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# Slack resources and the rent-generating potential of firm-specific knowledge

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# Slack Resources and the Rent-Generating Potential of Firm-Specific Knowledge

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*We examine how two types of slack resources relevant to knowledge employees—human resource slack and financial slack at the R&D functional level—influence the rent-generating potential of firm-specific knowledge resources. According to the resource- and knowledge-based views of the firm, firm-specific knowledge resources are critical for generating economic rents for a firm. However, without motivated knowledge employees investing in the corresponding specialized human capital in the process of absorbing and deploying firm-specific knowledge resources, the resource potential for rent generation would be greatly discounted. We argue that human resource slack among knowledge employees and financial slack available for R&D activities affect the rent-generating potential of firm-specific knowledge resources by influencing knowledge employees' incentives to invest in specialized human capital. In particular, while financial slack facilitates rent generation of firm-specific knowledge resources by increasing employee incentives to invest in specialized human capital, human resource slack hinders it by reducing such incentives. Empirical results based on longitudinal R&D employment data, U.S. patent data, and Compustat support these arguments.*

***Keywords:*** *firm-specific knowledge resources; financial slack; human resource slack; employee incentives; specialized human capital investments; firm performance*

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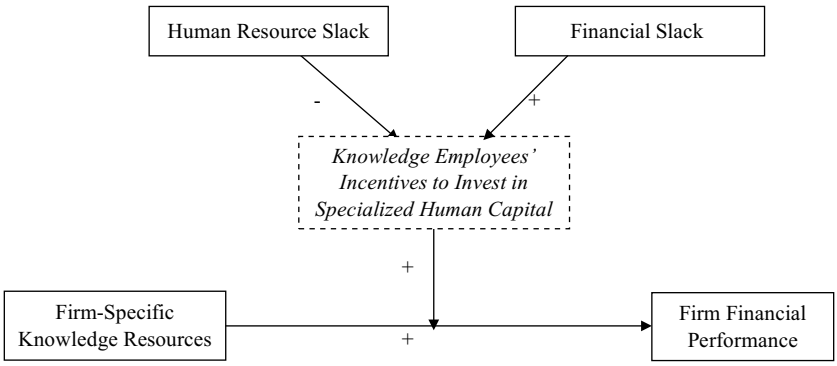
A critical argument of the resource-based view of the firm is that resources that are valuable, rare, and difficult to imitate and substitute are the sources of gaining and sustaining economic rents (Barney, 1991). Firm-specific rather than general knowledge resources would most likely meet these criteria, and they are considered as among the most important sources of economic rents (Coff, 1997; Grant, 1996; Kogut & Zander, 1992). However, rent generation from firm-specific knowledge resources is far from being automatic. The process of absorbing and deploying those resources usually requires knowledge employees to make complementary investments in human capital specialized to the knowledge resources.

In this study, we examined how slack resources at the R&D function level affect the rent-generating potential of firm-specific knowledge through their influence on the incentives of knowledge employees to invest in specialized human capital. Knowledge employees' incentives may be influenced by two risks that they potentially face—the risk of being held up by the firm and the risk of firm financial distress, which is often associated with underinvestment in R&D. As specialized human capital investments are more valuable in a particular firm than in any other company settings, such investments are subject to opportunistic behavior or holdup by the firm (Becker, 1975; Williamson, 1985). In addition, knowledge employees are likely to take into account the risk of their firm's financial distress in making investment decisions. When the financial prospects of a firm are unpromising, there is a higher likelihood of substantial cut of R&D investments. Knowledge employees are then more concerned about losing the value of their investments, and moreover the firm might renege on its promised rewards, a key lever for achieving goal alignment between the firm and its employees (Gottschalg & Zollo, 2007; Grossman & Hart, 1986; Hart, 1995; Hart & Moore, 1990; Rajan & Zingales, 1998). Consequently, employees come to be concerned about the possibility to appropriate rents from their specialized human capital investments.

The willingness of a firm's knowledge employees to invest in specialized human capital necessary in absorbing and exploiting firm-specific knowledge resources will be negatively affected by these two risks. When these risks are high, the potential economic rents and competitive advantage brought by firm-specific knowledge resources may be substantially discounted due to the employees' reluctance to make investments in specialized human capital. A more comprehensive theory of economic rents and competitive advantage, therefore, should take into account the risks knowledge employees face and their incentives to invest in developing specialized human capital.

Building on previous studies of organizational slack (Mishina, Pollock, & Porac, 2004; Singh, 1986; Voss, Sirdeshmukh, & Voss, 2008), we propose that levels of slack resources in the R&D functional level help to address the risks the knowledge employees face, and thus are significantly related to their incentives to invest in specialized human capital. In particular, we examined human resource slack among knowledge employees and financial slack available to these employees. Because of their different characteristics (Mishina et al., 2004; Voss et al., 2008) and differential effects on the two risks that knowledge employees face, they are expected to have different influences on knowledge employees' incentives to invest in specialized human capital. While human resource slack is expected to negatively moderate the relationship between firm-specific knowledge resources and financial performance, financial slack is expected to have a positive moderating effect on this relationship. Figure 1 summarizes the main arguments of this study.

**Figure 1**
**Theoretical Model**




## Firm-Specific Knowledge Resources and Employee Specialized Human Capital Investments

### *Firm-Specific Knowledge Resources and Superior Financial Performance*

The resource-based view of the firm considers the firm as a bundle of heterogeneous tangible and intangible resources (Amit & Schoemaker, 1993; Barney, 1991). Among the various resources examined, knowledge is considered to be one of the most important resources for generating economic rents (Grant, 1996; Kogut & Zander, 1992). Firm knowledge can be classified according to the degree to which it is specific to a firm's unique features. *Firm-specific knowledge* is closely related to a firm's current knowledge base highly embedded in its specific business setting (Helfat, 1994; Pavitt, 1991). Such knowledge will be more useful within the focal firm but less applicable and valuable in other firms. *General knowledge*, by contrast, is less specialized to a particular firm setting and thus more easily tradable in the market. Firms differ in the specificity of their knowledge resources, in part because they adopt different knowledge management strategies (Wang, He, & Mahoney, 2009).

