**Demystifying the non-linear effect of high commitment work systems (HCWS) on firms’ strategic intention of exploratory innovation: An extended resource-based view**

**Abstract**

Drawing on the extended resource-based view (RBV), this paper attempts to test the proactive role of high commitment work systems (HCWS) in affecting firms’ strategic intention of exploratory innovation, and the moderating effect of technological opportunity (TO). Multi-sourced survey data from Chinese firms in high-tech and manufacturing industries are used to test the hypotheses. The results show that HCWS have an inverted U-shaped relationship with firms’ strategic intention of exploratory innovation, and TO positively moderates such a non-linear relationship. By further decomposing TO into science-based (SBTO) and market-based (MBTO), the findings suggest that SBTO positively moderates the non-linear relationship between HCWS and firms’ strategic intention of exploratory innovation, while MBTO only positively moderate the linear relationship between them. These findings enrich the understanding of how HCWS affect firms’ strategic intention of exploratory innovation by highlighting the double-edged sword roles of HCWS, as well as TO’s asymmetrically moderating effect, respectively.

**Keywords:** High commitment work systems; strategic intention of exploratory innovation; technological opportunity; extended resource-based view

**1. Introduction**

Responding to the changing environment, firms’ strategic intention to explore new technologies become much more critical to maintain competitive advantage (Baskaran & Mehta, 2016; Faridian & Neubaum, 2020). Some successful firms can suddenly collapse because of their failure in adjusting their innovation strategy or seeking new opportunities accordingly (Levinthal & March, 1993; March, 1991; Onufrey & Bergek, 2021). Thus, it is important for firms to have a strong strategic intention of exploratory innovation, defined as firms’ willingness and desire to strategically “enter new product-market domains” to achieve long-term vitality (He &Wong, 2004; Ko, O’Neill, & Xie, 2021).

Scholars have long argued that strategic human resource management (HRM) systems, in particular, high commitment work systems (HCWS), can *reactively* support the implementation of firms’ chosen strategy (Beugelsdijk, 2008; Tajeddini & Martin, 2020). HCWS (also referred to as high performance or high involvement work systems) are defined as the strategic HRM systems that emphasize employees’ value and develop a relational environment in which employees are committed to their firms (Chang, Wang, & Cui, 2019; Collins & Smith, 2006; Zhou, Hong, & Liu 2013). Recent anecdotal studies focus on the role of HCWS in *proactively* forging the formulation of a firm’s strategy to achieve stronger competitive advantage by creating strategic alternatives (Andersen & Minbaeva, 2013; Brockbank, 1999; Delery & Roumpi, 2017; Stahl et al., 2020). However, there is a lack of empirical evidence as to how HCWS help formulate a firm’s strategic intention, in particular, its strategic intention of exploratory innovation. The dearth of survey-based empirical research hinders our understanding about HCWS’ impacts on strategy formulation.

A complete process of a specific strategy consists of its intention, behavior and result (Lyu et al., 2020). Here, the process of an exploratory innovation strategy includes strategic intention formulation, innovation behaviors and innovation performance outcomes. Prior research mainly focuses on the effect of HCWS on either innovation behaviors (Kang, Morris & Snell, 2007; Patel, Messersmith, & Lepak, 2013; Ubeda-Garcia, et al. 2018) or innovation performance outcomes (Kianto, Saenz, & Aramburu, 2017; Wei, Liu, & Herndon, 2011), while overlooking the fore end of an exploratory innovation strategy (Brockbank, 1999), i.e., the formulation of the strategic intention of an exploratory innovation, which is equally important because it determines firms’ willingness to initiate the innovation strategy leading to the subsequent behavior or performance consequence.

The formulation of the strategic intention of an exploratory innovation requires the involvement of employees in a firm (Cook & Saini, 2010). Some scholars argue that HCWS can encourage employees to expand their knowledge domain and engage in innovation activities (Chen & Huang, 2009; Galbreath, 2005; Lin et al., 2018; Tajeddini & Martin, 2020), which might increase the stock of firm-specific knowledge (Jimenez-Jimenez & Sanz-Valle, 2008; Shipton et al., 2006; Siepel, Cowling, & Coad, 2017). Others also report that HCWS can generate negative employee outcomes, such as job stress, emotion fatigue (Han, Sun, & Wang, 2019) and health harm of work (Mariappanadar, 2020), because firms might use HCWS as a tool to achieve organizational objectives at the expense of employees’ happiness (Jensen, Patel, & Messersmith, 2013; Poon & Law, 2021). These negative employee outcomes might result in the loss of firm-specific knowledge (Sks et al., 2021), thus constraining firms’ intention to expand their strategic alternatives. Given such inconsistence, it is not clear how HCWS affect firms’ strategic intention of their exploratory innovation in the extant literature.

In addition, to better forge the strategic intention of an exploratory innovation, firms also need to acquire external technological knowledge (Cassiman & Veugelers, 2006; Delgado-Verde, Martín-de Castro, & Amores-Salvadó, 2016) and align it with firms’ internal process (Datta, Guthrie, & Wright, 2005). Technological opportunity (TO), defined as the usefulness of technological knowledge externally sourced from the operational environment to the focal firms (Davies & Walters, 2004), is regarded as having important implication for firms’ knowledge sourcing management (Foss, Lyngsie, & Zahra, 2013). Firms can either obtain technological knowledge externally from TO or develop knowledge required for exploratory innovation internally via the HCWS. However, it is still not clear how HCWS and TO may interact with each other to affect firms’ strategic intention of exploratory innovation.

