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Can Knowledge-Intensive Teamwork Be Managed? Examining the Roles of HRM Systems, Leadership, and Tacit Knowledge

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Using a sample of 162 R&D teams, we investigated the influence of HRM systems for knowledge-intensive teamwork on external team knowledge acquisition and internal team knowledge sharing. This study also examined the interactive effect of HRM systems and knowledge tacitness and the combined influence of HRM systems and empowering leadership. HRM systems for knowledge-intensive teamwork were positively associated with team knowledge acquisition and team knowledge sharing. Knowledge tacitness moderated the HRM–knowledge acquisition relationship, reducing the influence of HRM systems. Further, empowering leadership appeared to substitute for the effect of HRM systems. Our findings suggest that an integration of strategic HRM and knowledge teamwork literatures will prove useful for advancing our understanding of knowledge-based competition. Furthermore, by investigating HRM systems and leadership behaviors in tandem, we gain new insights about the interplay between these two important aspects of organizational life.

Keywords: *HRM systems; empowering leadership; tacit knowledge; teamwork; cross-level research*

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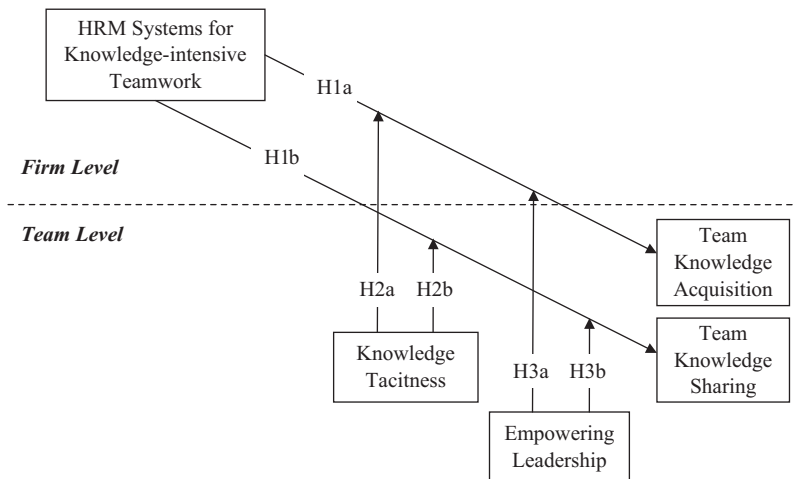
Among resources and capabilities that may help organizations obtain competitive advantages, knowledge is the primary strategic resource for organizations in a knowledge-based economy (Grant, 1996; Kogut & Zander, 1992). To create value for an organization, knowledge must flow through and be embedded in the organization. Knowledge-intensive teamwork, which comprises collaborative activities that locate, share, create, and apply knowledge among a group of people (Jackson, Chuang, Harden, & Jiang, 2006), is one of the central processes through which organizations transform knowledge held by individuals into intellectual capital for achieving competitive advantage (Nahapiet & Ghoshal, 1998; Wright, Dunford, & Snell, 2001). This study focuses on two specific types of knowledge-intensive teamwork—team knowledge acquisition and team knowledge sharing. External and internal knowledge activities (Zhou & Li, 2012) are widely recognized as indicators of knowledge flows that are central to successful innovation (e.g., see Damanpour, 1991; von Krogh, Ichijo, & Nonaka, 2000), yet to date there has been little research aimed at understanding the conditions that encourage and support these knowledge activities within teams (e.g., see Marrone, 2010). We aim to fill the gap.

Human resource management (HRM) systems have been recognized as one potential means through which organizations can stimulate effective knowledge behaviors and develop the depth and content of their knowledge stocks (e.g., see the Special Issue on HRM and Knowledge Processes published in *Human Resource Management*, 2009; Collins & Smith, 2006; Wright et al., 2001). The extant strategic HRM literature has documented the strategic importance of well-designed HRM systems as drivers of organizational outcomes (e.g., Collins & Smith, 2006; Huselid, 1995) as well as individual attitudes and behaviors (e.g., Takeuchi, Chen, & Lepak, 2009; Wu & Chaturvedi, 2009). However, despite widespread recognition of the prevalence of teamwork and its importance to knowledge-based competition, there has been very little research examining how HRM systems influence team outcomes—in particular, team knowledge behaviors. By examining the effects of firm-level HRM systems on team knowledge acquisition and team knowledge sharing, we address this void and also respond to recent calls for more multilevel management research (Hitt, Beamish, Jackson, & Mathieu, 2007; Paauwe, 2009; Wright & Boswell, 2002).

While recognizing the potential power of HRM systems, we realize that investigating the main effects of management practices seldom fully captures the complexity of organizations (Boyd, Haynes, Hitt, Bergh, & Ketchen, 2012); a more nuanced approach is required. Recent criticisms (see Jensen, Patel, & Messersmith, in press) and equivocal empirical evidence (see Chadwick, Way, Kerr, & Thacker, in press) indicate that research is needed to establish the boundaries that constrain the effectiveness of HRM systems. Likewise, recent meta-analyses (Combs, Liu, Hall, & Ketchen, 2006; Jiang, Lepak, Hu, & Baer, 2012) of studies that examined the influence of HRM systems reveal a great deal of unexplained variance in desired outcomes, suggesting the need for more fine-grained analyses of contingencies. Thus, this study considers how HRM systems work in combination with team tasks and team leadership to influence knowledge-intensive teamwork.

As we explain in more detail below, the current study contributes to our existing understanding of behavior in knowledge-intensive settings in three major ways: First, we extend the literature on strategic HRM by testing a multilevel framework for understanding the influence of HRM systems on knowledge-intensive teamwork. Second, we explore the contingent effects of knowledge tacitness to specify the situations in which HRM systems for knowledge-intensive teamwork are likely to exert the greatest influence on team knowledge

Figure 1
Research Model



Note: H = hypothesis.

acquisition and team knowledge sharing. Third, we investigate another contingency—empowering leadership—with the hope of opening a dialogue between scholars in the fields of strategic HRM and leadership. Figure 1 presents our research model.

Theoretical Background and Hypotheses

Employees engaged in the core processes of research and development (R&D) are among the most valuable contributors to a firm's success in knowledge-based competition (Lepak & Snell, 1999). Because of the potential strategic value and uniqueness of R&D employees, a firm's HRM architecture should recognize the unique characteristics of this employee group in order to effectively attract, retain, and motivate them to achieve the firm's strategic objectives (Lepak & Snell, 1999, 2002). Consistent with the well-accepted principle that within-firm variations in management practices are both possible and pervasive (Nishii & Wright, 2008; Schuler & Jackson, 1987b; Wright & Boswell, 2002), we focus on R&D employees to sharpen our conceptual model of how HRM systems can potentially influence important outcomes.

Team Knowledge Acquisition and Team Knowledge Sharing

The behavioral perspective on strategic HRM (Schuler & Jackson, 1987a) points to the importance of encouraging employees to engage in behaviors that support the achievement of a firm's strategic imperatives. Thus, for example, R&D employees often support the

strategic imperative of innovation by engaging in activities and behaviors that result in the creation and development of new products, services, and/or processes. R&D employees are prototypical knowledge workers who work in teams of interdependent experts. To develop new products, services, and/or processes that contribute to the firm's superior performance, R&D teams must capture, interpret, and deploy knowledge resources (Verona, 1999; Wong, 2004; Zahra & George, 2002). Knowledge activities of particular importance in R&D teams include knowledge acquisition, which helps a team increase the depth and width of its knowledge, and knowledge sharing, which enhances team efficiency and engages the team in articulating and evaluating knowledge as it explores new ideas and develops creative solutions (cf. Haas & Hansen, 2005; von Krogh et al., 2000).

Team knowledge acquisition occurs when the team gains knowledge it did not previously have; it involves locating sources of useful knowledge outside the team, transferring new knowledge into the team, and incorporating the new knowledge into the team's behavioral repertoire (Hansen, 1999; Jackson et al., 2006; Wong, 2004). The importance of external knowledge sources to R&D teams is supported by research showing that R&D teams with stronger external network ties are more productive (Chung & Jackson, 2013).

Team knowledge sharing refers to activities that aid the transfer of knowledge among team members (Jackson et al., 2006); it helps a team remember and exploit lessons learned and solve technical problems more effectively by ensuring that existing knowledge flows among team members with different types of specialized and distinct expertise (Grant, 1996). Such distributed expertise is typical in R&D teams. Thus, whereas knowledge acquisition draws the attention of a team outward, knowledge sharing focuses attention inward (Zhou & Li, 2012).