These interfirm differences in knowledge accumulation and utilization strategies, and the resulting differences in the degree of firm specificity of knowledge resources, have important implications for firms' competitive positions and economic performance. First, since firm-specific knowledge is not easily tradable outside the firm, it is likely to be rare and less subject to rival imitation (Helfat, 1994; Peteraf, 1993). Moreover, rival firms seeking to appropriate value through imitating the focal firm's firm-specific knowledge must gain access to the knowledge itself as well as the organizational routines and complementary resources supporting its deployment. Gaining access to the latter, however, is extremely difficult due to the complexities in knowledge management. The resource-based view thus

suggests that accumulating and deploying firm-specific knowledge provides firms with greater potential for gaining sustainable competitive advantage and economic rents (Barney, 1991; Dierickx & Cool, 1989; Helfat, 1994).

On the other hand, relative to general knowledge, firm-specific knowledge is sometimes associated with a greater risk. The ultimate value of firm-specific knowledge is determined in part by the degree to which it contributes to the firm's adaptation to environment change (Bowman & Ambrosini, 2003; Priem & Butler, 2001). The same firm specificity that makes it difficult for rivals to imitate may also be a source of core rigidities, which make it difficult for the firm to adapt to changing environment (Teece, Pisano, & Shuen, 1997). In contrast, although general knowledge is not a source of competitive advantage for firms, it helps firms to adapt to environment change and increases firms' chance of survival.

Therefore, although firm-specific knowledge has a greater rent-generating potential, the increased risk associated with accumulating such knowledge makes it unclear whether firm-specific knowledge will be always related to greater financial performance. However, it is often considered to be necessary for firms to develop and deploy firm-specific knowledge to gain and sustain competitive advantage (Helfat, 1994; Wang et al., 2009).

### *Employee Incentives to Specialize and the Rent-Generating Potential of Firm-Specific Knowledge*

Knowledge employees—employees with high information content in their work inputs and outputs (Davis, Rosann, Michael, & William, 1993)—play an important role in affecting the capacity of the organization to perform and to obtain results (Drucker, 1999). Although firm-specific knowledge resources have the potential to generate economic rents for firms, knowledge employees have to make complementary investments to develop human capital to absorb and deploy those firm-specific knowledge resources (Rajan & Zingales, 2001; Wang et al., 2009). Without such complementary investments, the potential for firm-specific knowledge to achieve superior economic performance can be very much discounted. To better understand the relationship between firm-specific knowledge and employee human capital, it is helpful to consider Wright, Dunford, and Snell's (2001) typology of intellectual capital, which was classified into three categories: human, social, and organizational capital. According to this typology, our concepts of *firm-specific knowledge* and *employee human capital* here can be regarded as two different constructs representing *organizational* and *human capital*, respectively. In particular, in the context of this article, firm-specific knowledge refers to knowledge uniquely possessed by a firm. On the other hand, employee specialized human capital indicates the employee's own expertise, knowledge, and skills required to utilize firm-specific knowledge resources. Thus, the rent-generating potential of firm-specific knowledge as a typical element of organizational capital will be seriously discounted without knowledge employees' specialized human capital.

A key problem faced by many firms in encouraging knowledge employees to make specialized investments is that the employees may be concerned about losing the value of their specialized human capital after irreversible investments have been made. Such concerns

could not be assuaged by writing a comprehensive compensation contract (Hart, 1995). Much research in organizational economics has suggested that the extent to which employees willingly make investments *ex ante* depends largely on their ability to appropriate returns on such investments *ex post* (Grossman & Hart, 1986; Hart, 1995; Hart & Moore, 1990; Rajan & Zingales, 1998, 2001). The expected *ex post* appropriation of returns on their specialized investments will thus be a critical consideration of the employees when deciding whether and to what extent such investments should be made (Helfat, 1994). Therefore, it is necessary to understand the conditions where employees are concerned about *ex post* appropriation of returns.

Drawing from human capital theory (Becker, 1975), transaction cost economics (Williamson, 1975, 1985), and economics- and psychology-based motivation theories (Gibbons, 1998; Holmstrom & Milgrom, 1991; Huselid, 1995; Kerr, 1975), we argue that two risks that may influence *ex post* return appropriation by employees determine knowledge employees' *ex ante* incentives to make specialized human capital investments and thus the rent-generating potential of firm-specific knowledge resources. The first risk stems from the potential threat of firm holdup. Once a knowledge employee makes investments in specialized human capital, the firm may be able to appropriate the quasi rents associated with the investments (Becker, 1975; Williamson, 1985). Thus, a critical concern of knowledge employees for investing in specialized human capital is their vulnerability to the threat of holdup by the firm, possibly in the form of reduced salary, limited promotion, and even the threat of layoff. Although the firm also relies on its knowledge employees with specialized investments (Rajan & Zingales, 2001), it is generally the case that employees are in a more disadvantaged bargaining position and thus are more vulnerable to the firm's opportunistic behavior. Knowledge employees' concerns about holdup may be mitigated if the firm bears some of the cost of the investment, through paying for firm-specific training, for example. However, the skills and knowledge developed from specialized investments are largely tacit and hard to observe and therefore difficult to obtain only through formal training programs. Employees' own efforts are likely to still play an important role, so their concerns about firm holdup have to be alleviated. Knowledge employees who feel the holdup risk will justifiably be less willing to make specialized human capital investments.

A second risk faced by knowledge employees is the possibility of a firm's financial distress. Particularly, when a firm is in financial distress, which is often associated with a significant reduction in long-term investment such as R&D (Thurow, 1993), it is likely that the knowledge employees will cast serious doubt on whether or not they will be appropriately rewarded for their investments (Huselid, 1995; Kerr, 1975). In general, uncertainty in financial reward will particularly loom larger to employees who make specialized human capital investments, since such investments are less valuable in a different setting (Becker, 1975; Williamson, 1985). In addition, financial distress is often associated with a substantial cut of R&D investment, which further exacerbates employee concerns. Anticipating that a firm is incapable of committing to R&D investments and paying due rewards to knowledge creation efforts, knowledge employees' motivations to exert efforts will be reduced in the first place (Brief & Aldag, 1975; Gottschalg & Zollo, 2007). Thus, when there is a high risk of financial distress, especially when it is manifested in the firm's underinvestment in R&D, the firm's knowledge employees may underinvest in specialized human capital.

In sum, the rent-generating potential of firm-specific knowledge resources depends on the two risks that knowledge employees face, which influence their incentives to invest in specialized human capital. We argue below that two types of slack resources in the R&D functional level—human resource slack and financial slack—will address those risks, affecting the rent-generating potential of firm-specific knowledge resources as a result. Knowledge employees become less inclined to make specialized human capital investments with the increase in human resource slack among knowledge employees because they face a greater risk of holdup. In contrast, financial slack available for R&D activities will lead knowledge employees to develop positive expectation of a favorable environment for R&D function and due reward for their investments, which is likely to contribute to their incentives for specialized human capital investments.