To address the above research gaps, this study attempts to empirically test the effect of HCWS, in conjunction with TO, on firms’ strategic intention of exploratory innovation. By so doing, this paper intends to make three primary contributions to the innovation strategy and HRM literature. First, this study is among the first to empirically test the impact of HCWS on firms’ strategic intention of exploratory innovation based on survey-based evidence. While scholars have actively argued to examine the impact of strategic HRM systems in the past decade (Andersen & Minbaeva, 2013; Stahl et al., 2020), the debates on HRM’s role as a strategy implementation facilitator (e.g. Beugelsdijk, 2008; Tajeddini & Martin, 2020) versus a strategy making force (e.g. Andersen & Minbaeva, 2013; Brockbank, 1999; Delery & Roumpi, 2017; Stahl et al., 2020) can hardly reach a conclusion, due to a lack of related empirical result to exclude the possible reverse causality of HRM systems-strategy linkage. By addressing this issue with survey-based evidence and robustness analysis, this study can enhance the validity of the argument on the proactive effect of strategic HRM systems on firms’ strategy formulation.

Second, this study provides a more complete picture regarding the effect of HCWS on the strategic intention of an exploratory innovation by proposing a non-linear relationship. Unlike prior research which emphasizes either the positive effect (Kianto, Saenz, & Aramburu, 2017; Ubeda-Garcia, et al. 2018) or negative effect (Jensen, Patel, & Messersmith, 2013; Mariappanadar, 2020), this study demonstrates the effect of HCWS can be simultaneously positive and negative, which not only reconciles the inconsistent findings regarding the role of HCWS in extant literature, but also inspires managers to take a balanced approach when adopting HCWS as a management tool.

Third, this study specifies TO as an important boundary condition of the relationship between HCWS and firms’ strategic intention of exploratory innovation. To better formulate the strategic intention of an exploratory innovation, firms ought to create internal knowledge via HCWS, but also need to seek external knowledge sourced from TO. By simultaneously incorporating internal and external knowledge in one framework, this study sheds new light into the non-linear interaction of HCWS and TO, and advances our understanding of the contingencies of HCWS in relation to the strategic intention of an exploratory innovation.

**2. Literature review and theoretical underpinning**

*2.1 Firms’ resources and strategic intention*

According to resource-based view (RBV), firms need to develop valuable, rare, imperfectly imitable, and non-substitutable resources to formulate and execute strategies to realize sustainable competitive advantage (Barney, 1991). As Barney (1991) states, “those attributes of a firms’ physical, human and organizational capital that do enable a firm to conceive of and implement strategies that improve its efficiency and effectiveness are, for purpose of this discussion, firm resources” (p. 102). Thus, before conceiving of a strategy, firms need to evaluate the stock of their resource base to see whether and to what extent it matches the strategy (Aragon-Correa & Sharma, 2003; Paiva, Roth, & Fensterseifer, 2008; Meyer et al., 2009). When firms perceive that a specific strategy will bring benefits to firms (Lyu et al., 2020), and they also have the required resources to gain these benefits (Chatterjee & Wernerfelt, 1991; Leonidou, Palihawadana, & Theodosiou, 2011), they are willing to choose this strategy. Taking diversification strategy as the example, firms would desire to diversify into other business domains if they own or control the required resources to make diversification economically feasible and beneficial (Wan et al., 2011). Prior research also indicates that firms’ investment in a specific domain, such as IT investment, can impact their business-level strategic intention by offering important information that enhance the value of making an investment in other resources *(*Drnevich & Croson, 2013). In sum, firms’ resources lay the foundation on firms’ strategic intention.

*2.2 Employees as firms’ critical resources*

Technological innovation requires the common efforts from core-knowledge employees in research and development (R&D) department and other functional departments in the firm (González-González & García-Almeida, 2021). Core-knowledge employees[[1]](#footnote-1) (abbreviated as employees hereafter) in this study do not mean employee at an individual level. Rather, they refer to employees at a collective/firm level (Lepak & Snell, 2002). Exploratory innovation is characterized by search and experimentation (He & Wong, 2004), which requires not only firms to intentionally invest in the R&D activities to generate original solutions, but also the involvement of employees in other functional departments to come up with novel ideas unintentionally (González-González & García-Almeida, 2021). Given the involvement of employees, their characteristics also play an important role in the process of innovation. For instance, employees’ diversity in age can significantly enhance firms’ innovation performance (Østergaarda, Timmermansa, & Kristinsson, 2011), and employees’ diversity in education would enhance their ability to recognize and absorb external knowledge, which was beneficial to firms’ open innovation (Bogersa, Fossb, & Lyngsie, 2018). Findings of Yildiz et al. (2021) demonstrate that employees’ aggregate absorptive capacity could help firms’ innovation outcomes when their activities were well coordinated. Therefore, employees, including their characteristics, are critical resources in the process of innovation.

