Can knowledge-intensive teamwork be managed? Examining the roles of HRM systems, leadership, and tacit knowledge.

Can Knowledge-Intensive Teamwork Be Managed?

Examining the Roles of HRM Systems, Leadership, and Tacit Knowledge

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Abstract

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.

Can Knowledge-Intensive Teamwork Be Managed?

Examining the Roles of HRM Systems, Leadership, and Tacit Knowledge

Among resources and capabilities that may help organizations obtain sustained competitive advantages, knowledge in particular appears to have broad relevance to organizations; it is the primary strategic resource in the knowledge-based economy (Grant, 1996; Kogut & Zander, 1992). In order for knowledge to create value for an organization, it must flow through and be embedded in the organization. Knowledge-intensive teamwork, which is comprised of 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 that can be used to achieve competitive advantage (Nahapite & Ghoshal, 1998; Wright, Dunford, & Snell, 2001).

In this study, we seek to improve our understanding of organizational conditions that facilitate 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; Fiol, 2003; 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). Recognizing that many organizational conditions may encourage or inhibit effective knowledge-intensive teamwork, we focus on three: human resource management (HRM) systems, the extent to which teams deal with knowledge that is relatively more tacit (vs. explicit), and team leadership.

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, Dunford, & Snell, 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; Datta, Guthrie, & Wright, 2005; Huselid, 1995) as well as individual attitudes and behaviors (e.g., Takeuchi, Chen, & Lepak, 2009; Wu & Chaturvedi, 2009). Yet, 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 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).

Two prominent logics for understanding HRM effectiveness are the *universalistic* perspective and the *contingency* perspective. The universalistic perspective asserts that some HRM systems (e.g., high performance work systems, or HPWS) are broadly effective across a wide range of settings, whereas the contingency perspective contends that the effectiveness of particular types of HRM systems depends on other conditions (Datta et. al, 2005; Youndt, Snell, Dean, & Lepak, 1996). Although numerous studies have found a positive relationship between HRM systems andorganizational performance (Combs, Liu, Hall, & Ketchen, 2006; Wright, Gardner, Moynihan, & Allen, 2005), recent criticisms (see Jensen, Patel, & Messersmith, in press) and equivocal empirical evidence (see Chadwick, Way, Kerr, & Thacker, in press)

indicate that more research is needed to establish the boundaries that constrain the effectiveness of various HRM systems. Likewise, recent meta-analyses (Combs et al., 2006; Jiang, Lepak, Hu, & Baer, in press) of studies that have 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.

Although the universalistic and contingency perspectives may appear to be opposing views, the two perspectives are not mutually exclusive; indeed, they can be treated as complementary (Datta et al., 2005; Sun, Aryee, & Law, 2007; Youndt et al., 1996). Investigating the main effects of management practices as proposed by the universalistic view is important and often the first step for an emerging area such as strategic HRM. But universalistic approaches seldom fully capture the complexity of organizations (Boyd, Haynes, Hitt, Bergh, & Ketchen, 2012), providing opportunities for investigation of potential contingent factors (Batt, 2002; Chadwick et al., in press; Combs, Liu, Hall, & Ketchen, 2006; Datta, Guthrie, & Wright, 2005; Jackson & Schuler, 1995; Jensen et al., in press; Kim & Wright, 2011; Neal, West, & Patterson, 2005; Sun et al., 2007; Youndt et al., 1996). Therefore, while recognizing the value of prior, first-generation studies of HRM systems, we argue that new research is now needed to understand how contextual conditions influence the effectiveness of an HRM system. Specifically, the present study considers how HRM systems work in combination with team tasks and team leadership to influence knowledge-intensive teamwork (Mathieu, Maybard, Rapp, & Gilson, 2008; Stewart, 2010). More specifically, we examine how empowering leadership and the extent to which team tasks involve knowledge that is relatively tacit (versus explicit) interact with HRM systems to influence the focal team activities of knowledge acquisition and knowledge sharing.

As we will 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 acquisition and 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.

Insert Figure 1 about here

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 in order to sharpen our conceptual model of how HRM systems can potentially influence important outcomes.

Team Knowledge Acquisition and 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 and knowledge sharing. Knowledge acquisition helps a team increase the depth and width of its knowledge, while knowledge sharing 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, in press).

Whereas knowledge acquisition draws the attention of a team outward, knowledge sharing focuses attention inward (Zhou & Li, 2012). Team knowledge sharing refers to activities that aid the transfer of knowledge among team members (Jackson et al., 2006); it helps a team to

remember and exploit lessons learned previously and solve technical problems more effectively. Because no individual can specialize in every domain and keep up with all relevant new knowledge continually being created, knowledge sharing helps the team to ensure that existing knowledge is distributed among members (Grant, 1996). Knowledge sharing is particularly important when task-relevant knowledge is distributed among experts with specialized and distinct knowledge, which is typical in R&D teams.

Using the HRM System to Support Knowledge Acquisition and Knowledge Sharing

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. The current study recognizes the importance of HRM systems designed to manage behaviors of knowledge workers engaged specifically in knowledge-intensive teamwork (versus, for example, highly skilled individual contributors).

HRM systems and firm-level outcomes. 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 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 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.

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. For example, the provision of various employee benefits such as health care and services such as child care are aspects of many HRM systems, but they probably have little influence on team knowledge acquisition or knowledge sharing. As prior research has shown, ability, motivation, and opportunity are three main drivers of knowledge acquisition and knowledge sharing (e.g., Argote, McEvily, & Reagans, 2003; Nahapiet & Ghoshal, 1998; Reagans & McEvily, 2003; Reinholt, Pedersen, & Foss, 2011). Thus, to identify practices that comprise an HRM system for knowledge-intensive teamwork, we adopted the widely used ability-motivation-opportunity (AMO) approach (e.g. see also Batt, 2002; Combs et al., 2006; Gardner, Wright, & Moynihan, 2011; Jiang, Lepak, Hu & Baer, in press; Kehoe & Wright, in press; Lawler, Chen, Wu, Bae, & Bai, 2011; Lepak, Liao, Chung, & Harden, 2006) to argue that HRM systems for knowledge-intensive teamwork should include HR practices intended to

enhance competencies, motivation, and opportunities for knowledge-intensive teamwork. [Note 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.] Next we describe the competency-enhancing HR practices, motivation-enhancing HR practices, and opportunity-enhancing HR practices that together form an HRM system for knowledge-intensive teamwork. While we recognize that both individuals and teams engage in knowledge work, and appreciate the need for more complex multi-level models (Jackson & Hong, 2008), this study focuses on work assigned to teams.

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, in press). 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 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 new and 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 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 non-relational learning (e.g., formal documents) (Rulke, Zaheer, & Anderson, 2000), interactions with other collaborators facilitate knowledge flow (Chung & Jackson, in press; 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 (Joshi & Jackson, 2003; Collins & Clark, 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, in press; 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 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 comprised of 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, Way, Kerr, & Thacker, in press; Chuang & Liao, 2010; Collins & Smith, 2006; Datta et al., 2005; Kehoe & Wright, in press; Jensen, Patel, & Messersmith, in press; Lawler et al., 2011; Lepak et al., 2006; Liao, Toya, 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:

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. Next we develop our logic further to recognize the likely role of contextual conditions that vary across R&D teams. That is, we turn now to incorporate the contingency perspective, which contends that the influence of HRM systems can be reinforced or constrained by specific situations (e.g., Jackson & Schuler, 1995; Kim & Wright, 2011).