Needless to say, human resource slack and financial slack are not the only factors influencing the two types of risks and an employee's incentive to invest in specialized human capital. For example, Wang and her colleagues (2009) found empirical support for the roles of employee stock ownership and firm–employee relations as firm governance mechanisms in facilitating employees' specialized human capital investments. Gottschalg and Zollo (2007) similarly discussed the rent-generating potential of various employee-motivating mechanisms including both intrinsic and extrinsic ones. However, to the extent that these alternative factors are not always available to firms and their employees, and that even if they are available, they are unlikely to completely solve all the employee incentive problems, there should still be room for other factors, such as the level of firm slack resources, to play a role in influencing employee incentives.

## The Role of Slack Resources

Organizational slack is defined as a "pool of resources in an organization in excess of the minimum necessary to produce a given level of organizational output" (Nohria & Gulati, 1996: 1246). A certain amount of slack resource, accumulated either unintentionally or intentionally, may be useful as an inducement to coalition members (Cyert & March, 1963) or employees (Barnard, 1938); as a mechanism to resolve conflicts (Bourgeois & Singh, 1983; Moch & Pondy, 1977); as a technical buffer against environmental turbulence (Thompson, 1967); and as a facilitator of strategic behavior such as innovation (Hambrick & Snow, 1977; Moses, 1992).

One main theme that previous research on organizational slack has focused on is the relationship between slack resources and firm performance (Bromiley, 1991; Singh, 1986) or innovation (Geiger & Cashen, 2002; Nohria & Gulati, 1996; Voss et al., 2008). Different theoretical camps present different, sometimes even opposite, predictions about the relationships (George, 2005; Nohria & Gulati, 1996; Singh, 1986; Tan & Peng, 2003). Some empirical studies have reported a positive, linear relationship between slack resources and financial performance (Daniel, Lohrke, Fornaciari, & Turner, 2004), while others have observed a curvilinear relationship (George, 2005). Some studies have demonstrated a positive association between slack and innovation (Singh, 1986), but others have found an inverted U-shaped relationship between the two (Geiger & Cashen, 2002; Nohria & Gulati,

1996). Thus, there appears to be no conclusive evidence about the relationship between slack resources and firm performance.

Some scholars (e.g., Mishina et al., 2004; Voss et al., 2008) have recently differentiated types of slack, typically human resource slack and financial slack, in an effort to reconcile the inconclusive findings of past studies. They have drawn different implications about the two types of slack. For instance, Mishina and his colleagues (2004) suggest that while human resource slack inhibits product expansion, financial slack facilitates it. Similarly, Voss and his colleagues (2008) maintain that human resource slack is positively associated with product exploitation, but financial slack is not significantly associated with it. Building on this recent line of research as well as arguments based on property rights theory (Hart & Moore, 1990; Rajan & Zingales, 1998), we suggest that the two types of slack may affect differently the relationship between firm-specific knowledge resources and corporate financial performance, through their differential influences on knowledge employees' incentives to make specialized human capital investments.

### *Human Resource Slack and the Rent-Generating Potential of Firm-Specific Knowledge*

A firm's human resources are the knowledge, skills, and abilities inherent in individuals who make up the organization (Wright, McMahan, & McWilliams, 1994). Human resource slack is the amount of human resources in excess of what is required by its operations. Human resource slack is largely path-dependent and context-embedded and is tightly tied up with current organizational arrangements (Love & Nohria, 2005; Voss et al., 2008). Human resource slack therefore is characterized by its dependence on current operational conditions (Mishina et al., 2004), which increases employees' vulnerability to a firm's opportunistic behavior.

As this study examines a firm's firm-specific knowledge resources, and knowledge employees' motivations to specialize their embedded human capital to those resources accordingly, we focus on human resource slack among knowledge employees in the R&D functional level. In particular, we argue that the level of human resource slack among knowledge employees influences the extent to which they are vulnerable to firm holdup when making specialized human capital investments. When there is a high level of human resource slack among knowledge employees, each employee is likely to face greater risk of being transferred to a different job setting, or even being dismissed altogether (Hallock, 1998). Making specialized human capital investments becomes even more risky in this situation, as the value of the investment is likely to be significantly discounted in a transfer or dismissal (Becker, 1975). Moreover, a high level of human resource slack makes collective reaction by knowledge employees to a firm's opportunistic behavior more difficult (Coff, 1999), providing further opportunity for the firm to hold up its knowledge employees. Therefore, with an increase in human resource slack among knowledge employees, their concern for firm holdup increases, making them less willing to invest in specialized human capital and preventing the potential of firm-specific knowledge from being fully realized.

In a bilateral bargaining relationship between a firm and its knowledge employees, the employees who make specialized human capital investments may become very important or even indispensable to the firm (Rajan & Zingales, 1998, 2001). If so, such employees may be able to use their indispensability in bargaining for higher compensation, job security, support for R&D activities, and so on. However, when a greater number of knowledge employees (more than necessary) make specialized investments (i.e., there is ample human resource slack), each employee is less likely to be indispensable to the firm (Glick & Feuer, 1984; Rajan & Zingales, 2000; Rock & Wachter, 1999). This line of reasoning is also consistent with the replacement cost argument (Coff, 1999). When a firm has ample human resource slack among knowledge employees, turnover will involve only limited replacement cost for the firm. Any threat to resign will not be as threatening, resulting in lower bargaining power on the part of knowledge employees.

As such, high levels of human resource slack among knowledge employees are associated with their greater vulnerability to firm holdup and lower bargaining power, which results in greater uncertainty in expected *ex post* appropriation of return from their specialized human capital investments. Consequently, knowledge employees will have less incentive for such specialized investments. Therefore, we expect that high levels of human resource slack among knowledge employees will substantially compromise the potential of firm-specific knowledge resources in generating superior economic performance.

*Hypothesis 1*: The relationship between firm-specific knowledge resources and firm financial performance is negatively moderated by the firm's human resource slack among knowledge employees.

### *Financial Slack and the Rent-Generating Potential of Firm-Specific Knowledge*

Financial slack generally refers to unabsorbed and easy-to-deploy liquid assets, often measured by cash flows or marketable securities (Greve, 2003; Miller, 2003; Mishina et al., 2004; Voss et al., 2008). It is usually considered a crucial buffer for a firm's activities (Bourgeois, 1981; Cyert & March, 1963; Thompson, 1967), especially in a fast-changing environment (Meyer, 1982). Thus firms without enough financial slack have a high likelihood of experiencing shortages of funds, retreat from capital investments, or even bankruptcy. Any of these can result in wage cuts and layoffs, even if the firm wants to act in good faith (Altman, 1968; Bromiley, 1991; Hambrick & D'Aveni, 1988; Jensen, 1986; Kochhar, 1996; Kochhar & Hitt, 1998).