Using the HRM System to Support Knowledge Acquisition and Knowledge Sharing

Numerous studies provide empirical support for the assertion that the alignment of a firm's strategic objectives and HRM systems can influence organizational effectiveness by shaping the behaviors of employees, as proposed by Schuler and Jackson's (1987a) behavioral perspective. For example, in a study of manufacturing organizations, HRM systems that promoted a safety climate reduced injury incidences (Zacharatos, Barling, & Iverson, 2005). As another example, a study of service organizations found that HRM systems that valued, expected, and rewarded service quality and promoted employees' competencies and motivation to serve customers well were associated with greater service performance (Chuang & Liao, 2010). In a study of orthopedics units, the quality and efficiency of patient care were higher in hospitals with human resource (HR) practices that supported cross-functional coordination among medical care providers (Gittell, Seidner, & Wimbush, 2010). We extend this line of research by investigating HRM systems to support business strategies that embrace the challenges of creating and leveraging knowledge to produce innovation, which is primarily embodied in knowledge-intensive teamwork by R&D teams.

If team knowledge behaviors such as knowledge acquisition and knowledge sharing are central to the performance of knowledge workers and R&D teams, it follows that strategic HRM systems designed for knowledge-based competition should promote such behaviors. However, traditional prescriptions for effective HRM have mostly ignored knowledge processes and activities (cf. Minbaeva, Foss, & Snell, 2009), and only a few studies have

specifically examined HRM systems for R&D employees or other knowledge workers (Collins & Smith, 2006; Lepak & Snell, 2002; Lopez-Cabrales, Pérez-Luño, & Valle Cabrera, 2009). These few contributions yield valuable insights about HR practices for attracting, retaining, and motivating individual knowledge workers, but they are mostly silent about practices for improving knowledge-intensive teamwork.

A firm's total HRM system typically comprises many HR practices, but not all of those practices are likely to directly influence knowledge acquisition and knowledge sharing behaviors in R&D teams. To identify practices that comprise an HRM system for knowledge-intensive teamwork, we adopted the widely used ability-motivation-opportunity approach (e.g., see also Batt, 2002; Combs et al., 2006; Gardner, Wright, & Moynihan, 2011; Jiang et al., 2012; Kehoe & Wright, 2013; Lawler, Chen, Wu, Bae, & Bai, 2011; Lepak, Liao, Chung, & Harden, 2006) to argue that HRM systems for knowledge-intensive teamwork should include competency-enhancing HR practices, motivation-enhancing HR practices, and opportunity-enhancing HR practices. Note, however, that we follow Jackson et al. (2006) in using the term "competency" rather than "ability" because the latter term refers to a narrow set of individual attributes whereas the former term is commonly used to refer to attributes of both individuals and larger social units. We refer to this modified multilevel perspective as the competency-motivation-opportunity approach.

Competency-enhancing HR practices for knowledge-intensive teamwork

The primary objectives of competency-enhancing HR practices for knowledge-intensive teamwork are ensuring that teams are staffed with members who have and continuously improve the knowledge, skills, and abilities needed to perform knowledge-intensive teamwork. Working in knowledge-intensive settings demands a breadth of technical knowledge and skills, but the required competencies go well beyond these to include teamwork knowledge and skills (Morgeson, Reider, & Campion, 2005). Teamwork skills (Stevens & Campion, 1999) facilitate effective interactions with collaborators. Through collaborative interactions, team members and the team as a whole can acquire and share new and valuable knowledge. In addition, a team can increase its chance to make contact with knowledge sources by selecting members who have good interpersonal relationships with people within and outside the organization (Chung & Jackson, 2013). Further, adaptation skills help the team recognize dynamic conditions and respond to them by continuously searching for new information and knowledge (LePine, Colquitt, & Erez, 2000).

Staffing practices that evaluate individual competencies can help ensure that individual team members have the necessary technical and teamwork skills, while training can be used to improve the competencies needed for team knowledge acquisition and team knowledge sharing (e.g., interpersonal and teamwork skills) and improve members' ability to learn from others (Collins & Smith, 2006; Jackson et al., 2006; Lopez-Cabrales et al., 2009). Traditional training programs that identify needed knowledge in advance and deliver it to individual employees might not be sufficient in building the competencies of knowledge-based teams, which work in dynamic, high-velocity environments (Brown & Eisenhardt, 1997); rather, training practices should help teams

develop and update technical and interpersonal know-how to facilitate learning on an “as-needed, just-in-time” basis (Jackson et al., 2006).

Motivation-enhancing HR practices for knowledge-intensive teamwork

The primary objective of motivation-enhancing HR practices is to drive team attention to knowledge activities and then to induce and enhance team members' discretionary effort. Assuming that effective R&D employees are expected to contribute both in-role and discretionary effort, HR practices that motivate team members to contribute to the team's objectives and reward the desired knowledge activities should increase knowledge acquisition and knowledge sharing (Lawler, 2003). Teams that engage in knowledge acquisition and knowledge sharing absorb and assimilate firm-specific knowledge, which may be particularly valuable and difficult for competitors to imitate. Offering team rewards for the best new ideas may motivate employees to seek new knowledge and share such knowledge within the team in order to generate creative insights (Lepak & Snell, 2002; Lopez-Cabrales et al., 2009). Recognizing and rewarding teams for sharing information and knowledge with others appears to facilitate knowledge flows within organizations (Wang & Barney, 2006) and align the interests of individuals with those of their team and the organization (Gottschalg & Zollo, 2007).

Opportunity-enhancing HR practices for knowledge-intensive teamwork

The primary objective of opportunity-enhancing HR practices is to create appropriate conditions for R&D teams and employees who have the needed competencies and adequate motivation to engage in knowledge-intensive teamwork. Effective knowledge exchange is more likely when a robust social network exists (Nahapiet & Ghoshal, 1998). Because relational learning (e.g., personal contacts) is more effective than nonrelational learning (e.g., formal documents) (Rulke, Zaheer, & Anderson, 2000), interactions with other collaborators facilitate knowledge flow (Chung & Jackson, 2013; Fiol, 2003; Hansen, 1999). Thus, an HRM system that provides opportunities for team members to connect with others within and outside the team can support and facilitate knowledge-intensive teamwork by building the team's social capital (Collins & Clark, 2003; Joshi & Jackson, 2003). Job rotation (Pil & MacDuffie, 1996) that moves knowledge workers across different functional areas or divisions can serve this purpose. By supporting social and knowledge-sharing events and communities of practice, a firm's HR practices encourage the development and extension of social capital and boundary spanning (Collins & Smith, 2006; Jackson et al., 2006), thereby creating more opportunities for knowledge flows.

An integrated HRM system for knowledge-intensive teamwork

Although we specify HR practices designed and implemented to manage knowledge-intensive teamwork and conceptually categorize them as competency-, motivation-, and opportunity-enhancing HR practices, we do not assume that these dimensions of an HRM system are independent by design or in their effects (Kehoe & Wright, 2013; Lawler et al.,

2011; Lepak et al., 2006). Nor do we expect a one-to-one correspondence between each subset of practices and the three targets (competencies, motivation, and opportunity). Instead, we view the HR practices as a set of complementary practices that work in unison to create an environment that supports team knowledge acquisition and team knowledge sharing. For example, training may improve members' competencies to acquire new knowledge and also enhance their motivation to do so by increasing the expectation that exerting greater effort to acquire knowledge results in better performance. Similarly, HR practices that encourage members to build social relationships can serve the multiple purposes of providing opportunities to acquire knowledge, improving the communication skills required to exchange knowledge, and motivating employees to further develop their competencies.