The findings of several strategic HRM studies are consistent with the contingency perspective (e.g., Batt, 2002; Chadwick et al., in press; Datta et al., 2005; Jensen et al., in press; Neal, West, & Patterson, 2005; Sun et al., 2007; Youndt, Snell, Dean, & Lepak, 1996). An early meta-analysis conducted by Combs and colleagues (2006) reported a mildly positive relationship between HRM systems and organizational performance with large variations in this relationship across studies. Likewise, in a more recent meta-analytical review of the influence of HRM systems and the processes leading to organizational outcomes, Jiang, et al. (in press) observed a great amount of unexplained variance in the relationships linking HRM systems to both mediating processes and firm outcomes.

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 date, the role of contextual conditions that are likely to be more directly experienced by employees has received very little attention. One

exception to this generalization is a recent study by Jensen et al. (in press), who found that lack of job control exacerbated the negative outcomes associated with high performance HRM systems. To our knowledge no previous studies have investigated possible contingencies in the relationships between firm-level HRM systems and team-level outcomes. Our study aims to extend the literature by examining the influence of knowledge tacitness and empowering leadership as two potential moderators of the relationships between HRM systems and team knowledge activities.

The Moderating Role of Knowledge Tacitness

The distinction between *explicit* knowledge and *tacit* knowledge (Polanyi, 1966; Kogut & Zander, 1992; Nonaka & Takeuchi, 1995) 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).

Knowledge attributes such as tacitness can influence knowledge acquisition and knowledge sharing within organizations and across organizational boundaries. For example, the "stickiness" of tacit knowledge appears to hinder knowledge acquisition and knowledge sharing by

constraining how easily knowledge can be articulated by the source and absorbed by the recipient (Coff, Coff, & Eastvold, 2006; Griffith & Sawyer, 2010; Szulanski, 1996; Szulanski, Cappetta, & Jensen, 2004). In a study of 35 major Swedish innovations, codifiable, product-based knowledge was more readily transferred compared to knowledge that was less easily articulated (Zander & Kogut, 1995).

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 employees behaviors that are desired 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 (Polanyi, 1966; Nonaka, 1991; Nonaka & Takeuchi, 1995); 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 and 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 break-through 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 no matter how hard they try to acquire new knowledge and share it with others, the likelihood of receiving recognition and rewards for that effort is low. Thus, we propose:

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 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 the competencies, motivation and/or opportunities for knowledge-intensive teamwork can act as a substitute for the formal HRM system and thereby weaken or neutralize the influence of the 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 et al., 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

To test our hypotheses, 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 for possible participation 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 leaders also provided information that was used to control for extraneous variables, including the number of members in each team (team size) and how often the team held meetings per week (team meeting frequency). Team members responded to items used to assess knowledge tacitness and empowering leadership. Team members also provided ratings of team interdependence, which were included as a control

in our analyses, and demographic background information. 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 resource, 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 percent was obtained for 72 percent 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 percent were male; 31 percent had earned a master degree and 14 percent 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 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 semi-conductor and software firms and a survey-based pilot study for the purpose of developing measures of team knowledge acquisition and 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 activities. The mean age of the pilot study participants was 36.84 years old; 66 percent were female; and 79 percent held a bachelor degree or above.

Constructs Measured Using Team Leaders' Responses

HRM systems for knowledge-intensive teamwork. We developed items to assess HR practices intended to enhance competencies, motivation, and opportunities of both knowledge workers and teams to support knowledge-intensive teamwork 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 (α = .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. In contrast to asking HRM managers to describe the HRM system, 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 measure of the HRM system (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, in press; Lawler et al., 2011; Liao et al., 2009; Sun et al., 2007; Takeuchi et al., 2009; Way 2002; Wright et al., 2005; Wu & Chaturvedi, 2009). The items included in our unitary HRM index referred to practices aimed at maintaining and improving competencies, enhancing motivation, and providing opportunities for knowledge-intensive teamwork. Our use of a unitary index was supported by good internal reliability for the measure (α= .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 of subscales made up of items assessing the three dimensions of HRM systems (competencies-, motivation-, and opportunity-enhancing HR practices) were substantial (Gittell et al., 2011; Wu & Chaturvedi, 2009): for individual leaders' ratings, r =.73 for competency- and motivation-enhancing HR

practices, $r = .73$ for competency- and opportunity-enhancing HR practices, and $r = .75$ for motivation- and opportunity-enhancing HR practices.

Team knowledge acquisition. This index measures the extent to which the team as a whole acquires ideas, expertise, or advice from outside. Team leaders described team knowledge acquisition using a four-item scale (shown in Appendix B), of which three items were taken 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. The index measures the extent to which team members share their special knowledge and expertise with others in their team. Team leaders described team knowledge sharing using a seven-item scale (shown in Appendix B), of which four items were taken from Faraj and Sproull (2000) and three items were developed specifically for this study ($\alpha = .90$). Leaders were asked to indicate the level of knowledge sharing for the entire team. All items used "team" as the referent.

Although team knowledge acquisition and 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, all items significantly loaded on their respective latent constructs ($p < .001$). The variance extracted estimates of knowledge acquisition and knowledge sharing 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 knowledge acquisition and knowledge sharing as two distinct constructs.

Constructs Measured Using Team Members' Responses

Empowering leadership. Team members provided descriptions of leaders' empowering leadership. Following Srivastava et al. (2006), we used 15 items from the measure originally developed by Arnold et al. (2000), which included multi-item subscales corresponding to five dimensions: leading by example (α = .81), participative decision-making (α =.82), coaching (α =.88), informing (α =.93), and showing concern (α =.90). A sample item is "the leader encourages our team members to express ideas/suggestions."

We conducted a CFA to assess the validity of this measure. The result confirmed the structure of five first-order factors plus an overall second-order factor (χ^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 (α = .96).

Knowledge tacitness. Team members provided their assessment of knowledge tacitness using four items adopted from Zander and Kogut (1995) and one item developed for this study: "It is difficult to articulate the knowledge content of our team tasks" (reverse coded). All items referred to the team as the referent (α = .83).

Control variables. We included several firm-level and team-level 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) (based on public records and information provided by HRM departments in the firms), 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

In this study, multiple respondents reported on a firm's HRM systems (rated by team leaders) and the team variables of primary interest (empowering leadership, knowledge tacitness, and team interdependence, described by individual team members). Thus, data collected from individuals was aggregated to these two different levels of analysis. To investigate the appropriateness of aggregating responses to the firm and team levels, 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 for knowledge-intensive teamwork was based on 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. 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 support our data aggregation, variance exists around this mean, so some teams may 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 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 multi-level data set encompasses employees who are nested within teams, which are nested within firms. The theoretical model is hierarchical with study variables conceptualized at the firm level (HRM systems for knowledge-intensive teamwork) and the team level (knowledge acquisition, knowledge sharing, knowledge tacitness, and empowering leadership). Therefore, 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 the study variables for the 162 teams used to test our hypotheses. Table 2 provides the results of hierarchical linear modeling for team knowledge acquisition and knowledge sharing.