Similar to the case of human resource slack, this study focuses on financial slack at the R&D functional level, which has a direct influence on knowledge employees' incentives to invest in firm-specific human capital. First, a greater amount of financial resources available for R&D fosters a favorable atmosphere for knowledge creation (Greve, 2003), which provides knowledge employees opportunities to conduct diverse R&D activities and make human capital investments specific to a firm's knowledge base.

Second, financial slack available for R&D investment enables knowledge employees to expect more generous reward, such as pay for performance and monetary incentives for their

specialized human capital investments. Indeed, one of the conventional solutions to the firm-specific investment problem includes offering attractive monetary reward to employees for firm-specific investments (Coff & Kryscynski, 2011). For an offer of attractive reward to become a credible commitment, the R&D activities dedicated for knowledge creation have to be supported by sound financial budget. So a high level of financial slack available for R&D helps knowledge employees to anticipate generous rewards for their R&D activities. Accordingly, knowledge employees will be more willing to invest in specialized human capital. By contrast, when R&D activities are under financial constraints, contracts with knowledge employees and due monetary rewards are less likely to be honored. Even worse, knowledge employees are more likely to lose their jobs, and with them much of the value of their specialized human capital investments.

As such, a high level of financial slack available for knowledge creation promotes interest alignment between a firm and its knowledge employees and reduces uncertainty about the appropriation of returns on any specialized human capital investments. This encourages employees to contribute more willingly to transforming firm-specific knowledge resources into superior financial performance.

*Hypothesis 2*: The relationship between firm-specific knowledge resources and firm financial performance is positively moderated by the firm's financial slack available for knowledge creation.

## Method

### *Data and Sample*

Our sample involved data from three sources: R&D employment survey data, National Bureau of Economic Research (NBER) patent data, and Standard & Poor's Compustat series. The R&D employment survey data were collected by the U.S. Bureau of the Census from 1997 to 2005, with an aim to investigate full-time equivalent R&D scientists and engineers in U.S. companies with heavy investments in R&D. As the detailed R&D employment data were available only for the top 100 R&D firms in each year, we selected our sample among these firms. Our focus on R&D- or knowledge-intensive firms is particularly suitable for this study, as the economic rents of these firms are mainly attributed to their knowledge-based assets. Meanwhile, there is still sufficient variation in the level of knowledge specificity among the firms. The NBER patent data files enable us to construct measures of firm-specific knowledge resources and some other patent-related variables. Hall, Jaffe, and Trajtenberg (2001) previously created a data file that contains detailed information about over 3 million U.S. patents and almost 24 million citations of patents granted between 1976 and 2006. Since our unit of analysis is the firm, we aggregated the patents and their citation counts to the firm level (Rosenkopf & Nerkar, 2001). Data on firms' financial performance and other key variables were collected from Standard & Poor's Compustat series. After merging the three data sets and deleting observations with missing values for our key variables, we had unbalanced panel data containing 596 firm-year observations between 1997 and 2005. Moreover, since our calculation of firm-specific knowledge uses patent forward

citations, to make sure there are at least three subsequent years of patent citations for each firm-year observation, our main sample has 483 firm-year observations between 1997 and 2003. The larger sample, on the other hand, is used in some robustness tests.

## *Key Measures*

### *Financial Performance*

A commonly used market-based performance measure, Tobin's q was employed to capture each firm's financial performance. This measure reflects the market's expectations of the firm's future growth and profit potential (Lindenberg & Ross, 1981). Although profits generated by firm-specific knowledge resources should ultimately be reflected in firm value, the impact of a knowledge resource on a firm's operations and accounting performance is unlikely to be immediate. Moreover, it is difficult to know the appropriate time period for analyzing the impact of accounting performance measures. In contrast, the stock market is likely to respond much more quickly to a firm's innovation-based knowledge resources, with the share price incorporating expectations about their potential value (Deng, Lev, & Narin, 1999). A market-based performance measure such as Tobin's q, therefore, is more appropriate for our study. A sophisticated Tobin's q measure requires arbitrary assumptions about depreciation and inflation rates in calculating assets' replacement value (Lindenberg & Ross, 1981). Following the work of Lindenberg and Ross, we used a simplified version of Tobin's q, the market-to-book ratio, which explains over 96% of the variance in the more sophisticated measure. The market value numerator was taken as the year-end market value of the firm's common stock plus the book value of its preferred stock and debt. The denominator was the year-end book value of its total assets. A natural logarithmic transformation was applied to Tobin's q on the assumption that firm resources have a multiplicative effect on Tobin's q (Wang et al., 2009). This approach is consistent with the results of previous studies relating a firm's market value to the economic value of its tangible assets and various measures of its intangible assets (Griliches, 1981; Hall, 2000; Hirsch & Seaks, 1993; Jaffe, 1986). Thus, a logarithmic transformation was considered preferable to linear form estimation (Hirsch & Seaks, 1993; Huselid, 1995).

### *Firm-Specific Knowledge*

Firm-specific knowledge often results from firms' searching for and accumulating new knowledge in accordance with their existing knowledge base (Cohen & Levinthal, 1989; Teece, 1986). Given that patents represent knowledge creation, and that patent citations represent knowledge flows, the frequency with which a firm cites its own previous patents is indicative of the degree to which it is building on its own knowledge base. The greater such internal accumulation is, the more likely that a firm's new knowledge will be firm specific. Especially if a firm's patents are more frequently cited by itself than by other firms in the subsequent years, it indicates that the knowledge underlying these patents has a greater value within the firm than in other firms; thus the knowledge accumulated by this firm is relatively more firm specific.