Our conceptualization of an HRM system for knowledge-intensive teamwork comprising interdependent HR practices is consistent with the principle that the phenomenon of interest is the system of HR practices, which is a foundational element of strategic HRM (see Fombrun, Tichy, & Devanna, 1984) and pervades current empirical research on this topic (e.g., see Becker & Huselid, 1998; Chadwick et al., in press; Chuang & Liao, 2010; Collins & Smith, 2006; Datta, Guthrie, & Wright, 2005; Jensen et al., in press; Kehoe & Wright, 2013; Lawler et al., 2011; Lepak et al., 2006; Liao, Taya, Lepak, & Hong, 2009; Sun, Aryee, & Law, 2007; Way, 2002; Wright & Boswell, 2002; Wu & Chaturvedi, 2009). Ideally, an HRM system bundles together a set of specific practices that are internally consistent and mutually reinforcing (Chuang & Liao, 2010; Datta et al., 2005; Lawler et al., 2011; Liao et al., 2009), and the positive influence of HRM systems is stronger than that of individual HR practices (Combs et al., 2006; Delery, 1998). Thus, we propose the following:

Hypothesis 1a: HRM systems for knowledge-intensive teamwork are positively related to team knowledge acquisition.

Hypothesis 1b: HRM systems for knowledge-intensive teamwork are positively related to team knowledge sharing.

Taking Contingencies Into Account

Our logic so far has assumed a universalistic view of the relationship between HRM systems for knowledge-intensive teamwork and team knowledge activities. The universalistic view assumes that all or most firms can improve their performance by adopting a set of so-called best practices (e.g., Huselid, 1995). In contrast, the contingency perspective contends that the influence of HRM systems can be amplified or constrained by specific situational conditions (Jackson & Schuler, 1995; Kim & Wright, 2011). Although they may appear to be opposite perspectives, we view them as complementary approaches (Datta et al., 2005; Sun et al., 2007; Youndt, Snell, Dean, & Lepak, 1996). As firms increasingly adopt a common set of best practices, the ability of a particular firm to achieve competitive advantage depends on how well it adapts its management practices to address its own particular strategic imperative.

In most previous strategic HRM research, the contingency of interest has been firm-level contextual factors such as business strategy (Chadwick et al., in press; Sun et al., 2007; Youndt et al., 1996) or features of the firm's external environment such as industry

characteristics (Batt, 2002; Chadwick et al., in press; Datta et al., 2005). To our knowledge no previous studies have investigated possible contingencies in the relationships between firm-level HRM systems and team-level outcomes.

The Moderating Role of Knowledge Tacitness

The distinction between *explicit* knowledge and *tacit* knowledge (Kogut & Zander, 1992; Nonaka & Takeuchi, 1995; Polanyi, 1966) is ubiquitous in discussions of knowledge management and organizational learning. Explicit knowledge is more easily codified and recorded than tacit knowledge; it can be formulated into sentences, mathematical equations, and other symbols for comprehension. By comparison, tacit knowledge is more complex, ambiguous, and subjective; it is accumulated by people through observation, imitation, and repeated interactions (Nonaka & Takeuchi, 1995). Explicit knowledge and tacit knowledge are not two distinct types of knowledge, however (Nonaka, 1991; Nonaka & von Krogh, 2009). Almost all knowledge has tacit components (Leonard & Sensiper, 1998). Rather than conceptualize knowledge as either tacit or explicit, it is more appropriate to view knowledge processed within teams as varying along a continuum that ranges from low tacitness (most explicit) to high tacitness (least explicit).

HRM systems for knowledge-intensive teamwork aim to facilitate team knowledge activities, but the tacit nature of knowledge may constrain how effectively they do so. According to the behavioral perspective for strategic HRM, the effectiveness of an HRM system reflects how well it defines the behaviors that are desired, provides a means for monitoring whether employees engage in the desired behaviors, and reinforces the desired behaviors. Adherence to this maxim assumes that the needed employee behaviors can be identified and articulated, and this may be more feasible when the behaviors desired involve acquiring and sharing knowledge that is less tacit (more explicit). When relevant knowledge is less tacit, it is more easily expressed, captured, stored, and reused (Nonaka, 1991; Nonaka & Takeuchi, 1995; Polanyi, 1966); the knowledge activities required from employees are more readily identified, observed, and reinforced by the HRM system. Employees are motivated to exert a high level of effort when they believe that such effort will lead to a good performance appraisal and rewards (Vroom, 1964). Under conditions of low knowledge tacitness, the linkages between knowledge activities and positive outcomes are likely to be more perceptible and clear to R&D employees. Therefore, the benefits of HRM systems for knowledge-intensive teamwork are more likely to be realized.

Conversely, HRM systems implemented in teams working with relatively more tacit knowledge may be less effective in encouraging knowledge acquisition and knowledge sharing. Tacit knowledge makes it harder to identify appropriate knowledge sources, regardless of one's willingness to acquire such knowledge. Even when the source of tacit knowledge is identified, knowledge sources find it difficult to explain the content and subtle nuances of their tacit knowledge; knowledge seekers, in turn, struggle to comprehend what they are being told (Hansen, Mors, & Løvås, 2005) and pass along their newly acquired knowledge.

The illusive nature of tacit knowledge may mean that its acquisition and sharing is less readily shaped by HRM systems, for HRM systems are typically directed at observable

behaviors and outcomes. For example, selection tests can more easily assess applicants' explicit knowledge than tacit knowledge; training programs are more likely to emphasize the acquisition of explicit knowledge than tacit knowledge; and the bestowing of recognition or rewards for a knowledge breakthrough is more easily justified when the new knowledge can be made explicit. In acquiring and sharing more tacit knowledge, team members may doubt whether their acts can be recognized even if they give a full range of effort. They may even believe that the likelihood of receiving recognition and rewards for that effort is low, no matter how hard they try to acquire new knowledge and share it with others. Thus, we propose the following:

Hypothesis 2a: HRM systems for knowledge-intensive teamwork interact with knowledge tacitness in predicting team knowledge acquisition; the relationship between HRM systems and team knowledge acquisition is more positive to the extent that knowledge tacitness is lower.

Hypothesis 2b: HRM systems for knowledge-intensive teamwork interact with knowledge tacitness in predicting team knowledge sharing; the relationship between HRM systems and team knowledge sharing is more positive to the extent that knowledge tacitness is lower.

The Moderating Role of Empowering Leadership

Empowering leadership refers to leader behaviors that stress the significance of work, express confidence in followers' performance, encourage followers' participation in decision making, and reduce frustration by removing resource constraints and administrative obstacles that interfere with performance (Ahearne, Mathieu, & Rapp, 2005; Arnold, Arad, Rhoades, & Drasgow, 2000; Zhang & Bartol, 2010). In knowledge-intensive work contexts, the essential ingredient of empowering leadership is leading knowledge workers to lead themselves (Manz & Sims, 1987) by sharing power with them and fostering their feelings of self-efficacy and intrinsic motivation (Conger & Kanungo, 1988; Srivastava, Bartol, & Locke, 2006).

Team knowledge activities require an array of self-initiated actions, which empowering leadership promotes. First, an empowering leader points out work meaningfulness to team members by helping them understand their value and contribution to organizational effectiveness (Conger & Kanungo, 1988); this in turn motivates members to engage in knowledge activities that are valuable to their team and organization.

Second, an empowering leader sets high expectations for performance and serves as a role model by searching for new insights, taking time for crucial reflection, sharing his or her knowledge openly, and so on; he or she also models appropriate self-leadership behaviors that are subsequently adopted by team members (Bandura, 1986). Consequently, team members who identify with the leader may feel confident to self-initiate knowledge activities despite the formidable challenges that typically characterize knowledge work (Ahearne et al., 2005; Jackson et al., 2006).

Third, an empowering leader encourages team members to participate in decision-making and provides autonomy over work methods and processes (Locke, Alavi, & Wagner, 1997). Meanwhile, knowledge acquisition and knowledge sharing are likely to be enhanced when team members observe that their leader actually uses their suggestions when making decisions. Seeing the impact of their ideas, team members experience greater task meaningfulness

(Kirkman & Rosen, 1999), which further encourages them to engage in acquiring and sharing relevant knowledge.

Last, an empowering leader teaches team members how to solve problems on their own and helps them see inadequacies in their knowledge, which in turn may prompt them to acquire new information and expertise. An empowering leader who coaches team members to solve problems together also facilitates knowledge sharing amongst them (Arnold et al., 2000). Meanwhile, by providing access to information necessary for task accomplishment, the leader empowers team members to search for solutions both within and outside the team and develop their knowledge through collaboration (Spreitzer, 1996). Consistent with these arguments, the empirical evidence reveals a positive relationship between leaders' empowerment behaviors and both team knowledge acquisition (Burke, Stagl, Klein, Goodwin, Salas, & Halpin, 2006) and team knowledge sharing (Srivastava et al., 2006).