Insert Table 1 about here

Insert Table 2 about here

Hypotheses 1a and 1b proposed that HRM systems for knowledge-intensive teamwork would be positively related to team knowledge acquisition and knowledge sharing. As shown in Models 2 and 5 of Table 2, the relationships between HRM systems and knowledge acquisition

(γ = .48, p < .01) and knowledge sharing (γ = .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 in predicting team knowledge acquisition and knowledge sharing. As shown in Model 3 of Table 2, the interaction of HRM systems with knowledge tacitness was significantly and negatively related to knowledge acquisition (γ = -.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 (γ = .68, t = 3.28, p < .01) whereas the slope was nonsignificant under conditions of high knowledge tacitness (γ = .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 knowledge sharing (γ = -.26, *n.s.*), failing to support Hypothesis 2b.

Insert Figure 2 about here

Hypotheses 3a and 3b stated that HRM systems for knowledge-intensive teamwork would interact with empowering leadership in predicting team knowledge acquisition and knowledge sharing. As shown in Model 3 of Table 2, the interaction of HRM systems with empowering leadership was significantly and negatively related to knowledge acquisition (γ = -.58, p < .05). As depicted in Figure 3, HRM systems and knowledge acquisition were positively associated

with each other under conditions of low empowering leadership (γ = .68, t = 2.50, p < .05), but not under conditions of high empowering leadership (γ = .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 knowledge sharing (γ = -.54, p < .01). As shown in Figure 4, HRM systems and knowledge sharing were positively associated with each other under conditions of low empowering leadership (γ = .67, t = 2.80, p < .01), but not under conditions of high empowering leadership (γ = .15, t = 0.78, *n.s.*). Thus, Hypothesis 3b was supported.

Insert Figure 3 about here

Insert Figure 4 about here

DISCUSSION

Integrating past research and theorizing on strategic HRM, empowering leadership, and knowledge-based competition, we developed a multilevel framework for understanding 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 knowledge acquisition and knowledge sharing for R&D teams working in firms with HRM systems designed to support knowledge-intensive teamwork. The more effective HRM systems included HR practices for enhancing employees' competencies, motivation, and opportunities to acquire knowledge from

sources outside the team and share knowledge with members within the team. Our results also showed that strategically aligned HRM systems were most 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 of this study, 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 for knowledge-intensive teamwork and team knowledge activities were rated by the same source—namely, the team leader. Nonetheless, the threat that same-source bias explains our results is limited for three reasons: First and most importantly, note that our firm-level measure of the HRM system (predictor) was created by aggregating the responses of several team leaders within the firm, whereas team knowledge activities (outcomes) were assessed for specific teams in each firm. Secondly, the items used to measure the predictor and outcomes clearly referred to different target entities—either the firm or the team, respectively. Third, the evident interaction effects we found involved measures from different sources (leaders and team members) and thus these key findings cannot be due to same-source bias (Schmitt, 1994).

As with most survey-based studies, we did not receive useable responses from everyone we invited to participate; some teams were dropped due to missing data. To assess the possible impact of including some teams for which we had fewer responses, we conducted supplemental analyses to ensure robustness of our results and we found that including teams with lower response rates (i.e., below 50 percent) did not significantly change our results. Nevertheless, we

cannot rule out a possibility of self-selection bias. Also, the number of raters from teams 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 the extent to which causality can be inferred. Causal models other than the one we proposed could produce the pattern of results we observed. Nevertheless, we believe it is less plausible that organizations develop HRM systems for knowledge-intensive teamwork as a response to having teams that engage in higher degrees of knowledge acquisition and knowledge sharing, versus the reverse causal ordering that we proposed. If R&D teams were freely engaging in such knowledge activities in the absence of a supportive HRM system, there would be little reason for an organization to invest in the design and implementation of 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 generalizability of our results cannot be established until they are replicated. Our conceptualization of HRM systems for knowledge-intensive teamwork and the sample of teams and firms we studied reflected our specific goal of illuminating the dynamics of knowledge-intensive teamwork within the context of R&D units within 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 recognize that additional investigations of HRM systems conducted in a wider

variety of firms and industries are needed and encourage others to engage in similar research in a variety of other contexts.

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. 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, by adopting a contingency perspective, 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. By investigating HRM systems and leadership behaviors in tandem, we gain new insights about the interplay between these two important aspects of organizational life. 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.

Team structures are prevalent across a variety of industries and occupational groups; they are pervasive in organizations that compete on the basis of knowledge for often it is through teamwork that new knowledge is created and new uses of knowledge are discovered. Teams in general and R&D teams specifically often are used to develop knowledge stocks and promote knowledge flows. In knowledge-focused firms where large numbers of employees are organized into teams whose tasks involve knowledge acquisition and knowledge sharing, organizational capabilities for effectively managing such teams are of significant strategic importance. Prior theory and research have provided a strong basis for asserting that appropriately designed HRM systems represent one component of such organizational capabilities (Collins & Smith, 2006; Jackson et al., 2006).

This study demonstrates the potential value of research that integrates the two robust but largely unconnected literatures on work teams and strategic HRM, while it also takes into account two other contextual conditions that influence behavior in R&D teams—namely, knowledge tacitness and empowering leadership. As team scholars have pointed out repeatedly (e.g., see Mathieu et al., 2008; Hempel et al., 2012; 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. Knowledge attributes appear to affect the potential value of HRM systems. 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 team tasks that involve more explicit knowledge, the desired behaviors are more readily subjected to observation and measurement. For example, the knowledge needed to develop a low-end cellular phone is easier to be articulated (less tacit) than the knowledge needed to develop a stylish and sophisticated high-end smart phone. Because less tacit knowledge is more easily articulated, observed, and evaluated, HR practices can be effectively used to motivate and provide opportunities for employees to acquire such 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 be articulated, observed, and evaluated, it is less subject to the control of formal HRM systems that include HR practices such as staffing, training, rewards, and so on.

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 in teamwork; HRM systems for knowledge-intensive teamwork were associated with greater sharing of knowledge that was relatively tacit as well as knowledge that was more explicit. The apparent influence of HRM systems on the sharing of relatively tacit knowledge was unexpected, because tacit knowledge is often assumed to be less subject to observation and external control.

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 a stylish, stunning smart phone is both highly tacit and of considerable value, imbuing it with strategic significance. Thus,

those who have such knowledge may be less willing to reveal it. Yet our results showed that R&D teams in firms with HRM systems designed to support and encourage knowledge-intensive teamwork engaged in more sharing of both explicit and tacit knowledge. Apparently, well-designed HRM systems effectively reduced the influence of political forces and knowledge-hoarding inclinations of team members while strengthening the influence of performance requirements and motivating them 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 both 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 that 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 can promote 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 more 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 create 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 offers an approach that is mutually beneficial for accelerating progress in both areas. Leadership scholars may find that they can shed new light on the phenomenon of team leadership by examining the influence of HRM systems on the behaviors of both leaders and their subordinates, while HRM scholars may find that leadership behaviors can serve to either amplify or mute the potential value of strategically aligned HRM systems.