Following Wang and Chen (2010), we construct two measures of firm-specific knowledge using forward patent citations. The first is the extent to which a focal firm's patents in a certain year is cited by itself vis-à-vis by other firms in the 3 years that follow, designed to capture the *degree* of firm specificity in a firm's knowledge base. It is calculated by dividing the number of forward self-citations by the total number of forward citations received by all firms. The second is the number of self-citations received, designed to capture the overall *level* of firm-specific knowledge resources. This is calculated simply by counting forward self-citations of a focal firm's patents within 3 subsequent years scaled by firm size (i.e., total assets). The specific formulas are as follows:

*Firm-Specific Knowledge (degree) = Number of Forward Citations Subsequently received by the Focal Firm / Number of Total Citations Subsequently received*

*Firm-Specific Knowledge (level) = Number of Forward Citations Subsequently received by the Focal Firm (adjusted by Firm Size)*

*Human Resource Slack*

While human resource slack was typically measured in previous studies as *organizational*-level human resources relative to a reference level, since our focus in this study is on knowledge employees, it is more appropriate for us to measure human resource slack among knowledge employees in the R&D functional department. However, there is no readily available information about the reference level of R&D human resources or the ideal number of knowledge employees for each firm. Some previous work (e.g., Welbourne, Neck, & Meyer, 1999) used industry-level average human resources as the reference level by aggregating firm-level data. However, as firms within an industry are heterogeneous and so are their desired levels of human resources, an industry average may not be a proper reference level for each particular firm in that industry. Moreover, our R&D employment data do not cover all firms in each industry and thus are not able to provide industry-level information for R&D human resources.

Therefore, we depart from previous studies to measure human resource slack based on a predicted value approach (Shen, Tang, & Chen, in press). In particular, we estimate each firm's desired level of R&D human resources by regressing the actual level of its full time R&D scientists and engineers against some key firm, industry, and year attributes that are thought to affect a firm's need for knowledge employees. In particular, in the model predicting the appropriate reference level of R&D human resources, we included variables such as firm size, firm age, the level of firm-specific knowledge, as well as some industry characteristics. Previous literature suggested that industry environment, organizational size, organizational age, and characteristics of technology in the production process influence the level of firm low discretion slack such as skilled labor (March & Simon, 1958; Sharfman, Wolf, Chase, & Tansik, 1988). In addition, industry-level employment was included in the estimation. As this variable has been used as the reference level of a firm's human resources in some calculations of human resource slack (e.g., Welbourne et al., 1999), it may have an influence on the reference level of R&D human resources as well. Industry and year dummies were also included as controls.

The predicted level of R&D human resources was then used as a proxy of the reference level for a firm as its need of R&D human resources allowing for unique firm and industry features. Human resource slack among knowledge employees was then computed as the difference between the actual and the predicted level of R&D human resources. We applied a common procedure by taking the natural logarithm of the number of R&D employees, given the positive skewness in this variable.

*Financial Slack*

Following Daniel et al.'s (2004) conceptualization of R&D expenses as recoverable slack, we measure financial slack available for R&D activities and knowledge creation by using R&D expenses over total assets. Compared to other measures of financial slack (e.g., current ratio), the measure based on R&D expenses is more appropriate for our study focusing on financial slack at the R&D functional level. Knowledge employees should be more concerned about financial slack available for R&D activities and knowledge creation, which can be best captured by a firm's R&D expenses. Moreover, as large firms are usually associated with higher level of R&D expenses (Baysinger & Hoskisson, 1989; Rothwell, 1984), we scale R&D expenses by firm size as measured by total assets.

*Control Variables*

Besides the above key variables, we also included a few variables as controls. First, we control for *firm size*, proxied by the natural logarithm of each firm's total assets, given the evident positive skewness in this variable. *Firm age*, calculated as the natural logarithm of years since each firm's establishment, was also included in the regressions. *Prior performance* based on an accounting measure, ROA, was included in the equations to control for the effect of previous performance on current performance. As a firm's capital structure is generally thought to have an influence on its financial performance, we also control for *financial leverage*, measured as total debt over total assets. In addition, variations across industries were controlled at the four-digit SIC level. Last, year dummies were also included in all equations.

## *Estimation Method*

Our analysis requires taking into consideration the possibility that slack resources might be endogenously determined, to the extent that managers have some discretion in altering the level of slack. It is then possible that the factors affecting the level of financial slack are correlated with financial performance. Ordinary least squares (OLS) regression of financial performance against organizational slack would then lead to biased estimates. To address this endogeneity issue associated with financial slack, we used an econometric approach involving simultaneous equations estimated using the two-stage least squares (2SLS) method (Greene, 1997). The 2SLS estimation in this

study had two stages. In the first stage, financial slack served as the dependent variable. It was regressed against variables that are thought to affect a firm's allocation of financial resources to its R&D investment. The fitted value of financial slack was thus created and used in the second-stage financial performance regressions to reduce any biases caused by endogeneity. Please note that for our human resource slack variable, since we have applied the predicted value approach, which helps partial out the endogenously determined variance of the level of R&D human resources, we do not need to separately include another first-stage equation.

The first variable included in the first-stage equation was the level of firm-specific knowledge. If R&D investment influences the extent to which a firm can benefit from its firm-specific knowledge resources, firms with high levels of firm-specific knowledge resources should have a greater incentive to modify their levels of R&D investment to maximize the benefit from their knowledge resources. If so, firm-specific knowledge resources should correlate with the level of financial slack. Also included in the first-stage equation are firm size and age because they are often thought to affect the level of organizational resources and slack (Baysinger & Hoskisson, 1989; Daniel et al., 2004; March & Simon, 1958; Sharfman et al., 1988; Singh, 1986; Voss et al., 2008). Industry and year dummies were also included to account for the differences across these dimensions.

Other variables related to a firm's financial resources were also included in the first-stage equation for financial slack. Past performance, financial leverage, and current ratio were important factors influencing a firm's R&D expenses (Greve, 2003). In addition, since firms with intensive knowledge production face greater operational risks resulting from a large scale of patenting intensity, they are more likely to maintain higher levels of financial slack (Damanpour, 1987; Sharfman et al., 1988). Thus, citation-weighted patent intensity was added. Finally, industry-level financial slack was used as an instrument. Industry-level financial slack satisfies the requirements for being an instrumental variable since the industry average slack is expected to affect firm financial slack through the pressures of isomorphism (DiMaggio & Powell, 1983). However, it is unlikely that the level of slack in other firms in the same industry has a direct impact on a focal firm's subsequent financial performance. In the second stage, financial performance was regressed against the newly estimated slack variables, firm-specific knowledge resources, and their interactions. We measured financial performance one year after the other independent variable to avoid the possibility of reverse causality. The following equation was used to test the hypotheses in the second stage,

$$\log(q_{t+1}) = \beta_0 + \beta_1 FSK_t + \beta_2 HRSlack_t + \beta_3 FSK_t \times HRSlack_t + \beta_4 FISlack_t + \beta_5 FSK_t \times FISlack_t + \lambda X_t + \varepsilon_t$$

where $\log(q_{t+1})$ is the log-transformed Tobin's q, $X_t$ is a set of control variables that are expected to influence financial performance, and $FSK_t$ is a continuous variable reflecting the level of firm-specific knowledge. $HRSlack_t$ and $FISlack_t$ refer to human resource slack and financial slack, respectively. We mean-centered firm-specific knowledge and slack variables and added their interaction terms to test our hypotheses.