In this study, we move forward and consider the potential joint effects of HRM systems and empowering leadership on team knowledge activities. Specifically, we argue that HRM systems for knowledge-intensive teamwork and empowering leadership are likely to function as substitutes for each other in their influence on team knowledge acquisition and team knowledge sharing.

Kerr and his collaborators (Howell, Dorfman, & Kerr, 1986; Kerr, 1977; Kerr & Jermier, 1978) argued that certain organizational conditions may substitute for or neutralize the effects of leader behaviors. According to the substitutes-for-leadership model, an HRM system designed to support knowledge acquisition and knowledge sharing can act as a leadership substitute (Podsakoff, MacKenzie, & Fetter, 1993). Turning this idea around, we argue that leadership behaviors can serve as substitutes for formal HRM systems. As Keller (2006) noted, R&D teams depict a context where the "substitutes" perspective might be particularly relevant because team members have extensive prior experience and training, are motivated internally, and engage in interesting work.

An empowering leader who enhances competencies, motivation, and/or opportunities for knowledge-intensive teamwork can act as a substitute for formal HRM systems and thereby weaken or neutralize the influence of HRM systems. For example, leaders who create a climate of empowerment (e.g., Kirkman & Rosen, 1999; Raub & Robert, 2010; Zhang & Bartol, 2010) contribute to autonomous motivation, which implies a sense of volition and choice (Gagné & Deci, 2005). When team members experience autonomous motivation to fulfill their needs for autonomy and competence (Sheldon, Turban, Brown, Barrick, & Judge, 2003), they are more willing to exert discretionary effort to acquire and share knowledge (Reinholt, Pedersen, & Foss, 2011).

HRM systems use formalized rules and routines that can produce team empowerment by providing clear direction and preventing ambiguity (Hempel, Zhang, & Han, 2012), whereas leader behaviors are a more proximal source for shaping empowerment perceptions of R&D members. Empowering leaders create the conditions that encourage and support knowledge acquisition and knowledge sharing through their direct interactions with team members. When the formal system is redundant with the informal interactions between team members and team leaders, the potential value of a well-designed HRM system may be reduced. Thus, we propose that HRM systems for knowledge-intensive teamwork would produce relatively less benefit for teams with empowering leaders, as follows:

Hypothesis 3a: HRM systems for knowledge-intensive teamwork interact with empowering leadership in predicting team knowledge acquisition; the relationship between HRM systems and team knowledge acquisition is more positive to the extent that empowering leadership is lower.

Hypothesis 3b: HRM systems for knowledge-intensive teamwork interact with empowering leadership in predicting team knowledge sharing; the relationship between HRM systems and team knowledge sharing is more positive to the extent that empowering leadership is lower.

Method

Procedures and Sample

We collected data from R&D employees and team leaders in firms in the information technology industry in Taiwan, which is among the most competitive in semiconductor, optoelectronics, and computer and peripheral devices manufacturing. Only firms employing more than 100 employees were contacted to participate in this study because they were more likely to implement formal HRM systems (Collins & Smith, 2006; Huselid, 1995).

We surveyed both team leaders and team members in order to minimize common method bias. Team leaders responded to a survey that asked them to describe HR practices, team knowledge acquisition, and team knowledge sharing. Team members responded to items used to assess knowledge tacitness and empowering leadership. Team leaders and team members both also provided information that was used to control for extraneous variables. Participants were Taiwanese and responded to surveys in the local language.

The 34 participating firms were from a variety of information technology sectors, including semiconductors ($N = 17$ firms), optoelectronics ($N = 9$ firms), computer electronics ($N = 6$ firms), and telecommunications ($N = 2$ firms). The firms ranged in age from 4 years to 35 years (Mean = 17.15 years, $SD = 7.39$), and ranged in size from 126 to 20,566 employees (Mean = 2,781 employees, $SD = 4,898$). Of the 34 firms, 31 were publicly listed.

After deleting 4 teams (accounting, human resources, and warehousing) not engaged in R&D work and 6 teams with fewer than three member respondents or with incomplete information, we were able to match 172 leader surveys (1 leader per team) with 826 member surveys for 172 teams in these 34 firms. The average number of participating teams per firm was 5.06 (Median = 5, $SD = 3.03$, with a range of 3 to 20). The average number of member respondents per team was 4.80 (Median = 5, $SD = 1.27$, with a range of 3 to 10). We calculated a *within-team* response rate for each team by dividing the number of respondents by the number of team members (reported by the leader). A response rate of at least 50% was obtained for 72% of the 172 teams, and the average within-team response rate was 69%.

Of the 172 teams, the average team members reported by team leaders was 8.23 ($SD = 4.26$), and the average team duration was 21.80 months ($SD = 20.36$). The demographic characteristics of individual team members were as follows: 76% were male; 31% had earned a master's degree, and 14% had earned a PhD; their average age was 31.38 years old ($SD = 5.03$); and their average tenure in the organization was 41.68 months ($SD = 37.21$).

Measures

For items adapted from published measures in other languages, back-translation procedures (Brislin, 1980) were followed. Items were answered on 7-point Likert-type scales (1 = “strongly disagree” to 7 = “strongly agree”).

Prior to collecting the study data, we conducted interviews with HRM executives and team leaders at five semiconductor and software firms and a survey-based pilot study for the purpose of developing measures of team knowledge acquisition and team knowledge sharing and to translate the measure of empowering leadership. The pilot survey was completed by 252 professional employees of a large hospital in Taiwan. These professional knowledge workers were members of problem-solving teams (i.e., quality circles) whose responsibilities required them to engage in knowledge acquisition and knowledge sharing. The mean age of the participants was 36.84 years old; 66% were female; and 79% held a bachelor's degree or above.

Constructs Measured Using Team Leaders' Responses

HRM systems for knowledge-intensive teamwork

We developed items to assess HRM systems by drawing from prior studies of HR practices for knowledge workers (Collins & Smith, 2006; Lepak & Snell, 2002; Lopez-Cabrales et al., 2009), the theoretical arguments developed by Jackson et al. (2006), and information obtained during interviews with HRM executives and team leaders. A preliminary set of items was refined based on face validity evaluations made by 4 team leaders, 2 HRM scholars, and 2 HRM practitioners. The final measure included 15 items about enhancing competencies for knowledge-intensive teamwork ($\alpha = .88$), 10 items about enhancing motivation for knowledge-intensive teamwork ($\alpha = .82$), and 6 items about enhancing opportunities for knowledge-intensive teamwork ($\alpha = .80$), as shown in Appendix A. The introductory statement in the survey clearly asked team leaders to report actual HR practices of the firm toward knowledge workers and teams.

Asking multiple team leaders rather than HRM managers or other top executives to rate the firm's HRM systems fits our interest in firm-level HR practices and also has other benefits. The responses of team leaders likely reflect the HRM system as it is implemented in the firm rather than mere formal policies (Wright, Gardner, Moynihan, Park, Gerhart, & Delery, 2001). Further, using the reports of multiple teams in each firm enabled us to assess the inter-rater reliability of our HRM measure (Gerhart, Wright, & McMahan, 2000; Wright & Boswell, 2002).

Reflecting our focus on the overall HRM system and following previous research, we used a unitary HRM index based on the entire set of HR practices (e.g., see Collins & Smith, 2006; Datta et al., 2005; Gittell et al., 2010; Kehoe & Wright, 2013; Lawler et al., 2011; Liao et al., 2009; Sun et al., 2007; Takeuchi et al., 2009; Way, 2002; Wright, Gardner, Moynihan, & Allen, 2005; Wu & Chaturvedi, 2009). Our use of a unitary index was supported by good internal reliability for the measure ($\alpha = .93$) and the results of a principal components factor analysis (Chadwick et al., in press; Collins & Smith, 2006; Liao et al., 2009), which yielded only one factor with an eigenvalue greater than 1. In addition, the intercorrelations among the subscales assessing competency-,

motivation-, and opportunity-enhancing HR practices were substantial (Gittell et al., 2010; Wu & Chaturvedi, 2009), ranging from $r = .73$ to $r = .75$.

Team knowledge acquisition

To measure the extent to which the team as a whole acquired ideas, expertise, or advice from outside, team leaders responded to a four-item scale (shown in Appendix B), of which three items were adopted from Wong (2004) and one item was adapted from Ancona and Caldwell (1992) ($\alpha = .84$). All items used “team” as the referent.

