 2, providing evidence for our argument regarding the endogeneity of employee governance mechanisms.

Table 2 also shows that employee stock ownership and firm-employee relationships were negatively associated with each other, indicating that these two governance mechanisms may be substitutive.[8] Further, large firms were found to be more likely to use both forms of employee governance mechanisms, while older firms were more likely to rely on good relationships with their employees. Financial slack was positively associated with firm-employee relationships, consistent with the

[8] To further explore the interrelationship between the two governance mechanisms in influencing the performance effects of firm-specific knowledge, we conducted additional analysis by including a three-way interaction term among firm-specific knowledge, employee stock ownership, and firm-employee relations. However, no statistically significant effect was found for the interaction term. Details of these empirical results are available from the authors upon request.

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idea that cash-rich firms are more likely to spend on activities that enhance their relationships with employees (Waddock and Graves, 1997). But the same effect was not found when employee stock ownership was used as the dependent variable. Similarly, consistent with our prediction, R&D intensity was positively related to firm-employee relationships; but the effect is not statistically significant for employee stock ownership.

Second-stage financial performance estimates

Table 3 presents the empirical results from the second-stage models. For the models applying 2SLS, we used the estimated employee stock ownership and firm-employee relationships variables generated in the first stage, their interactions with firm-specific knowledge, and other factors that were thought to affect Tobin's Q as regressors.

The effects of the level of firm-specific knowledge, other intangible resources, including R&D and patenting intensities, and firm size, are shown in Models 1 and 6. Both measures of firm-specific knowledge showed positive and statistically significant effects on firm performance, indicating that firms with higher levels of firm-specific knowledge assets are more likely to achieve better economic performance. Also, as expected, both R&D spending and patenting intensity were positively and significantly related to performance.

In Models 2 and 7, employee stock ownership and its interactions with measures of the level of firm-specific knowledge assets were added. The interaction term was positively related to firm performance for both measures of firm-specific knowledge, although the coefficients on the interaction terms were only marginally significant. These results provide some support for Hypothesis 3a, which proposes that the effect of firm-specific knowledge assets on firm performance should be positively moderated by employee stock ownership.

Models 3 and 8 added a three-way interaction term among employee stock ownership, firm-specific knowledge, and firm size. This was to directly test Hypothesis 4, which states that the moderating role of employee stock ownership in the relationship between the level of firm-specific knowledge resources and firm-level economic performance should be weaker for larger firms. Consistent with our prediction, the coefficients on the three-way interaction terms were significant and negative in both models.[9]

Models 4 and 9 in Table 3 provide the results after adding the firm-employee relationships measure and its interaction with measures of firm-specific knowledge assets to Models 1 and 4. For both firm-specific knowledge measures, the coefficients on the interaction terms were positive and statistically significant. These results suggest that the relationship between firm-specific knowledge assets and performance is positively moderated by firm-employee relationships, supporting Hypothesis 3b.

Models 5 and 10 are the full models with the two governance mechanisms and their associated interaction terms included in one model. The results are largely consistent with those of the other models presented.

DISCUSSION AND CONCLUSIONS

The resource-based view of the firm emphasizes the role of firm-specific resources, especially firm-specific knowledge assets, in achieving superior economic performance (Barney, 1991; Kogut and Zander, 1992). However, relatively little research has explored employee governance mechanisms and how they may influence the actual economic benefits that can be obtained from firm-specific resources (Gottschalg and Zollo, 2007; Makadok, 2003). This study was based on the idea that the features of firm-specific knowledge resources that constitute *potential* performance advantages simultaneously give rise justifiably to employee concerns about holdup by the firm *ex post*, and thus a reluctance to invest in firm-specific human capital. Moreover, adopting governance mechanisms that help resolve the problem of employee underinvestment in firm-specific human capital will enable the firm to achieve a greater level of economic performance from its efforts to deploy firm-specific knowledge assets by reducing the gap between potential and realized economic rents.

[9] As an alternative test, in a supplementary analysis we split the sample into two subsamples according to firm size (with the mean size as the cutoff point) and ran the regressions again using employee stock ownership as a moderator. The coefficients on the interaction terms were positive and statistically stronger for small firms than for large firms, a result consistent with that using the three-way interactions. These results are available upon request.