*2.3 HCWS as the HRM practices to motivate employees*

Recently, HCWS have attracted more interests as they help firms attract, select and retain best possible human capital via an internally ‘make’, rather than externally ‘buy’, approach (Huselid, 1995; Lepak et al., 2006). Although there is no consensus on the elements of HCWS, scholars usually include a broad range of HRM practices, such as clear job design, selective recruitment and selection, extensive training and development, result-oriented performance appraisal, and so on (Lin & Sanders, 2017; Lepak et al., 2006). Scholars in the strategic HRM field usually contend that the focus should be placed on an overall HRM system to better understand the effect of HRM practices on firms’ outcomes (see Takeuchi et al., 2007), because “employees are typically exposed to a host of HR practices simultaneously, and these practices do not always influence the employees independently. Thus, any empirical investigation of HR activities and their organizational outcomes should operate at the system level” (p. 1070). Due to the complementarity and interdependence among HRM practices, HCWS should be taken as the bundle of various HRM practices, in that “HR systems (as opposed to individual practices) can be unique, causally ambiguous and synergistic in how they enhance firm competencies, and thus could be inimitable” (Wright, Dunford, & Snell, 2001, p. 704), which provides a source of sustainable competitive advantage.

Unlike the traditional reactive role of strategic HRM systems to ‘make strategy happen’ and support the implementation of firms’ chosen strategy, some scholars argue that strategic HRM systems can take a proactive role to ‘create strategic alternative’ and support the formulation of a firm’s strategy (Andersen &Minbaeva, 2013; Brockbank, 1999). Drawing on the above insight, we propose that HCWS may affect firms’ strategic intention of exploratory innovation by helping employees develop firm-specific knowledge (Jiang, Takeuchi, & Lepak, 2013; Kang & Snell, 2009). Firm-specific knowledge is not limited to technological knowledge. It derives from firms’ multiple domains, and can “expand its range of strategic choices” (Kang & Snell, 2009; p. 65), enhance knowledge diversity (Kang & Snell, 2009), all of which are required for the formulation of strategic intention of exploratory innovation. Using case analysis, Andersen and Minbaeva (2013) propose that HRM systems help firms develop human capital to support firms’ centralized-decentralized strategy making by offering aspirations (e.g., channel strategic intent, creating space for managers to experiment) and serving as an inspiration (e.g., bring autonomous initiatives to the top, collect and reflect on distributed employee’s insights).

Traditional RBV focuses on the role of ownership or control of firms’ internal resources in generating strategic alternatives and value (Barney, 1991; Barney, Ketchen, & Wright, 2011; Wright, Dunford, & Snell, 2001; Wright & McMahan, 2011). An extended RBV emphasizes the role of accessing and seeking firms’ resources via external linkage to strengthen strategic advantage (Arya & Lin, 2007; Dyer & Singh, 1998; Popli, Ladkani, & Gaur, 2017). Thus, the extended RBV highlights the joint ownership or control of internal and external resources that simultaneously determine firms’ strategic intention or choice (Aragon-Correa & Sharma, 2003; Popli, Ladkani, & Gaur, 2017). Thus, integrating internal and external knowledge help firms further expand their knowledge domains and facilitate strategic renewal (Munoz-Bullon, Sanchez-Bueno, & De Massis, 2020). TO provides the external sources of knowledge, and HCWS, the HRM systems that contribute to the development of internal knowledge, can enable firms to “integrate, build, and reconfigure internal and external competences” to develop sustainable competitive advantage (Teece, Pisano, & Shuen, 1997; p. 516). Therefore, firms’ strategic intention of exploratory innovation is likely to depend on how well HCWS motivate employees to be willing and able to generate new and diverse knowledge internally, to identify and assimilate external knowledge from TO, and to integrate knowledge sourced both internally and externally. Against this theoretical background, the authors develop hypotheses about the main effect of HCWS, and the interactive effect with TO, on firms’ strategic intention of exploratory innovation.

**3. Hypotheses development**

*3.1 The non-linear effect of HCWS on firms’* strategic intention of exploratory innovation

Prior research demonstrates that the development of exploratory innovation requires new or diverse knowledge (He & Wong, 2004; Kang & Snell, 2009). Firms’ knowledge base is an important consideration when strategic decision is made (Grant, 1996; He & Wong, 2004). If employees in a firm do not have the opportunities, or are unwilling or unable to generate new knowledge, firms will have less intention to formulate an exploratory innovation strategy. Drawing on the extended RBV, this study argues that HCWS can help firms enhance their knowledge diversity by encouraging employees to create new firm-specific knowledge as well as expand their knowledge domains. HCWS stress the use of broadly well-designed job description, selective recruitment and selection, extensive training and development, results-oriented performance appraisal, and incentive compensation (Lepak & Snell, 2002). All of these HRM practices together allow employees to experience a wide variety of tasks and to accumulate a broad range of knowledge (Kang et al., 2012).

HCWS can be classified into three categories from ability-motivation-opportunity (AOM) framework (Lepak et al., 2006). Clear job design provides the internal promotion *opportunities* for employees to create their knowledge required for exploratory innovation. Selective recruitment and selection, as well as extensive training and development, can encourage employees to enhance their *ability* to integrate and exchange knowledge, which can expand firms’ knowledge domain (Lepak et al., 2006). Results-oriented performance appraisal and incentive compensation will augment employees’ *motivation* to learn from each other by sharing knowledge, thus extending firms’ variety of knowledge (Kang et al., 2007; Krammer, 2021). Despite this, the literature emphasizes that it is the combination or bundling of these HRM practices that generates synergistic value for firms (Delery & Doty, 1996; Wright, Dunford, & Snell, 2001). Hence, this study considers HCWS as a bundle of HRM practices and develops all the hypotheses based on the overall construct, rather than the specific dimensions or categories.