Team knowledge sharing

To measure the extent to which team members shared their special knowledge and expertise with others in their team, team leaders responded to a seven-item scale (shown in Appendix B), of which four items were adapted from Faraj and Sproull (2000) and three items were developed specifically for this study ($\alpha = .90$). Leaders were asked to rate the level of knowledge sharing for the entire team, and all items used “team” as the referent.

Although team knowledge acquisition and team knowledge sharing were correlated ($r = .55$, $p < .01$), they are theoretically distinguishable constructs. We conducted a confirmatory factor analysis (CFA) and used several criteria to examine their distinctiveness. Results of CFA showed a significant difference between the two-factor model and the one-factor model ($\Delta\chi^2 = 138.21$, $\Delta df = 1$, $p < .001$), and the two-factor model (RMSEA = .07, SRMR = .05, NNFI = .95, CFI = .96) fit the data better than the one-factor model (RMSEA = .17, SRMR = .10, NNFI = .75, CFI = .81). In the two-factor model, the variance extracted estimates were .57 and .59, respectively, and both exceeded the squared path coefficient between these two constructs ($\Phi^2 = .31$) (Fornell & Larcker, 1981). The phi coefficient was significantly less than 1 (standard error = .06). Finally, we used standard error to create a confidence interval around the correlation estimate between the two constructs and found that the confidence interval did not include a value of 1 (Jöreskog & Sörbom, 1993). Together, these analyses provided support for treating team knowledge acquisition and team knowledge sharing as two distinct constructs.

Constructs Measured Using Team Members' Responses

Empowering leadership

Team members provided descriptions of leaders' empowering leadership. Following Arnold et al. (2000) and Srivastava et al. (2006), we used 15 items corresponding to five dimensions: leading by example ($\alpha = .81$), participative decision making ($\alpha = .82$), coaching ($\alpha = .88$), informing ($\alpha = .93$), and showing concern ($\alpha = .90$). A sample item is “the leader encourages our team members to express ideas/suggestions.” The result of a CFA conducted to assess the validity of this measure confirmed the structure of five first-order factors plus an overall second-order factor ($\chi^2 = 638.56$, $df = 85$, $p < .001$; RMSEA = .09, SRMR = .04, NNFI = .94, CFI = .95). Because the second-order CFA supported the notion that the five

dimensions collectively reflect the overall construct of empowering leadership, we averaged the scores of items to create a composite index ($\alpha = .96$).

Knowledge tacitness

Team members provided their assessment of knowledge tacitness using four items adapted from Zander and Kogut (1995) and one item developed for this study: "It is difficult to articulate the knowledge content of our team tasks." All items used "team" as the referent ($\alpha = .83$).

Control variables

We included several control variables when testing our hypotheses. At the firm level, we controlled for *firm age* (the number of years since the firm was established) and *firm size* (using the natural logarithm of the number of employees as a proxy), because they may be associated with the use of more progressive HR practices such as those that support knowledge-intensive teamwork (Collins & Smith, 2006; Datta et al., 2005; Jackson & Schuler, 1995). At the team level, we included *team size* (the actual number of team members, as reported by team leaders) because it can influence intra-team communication (Ancona & Caldwell, 1992) and also because larger teams may have more knowledge resources (Zellmer-Bruhn & Gibson, 2006). We also controlled for *team meeting frequency* per week because teams that meet less often are vulnerable to process losses (Gibson & Cohen, 2003); face-to-face meetings promote team cohesion and mutual accountability, which may enhance team learning (Kirkman, Rosen, Tesluk, & Gibson, 2004). Finally, although the R&D teams we studied were presumed to work interdependently, we adopted a conservative strategy of controlling for this variable. *Team interdependence* refers to the extent to which team members cooperate and work interactively to complete their tasks (Stewart & Barrick, 2000) and is known to influence team dynamics in a variety of ways (e.g., Kozlowski & Bell, 2003). We measured interdependence with three items ($\alpha = .75$) from Campion, Medsker, and Higgs (1993).

Data Aggregation

Data collected from individuals were aggregated to firm and team levels of analysis. To investigate the appropriateness of aggregating responses to each level, we computed the appropriate $r_{wg(j)}$ values using a uniform distribution as the null distribution (James, Demaree, & Wolf, 1984) and the intra-class correlation (ICC) coefficients (Bliese, 2000).

Aggregation to the firm level of analysis

Our index assessing firm-level HRM systems used responses of team leaders. The $r_{wg(j)}$ values for the firm-level HRM index ranged from .84 to .99, with a mean of .97.

Table 1
Means, Standard Deviation, and Correlations

Variables	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9
<i>Firm-level variables</i>											
1. Firm age	17.15	7.39	—								
2. Firm size	2,781	4,898	.19	—							
3. HRM systems for knowledge-intensive teamwork	4.97	0.49	-.11	.26	—						
<i>Team-level variables</i>											
4. Team size	8.19	4.22	-.22*	-.01	.22**	—					
5. Team meeting frequency	2.18	2.73	.02	.11	-.03	.07	—				
6. Team interdependence	5.38	0.45	-.04	-.08	-.07	.06	.04	—			
7. Knowledge tacitness	3.67	0.50	-.02	.13	.01	-.11	-.05	-.32**	—		
8. Empowering leadership	5.39	0.55	-.17*	-.34**	-.07	.03	.01	.44**	-.28**	—	
9. Team knowledge acquisition	5.19	0.87	-.14	-.03	.22**	.04	.14	.05	-.07	.10	—
10. Team knowledge sharing	5.59	0.73	-.13	-.16*	.13	-.09	.09	.09	-.11	.33**	.55**

Note: $N = 162$ teams in 34 firms. The reported values of team-level variables are for 162 teams, after excluding those teams with low inter-rater agreement. Firm age indicates the number of years since the firm was established. Firm size was calculated as the natural logarithm of the number of employees, but the reported mean and standard deviation are original numbers. Correlations between firm-level and team-level variables are cross-level when the values of firm age, firm size, and HRM systems were assigned to each team in the same firm.

* $p < .05$. ** $p < .01$ (two-tailed test).

The values of ICC(1) and ICC(2) were .28 and .66, respectively. These statistics supported the aggregation of HRM scores and appropriately reflected the concept of firm-level HRM systems.

Aggregation to the team level of analysis

For the three team-level variables rated by team members, the mean $r_{wg(J)}$ values were .81 for knowledge tacitness, .91 for empowering leadership, and .83 for team interdependence. The ICC(1) values pertaining to knowledge tacitness, empowering leadership, and team interdependence were .18, .19, and .20, respectively, and the ICC(2) values of knowledge tacitness, empowering leadership, and team interdependence were .51, .53, and .54, respectively. Taken together, these statistics showed acceptable levels of inter-rater agreement and reliability to justify data aggregation to the team level.

Although the mean values of $r_{wg(J)}$ generally supported our data aggregation, variance existed around the means, suggesting that some teams might lack sufficient agreement among team members' ratings. When we examined the distribution of $r_{wg(J)}$ values across teams, we found unacceptably low inter-rater agreement for some teams, using .50 as a cut-off for lack of agreement (LeBreton & Senter, 2008). Because aggregated measures with low within-team agreement may lack construct validity (Klein, Conn, Smith, & Sorra, 2001), we dropped 10 teams with $r_{wg(J)}$ values below .50, yielding the final sample of 162 teams for subsequent hypotheses testing. To test the robustness of our results (reported below), we conducted supplemental analyses using

Table 2
Results of Hierarchical Linear Modeling for Team Knowledge Acquisition and Team Knowledge Sharing

Variables	Team Knowledge Acquisition			Team Knowledge Sharing		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	5.22***	5.25***	5.25***	5.64***	5.62***	5.61***
<i>Firm-level variables</i>						
Firm age	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01
Firm size	0.18	0.06	0.04	0.10	0.09	0.08
HRM systems for knowledge-intensive teamwork		0.48**	0.47**		0.37*	0.38**
<i>Team-level variables</i>						
Team size	-0.01	-0.01	-0.02	-0.04*	-0.02	-0.03
Team meeting frequency	0.03	0.03	0.04	0.02	0.02*	0.02*
Team interdependence	-0.07	0.08	0.10	-0.05	-0.19	-0.18
Knowledge tacitness		0.09	0.13		0.01	0.03
Empowering leadership		-0.13	-0.11		0.31*	0.32*
<i>Cross-level interactions</i>						
HRM systems for knowledge-intensive teamwork × knowledge tacitness			-0.47*			-0.26
HRM systems for knowledge-intensive teamwork × empowering leadership			-0.58*			-0.54**
Level 1 residual variance (σ^2)	0.52	0.46	0.45	0.30	0.24	0.24
Pseudo R^2	0.12	0.22	0.24	0.17	0.34	0.34

Note: $N = 162$ teams in 34 firms. Firm age indicates the number of years since the firm was established. Firm size was calculated as the natural logarithm of the number of employees. Entries for the predicting variables are estimations of the fixed effects with robust standard errors. All variables were grand-mean centered.