**Table 1**
**Descriptive Statistics and Correlations**

| Variables | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Financial performance: Log(Tobin's q) | –0.63 | 0.29 | | | | | | | | | | | | |
| 2. Firm-specific knowledge (degree) | 0.21 | 0.13 | .03 | | | | | | | | | | | |
| 3. Firm-specific knowledge (level) | 0.02 | 0.03 | .16* | .29* | | | | | | | | | | |
| 4. Human resource slack | 0.01 | 0.24 | –.04 | –.10* | –.02 | | | | | | | | | |
| 5. Financial slack | 0.09 | 0.06 | .28* | .02 | .16* | –.11* | | | | | | | | |
| 6. Firm size | 10.03 | 0.84 | –.32* | –.11* | –.31* | .18* | –.73* | | | | | | | |
| 7. Firm age | 29.58 | 17.94 | .07 | .19* | –.05 | .10* | –.23* | .14* | | | | | | |
| 8. Prior performance | 0.15 | 0.10 | .27* | .16* | –.09* | .15* | –.09* | –.06 | .25* | | | | | |
| 9. Financial leverage | 0.14 | 0.10 | –.18* | .00 | .02 | –.13* | –.27* | .15* | .20* | –.29* | | | | |
| 10. Current ratio | 1.65 | 0.73 | .55* | .02 | .12* | –.06 | .44* | –.36* | –.18* | .06 | –.34* | | | |
| 11. Patent number | 4.90 | 1.52 | –.14* | –.13* | .32* | .12* | –.19* | .24* | .00 | –.22* | .02 | –.07 | | |
| 12. Industry financial slack | 0.31 | 2.44 | –.05 | .01 | –.02 | –.05 | –.02 | .01 | .06 | –.00 | .01 | .03 | –.03 | |
| 13. Industry employment | 2.16 | 1.43 | –.45* | –.05 | –.17* | .05 | –.47* | .52* | .02 | –.24* | .15* | –.48* | .12* | –.02 |

*$p < .05$.

# Results

## *Descriptive Statistics and Hypothesis Testing*

Table 1 presents descriptive statistics and correlations for the major variables. Consistent with expectations, the correlations between both measures of firm-specific knowledge and financial performance are positive. There is a positive correlation between financial slack and financial performance, whereas the correlation between human resource slack and financial performance is not significant. Significant intercorrelations are also observed among some other variables such as firm size, firm age, prior performance, and financial leverage. Hence, we investigate whether there is a potential multicollinearity problem by computing variance inflation factors (VIFs). The maximum VIF obtained in any of the models was less than 4, while the mean VIF was around 2.1; these values are substantially below the rule-of-thumb cutoff of 10 for regression models (Ryan, 1997). Therefore, multicollinearity is not a concern in our results.

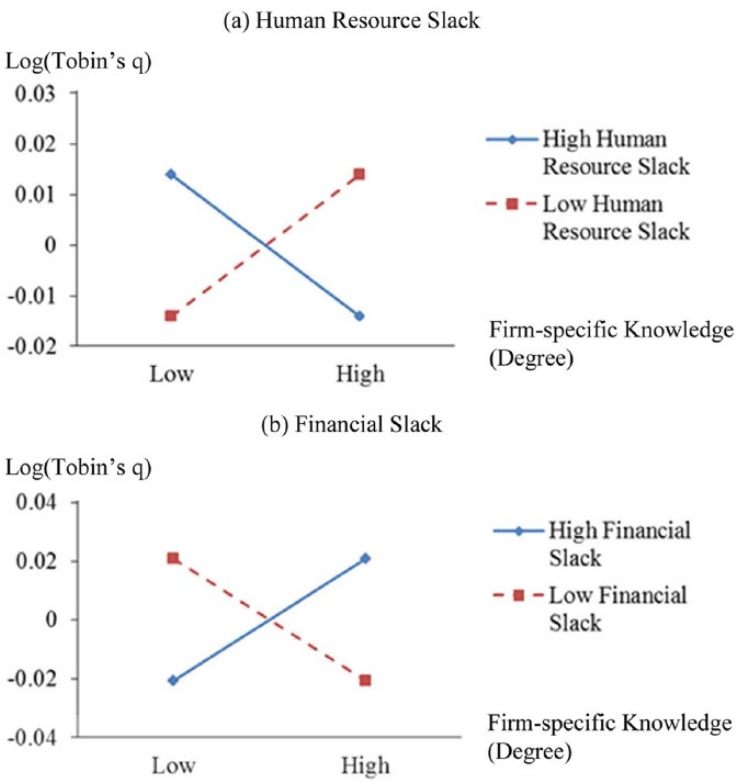
In general, the influences of most factors in first-stage equations were significant. The adjusted $R^2$ of the human resource slack model was 84% ($F = 52.34$, $p < .001$), and the adjusted $R^2$ of the financial slack model was 54% ($F = 10.62$, $p < .001$). Results of first-stage regression are not reported here to save space but are available if requested. Second-stage analysis was then conducted using the slack variables newly estimated by the first-stage regression (in the case of human resource slack, the difference between actual level of R&D human resource and the estimated value), firm-specific knowledge, and their interaction terms as regressors against financial performance. Table 2 presents the second-stage regression results with financial performance as the dependent variable. Models 1a and 2a report the effects of firm-specific knowledge (both degree and level) and the various control variables (firm size, firm age, prior performance, and financial leverage) on financial performance.