This study argues that HCWS can provide *opportunities* and empowerment for employees to develop new firm-specific knowledge by searching for new ways of problem solving (Chang et al., 2014; Rosenkopf & Nerkar, 2001), and embracing error and risk-taking (Seeck & Diehl, 2017; Ubeda-Garcia, et al. 2018). In addition, HCWS can also help firms expand the knowledge base by recruiting talented employees and training them to go beyond the current knowledge domain (Ahuja & Lampert, 2001; González-Álvarez & Nieto-Antolín, 2007). This will enhance employees’ *ability* to contribute to new knowledge. Lastly, HCWS motivate employees to expand their cognition domain (Escriba-Carda, Balbastre-Benavent, & Canet-Giner, 2017; Kang & Snell, 2009) via designing appropriate performance program and compensation structure, which will enhance employees’ *motivation* to adjust their attention to be consistent with the requirement of exploratory innovation strategy. In sum, HCWS help employees develop versatile repertoire of skills and multiple domains of knowledge, motivate them to develop diverse knowledge (Kang, Snell & Swart, 2012), which is deemed to enhancing firms’ strategic intention of exploratory innovation (Cao, Gedajlovic, & Zhang, 2009; He & Wong, 2004).

However, the overuse of HCWS might generate decreasing returns on firms’ strategic intention of exploratory innovation for three reasons: first, the overuse of HCWS might cause tight control of employees and contain the empowerment, thus reducing employee’ opportunity to contribute to new knowledge. HCWS place employees with both great opportunities and much expectation (Jensen, Patel, & Messersmith, 2013). To enhance strategic objectives (e.g., exploratory innovation), firms might overly use HCWS to strengthen employees’ control via setting more demanding target, which enhances employees’ work intensity and conformity to target standard (Guest, 2011). Yet, these practices might also reduce the opportunity of employees’ career development (Mariappanadar, 2020), and decrease their creativity and desire to create new knowledge.

Second, the overuse of HCWS might put more stress on employees (Han, Sun, & Wang, 2019). The overuse of HCWS might be perceived by employees as the job stressor (Jensen, Patel, & Messersmith, 2013), which sends the signal that firms regard organizational objective as being more important than employees’ wellbeing. Prior study also shows that firms should balance their economic success and employees’ life quality, and HCWS should not be used as a tool to realize organizational success at the expense of employee’s happiness (Boxall & Macky, 2009). This argument is consistent with the view that too much stress on employees can lead to high anxiety (Jensen, Patel, & Messersmith, 2013) and counterproductive behaviors (Han, Sun, & Wang, 2019). All of these negative consequences could result in increased employee turnover and the loss of firm-specific knowledge, constraining employees’ ability to generate new ideas and solutions

Third, the overuse of HCWS might also result in employees’ attention deviation, pushing employees to focus on immediate or short-term strategic objective instead of long-term target (Ocasio, 1997). As discussed above, the overuse of HCWS could generate high expectations (Guest, 2011), pressurizing employees to explore solutions to meet the immediate targets for survival. Such self-reinforcing behaviors could lead to employees overlooking, intentionally or unintentionally, long-term strategic objective. This view is corroborated by self-limiting learning argument[[2]](#footnote-2) (Levinthal & March 1993), which contends that “by simplifying experience and specializing adaptive responses, learning improves organizational performance, on average. However, the same mechanisms of learning that lead to the improvements also lead to limits to those improvements” (Levinthal & March, 1993, p.101). Hence, the overuse of HCWS might shift employees’ motivation to their immediate target and returns owing to higher demands, while overlooking the long-term knowledge development for exploratory innovation strategy. Therefore, we hypothesize that:

**H1.** The use of HCWS will be positively related to firms’ strategic intention of exploratory innovation, however, the overuse of HCWS will be negatively associated with strategic intention of exploratory innovation, resulting in an inverted U-shaped relationship.

*3.2 The moderating role of technological opportunity*

TO consists of two dimensions according to the origin of source: science-based (SBTO) and market-based TO (MBTO) (Davies & Walters, 2004). SBTO can provide new science-based knowledge[[3]](#footnote-3), which provides firms with the development status and trends of new technology with highly uncertain and future-oriented outcomes (Lee et al., 2020). Firms can access the science-based knowledge by building connections with universities and research institutes, inviting scientific experts to offer consulting services, attending science-related conferences, or using the information from scientific publication (Schneider, 2009). MBTO can offer new market-based knowledge characterized by relative certainty and present-orientation, which can be more easily transformed into commercial value (Schneider, 2009). Firms can obtain market-based knowledge from a variety of sources, including customers, competitors, suppliers, and distributors, helping mitigate innovation uncertainty, and improving market acceptance (Schneider, 2009). Prior research shows that the joint use of science- and market-based knowledge can prevent firms from falling into traps of familiarity and path dependence (Ahuja & Lampert, 2001). Given this, we combine SBTO and MBTO into an overall construct, and investigate the moderating role of TO.