* $p < .05$. ** $p < .01$. *** $p < .001$.

only teams that met a more conservative criterion for $r_{wg(j)} = .70$ or above. The results for the smaller, more restricted sample were very similar. Thus, we report the results for analyses conducted using the 162 teams with moderate to high inter-rater agreement (LeBreton & Senter, 2008) and excluding teams with $r_{wg(j)}$ values below .50.

Analytical Strategy

Our theoretical model and multilevel data set encompass employees who are nested within teams, which are nested within firms, so we conducted two-level hierarchical linear modeling (Raudenbush & Bryk, 2002) to test our hypotheses.

Results

Table 1 presents the means, standard deviations, and correlations for our study variables. Table 2 provides the results of hierarchical linear modeling for the outcomes of team knowledge acquisition and team knowledge sharing.

Hypotheses 1a and 1b proposed that HRM systems for knowledge-intensive teamwork would be positively related to team knowledge acquisition and team knowledge sharing. As shown in Models 2 and 5 of Table 2, the relationships between HRM systems and team knowledge acquisition ($\gamma = .48, p < .01$) and team knowledge sharing ($\gamma = .37, p < .05$) were positive and significant. Thus, Hypotheses 1a and 1b were both supported.

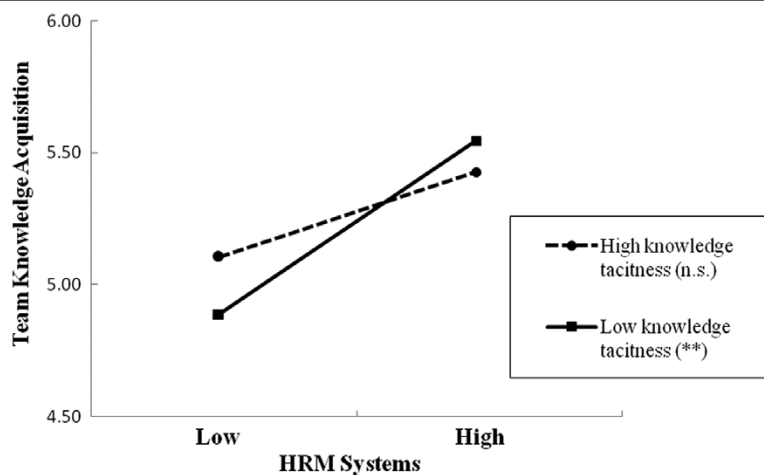
Hypotheses 2a and 2b stated that HRM systems for knowledge-intensive teamwork would interact with knowledge tacitness to predict team knowledge acquisition and team knowledge sharing. As shown in Model 3 of Table 2, the interaction of HRM systems with knowledge tacitness was significantly and negatively related to team knowledge acquisition ($\gamma = -.47, p < .05$). We used the techniques developed by Preacher, Curran, and Bauer (2006) to test the significance of simple slopes and plotted the relationship between HRM systems and team knowledge acquisition at one standard deviation above and below the mean of knowledge tacitness (Aiken & West, 1991). Figure 2 shows the plot of the interaction. The simple slope for HRM systems was significantly positive under conditions of low knowledge tacitness ($\gamma = .68, t = 3.28, p < .01$), whereas the slope was nonsignificant under conditions of high knowledge tacitness ($\gamma = .33, t = 1.17, n.s.$), providing support for Hypothesis 2a. However, as presented in Model 6 of Table 2, the interaction of HRM systems with knowledge tacitness was not significantly related to team knowledge sharing ($\gamma = -.26, n.s.$), failing to support Hypothesis 2b.

Hypotheses 3a and 3b stated that HRM systems for knowledge-intensive teamwork would interact with empowering leadership in predicting team knowledge acquisition and team knowledge sharing. As shown in Model 3 of Table 2, the interaction of HRM systems with empowering leadership was significantly and negatively related to team knowledge acquisition ($\gamma = -.58, p < .05$). As depicted in Figure 3, HRM systems and team knowledge acquisition were positively associated with each other under conditions of low empowering leadership ($\gamma = .68, t = 2.50, p < .05$) but not under conditions of high empowering leadership ($\gamma = .41, t = 1.84, n.s.$). Thus Hypothesis 3a was supported. On the other hand, as presented in Model 6 of Table 2, the interaction of HRM systems with empowering leadership was significantly and negatively related to team knowledge sharing ($\gamma = -.54, p < .01$). As shown in Figure 4, HRM systems and team knowledge sharing were positively associated with each other under conditions of low empowering leadership ($\gamma = .67, t = 2.80, p < .01$), but not under conditions of high empowering leadership ($\gamma = .15, t = 0.78, n.s.$). Thus, Hypothesis 3b was supported.

Discussion

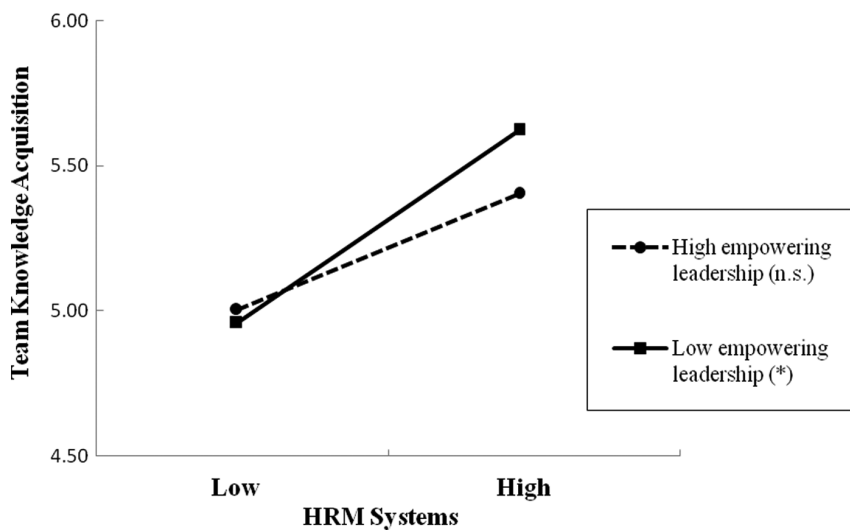
Integrating past research and theorizing on strategic HRM, empowering leadership, and knowledge-based competition, we developed a multilevel framework for understanding the management of knowledge-intensive teamwork and tested it with multi-source data collected from 162 R&D teams in 34 information technology firms. The results generally supported our research model (illustrated in Figure 1). Briefly, we found higher levels of team knowledge acquisition and team knowledge sharing for R&D teams working in firms with HRM systems designed to support knowledge-intensive teamwork. Our results also showed that strategically aligned HRM systems were most

Figure 2
Interaction of HRM Systems and Knowledge Tacitness on Team Knowledge Acquisition



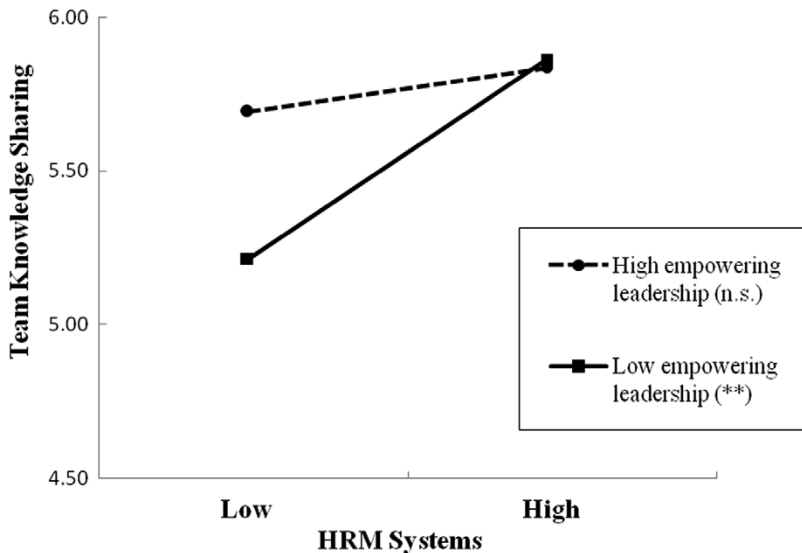
** $p < .01$.