Regarding team leadership, our results are consistent with a "substitution perspective" of HRM systems and leadership: the presence of empowering leadership appeared to weaken the positive influence of strategically aligned HRM systems, and conversely, the presence of HRM systems for knowledge-intensive teamwork appeared to weaken the positive influence of empowering leadership. We note, however, that Mintzberg (1979) provided a competing view, suggesting that in an organization where power is shared and decision-making is moving

downward, 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 findings, and we further provide preliminary evidence of the interactive effects of formalization and decentralization.

Nonetheless, it is premature to conclude that substitution effects exist for HRM systems and leadership. The interplay of these two factors 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 (Schuler & Jackson, 1987a; Becker & Huselid, 1998). 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, the items used to measure HRM systems for knowledge-intensive teamwork identify specific HR practices that firms should consider adopting and can be used as a diagnostic tool for evaluating the firm's HRM system.

However, our findings also caution that the practical and economic value of a strategically-aligned HRM system that supports knowledge-intensive teamwork likely depends partly 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 to seek information or find 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 project, the presence of demographic faultlines interfered with knowledge sharing over the course of several weeks (Jiang, Jackson, Shaw, & Chung, in press), 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.

REFERENCES

Ahearne, M., Mathieu, J., & Rapp, A. 2005. To empower or not to empower your sales force? An empirical examination of the influence of leadership empowerment behavior on customer satisfaction and performance. *Journal of Applied Psychology,* 90: 945-955.

Aiken, L. S., & West, S. G. 1991. *Multiple regression: Testing and interpreting interactions.* Newbury Park, CA: Sage.

Ancona, D. G., & Caldwell, D. F. 1992. Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly,* 37: 634-665.

Argote, L., McEvily, B., & Reagans, R. 2003. Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science,* 49: 571-582.

Arnold, J. A., Arad, S., Rhoades, J. A., & Drasgow, F. 2000. The empowering leadership questionnaire: The construction and validation of a new scale for measuring leader behaviors. *Journal of Organizational Behavior,* 21: 249-269.

Bandura, A. 1986. *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Batt, R. 2002. Managing customer services: Human resource practices, quit rates, and sales growth. *Academy of Management Journal,* 45: 587-597.

Becker, B. E., & Huselid, M. A. 1998. High performance work systems and firm performance: A synthesis of research and managerial implications. In G. R. Ferris (Ed.), *Research in personnel and human resources management,* vol. 16: 53-101. Greenwich, CT: JAI Press.

Bliese, P. D. 2000. Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations:* 349-381. San Francisco: Jossey-Bass.

Boyd, B. K., Haynes, K. T., Hitt, M. A., Bergh, D. D., Ketchen, D. J. Jr. 2012. Contingency hypotheses in strategic management research: Use, disuse, or misuse. *Journal of Management,* 38: 278-313.

Brislin, R. W. 1980. Translation and content analysis of oral and written material. In H. C. Triandis & J. W. Berry (Eds.), *Handbook of cross-cultural psychology:* 398-444. Boston, MA: Allyn & Bacon.

Brown, S. L., & Eisenhardt, K. M. 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly,* 42: 1-34.

Burke, C. S., Stagl, K. C., Klein, C., Goodwin, G. F., Salas, E., & Halpin, S. M. 2006. What type of leadership behaviors are functional in teams? A meta-analysis. *The Leadership Quarterly,* 17: 288-307.

Campion, M. A., Medsker, G. J., & Higgs, A. C. 1993. Relations between work group characteristics and effectiveness: Implications for designing effective work groups. *Personnel Psychology,* 46: 823-850.

Chadwick, C., Way, S., Kerr, G., & Thacker, J. W. in press. Boundary conditions of the high-investment human resource systems—Small firm labor productivity relationship. *Personnel Psychology.* doi: 10.1111/peps.12015

Chuang, C. H., & Liao, H. 2010. Strategic human resource management in service context: Taking care of business by taking care of employees and customers. *Personnel Psychology,* 63: 153-196.

Chung, Y., & Jackson, S. E. in press. The internal and external networks of knowledge-intensive teams: The role of task routineness. *Journal of Management.* doi: 10.1177/0149206310394168.

Coff, R. W., Coff, D. C., & Eastvold, R. 2006. The knowledge-leveraging paradox: How to achieve scale without making knowledge imitable. *Academy of Management Review,* 31: 452-465.

Collins, C. J., & Clark, K. D. 2003. Strategic human resources practices, top management team social networks, and firm performance: The role of HR practices in creating organizational competitive advantage. *Academy of Management Journal,* 46: 740-752.

Collins, C. J., & Smith, K. G. 2006. Knowledge exchange and combination: The role of human resource practices in the performance of high-technology firms. *Academy of Management Journal,* 49: 544-560.

Combs, J., Liu, Y., Hall, A., & Ketchen, D. 2006. How much do high-performance work practices matter? A meta-analysis of their effects on organizational performance. *Personnel Psychology,* 59: 501-528.

Conger, J. A., & Kanungo, R. N. 1988. The empowerment process: Integrating theory and practice. *Academy of Management Review,* 3: 471-482.

Damanpour, F. 1991. Organizational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal,* 34: 555-590.

Datta, D. K., Guthrie, J. P., & Wright, P. M. 2005. Human resource management and labor productivity: Does industry matter? *Academy of Management Journal,* 48: 135-145.

Delery, J. E. 1998. Issues of fit in strategic human resource management: Implications for research. *Human Resource Management Review,* 8: 289-309.

Drucker, P. F. 1993. *Post-Capitalist Society*. New York: HarperCollins.

Faraj, S., & Sproull, L. 2000. Coordinating expertise in software development teams. *Management Science,* 46: 1554-1568.

Fiol, C. M. 2003. Organizing for knowledge-based competitiveness: About pipelines and rivers. In S. E. Jackson, M. A. Hitt & A. S. Denisi (Eds.), *Managing knowledge for sustained competitive advantage:* 64-93. San Francisco, CA: Jossey-Bass.

Fombrun, C. J., Tichy, N. M., & Devanna, M. A. 1984. Strategic human resource management. New York: Wiley & Sons.

Fornell, C., & Larcker, D. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 18: 39-50.

Gagné, M., & Deci, E. L. 2005. Self-determination theory and work motivation. *Journal of Organizational Behavior,* 26: 331-362.

Gardner, T. M., Wright, P. M., &Moynihan, L. M. 2011. The impact of motivation, empowerment, and skill-enhancing practices on aggregate voluntary turnover: The mediating effect of collective affective commitment. *Personnel Psychology,* 64: 315-350.

Gerhart, B., Wright, P. M., & McMahan, G. 2000. Measurement error in research on the human resources and firm performance relationship: Further evidence and analysis. *Personnel Psychology,* 53: 855-872.