TO provides employees the channels to sense the frontier of advanced technological knowledge, realize the technological gap (Leten, Belderbos, & Looy, 2016), and seek more opportunities to commercialize the new technology. We submit that the use of HCWS can be more beneficial to the formulation of firms’ strategic intention of exploratory innovation in an environment with more TO. First, the environment with more TO offers firms with alternative and new knowledge from external sources (Leten, Belderbos, & Looy, 2016), which can provide more opportunities for employees to integrate new knowledge from external and internal sources via HCWS. When firms are exposed to more TO, employees have more access to new knowledge. Feedback and suggestions from customers or suppliers offer ways to update firms’ technology and product quality (Ahuja & Lampert, 2001). These external feedback and suggestions create opportunities to learn and innovate. Thus, employees who are empowered by HCWS have more opportunities to combine internal and external knowledge to expand firms’ knowledge base.

Second, the environment with more TO helps employees realize the technological gap, which can motivate employees to further enhance their ability via HCWS to create new knowledge and narrow the technological gap. TO generates more possibilities to help employees realize the gap between firms’ own technological status quo and frontier technology in their business environment (Leten, Belderbos, & Looy, 2016). Such a gap will inspire employees to search new solutions (Cyert & March, 1963), learn new knowledge, and enhance their ability to close the gap. For instance, customers’ complaints help employees recognize the gap between firms’ product and service quality and customers’ expectation.

Third, the environment with more TO generates more commercial opportunities for firms’ technology development (Nieto & Quevedo, 2005), which further enhances employees’ motivation to combine external and internal knowledge via HCWS. In such an environment, firms find it easier to commercialize their new technology because of more customers’ feedback and test, thus enhancing the success rate of developing new product in the market. Prior search shows that suggestions from suppliers or customers may demand specific new technological functions (Christensen & Bower, 1996). Addressing them can enable new technology to be more acceptable by the market.

Hence, employees in firms that adopt HCWS have more opportunities to identify external new technology (Ambituuni, Azizsafaei, & Keegan, 2021), higher ability to recognize their potential, and stronger motivation to integrate the external knowledge sourced from TO with existing knowledge to create new knowledge required for the formulation of strategic intention of exploratory innovation. In sum, the authors propose that TO can help firms strengthen the positive impact of HCWS on strategic intention of exploratory innovation when HCWS are adopted.

This study also posits that the negative impact of HCWS can be mitigated by TO when HCWS are over used. First, TO reduces the concerns of control over employees caused by the overuse of HCWS. In an environment with more TO, firms can get access to various resources and cooperation (Katila & Mang, 2003; Mcevily & Chakravarthy, 2002), which creates new opportunity for employees to realize their growth potential and achieve their personal value. In this case, employees are likely to feel highly valued rather than being controlled by HCWS. Prior research also indicates that when employees feel they have more latitude of freedom in their job, their attitude becomes less negative toward the HCWS (Jensen, Patel, & Messersmith, 2013).

 Second, TO also mitigates employees’ job stress resulting from the overuse of HCWS, in that TO offers a platform for employees to relieve their job pressure and develop their ability via cooperating with distributors or suppliers. By linking with external knowledge providers, employees have more room to learn new knowledge (Katila & Mang, 2003; Leten, Belderbos, & Looy, 2016), generate more ideas and enhance their ability for future career development. Employees can also apply their creative ideas and transform them into commercial value with more market acceptance (Foss, Lyngsie, & Zahra, 2013; Wagner, Hoisl, & Thoma, 2014).

Third, TO can provide firms with changes in technological development and updated knowledge of technology frontier (Schneider, 2009), which could prevent employees from locking in the “myopia of learning” (Levinthal & March, 1993; March, 1991). Such an environmental change might stimulate employees to break their attention rigidity (Levinthal & March, 1993), and shift their attention to the new technology development and its long-term strategic objective, such as exploratory innovation. Hence, employees are more motivated to shift their attention and explore new knowledge, leading to reduced detrimental impact of excessive HCWS on the strategic intention of exploratory innovation. Thus, we hypothesize as follows:

**H2.** TO positively moderates the inverted U-shaped relationship between HCWS and the strategic intention of exploratory innovation, in such a way that TO strengthens their positive relationship when HCWS are used, and weakens their negative relationship when HCWS are over used.

**4. Methodology**

*4.1 Research setting*

The authors use data from firms in the hi-tech and manufacturing industries in China to test the hypotheses. It is a suitable setting for this research in that, first, since the opening up of the Chinese economy at the end of the 1970s, Chinese firms in the high-tech and manufacturing industries have learned and explored managerial knowledge from their foreign counterparts in order to survive in the highly competitive market (Wang & Chen, 2020). They have also been under pressure to explore and venture into new technological domains to ensure that they can outperform their foreign rivals in the long run.

 Second, China has been the largest manufacturing base in the world in the past decade, and the Chinese government has initiated development strategy from ‘Made in China’ to ‘Created in China’, which requires advanced technology to achieve the transformation of its growth model. Thus, firms in the manufacturing and hi-tech industries become more important to achieve such an objective. Third, given the above background, searching and retaining most talented employees for firms to compete in these industries is a priority. HCWS could help firms quickly recruit suitable employees and motivate them to work harder in order to achieve firms’ strategic intention in the manufacturing and hi-tech industries.

*4.2 Sampling and data collection*

As our research purpose is to test the relationship between HCWS and the strategic intention of exploratory innovation, questionnaire based survey would be a suitable method to collect primary data. The authors accessed the lists of 5000 member firms in the Chinese hi-tech and manufacturing industries through local industry associations, and randomly selected a sample of 630 firms with detailed information, including location and phone numbers of chief executive officers (CEOs) in four provinces or municipalities - Beijing municipality and Jilin province from the North of China, and Guangdong province and Hainan province from the South of China. To mitigate concerns on common method bias (Fuller et al., 2016), the authors invited three respondents from each firm to fill out different surveys, a) chief human resource officers (CHROs) for high commitment work systems, b) chief technology officers (CTOs) for strategic intention of exploratory innovation, and c) chief executive officers (CEOs) for technological opportunity and background information.