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Table 3. The determinants of firm economic performance (DV: log (Tobin's Q)): results from second-stage models with firm fixed effect

Labels	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
	Base	2SLS	2SLS	2SLS	2SLS	Base	2SLS	2SLS	2SLS	2SLS
R&D intensity	4.04***	4.13***	3.97***	4.28***	4.29***	4.22***	4.51***	4.17***	5.15***	5.11***
	(0.43)	(0.46)	(0.45)	(0.43)	(0.42)	(0.44)	(0.47)	(0.45)	(0.43)	(0.44)
Patenting intensity	3.12***	3.30***	3.25***	2.91***	2.83***	3.33***	3.27***	3.09***	3.23***	3.17***
	(0.72)	(0.73)	(0.71)	(0.70)	(0.69)	(0.71)	(0.69)	(0.72)	(0.71)	(0.70)
Firm size	−0.03*	−0.02*	−0.02*	−0.02*	−0.02*	−0.04**	−0.04**	−0.03**	−0.04**	−0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm-specific knowledge resources										
Share of self-cites	0.57***	0.55***	0.62**	0.58***	0.46**					
	(0.17)	(0.16)	(0.16)	(0.16)	(0.17)					
Weighted number of self-cites ($\times 10^{-2}$)						0.06**	0.04*	0.05**	0.11**	0.13**
						(0.03)	(0.02)	(0.02)	(0.04)	(0.05)
Employee stock ownership (ESO)		0.01	0.01		0.00		0.01	0.01		0.00
		(0.00)	(0.00)		(0.00)		(0.01)	(0.01)		(0.00)
ESO * Firm-specific knowledge		0.12+	0.13*		0.08*		0.04+	0.03+		0.03+
		(0.07)	(0.06)		(0.04)		(0.02)	(0.02)		(0.02)
ESO * Firm-specific knowledge * Firm size			−0.10*		−0.09+			−0.07*		−0.06*
			(0.05)		(0.05)			(0.03)		(0.03)
Firm-employee relationships (ER)				0.06***	0.07***				0.05***	0.06**
				(0.01)	(0.02)				(0.01)	(0.02)
ER * Firm-specific knowledge				0.29***	0.32**				0.08**	0.06*
				(0.10)	(0.12)				(0.03)	(0.03)
R^2	0.71	0.72	0.74	0.74	0.75	0.70	0.71	0.73	0.74	0.76
ΔR^2 (vs. Model 1 or 5)		0.01	0.03	0.03	0.04		0.01	0.02	0.03	0.05

N = 1,329.
Standard errors are shown in parentheses.
Industry and year dummies are included but not reported.
Significant at the + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ level.

The study's key results broadly support this organizational economics logic. The empirical findings show that firms with greater firm-specific knowledge resources are more likely to adopt governance mechanisms appropriate for reducing key employees' concerns about holdup by the firm. The specific governance mechanisms discussed in this study include both an economic-based governance mechanism of granting employee stock ownership, and a relationship-based governance mechanism of building firm-employee relationships. Further, the increased use of these governance mechanisms strengthens the relationship between the level of firm-specific knowledge and a firm's economic performance.

This paper thus contributes to the existing research literature in three key aspects. *First,* while previous research has investigated employee governance primarily in general terms, this study considered interfirm differences in knowledge assets explicitly and emphasized a contingency view of employee governance systems. We maintain that employee governance mechanisms are *endogenous* to the nature of firm knowledge resources. *Second,* this paper contributes to resource-based theory by emphasizing that firm-specific knowledge only defines a firm's potential for generating economic rents, and that the rents actually generated will also be influenced by the effectiveness of the firm's governance mechanisms. These efforts thus extend the resource-based view by emphasizing that a firm's resource base and the effectiveness of its governance mechanisms *jointly* influence its profitability. *Third,* the current paper provides the first systematic empirical tests of these arguments.

Despite these contributions, this paper has some limitations that require future research to advance its key arguments. First, this study followed an equilibrium approach by considering the firm as a bundle of idiosyncratic knowledge resources. By design, it was not able to address how differences in firm-specific knowledge across firms arise in the first place. Future research can fill this gap by taking a dynamic, process-focused approach in exploring firm-specific knowledge creation and the related employee governance issues.

Second, although employee stock ownership and firm-employee relationship were proposed in this study as the most important employee governance mechanisms, there are many other alternatives that may also be applied to motivate a firm's employees to make firm-specific human capital investments. For instance, employees may be more willing to invest in firm-specific human capital if they are promised future promotion opportunities (Carmichael, 1983) or board membership (Roberts and Van den Steen, 2000). Due to data limitations, we are not able to directly incorporate these alternative mechanisms in this study. Future research can take into consideration a broader range of governance or motivating mechanisms. Moreover, this study has implicitly treated the two employee governance mechanisms as independent, alternative channels that help a firm achieve performance advantages based on its firm-specific knowledge resources. However, the two governance mechanisms may be interrelated in that they can be either complementary or substitutive. Although we conducted some preliminary analysis exploring such relationships and found some mixed evidence, future research might consider examining the interrelationship of the governance mechanisms more deliberately.