**Table 2**
**Regression Analysis of Financial Performance: Log(Tobin's q)**

| | Firm-Specific Knowledge (degree) | | | | Firm-Specific Knowledge (level) | | | |
|---|---|---|---|---|---|---|---|---|
| Variables | 1a | 1b | 1c | 1d | 2a | 2b | 2c | 2d |
| Intercept | –0.42 (0.25) | –0.54* (0.25) | –3.51** (1.17) | –3.36** (1.17) | –0.42 (0.25) | –0.43 (0.25) | –4.57*** (1.16) | –4.57*** (1.14) |
| Firm size | 0.00 (0.02) | 0.02 (0.02) | 0.25** (0.09) | 0.24** (0.09) | 0.00 (0.02) | 0.01 (0.02) | 0.33*** (0.09) | 0.33*** (0.09) |
| Firm age | 0.00* (0.00) | 0.00* (0.00) | 0.00* (0.00) | 0.00** (0.00) | 0.00* (0.00) | 0.00* (0.00) | 0.00* (0.00) | 0.00** (0.00) |
| Prior performance | 0.36** (0.13) | 0.46*** (0.13) | 1.07*** (0.28) | 1.08*** (0.28) | 0.35** (0.13) | 0.43*** (0.13) | 1.44*** (0.28) | 1.48*** (0.28) |
| Financial leverage | –0.21 (0.13) | –0.25* (0.13) | 0.58 (0.31) | 0.46 (0.31) | –0.20 (0.13) | –0.27* (0.13) | 0.75* (0.30) | 0.70* (0.30) |
| Firm-specific knowledge | –0.06 (0.09) | –0.13 (0.10) | –0.18 (0.11) | –0.16 (0.11) | –0.09 (0.31) | –0.71 (0.39) | –3.72*** (0.65) | –3.77*** (0.66) |
| Human resource slack | | –0.11* (0.04) | | –0.11* (0.04) | | –0.12** (0.04) | | –0.10* (0.04) |
| Firm-specific knowledge × human resource slack | | –0.45* (0.19) | | –0.31 (0.24) | | –4.71** (1.66) | | –3.26* (1.61) |
| Financial slack | | | 4.58** (1.73) | 4.26* (1.73) | | | 5.94*** (1.70) | 5.94*** (1.68) |
| Firm-specific knowledge × financial slack | | | 2.66* (1.06) | 0.89 (1.34) | | | 70.29*** (10.77) | 63.60*** (10.87) |
| Industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | .56 | .58 | .57 | .58 | .56 | .58 | .61 | .61 |
| $F$ | 11.62*** | 11.87*** | 11.76*** | 11.71*** | 11.60*** | 11.93*** | 13.34*** | 13.36*** |

*Note:* $N = 483$ firm-year observations. Standard errors are in parentheses.
*$p < .05$. ** $p < .01$. *** $p < .001$.

**Figure 2**
**The Moderating Effects of Slack Resources**




Models 1b, 2b, 1c, and 2c add the interaction terms between the two slack variables and firm-specific knowledge, respectively. Models 1b and 2b suggest that human resource slack has a negative main effect on the firm's financial performance. More important, the moderating effects of human resource slack on the relationship between both measures of firm-specific knowledge and financial performance are negative and significant. These findings strongly support Hypothesis 1.

On the other hand, financial slack shows a strong main effect on financial performance and its interaction with firm-specific knowledge (measured both as a level and degree) is positive and significant (Models 1c and 2c). Hypothesis 2, which predicts a positive moderating effect of financial slack, is also supported.

To better interpret these results, the interaction effects were plotted in Figure 2 using the procedure proposed by Aiken and West (1991) based on Models 1b and 1c, which show consistently significant moderating effects for both types of slack resources when firm-specific knowledge is measured as a degree. The figures show that firm specificity

in a firm's knowledge resources has a positive effect on the firm's financial performance when the firm has a low level of human resource slack or a high level of financial slack. However, the effect becomes negative when a firm has a high level of human resource slack or a low level of financial slack. This suggests that firm-specific knowledge may damage financial performance when there is too much human resource slack or insufficient financial slack.

### *Robustness Checks*

To ensure that our results are not subject to biases in the specific measures and methods that this study used, we conducted a few robustness checks. First, as the R&D and patenting strategies might be very different between manufacturing and service firms, we excluded firms from service industries and conducted the same sets of analyses with a sample of manufacturing firms only (428 firm-year observations). We found quite consistent results that support both of our hypotheses.

Second, to make sure that the patents for each firm-year observation have at least 3-year forward citations, we used observations between 1997 and 2003 (our patents citations data cover until 2006) for our main analyses. To ensure the results are robust, we have tried alternative year cutoff points, including 2002 and 2004, which allow each firm-year patents to have at least 4 and 2 years forward citations, respectively. In addition, we have done some robustness tests with alternative measures of firm-specific knowledge based on backward citations. All the results using these alternative measures are quite consistent with the main results.

Third, given that prior studies (e.g., Cheng & Kesner, 1997; Mishina et al., 2004) frequently used the current ratio, that is, current assets divided by current liabilities, as the measure of financial slack, we also conducted the analyses using current ratio as an alternative measure of financial slack. The results are consistent with those using our measure based on R&D intensity. This again supports Hypothesis 2.

Finally, as an alternative to a 2SLS analysis to address the potential endogeneity of slack resources, firm-fixed effects model was applied. The results were again largely consistent with those using 2SLS models, although the overall level of significance for some of the variables was somewhat lower.

## Discussion

The resource-based view of the firm emphasizes the role of firm-specific knowledge resources in achieving superior economic performance (Barney, 1991; Coff, 1997; Grant, 1996; Kogut & Zander, 1992). However, without the employee investments in specialized human capital needed to absorb and deploy firm-specific knowledge resources, the potential of those resources to generate superior performance would be substantially compromised. Thus in analyzing a firm's competitive advantage it is important to consider factors that may influence employees' incentives to make specialized human capital investments. This study examines the roles of two types of slack resources in affecting employee investments.

Financial slack available for R&D investments was found to enable a firm to achieve a better economic performance from its firm-specific knowledge resources by enhancing employee incentives to make specialized human capital investments. In contrast, our findings show that human resource slack among knowledge employees has the opposite effect.

This study contributes to the resource-based view of the firm in several ways. First, it helps delimit its applicability by demonstrating contingencies that either enhance or depreciate the value of firm-specific knowledge resources. The traditional resource-based view of the firm has focused mainly on a firm's core resources and the criteria making these resources sources of competitive advantage. What has often been overlooked is the role of employee incentives in the process of absorbing and deploying the core resources that contribute to superior financial performance and competitive advantage. In line with some recent research (Gottschalg & Zollo, 2007; Wang & Barney, 2006; Wang et al., 2009), this study suggests that a more complete understanding of firm competitive advantage requires considering both core resources and employee incentives to deploy them.