Gibson, C. B., & Cohen, S. G. 2003. The last word: Conclusions and implications. In G. B. Gibson & S. G. Cohen (Eds.), *Virtual teams that work: Creating conditions for virtual team effectiveness:* 403-421. San Francisco: Jossey-Bass.

Gittell, J. H., Seidner, R., & Wimbush, J. 2010. A relational model of how high-performance work systems work. *Organization Science,* 21: 490-506.

Gottschalg, O., & Zollo, M. 2007. Interest alignment and competitive advantage. *Academy of Management Review,* 32: 418-437.

Grant, R. M. 1996. Toward a knowledge-based view of the firm. *Strategic Management Journal,* 17: 109-122.

Griffith, T. L., & Sawyer, J. E. 2010. Multilevel knowledge and team performance. *Journal of Organizational Behavior,* 31: 1003-1031.

Hansen, M. T.1999. The search-transfer problem: The role of weak ties in sharing knowledge across organizational subunits. *Administrative Science Quarterly,* 44: 82-111.

Hansen, M. T., Mors, M. L., & Løvås, B. 2005. Knowledge sharing in organizations: Multiple networks, multiple phases. *Academy of Management Journal,* 48:776-793.

Hass, M. R., & Hansen, M. T. 2005. When using knowledge can hurt performance: The value of organizational capabilities in a management consulting company. *Strategic Management Journal,* 26: 1-24.

Hempel, P. S., Zhang, Z. X., & Han, Y. 2012. Team empowerment and the organizational context: Decentralization and the contrasting effects of formalization. *Journal of Management,* 38: 475-501.

Hitt, M. A., Beamish, P. W., Jackson, S. E., & Mathieu, J. E. 2007. Building theoretical and empirical bridges across levels: Multilevel research in management. *Academy of Management Journal,* 50: 1385-1400.

Howell, J. P., Dorfman, P. W., & Kerr, S. 1986. Moderator variables in leadership research. *Academy of Management Review,* 11: 88-102.

Huselid, M. A. 1995. The impact of human resource management practices on turnover, productivity, corporate financial performance. *Academy of Management Journal,* 38: 635-672.

Jackson, S. E., and Hong, Y. 2008. Knowledge work. In C. L. Cooper and J. Barling (eds.), *The Sage Handbook of Organizational Behavior, Volume 1: Micro Approaches*, pp. 371-392. London, UK: Sage.

Jackson, S. E., & Schuler, R. S. 1995. Understanding human resource management in the context of organizations and their environments. *Annual Review of Psychology,* 46: 237-264.

Jackson, S. E., Chuang, C. H., Harden, E. E., & Jiang, Y. 2006. Toward developing human resource management systems for knowledge-intensive teamwork. In J. Martocchio (Ed.), *Research in personnel and human resources management,* vol. 25: 27-70. Oxford, UK: Elsevier.

James, L. R., Demaree, R. G., & Wolf, G. 1984. Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology,* 69: 85-98.

Jensen, J. M., Patel, P. C., & Messersmith, J. G. in press. High-performance work systems and job control: Consequences for anxiety, role overload, and turnover intentions. *Journal of Management.* doi: 10.1177/0149206311419663

Jiang, K., Lepak, D. P., Hu, J., & Baer, J. C. in press. How does human resource management influence organizational outcomes? A meta-analytical investigation of mediating mechanisms. *Academy of Management Journal.* doi: amj.2011.0088

Jöreskog, K. G., & Sörbom, D. 1993. *LISREL 8: Structural equation modeling with the SIMPLIS command language.* Chicago: Scientific Software International.

Joshi, A., & Jackson, S. E. 2003. Managing workforce diversity to enhance cooperation in organizations. In M. A. West, D. Tjosvold, & K. Smith (Eds.), *International handbook of organizational teamwork and cooperative working:* 277-296. New York: Wiley.

Kachra, A., & White, R. E. 2008. Know-how transfer: The role of social, economic/competitive, and firm boundary factors. *Strategic Management Journal,* 29: 425-445.

Kehoe, R., & Wright, P. M. in press. The impact of high performance human resource practices on employees' attitudes and behaviors. *Journal of Management.* doi: 10.1177/0149206310365901

Keller, R. T. 2006. Transformational leadership, initiating structure, and substitutes for leadership: A longitudinal study of research and development project team performance. *Journal of Applied Psychology,* 91: 202-210.

Kerr, S. 1977. Substitutes for leadership: Some implications for organizational design. *Organization and Administrative Sciences,* 8: 135-146.

Kerr, S., & Jermier, J. M. 1978. Substitutes for leadership: Their meaning and measurement. *Organizational Behavior and Human Performance,* 22: 375-403.

Kim, S., & Wright, P. M. 2011. Putting strategic human resource management in context: A contextualized model of high commitment work systems and its implications in China. *Management and Organization Review,* 7: 153-174.

Kirkman, B. L., & Rosen, B. 1999. Beyond self-management: Antecedents and consequences of team empowerment. *Academy of Management Journal,* 42: 58–74.

Kirkman, B. L., Rosen, B., Tesluk, P. E., & Gibson, C. B. 2004. The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *Academy of Management Journal,* 47: 175-192.

Klein, K. J., Conn, A. B., Smith, D. B., & Sorra, J. S. 2001. Is everyone in agreement? An exploration of within-group agreement in employee perceptions of the work environment. *Journal of Applied Psychology,* 86: 3-16.

Kogut, B., & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science,* 3: 383-97.

Kozlowski, S. W. J., & Bell, B. S. 2003. Work groups and teams in organizations. In W. C. Borman, D. R. Ilgen, & I. L. J. Klimoski (Eds.), *Handbook of psychology: Industrial and organizational psychology,* vol. 12: 333-375. London: Wiley.

Lawler, E. E., III. 2003. Reward systems in knowledge-based organizations. In S. E. Jackson, M. A. Hitt & A. S. Denisi (Eds.), *Managing knowledge for sustained competitive advantage:* 274-302. SanFrancisco, CA: Jossey-Bass.

Lawler, J. J., Chen, S. J, Wu, P. C., Bae, J., & Bai, B. 2011. High-performance work systems in foreign subsidiaries of American multinationals: An institutional model. *Journal of International Business Studies,* 42: 202-220.

LeBreton, J. M., & Senter, J. L. 2008. Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods,* 9: 815-852.

Leonard, D., & Sensiper, S. 1998. The role of tacit knowledge in group innovation. *California Management Review,* 40: 112-132.

Lepak, D. P., & Snell, S. A. 1999. The human resource architecture: Toward a theory of human capital allocation and development. *Academy of Management Review,* 24: 31-48.

Lepak, D. P., & Snell, S. A. 2002. Examining the human resource architecture: The relationships among human capital, employment, and human resource configurations, *Journal of Management,* 28: 517-543.

Lepak, D. P, Liao, H., Chung, Y., & Harden, E. H. 2006. A conceptual review of human resource management systems in strategic human resource management research. In J. J. Martocchio (Ed.), *Research in personnel and human resources management,* vol. 25: 217-271. Oxford, UK: Elsevier.