Figure 3
Interaction of HRM Systems and Empowering Leadership on Team Knowledge Acquisition



* $p < .05$.

Figure 4
Interaction of HRM Systems and Empowering Leadership on Team Knowledge Sharing



** $p < .01$.

strongly associated with knowledge activities in the absence of an empowering team leader and for teams engaged in work that involved relatively less tacit knowledge.

Limitations

Before discussing important theoretical and practical implications, we acknowledge that our findings should be cautiously interpreted, as this study is not without limitations. First, although we attempted to minimize potential common method bias by collecting data from two sources (team leaders and members), our measures of HRM systems and team knowledge activities were rated by the same source. Nonetheless, the threat of same-source bias is limited for three reasons: First, our firm-level measure of HRM systems was created by aggregating the responses of several team leaders within a firm, whereas team knowledge activities were assessed for specific teams in each firm. Second, the items used to measure these constructs clearly referred to different target entities. Third, the interactive effects we observed involved measures from different sources, and thus our key findings cannot be due to same-source bias (Schmitt, 1994).

As with most survey-based studies, not everyone we invited to participate responded. Supplemental analyses that we conducted to ensure the robustness of our results found that dropping teams with lower response rates (i.e., below 50%) did not significantly change our conclusions. Nevertheless, we cannot rule out the possibility of self-selection bias. Also, the number of raters can affect the magnitude of $r_{wg(j)}$ values (LeBreton & Senter, 2008); a small number of respondents in some teams might have attenuated the inter-rater agreement values and introduced measurement error. Such problems may have reduced our ability to detect some “true” relationships.

The cross-sectional design of our study limits our ability to infer causality, but we believe it is less plausible that organizations developed HRM systems for knowledge-intensive teamwork as a response to having teams that engage in more knowledge activities versus the reverse causal ordering that we proposed. If R&D teams were freely engaging in desired knowledge activities in the absence of a supportive HRM system, there would be little reason to invest in an HRM system to induce those behaviors. Also, by including several control variables in our analyses, we sought to reduce the spurious influences. Nonetheless, longitudinal designs are required to firmly establish causality.

Finally, the sample we studied reflected our specific goal of illuminating the dynamics of knowledge-intensive teamwork within the context of R&D units in the information technology industry. To the extent that knowledge is becoming more pivotal for firms across a variety of industries, our conceptualization of HRM systems may eventually prove useful for firms in other industries (Collins & Smith, 2006) that rely on other types of knowledge-intensive teamwork. We encourage others to engage in similar research in a variety of other contexts in order to establish the generalizability of these results.

Contributions of Our Research

Our research offers several theoretical implications and practical contributions. Here we summarize the major contributions before elaborating a bit about each one. First, our multilevel model begins to fill a hole in the strategic HRM literature, which has largely ignored the challenge of developing HRM systems that take seriously the proliferation of team-based organizational structures. Focusing on R&D teams, this study advances our understanding of how HRM systems can shape meso-level phenomena and bridges the macro-micro divide that characterizes management research (Hitt et al., 2007; Wright & Boswell, 2002). Second, this study examined the boundaries and limitations of HRM systems to provide theoretical refinement to the basic logic that dominates strategic HRM studies of so-called high-performance work systems (cf. Boyd et al., 2012) and to extend and enrich our understanding of the interplay between strategic HRM systems, leader effectiveness, and types of knowledge. Finally, although our results should be replicated before they are used to make bold prescriptions to practicing managers, we nevertheless include speculations about the practical implications of our research.

HRM systems for knowledge-intensive teamwork

Despite an explosion of management research on knowledge-based competition during the past two decades since Peter Drucker published his thoughtful book titled *Post-Capitalist*

Society (Drucker, 1993), little empirical evidence has accumulated about the role that HRM systems play in firms competing on the basis of knowledge, and the extant strategic HRM literature offers little guidance for designing HRM systems that promote effective teamwork. The few relevant studies we located examined the linkages between HRM systems and the reactions of individual employees (e.g., Jensen et al., in press; Takeuchi et al., 2009; Wu & Chaturvedi, 2009) while remaining silent about how HRM systems can improve teamwork in general and knowledge-intensive teamwork in particular. As team scholars have pointed out repeatedly (e.g., see Hempel et al., 2012; Mathieu, Maynard, Rapp, & Gilson, 2008; Stewart, 2010), advancement in our understanding of how contextual factors influence team dynamics is sorely needed, and this study is a small step in that direction.

Context matters: Knowledge attributes

Our findings indicate that HRM systems were more effective in shaping the acquisition of more explicit knowledge and less effective in shaping the subtle, less observable, and often unmeasured behaviors involved in acquiring tacit knowledge. For example, the knowledge needed to develop a low-end cellular phone is easier to articulate (less tacit) than the knowledge needed to develop a stylish and sophisticated high-end smart phone. HR practices can be effectively used to motivate and provide opportunities for employees to acquire such less tacit knowledge. By contrast, the knowledge required to design a stylish and stunning new smart phone is more tacit. In part because tacit knowledge is difficult to articulate, observe, and evaluate, it is less subject to control through formal HRM systems.

Although we predicted otherwise, our results indicate that HRM systems supporting knowledge-intensive teamwork were equally effective in promoting team knowledge sharing regardless of the degree to which tacit knowledge was involved. Tacit knowledge is a source of competition within as well as between firms (Kachra & White, 2008). For example, the know-how involved in the design of an appealing smart phone is both highly tacit and of considerable value, imbuing it with strategic significance. Thus, those who have such knowledge may be unwilling to reveal it. Yet our results suggest that well-designed HRM systems effectively reduced the influence of political forces and the knowledge-hoarding inclinations of team members while strengthening the influence of performance requirements and motivating employees to share tacit knowledge for the benefit of their team.

Additional research is needed to illuminate the specific processes through which HRM systems encourage and support the sharing of tacit and explicit knowledge. Such research should examine the role of specific practices in shaping both individual behaviors and internal team dynamics, for knowledge sharing is an internal integration activity for teams. Although individual team members may feel inclined to hoard their tacit knowledge because of a fear that sharing what they know will result in power loss, their inclinations can be blunted by an HRM system that promotes and supports knowledge sharing through performance evaluations, rewards, resource distribution, and promotion. Together, an HRM system and effective leadership should send the message that sharing tacit knowledge enhances

rather than lessens one's personal status; knowledge sharing should be loudly applauded. Because both the provider and the recipient involved in knowledge sharing are attached to the same team, common goals may override the competitive forces that cause knowledge hoarding (Kozlowski & Bell, 2003). When HRM systems send clear messages that knowledge sharing is positively evaluated and rewarded, collective team identification (Van der Vegt & Bunderson, 2005) may enhance team members' willingness to share what they know, even including tacit knowledge. Understanding the specific social and psychological dynamics through which HRM systems influence knowledge activities will be advanced by future research that focuses on those processes. Likewise, future research should explore other potential means for facilitating the acquisition of tacit knowledge since the power of HRM systems appears to be constrained by knowledge tacitness.

Context matters: Empowering leadership

We also found that leadership styles created contextual conditions that influence the usefulness of HRM systems for knowledge-intensive teamwork. The strategic HRM literature argues persuasively that HR practices can influence the behaviors of employees engaged in knowledge work (e.g., Collins & Smith, 2006; Lopez-Cabrales et al., 2009); likewise, the leadership literature argues persuasively that leader behaviors can facilitate knowledge work (e.g., Burke et al., 2006; Srivastava et al., 2006). Yet these two streams of scholarship have evolved to their current mature states by traveling parallel paths, with little recognition of each other's work. Our study suggests that building a conceptual bridge to connect these two domains of scholarship can accelerate progress in both areas.