 A questionnaire based survey method was used to collect the data. First, the authors used referral from industry associations to call the CEO in each firm asking for their permission to collect data from three executives, and assuring them the confidentiality and anonymity of this research. 398 CEOs in the sampled firms (63%) agreed to participate in the research. Next, all the questionnaires were sent to these CEOs by post with a covering letter introducing the background and purpose of the project. All these efforts resulted in 176 completed questionnaires (28%). Data from eight sampled firms were deleted because of unmatched respondents. 21 firms were further dropped due to excessive missing data. Thus, the final sample comprised 147 firms (23%), similar to the response rate for data collected from senior executives in past studies (He & Wong, 2004).

 To examine the potential non-response bias in the sample, the authors recorded the order of the firms’ response to the survey and calculated the correlations of the response order with firm age and firm size and found no significant differences between early and late responses, hence non-response bias may not be a major concern in this study (Cao, Simsek, & Zhang, 2010)[[4]](#footnote-4). As the independent, dependent and moderating variables were collected from three different respondents, common method variance (CMV) might not be a concern in this study (Fuller et al., 2016). However, to further address this concern, the authors used Harman single factor analysis and found that a single factor only accounts for 20.53% of the total variance, which shows that CMV is not a concern.

 The authors used the total number of employees as the proxy for firm size (Mean = 1217 employees). Firm age is measured by the years since its inception (Mean = 11.67 years). About half (51.7%) of the firms are in high-tech industry (coded as 1) and the others in manufacturing industry (coded as 0). The sample consists of a variety of firm ownerships, including private (38.1%), state-owned (19.7%), foreign-invested (17.7%) and international joint ventures (24.5%). Ownership type is coded as a categorical variable, with international joint venture set as the reference category in the regression analysis. R&D intensity is measured by the average ratio of R&D expenditure to total sales during the past three years by using a Likert-type five-point scale (1 = less than 1%, 2 = 1%~3%, 3 = 4%~6%, 4 = 7%~9%, 5 = over 10%).

*4.3 Measures*

This study adopted established scales from prior research to ensure their validity and reliability, and used translation and back-translation procedure to guarantee equivalence with their original English versions (Brislin, 1970). Further efforts were made to improve the scale’s validity and reliability. First, the authors used colloquial expressions to reduce possible homologous popular errors. Second, seven senior executives were invited to validate the relevance of the scale’s items. The authors informed them the research background and aims, introduced the scale’s meaning, and requested them to provide their suggestions on each scale and item. Minor revisions were made to the scales based on their comments. Third, the scales were sent to three Chinese professors in human resource management and innovation management for their comments. A few minor revisions were further made according to their feedback. Fourth, a pilot test with 19 senior executives in Chinese firms, comprising CEOs, CTOs and CHROs, helped test the final survey including its wordings and design. The pilot study revealed no major issues and all the scale items were well understood. Appendix I shows all the scale items and their psychometric properties.

 *Strategic intention of exploratory innovation.* This scale was adopted from He and Wong (2004) and was completed by the CTOs answering: “To what extent do you agree with the items describing your firm’s current innovation strategy”, by using a five-point Likert scale (1=strongly disagree, 5=strongly agree). This scale has four items with a high Cronbach’s alpha (0.796), suggesting good reliability.

 *High commitment work systems.* This scale was adopted from Lepak and Snell (2002) with five dimensions: clear job design, selective recruitment and selection, extensive training and development, results-oriented performance appraisal, and incentive compensation. Following Collins and Smith’s (2006) approach, CHROs, on the basis of a five-point Likert scale (1=strongly disagree, 5=strongly agree), were invited to complete 21 items describing firm’s HCWS by asking them: “To what extent do you agree with the following items describing your firm’s HRM practices applicable to core-knowledge employees during past three years?” One reversed item was deleted in the original scale because of cross-loading issue, resulting in 20 items with a Cronbach’s alpha value (0.834) higher than the 0.70 threshold value, suggesting satisfactory reliability.

 *Technological opportunity.* This scale was adopted from Davies and Walters (2004) and was completed by the CEOs on the five-point Likert scale (1=strongly disagree, 5=strongly agree), to assess: “To what extent do you agree with the situations in your industry over the last three years?” This scale consists of five items with a high Cronbach’s alpha (0.864), indicating satisfactory reliability.

 *Control variables.* This study includes many control variables that may impact the firms’ exploratory innovation strategies. Firm age was controlled as older firms might have greater organizational inertia, and hesitate to explore new technological territories (Huselid, 1995; Lin et al., 2017). Firm size was controlled because large firms usually have more slack resources to buffer the risks from exploratory innovation (Lin et al., 2017). In addition, firm ownership and industry type may also influence firm’s exploration (Wei, Liu, & Herndon, 2011; Zhou, Hong, & Liu, 2013), hence these variables were also controlled.