LePine, J. A., Colquitt, J. A., & Erez, A. 2000. Adaptability to changing task concerns: Effects of general cognitive ability, conscientiousness and openness to experience. *Personnel Psychology,* 53: 563-594.

Liao, H., Toya, K., Lepak, D. P., & Hong, Y. 2009. Do they see eye to eye? Management and employee perspectives of high-performance work systems and influence processes on service quality. *Journal of Applied Psychology*, 94: 371-391.

Locke, A. E., Alavi, M., & Wagner, J. 1997. Participation in decision making: An information exchange perspective. In G. R. Ferris (Ed.), *Research in personnel and human resources management,* vol. 15: 293-331. Greenwich, CT: JAI Press.

Lopez-Cabrales, A., Pérez-Luño, A., & Valle Cabrera, R. 2009. Knowledge as a mediator between HRM practices and innovative activity. *Human Resource Management,* 48: 485-503.

Manz, C. C., & Sims, H. P. 1987. Leading workers to lead themselves: The external leadership of self-managing work teams. *Administrative Science Quarterly,* 32: 106-129.

Marrone, J. A. 2010. Team boundary-spanning: A multilevel review of past research and proposals for the future. *Journal of Management,* 36: 911-940.

Mathieu, J., Maynard, M. T., Rapp, T., & Gilson, L. 2008. Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future. *Journal of Management*, 34: 410-476.

Minbaeva, D., Foss, N., & Snell, S. 2009. Guest editors' introduction: Bringing the knowledge perspective into HRM. *Human Resource Management,* 48: 477-483.

Mintzberg, H. 1979. *The structuring of organizations*. Englewood Cliffs, NJ: Prentice Hall.

Morgeson, F. P., DeRue, D. S., & Karam, E. P. 2010. Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of Management,* 36: 5-39.

Morgeson, F. P., Reider, M. H., & Campion, M. A. 2005. Selecting individuals in team settings: The importance of social skills, personality characteristics, and teamwork knowledge. *Personnel Psychology,* 58: 583-611.

Nahapiet, J., & Ghoshal, S. 1998. Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review,* 23: 242-266.

Neal, A., West, M. A., & Patterson, M. G. 2005. Do organizational climate and competitive strategy moderate the relationship between human resource management and productivity? *Journal of Management,* 31: 492-512.

Nishii, L. H., & Wright, P. M. 2008. Variability within organizations: Implications for strategic human resources management. In D. B. Smith (Ed.), *The people make the place: Dynamic linkages between individuals and organizations:* 225-248. Mahwah, NJ: Erlbaum.

Nonaka, I. 1991. The knowledge creating company. *Harvard Business Review,* 69(6): 96-104.

Nonaka, I., & Takeuchi, H. 1995. *The knowledge-creating company.* New York: Oxford University Press.

Nonaka, I., & von Krogh, G. 2009. Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. *Organization Science,* 20: 635-652.

Organ, D. W., & Greene, C. N. 1981. The effects of formalization on professional involvement: A compensatory process approach. *Administrative Science Quarterly,* 26: 237-252.

Paauwe, J. 2009. HRM and performance: Achievements, methodological issues and prospects. *Journal of Management Studies,* 46: 129-142.

Pil, F. K., MacDuffie, J. P. 1996. The adoption of high-involvement work practices. *Industrial Relations,* 35: 423-455.

Podsakoff, P.M., MacKenzie, S.B., & Fetter, R. 1993. Substitutes for leadership and the management of professionals. *The Leadership Quarterly,* 4: l-44.

Polanyi, M. 1966. *The tacit dimension.* London: Routledge.

Preacher, K. J., Curran, P. J., & Bauer, D. J. 2006. Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics,* 31: 437-448.

Raub, S., & Robert, C. 2010. Differential effects of empowering leadership on in-role and extra-role employee behaviors: Exploring the role of psychological empowerment and power values. *Human Relations,* 63: 1743-1770.

Raudenbush, S. W., & Bryk, A. S. 2002. *Hierarchical linear models: Applications and data analysis methods* (2nd Ed.). Thousand Oaks, CA: Sage.

Reagans, R. & McEvily, R. 2003. Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly,* 48: 240-267.

Reinholt, M., Pedersen, T., & Foss, N. J. 2011. Why a central network position isn't enough: The role of motivation and ability for knowledge sharing in employee networks. *Academy of Management Journal,* 54: 1277-1297.

Rulke, D. L., Zaheer, S., & Anderson, M. H. 2000. Sources of managers' knowledge of organizational capabilities. *Organizational Behavior and Human Decision Processes,* 82: 134-149.

Schmitt, N. 1994. Method bias: The importance to theory and measurement. *Journal of Organizational Behavior,* 15: 393-398.

Schuler, R. S., & Jackson, S. E. 1987a. Linking competitive strategies with human resource management practices. *Academy of Management Executive,* 1: 207-219.

Schuler, R. S. & Jackson, S. E. 1987b. Organizational strategy and organizational level as determinants of human resource management practices. *Human Resource Planning,* 10 (3): 125-141.

Sheldon, K. M., Turban, D. T., Brown, K. G., Barrick, M. R, & Judge, T. A. 2003. Applying self-determination theory to organizational research. In J. J. Martocchio & G. Ferris (Eds.), *Research in Personnel and Human Resources Management*, vol. 22: 357-393. Boston, MA: Elsevier.

Spreitzer, G. M. 1996. Social structural characteristics of psychological empowerment. *Academy of Management Journal,* 39: 483-504.

Srivastava, A., Bartol, K. M., & Locke, E. A. 2006. Empowering Leadership in management teams: Effects on knowledge sharing, efficacy, and performance. *Academy of Management Journal,* 49: 1239-1251.

Stevens, M. J., & Campion, M. A. 1999. Staffing work teams: Development and validation of a selection test for teamwork settings. *Journal of Management,* 25: 207-228.

Stewart, G. L. 2010. The past twenty years: Team research is alive and well at the Journal of Management. *Journal of Management,* 36: 801-805.

Stewart, G. L., & Barrick, M. R. 2000. Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of Management Journal,* 43: 135-148.

Sun, L.Y., Aryee, S., & Law, K. S. 2007. High-performance human resource practices, citizenship behavior, and organizational performance: A relational perspective. *Academy of Management Journal,* 50: 558-577.

Szulanski, G. 1996. Exploring internal stickness: Impediments to the transfer of best practices within the firm. *Strategic Management Journal,* 17: 27-43.

Szulanski, G., Cappetta, R., & Jensen, R. J. 2004. When and how trustworthiness matters: Knowledge transfer and the moderating effect of causal ambiguity. *Organization Science,* 15: 600-613.

Takeuchi, R., Chen, G., & Lepak, D. P. 2009. Through the looking glass of a social system: Cross-level effects of high performance work systems on employees' attitudes. *Personnel Psychology,* 62: 1-29.

Van der Vegt, G. S., & Bunderson, J. S. 2005. Learning and performance in multidisciplinary teams: The importance of collective team identification. *Academy of Management Journal,* 48: 532-547.