Third, our study has focused mainly on nonexecutive employees, but it could be argued that executives' motivation and governance may also play a critical role in exploiting firm-specific resources. Executives, after all, make the major decisions about resource accumulation and allocation. The governance of executives in larger firms operating in complex environments may be particularly important. Therefore, although it was beyond the scope of this study, it would be interesting for future research to study the conditions under which executive-level ownership and nonexecutive-level employee ownership may have similar or different motivating roles.

Fourth, this study also suffered from certain data limitations. For example, the study was concerned with key employees who are directly involved in the deployment of firm-specific knowledge and thus need to invest in firm-specific human capital. But the items compiled in the 'employee relations' dimension of the KLD data relate to a much broader range of employees, including lower-level employees. Although we conducted robustness tests by removing some items especially related to lower-level employees and applied an alternative measure of firm-employee relationships, this does not resolve all of the concerns. Similarly, employee stock ownership may be targeted to various levels of employees, including lower-level employees. Although some previous

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empirical studies have shown that key employees are likely to have greater stock ownership (Brickley and Hevert, 1991) and that knowledge-intensive firms have greater employee ownership (Chen and Huang, 2006; Ryan and Wiggins, 2002), data on the specific shareholding of key knowledge workers would enhance the validity of the empirical findings.

Further, the effectiveness of using stock ownership as an employee governance mechanism should be affected by the specific nature of the ownership. For example, many employee stock ownership programs involve a vesting process. As vesting schedules vary enormously, the effectiveness of employee stock ownership as a governance mechanism is likely to be influenced by the vesting period. This study could not directly incorporate this information because of the unavailability of systematic archival data. In addition, some previous research studies have maintained that it is not employee ownership *per se*, but employees' voting rights and participation that motivate them to make firm-specific human capital investments (Caramelli and Briole, 2007; Klein, 1987; Kruse and Blasi, 1997). Again, we did not have detailed data on employees' voting rights and bargaining channels. Our percentage ownership was only a proxy for employees' *ex post* bargaining power and incentives for participation. Future research may be able to collect additional data to consider these different features and dimensions of employee stock ownership and examine the effects of employee ownership arrangements at a finer-grained level.

The patent data utilized in this study provided rich information about technological knowledge stocks and flows, but they also had inherent limitations when applied to measuring firm-specific knowledge assets. Future research might use survey data to explore other types of unpatented knowledge. The exploration of the role of firm-specific knowledge assets can be extended to firm-specificity in heterogeneous knowledge creation processes. For example, superior economic performance may come not only from the firm specificity of a firm's innovative output, but also from the firm's unique configurational capability for continuously generating new innovations ahead of its competitors.

In summary, the resource-based view places human resources among the most important resources available to a firm, and central to the debate about how firms achieve sustainable competitive advantage (Coff, 1999; Mahoney, 2005). Thus, the willingness of a firm's key employees to invest in essential firm-specific knowledge should be an important area of study in the evolving science of organization. This study was conceived as another step toward a better understanding at the strategic level of the effect of employee motivation and governance on firm behavior and performance.

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APPENDIX: THE CATEGORIES IN THE 'EMPLOYEE RELATIONS' DIMENSION OF THE KLD DATASET

STRENGTHS

Strong Union Relations (EMP-str-A): The Company has a history of notably strong union relations.

No-Layoff Policy (EMP-str-B): The Company has maintained a consistent no-layoff policy. KLD has not assigned strengths for this issue since 1994.

Cash Profit-Sharing (EMP-str-C): The Company has a cash profit-sharing program through which it has recently made distributions to a majority of its workforce.

Employee Involvement (EMP-str-D): The Company strongly encourages worker involvement and/or ownership through stock options available to a majority of its employees through gain sharing, stock ownership, sharing of financial information, or participation in management decision making.

Strong Retirement Benefits (EMP-str-F): The Company has a notably strong retirement benefits program.

Health and Safety Strength (EMP-str-G): The Company is noted by the U.S. Occupational Health and Safety Administration for its safety programs. KLD began assigning strengths for this issue in 2003.

Other Strength (EMP-str-X): The Company has a good employee safety record or demonstrates other noteworthy commitments to its employees' well-being.

CONCERNS

Poor Union Relations (EMP-con-A): The Company has a history of notably poor union relations.

Health and Safety Concern (EMP-con-B): The Company recently has either paid substantial fines or civil penalties for willful violations of employee health and safety standards, or has been otherwise involved in major health and safety controversies. KLD changed the name of this rating from Safety Controversies in 2003.

Workforce Reductions (EMP-con-C): The Company has reduced its workforce by 15 percent in the most recent year or by 25 percent during the past two years, or it has announced plans for such reductions. Before 1994, the concern is only assigned to companies that have laid off 15 percent of workers in the most recent year.

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