 R&D intensity and its squared term were controlled because investment in innovation activities enables the development of exploratory innovation (Blindenbach-Driessen & Ende, 2014), whereas too much investment in R&D might cause high failure rate of exploration (He & Wong, 2004). As a contrast, firm’s cost leadership strategy[[5]](#footnote-5) was also controlled in that an emphasis on cost leadership strategy might reduce firm’s investment in exploratory activities (Homburg, Krohmer, & Workman. Jr, 1999), which can constrain the development of exploratory innovation. Finally, three environmental variables[[6]](#footnote-6) were controlled because firms’ exploratory innovation might be different under differing environments (Davies &Walters, 2004). Industry competitiveness and market attractiveness were controlled because highly competitive industry will push firms to enhance their efficiency and invest in exploitative innovation to survive in the fierce competition. Market attractiveness can provide ample resources to leverage high-risk activities, such as exploratory innovation (Cao, Gedajlovic, & Zhang, 2009). Technology appropriation, reflecting the “ease of copying” in the industry, was controlled because effectively protecting new technology can be beneficial to the exploratory innovation (Davies &Walters, 2004).

**5. Data analysis and results**

*5.1 Hypotheses test*

The authors began with a confirmatory factor analysis (CFA) to compare their seven-factor baseline model (high-commitment work systems contained five factors, strategic intention of exploratory innovation comprised one factor, technological opportunity included one factor) with alternate nested models. As shown in Table 1, the comparison of nested models reveals that seven-factor baseline model provides the best fit among all the models, demonstrating good validity of these scales. Table 2 shows the descriptive statistics and correlations.

< Insert Tables 1 & 2 about here >

 Multiple regression analysis with *Ordinary Least Square* (OLS) model was used to test the hypotheses. All the variables were mean-centered to avoid multicollinearity issues (Aiken & West, 1991). The largest VIF coefficient is 2.683 in all estimation models, far below the 10.0 threshold level (Tabachnick & Fidell, 1996), thus, multicollinearity is not a major concern. Table 3 presents the results with unstandardized coefficients and standard errors.

< Insert Table 3 and Figure 1 about here >

As shown in Table 3, HCWS have a significant and positive effect (Model 2: b = 0.327, p < 0.05), and HCWS squared term has a significant and negative effect on strategic intention of exploratory innovation (Model 3: b = -0.086, p < 0.01), thus supporting H1. Given the data range of the HCWS is between 1 and 5, the inverted U-shaped curve is plotted in Figure 1 according to the ranged value, in which HCWS have a positive effect on strategic intention of exploratory innovation before the optimal level; the effect gradually turns into negative afterward. Thus, Figure 1 further supports the prediction of H1.

Following the approach of Haans, Pieters and He (2016), as well as Deligianni et al. (2019), several tests were performed to further confirm the finding of an inverted U-shape. First, the turning point of the inverted U-shaped curve was assessed, in other words, the value of HCWS which maximizes strategic intention of exploratory innovation was at –b1/2b2, where b1 = coefficient value of HCWS, and b2 = coefficient value of HCWS squared term. The value of the turning point was 1.901, which was located in the data range, confirming the inverted U-shaped curve. Second, when applying bootstrap method, the turning point was still within 95% confidence interval. Third, additional analysis was conducted to incorporate the cubic term of HCWS into the estimation model, and the finding suggested that the cubic term of HCWS was not significantly related to strategic intention of exploratory innovation, further confirming the quadratic rather than the S-shaped curve[[7]](#footnote-7). In addition, the interaction of HCWS and TO has a significant and positive effect (Model 5: b = 0.126, p < 0.01), and the interaction of HCWS squared term and TO also has a significant and positive impact on strategic intention of exploratory innovation (Model 6: b = 0.064, p < 0.05), supporting H2.

For the non-linear interaction effect, b1b4-b2b3 was assessed to determine the location change of the turning point, where b1 = coefficient of HCWS, b2 = coefficient of HCWS squared term, b3 = interaction coefficient of HCWS with TO, b4 = interaction coefficient of HCWS squared term with TO. The value was positive (0.032), confirming that the turning point shift to the right side (Deligianni et al., 2019; Haans, Pieters, & He, 2016) as HCWS increase further. Figure 2 shows the difference in the interactive effect of HCWS and TO on strategic intention of exploratory innovation at high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of TO (Aiken & West, 1991).

 < Insert Figure 2 about here >

At high level of TO, HCWS have a decreasingly positive effect on strategic intention of exploratory innovation, in which the left side of the curve becomes steeper while the right side becomes flatter compared with Figure 1, suggesting that more TO strengthens the positive effect while mitigating the negative impact of HCWS on strategic intention of exploratory innovation. Whereas at low level of TO, HCWS have an increasingly negative impact on strategic intention of exploratory innovation, in which the left side of the curve becomes flattened but the right side becomes steeper compared to Figure 1, suggesting that less TO weakens the positive impact while strengthening the negative impact of HCWS on strategic intention of exploratory innovation. The asymmetry moderating role of (more and less) TO suggests that despite more TO strengthens the effect of HCWS, the positive marginal contribution of HCWS to strategic intention of exploratory innovation gradually diminishes. Whereas in the environment with less TO, even though less TO weakens the effect of HCWS on strategic intention of exploratory innovation, the negative marginal contribution of HCWS gradually magnifies.