Verona G. 1999. A resource-based view of product development. *Academy of Management Review,* 24: 132-142.

von Krogh, G., Ichijo, K., & Nonaka, I. 2000. *Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation.* New York: Oxford University Press.

Vroom, V. H. 1964. *Work and motivation.* New York: Wiley.

Wang, H. C., & Barney, J. B. 2006. Employee incentives to make firm-specific investments: Implications for resource-based theories of corporate diversification. *Academy of Management Review,* 31: 466-476.

Way, S. A. 2002. High performance work systems and intermediate indicators of firm performance within the US small business sector. *Journal of Management,* 28: 765-785.

Wong, S. S. 2004. Distal and local group learning: Performance trade-offs and tensions. *Organization Science,* 15: 645-656.

Wright, P. M., & Boswell, W. R. 2002. Desegregating HRM: A review and synthesis of micro and macro human resource management research. *Journal of Management,* 28: 247-276.

Wright, P. M., Dunford, B. B., & Snell, S. A. 2001. Human resources and the resource based view of the firm. *Journal of Management,* 27: 701-721.

Wright, P. M., Gardner, T. M., Moynihan, L. M., & Allen, M. R. 2005. The relationship between HR practices and firm performance: Examining causal order. *Personnel Psychology,* 58: 409-446.

Wright, P. M., Gardner, T. M., Moynihan, L. M., Park, H. J., Gerhart, B., & Delery, J. E. 2001. Measurement error in research on human resources and firm performance: Additional data and suggestions for future research. *Personnel Psychology,* 54: 875-901.

Wu, P. C., & Chaturvedi, S. 2009. The role of procedural justice and power distance in the relationship between high performance work systems and employee attitudes: A multilevel perspective. *Journal of Management,* 35: 1228-1247.

Youndt, M. A., Snell, S. A., Dean, J. W., & Lepak, D. W. 1996. Human resource management, manufacturing strategy, and firm performance. *Academy of Management Journal,* 39: 836-865.

Zacharatos, A., Barling, J., & Iverson, R. D. 2005. High-performance work systems and occupational safety. *Journal of Applied Psychology,* 90: 77-93.

Zahra, S. A., & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review,* 27: 185-203.

Zander, U., & Kogut, B. 1995. Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science,* 6: 76-92.

Zellmer-Bruhn, M., & Gibson, C. 2006. Multinational organization context: Implications for team learning and performance. *Academy of Management Journal,* 49: 501-518.

Zhang, X. & Bartol, K. M. 2010. Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement. *Academy of Management Journal,* 53: 107-128.

Zhou, K. Z., & Li, C. B. 2012. How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal,* 33: 1090-1102.

TABLE1

Means, Standard Deviation, and Correlations

Variables	M	SD	1	2	3	4	5	6	7	8	9
Firm-level variables											
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	—						
Team-level variables											
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. Knowledge acquisition	5.19	0.87	-.14	-.03	.22**	.04	.14	.05	-.07	.10	—
10. 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 of 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)

TABLE2

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

Variables	Knowledge Acquisition			Knowledge Sharing		
	Model1	Model2	Model 3	Model4	Model5	Model 6
Intercept	5.22***	5.25***	5.25***	5.64***	5.62***	5.61***
Firm-level variables						
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**
Team-level variables						
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*
Cross-level interactions						

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

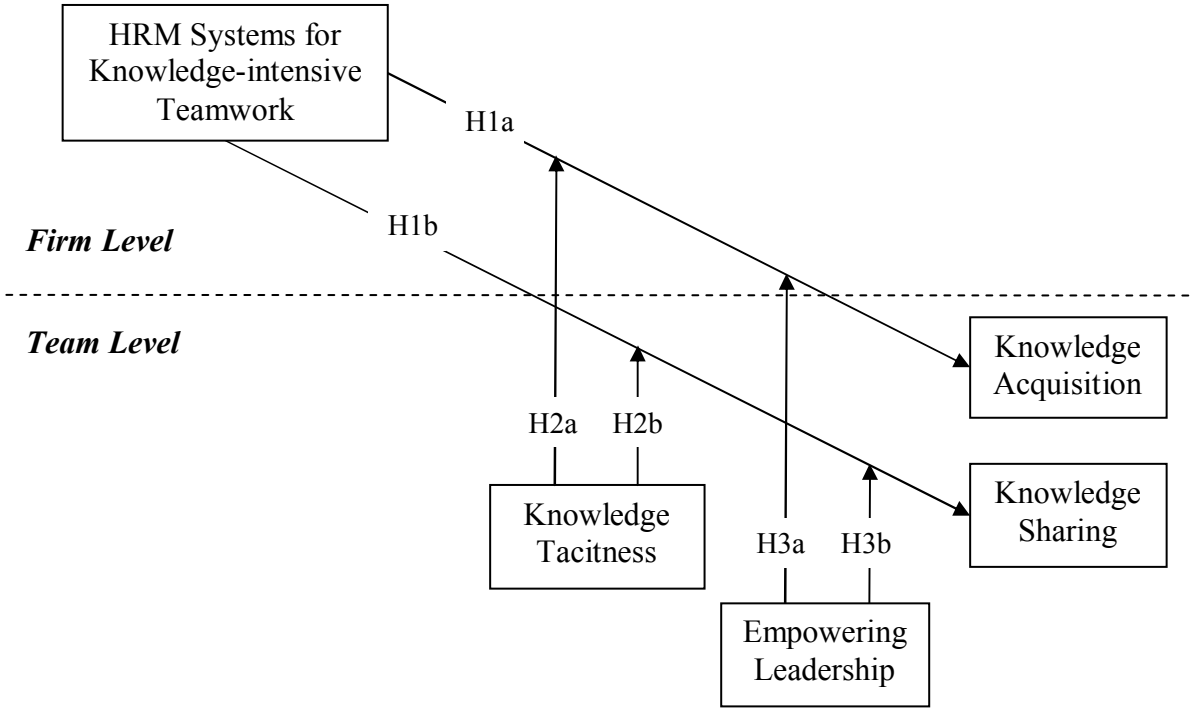
Note: N = 162 teams in 34 firms. Firm age indicates the number of years since the firm was established. Firm size was calculated as the natural logarithm of the number of employees. Entries of the predicting variables are estimations of the fixed effects with robust standard errors. All variables were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