Regarding team leadership, our results indicate that HRM systems and leadership behaviors can substitute for each other: The presence of empowering leadership weakened the positive influence of strategically aligned HRM systems, and conversely, the presence of HRM systems appeared to weaken the positive influence of empowering leadership. We note, however, that Mintzberg (1979) provided a competing view, suggesting that in organizations where power is shared and decision making is delegated, formal rules and policies are required to clarify goals and provide guidance (Organ & Greene, 1981). Accordingly, formalization of practices should enhance the value derived from decentralization. Additional research is needed to test Mintzberg's arguments and possibly reconcile them with our findings. A recent study of Chinese high-technology firms (Hempel et al., 2012) is a step in this direction. The authors demonstrated that team performance was influenced by organizational formalization (indirectly through team empowerment) but not by the interaction of formalization and decentralization. Our results concerning the positive effects of HRM systems on knowledge activities are consistent with Hempel et al.'s (2012) findings, and we further provide preliminary evidence of the interactive effects of formalization through HRM systems and decentralization through empowering leadership.

Nonetheless, it is premature to conclude that these substitution effects are pervasive. The interplay of HRM systems and leadership behaviors may depend on the outcomes of interest. While our results generally supported a substitution perspective, they also point to differences in how HRM systems and empowering leadership combine to

influence knowledge acquisition versus knowledge sharing. Specifically, HRM systems but not empowering leadership had a significant and positive relationship with team knowledge acquisition, while both HRM systems and empowering leadership were significantly and positively related to team knowledge sharing. Furthermore, such interactive effects may be influenced by other aspects of the work tasks and organizational context that we did not investigate.

Managerial Implications

Our findings further bolster a growing body of evidence that shows it is worth investing resources to design and implement a coherent HRM system that is aligned with a firm's strategic imperatives (Becker & Huselid, 1998; Schuler & Jackson, 1987a). More specifically, an HRM system for knowledge-intensive teamwork may be an essential element of an effective HRM architecture for firms that compete in knowledge-intensive environments. For managers striving to achieve such alignment, the research tools we developed for this study have some practical utility: For example, our measure of HRM systems for knowledge-intensive teamwork specified particular HR practices that firms competing on knowledge should consider adopting. This measure also can be used as a diagnostic tool for evaluating how well a firm's HRM system supports knowledge-intensive teamwork.

Our findings also caution that the practical and economic value of a strategically aligned HRM system for knowledge-intensive teamwork likely depends on local conditions, including the degree to which the knowledge most valued by the firm is relatively tacit. Managers may find that investing in HRM systems designed to encourage team knowledge acquisition can produce greater returns when team tasks involve acquiring knowledge that is less tacit (more explicit), for the behaviors required in these contexts are more readily understood and thus more amenable to influence through a formal HRM system. On the other hand, when knowledge-intensive teamwork involves knowledge that is more tacit (less explicit), it may be more effective for an organization to focus its HRM system on developing a cadre of team leaders who foster effective knowledge acquisition through their direct interactions with team members—for example, by acting as a liaison or representative of the team and assisting the team in its pursuit of information and expert resources (Morgeson, DeRue, & Karam, 2010).

Further, although both empowering leadership and HRM systems for knowledge-intensive teamwork are likely to contribute to the development of a firm's knowledge resources and capabilities, it may not be necessary to invest in both. If empowering leaders can ensure that team members continuously strive to explore sources of new knowledge, exploit the lessons learned, and solve technical problems together effectively, then it may be more economical to select and/or develop empowering team leaders rather than design a formal HRM system for managing R&D teams. We did not examine the HR practices that firms used to influence leadership behaviors—for example, selecting, developing, and rewarding leaders who empower team members—but our results suggest that this is another useful direction for future research.

Overall, our results suggest that organizations should attend to the specific local conditions present in their organizations when designing and developing their HRM systems.

The structure of work around individuals and teams, leadership behaviors, and tacitness of the required knowledge can all dampen or amplify the influence of HRM systems for knowledge-intensive teamwork. It is likely that other local conditions can influence the potential value of HRM systems for knowledge-intensive teamwork, also. For example, in a study of student teams working on field projects, the presence of demographic faultlines interfered with knowledge sharing over the course of several weeks (Jiang, Jackson, Shaw, & Chung, 2012), suggesting that HRM systems for knowledge-intensive teamwork may be particularly beneficial when high degrees of workforce diversity introduce the risk of strong faultlines becoming salient within work teams. As future research seeks to extend our understanding of HRM systems to support teamwork, workforce diversity and other situational conditions known to influence teamwork (see Mathieu et al., 2008) also should be examined in order to provide useful insights for managers striving to reap the rewards of more effective teamwork.

Appendix A

Items to Assess HRM Systems for Knowledge-Intensive Teamwork

Competency-enhancing HR practices for knowledge-intensive teamwork

1. The selection of knowledge workers emphasizes their overall fit to the company (personality, values, etc.).
2. The selection of knowledge workers focuses on their potential to learn and grow.
3. If a team member has good technical skills, his/her interpersonal skills are NOT very important. (reverse coded)
4. When new team members are being selected for my team, their teamwork ability is weighted heavily in the decision.
5. When new team members are being selected for my team, their adaptability to the environment and self-adjustment is weighted heavily in the decision.
6. When new team members are being selected for my team, their interpersonal relationships within the company are weighted heavily in the decision.
7. When new team members are being selected for my team, their interpersonal relationships with people outside the company (e.g., suppliers, customers, other professionals) are weighted heavily in the decision.
8. The company invests considerable time and resources in training for knowledge workers.
9. The company provides an orientation program for new knowledge workers to learn the history, culture, and values of the company.
10. The company has a mentoring program (individually or as a group) aimed at employee development.
11. The company uses mentoring assignments as a way to encourage employees to learn from each other.
12. The company provides training that improves my team employees' ability to learn from each other.
13. The company provides training to improve the interpersonal skills of employees in my team.
14. The company provides training to help my team employees develop and update their technological know-how.
15. The employees in my team have attended training designed to improve their teamwork skills.

Motivation-enhancing HR practices for knowledge-intensive teamwork

16. The company's performance management practices emphasize individual improvement and development.
17. Performance appraisals are based on input from multiple sources (coworkers, supervisors, clients, etc.).
18. Internal candidates take priority over external candidates for knowledge job openings.
19. Team members' pay and rewards are closely linked to the team's overall performance.
20. Knowledge workers' bonuses or incentive plans are based primarily on the performance of the company.
21. On average the pay level of our knowledge workers is higher than that of our competitors.
22. The company offers a variety of incentives (e.g., gain sharing, stock option, etc.) to attract and retain top talent.
23. The company provides many benefits for knowledge workers to continually learn new knowledge (e.g., paying tuition costs, supporting attendance of conference or other learning events, etc.).
24. The company recognizes and rewards teams who come up with the best new ideas.
25. The company rewards teams for sharing new information and knowledge.

Opportunity-enhancing HR practices for knowledge-intensive teamwork

26. The company uses job rotation for knowledge workers to gain experience by moving them across different functional areas or divisions.
27. Members of my team are evaluated on their interpersonal relationships with other coworkers outside the team.
28. My team often arranges events for knowledge exchange (e.g., seminars, visits by outside experts, etc.).
29. The company sponsors various social events to encourage contact and relationship building among employees.
30. The company actively encourages knowledge workers to participate in "knowledge communities" (a bunch of people who have similar interests communicate and exchange information by using discussion board, forum, listserv, etc.).
31. The company invests considerable time and resources in building and operating communities of practice (e.g., providing technical support, budgets, rewards, etc.).

Appendix B

Items to Assess Team Knowledge Acquisition and Team Knowledge Sharing

Team knowledge acquisition

1. Our team seeks ideas/expertise from people external to the team.
2. Our team seeks feedback about the team's work from people external to the team.
3. Our team obtains advice from people external to the team.
4. Our team scans the environment inside and outside the organization for knowledge about the market.

Team knowledge sharing

5. Members of our team share their special knowledge and expertise with one another.
6. If a member in our team has some special knowledge about how to perform the team task, he/she will tell other members about it.
7. There is virtually no exchange of information, knowledge, or sharing of skills among members of the team. (reverse coded)
8. More knowledgeable team members freely provide other members with hard-to-find knowledge or specialized skills.
9. Members of our team provide a lot of work-related suggestions to each other.
10. There is a lot of constructive discussion during team meetings.
11. Members in our team provide their experience and knowledge to help other members find solutions to their problems.

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