This study also shows the interconnectedness of a firm's various resources (Dierickx & Cool, 1989). Considering a firm as a bundle of heterogeneous resources (Barney, 1991), it is possible that the financial implications of one type of resource are affected by the availability of others. According to our findings, the value of firm-specific knowledge resources may be enhanced or impaired by the presence of slack resources. This finding is also in line with the literature on resource bundling (Sirmon, Hitt, & Ireland, 2007; Tzabbar, Aharonson, Amburgey, & Al-Laham, 2008), which emphasizes the complementarity between human resources and other organizational resources. Thus, in explaining the effect of a particular resource on economic performance, future research on the resource-based view of the firm should examine the features of a focal resource (e.g., value, rarity, and inimitability) and its interconnectedness with other firm resources.

An additional contribution this article makes to the resource-based view of the firm literature is about measurement. Despite the demonstrated utility of the resource-based view for explaining performance differences among firms, several of the resources that generate sustainable advantage are either unobservable or extremely difficult to measure (Godfrey & Hill, 1995; Rouse & Daellenbach, 1999). This study represents a step toward overcoming this limitation by taking advantage of patent citation data to measure firm specificity in innovation-based knowledge resources.

This article also contributes to the organizational slack literature in several aspects. First, earlier studies have focused primarily on the direct effects of slack resources on a firm's financial (Bromiley, 1991; Hambrick & D'Aveni, 1988; Singh, 1986) or innovative (Nohria & Gulati, 1996) performance. Although some recent studies have accounted for some contingent factors that may influence the role of slack resources, they have mostly focused on the role of external environment (George, 2005). Voss and colleagues (2008) demonstrated that the effect of organizational slack on product strategy is contingent on the level of environmental threat a firm faces. Our study has demonstrated that the value of slack resources may vary with firm-specific knowledge. It thus complements previous studies by suggesting a firm-level contingency factor.

Second, previous studies of organizational slack have focused on its role as a buffer to protect the firm's technical core from environmental turbulence (Daniel et al., 2004; Nohria

& Gulati, 1996; Tan & Peng, 2003). Although Bourgeois (1981) and Cyert and March (1963) conceptualized organizational slack as an inducement to provide employee incentives, none of the empirical studies in this area have paid particular attention to its role as a motivator. This study has highlighted its influence on employees' willingness to deploy firm-specific knowledge. So slack resources not only help firms better deal with environmental turbulence, but also have impacts on human factors by influencing employees to invest in specialized human capital.

Another contribution of this article has been elucidating the distinction between human resource slack and financial slack. A few recent studies (e.g., Mishina et al., 2004; Voss et al., 2008) have begun to make such a distinction, and this study has also demonstrated that human resource slack and financial slack have opposite influences on employee incentives to invest in specialized human capital. It is thus important that future research on organizational slack continue to differentiate among different types of slack.

Despite these contributions, this study has some limitations that future research might fruitfully deal with in refining its key arguments. First, the study takes as given that a firm is composed of a bundle of knowledge resources, and we did not investigate how differences in firm-specific knowledge among firms arise in the first place. Future research might fill this gap by taking a dynamic, process-focused approach to firm-specific knowledge creation and the related employee governance issues. For this purpose, future research into the dynamics of resource accumulation may need to introduce different theoretical perspectives such as the evolutionary theory of the firm.

Second, this study has proposed that managing slack is an important mechanism by which firms manage the risks associated with employees' making specialized human capital investments, but many other alternative techniques can also be applied to induce employees to make such investments. For instance, Wang and her colleagues (2009) have recently demonstrated that employee stock ownership and trusting firm–employee relationships enhance employees' incentives to make specialized human capital investments. Employees may also be more willing to invest in specialized skills if they are credibly promised future promotion opportunities (Carmichael, 1983) or board membership (Roberts & Van den Steen, 2000). Due to data limitations, we were not able to directly incorporate these alternative mechanisms into this study. Future research might profitably examine a broader range of governance or motivating mechanisms and their interactions.

Third, our key arguments suggest that knowledge employees' incentive to invest in specialized human capital is a main mechanism through which the two types of slack resources affect the rent-generating potential of firm-specific knowledge. By providing supportive findings based on a sample of R&D firms and measures of the slack resources operationalized in terms of excess human and financial resources at the R&D functional level, we have come close to tapping into employee incentives as the underlying mechanism. Nevertheless, because we are still not able to directly measure employee incentives, it is difficult to rule out other possible alternative mechanisms. Therefore, future research may consider different research designs that help more directly capture the underlying mechanism of employee incentives, for instance, by applying the survey method.

Patent data provide rich information about the flow of knowledge, but they are limited to patented knowledge. This inherent limitation may constrain the interpretation of our results.

Moreover, due to the role patent examiners play in citations (Alcacer & Gittelman, 2006), patent citation data have been shown to be reflective of many issues rather than just knowledge flow and spillovers (Criscuolo & Verspagen, 2008). Thus, future research might attempt to use survey or field data to explore knowledge flows and the degree of firm specificity in unpatented knowledge. In addition, some of the citations used in this study were made by patent examiners, and some by the inventors themselves. Inferences about inventor knowledge using pooled citations may thus involve some bias or overestimated significance (Alcacer & Gittelman, 2006). Our data did not allow us to separate these two possibilities, but future research might analyze more recent patent data that provide information on the sources of patent citations.

The findings of this study suggest that the relationship between levels of slack resources and performance is not as simple as previous studies have proposed (Mishina et al., 2004; Tan & Peng, 2003; Voss et al., 2008), and this has important implications for practicing managers. Slack can be either a facilitator or an inhibitor for firm-specific knowledge management. The findings therefore call for careful planning and accumulation of different types of slack resources in a firm highly reliant on firm-specific knowledge. In particular, the negative moderating effect of human resource slack implies that caution should be exercised in designing human resource development programs among R&D employees. Managers have to keep in mind that too much is as bad as too little when it comes to human resources. Based on a thorough analysis of internal resource endowment and environmental demand, a firm should maintain the proper level of skilled R&D human resources. Given the high costs of obtaining and maintaining knowledge employees, a careful management of human resource slack will also help the firm to conduct efficient cost management in human resources.

In summary, the resource-based view of the firm places firm-specific knowledge among the most important of a firm's resources, and central to the debate about how firms achieve sustainable competitive advantage (Coff, 1999; Mahoney, 2005). The willingness of a firm's employees to invest in deploying firm-specific knowledge, in contrast, has received relatively little attention. The role of slacks as complementary resources to potentially rent-generating firm-specific knowledge through their influences on knowledge employees' incentives to invest in specialized human capital has been highlighted in this study. By doing so, this study, along with some other recent studies in related fields (Gottschalg & Zollo, 2007; Wang & Barney, 2006; Wang et al., 2009), helps advance the resource-based view of the firm and develop a more comprehensive theory of the sustainability of competitive advantage.

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