* $p < .05$

** $p < .01$

*** $p < .001$.

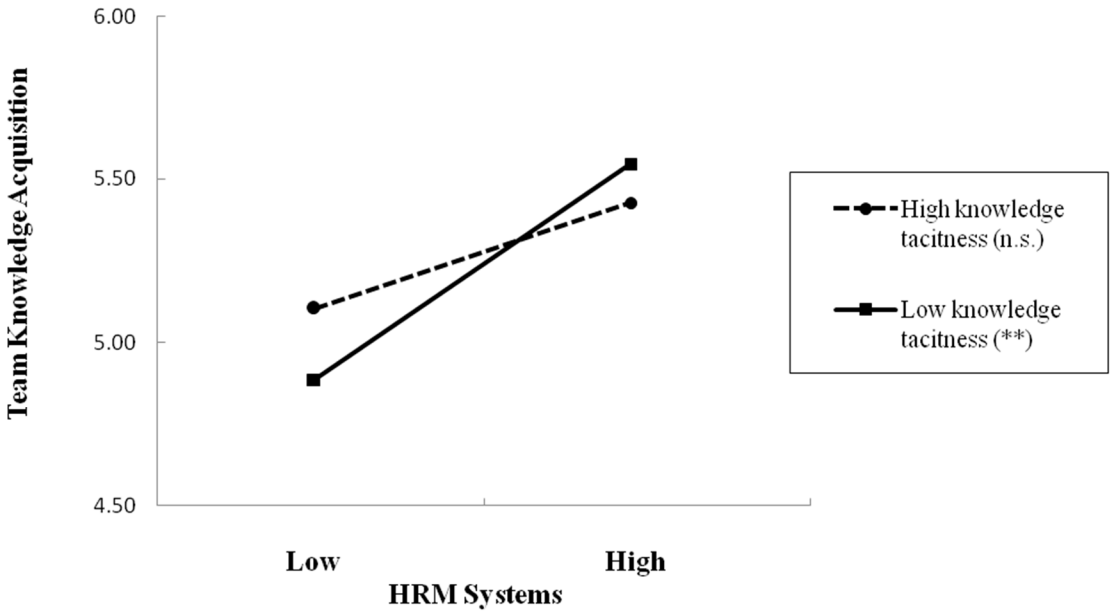
Figure 1
Research Model



Note: H = hypothesis.

Figure 2

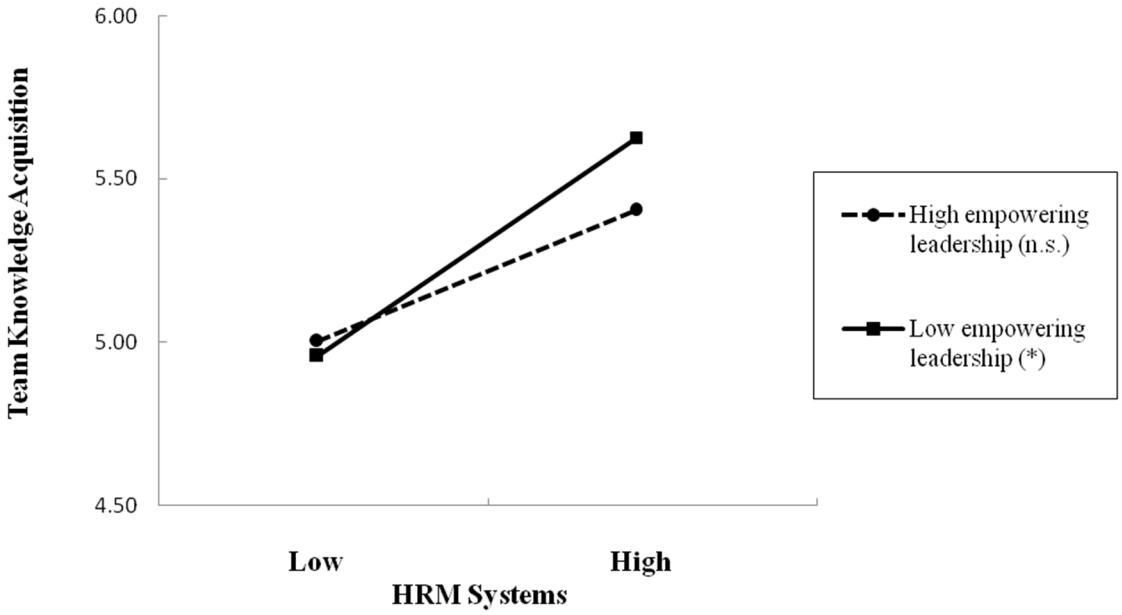
Interaction of HRM Systems and Knowledge Tacitness on Team Knowledge Acquisition



** $p < .01$

Figure 3

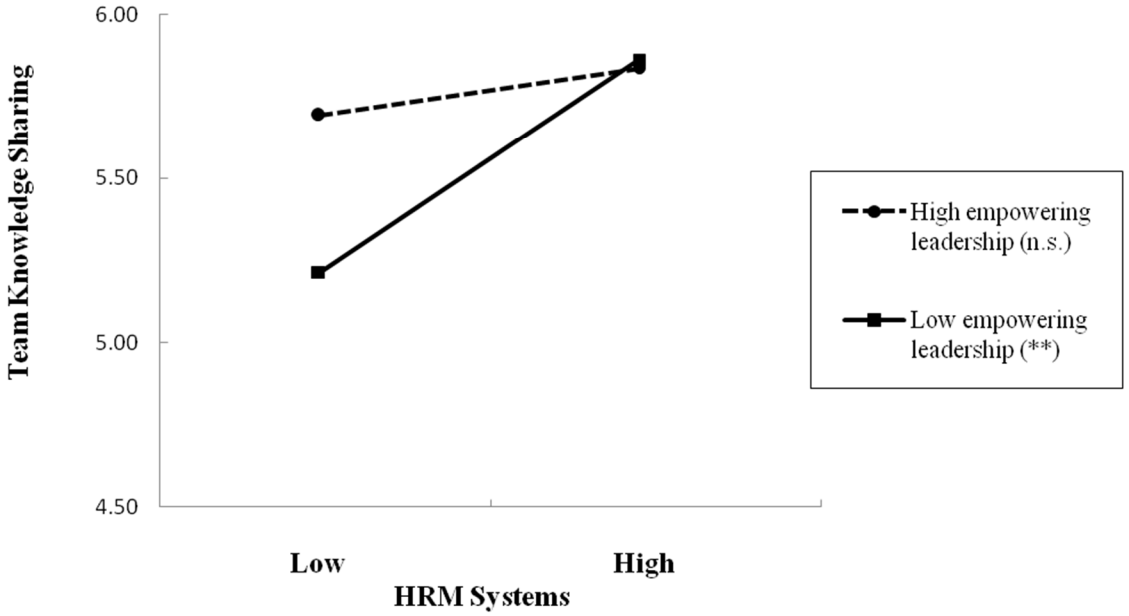
Interaction of HRM Systems and Empowering Leadership on Team Knowledge Acquisition



* $p < .05$

Figure 4

Interaction of HRM Systems and Empowering Leadership on Team Knowledge Sharing



** $p < .01$

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 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 practices (e.g., providing technical support, budgets, rewards, etc.).

APPENDIX B

Items to Assess Team Knowledge Acquisition and 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

1. Members of our team share their special knowledge and expertise with one another.
2. 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.
3. There is virtually no exchange of information, knowledge, or sharing of skills among members of the team. (Reverse coded)
4. More knowledgeable team members freely provide other members with hard-to-find knowledge or specialized skills.
5. Members of our team provide a lot of work-related suggestions to each other.
6. There is a lot of constructive discussion during team meetings.
7. Members in our team provide their experience and knowledge to help other members find solutions to their problems.