*5.2 Additional analysis and robustness test*

To further check the robustness of these results, additional analyses were performed. First, as discussed before, TO consists of two dimensions: SBTO and MBTO, additional analyses were conducted to examine the interaction of HCWS (or its squared term) and SBTO or MBTO on strategic intention of exploratory innovation. Table 4 shows that the interaction of HCWS and SBTO has a significant and positive t effect (Model 5: b = 0.123, p<0.05), and the interaction of HCWS squared term and SBTO has a significant and positive effect on strategic intention of exploratory innovation (Model 6: b = 0.061, p<0.05). The result suggests that it is the SBTO that strengthens the positive impact of HCWS when HCWS are before the optimal level, and that mitigates its negative effect on strategic intention of exploratory innovation when HCWS exceed the optimal level. Figure 3 shows the non-linear interactive effect of HCWS and SBTO on strategic intention of exploratory innovation.

 < Insert Tables 4 & 5 about here >

Table 5 demonstrates that the interaction of HCWS and MBTO has a significant and positive effect (Model 5: b = 0.200, p<0.001), and the interaction of HCWS squared term and MBTO has a non-significant effect on strategic intention of exploratory innovation (Model 6: b = 0.051, ns), which indicates that despite MBTO can strengthen the positive impact of HCWS before its optimal level, it cannot reduce the negative effect of HCWS when HCWS exceed the optimal level. The possible reason might be that MBTO can help firms refine or moderate their technology to satisfy customers’ present need, which cannot solely motivate firms to take high risk and explore the opportunity for breakthrough technologies. This finding also corroborates the prior argument that SBTO and MBTO are interconnected (Schneider, 2009), and they should be combined to jointly stimulate firms to adopt risky innovation strategies. Figure 4 demonstrates the linear interactive effect of HCWS and MBTO on strategic intention of exploratory innovation.

< Insert Figures 3 & 4 about here >

Second, according to the AMO framework, HCWS can be classified into three categories. *Opportunity-based* HRM practices consist of the dimension of clear job design. *Ability-based* HRM practices include two dimensions: selective recruitment and selection, extensive training and development. *Motivation-based* HRM practices consist of two dimensions: results-oriented performance appraisal, and incentive compensation (Lepak et al., 2006). The authors additionally differentiated the impacts of three categories of HCWS, as well as their interactions with TO, on strategic intention of exploratory innovation[[8]](#footnote-8).

< Insert Tables 6, 7 & 8 about here >

Table 6 shows that despite opportunity-based HRM practices have an insignificant effect (Model 2: b = 0.056, ns), their squared term has a significant and negative effect on strategic intention of exploratory innovation (Model 3: b = -0.090, p<0.05). This finding is interesting because it puts firms at an awkward situation: a least emphasis on the opportunity-based HRM practices cannot significantly enhance firms’ strategic intention of exploratory innovation, while too much emphasis causes harmful effect. Despite the interaction of opportunity-based HRM practices and TO has an insignificant effect (Model 5: b = 0.109, ns), the interaction of HCWS squared term and TO has a significant and positive effect on strategic intention of exploratory innovation (Model 6: b = 0.061, p<0.05). The result suggests that TO can strengthen the positive impact of opportunity-based HRM practices when they are before the optimal level, and mitigate its negative effect on strategic intention of exploratory innovation when exceeding the optimal level. This finding also indicates that the utilization of TO is an effective approach to activate the positive impact and attenuate the negative effect of opportunity-based HRM practices. Figure 5 shows the non-linear interactive effect of opportunity-based HRM practices and TO on strategic intention of exploratory innovation.

Table 7 shows that ability-based HRM practices have a significant and positive effect (Model 2: b = 0.237, p<0.05), and the squared term has a significant and negative effect on strategic intention of exploratory innovation (Model 3: b = -0.069, p<0.05). The interaction of ability-based HRM practices and TO has a positive and significant effect (Model 5: b = 0.108, p<0.05), and the interaction of its squared term and TO also has a significant and positive effect on strategic intention of exploratory innovation (Model 6: b = 0.053, p<0.05). The result suggests that TO strengthens the positive impact of ability-based HRM practices when they are before the optimal level and mitigates its negative effect on strategic intention of exploratory innovation when exceeding the optimal level. Figure 6 demonstrates the non-linear interactive effect of ability-based HRM practices and TO on strategic intention of exploratory innovation.

Table 8 shows that motivation-based HRM practices have a significant and positive effect (Model 2: b = 0.335, p<0.01), and the squared term has a significant and negative effect on strategic intention of exploratory innovation (Model 3: b = -0.090, p<0.01). Despite the interaction of motivation-based HRM practices and TO has an insignificant effect (Model 5: b = 0.075, ns), the interaction of its squared term and TO has a significant and positive effect on strategic intention of exploratory innovation (Model 6: b = 0.068, p<0.05). The result suggests that TO could strengthen the positive impact of motivation-based HRM practices when they are before the optimal level, and reduce its negative effect on strategic intention of exploratory innovation when exceeding the optimal level. Figure 7 shows the non-linear interactive effect of motivation-based HRM practices and TO on strategic intention of exploratory innovation. In sum, by dividing HCWS into three categories, we find that they have an inverted U-shaped relationship with strategic intention of exploratory innovation, and the interaction of their squared terms and TO remain general similar with the main findings in Table 3, even though some linear effects are insignificant.

< Insert Figure 5, 6 & 7 about here >

 Third, this study used a retrospective approach to ask the respondents to assess the situation of HCWS in their firms over the last three years, but the research design is cross-sectional in nature, which may raise concerns about reverse causality. To reduce such a possibility, as suggested by Landis and Dunlap (2000)[[9]](#footnote-9), the authors set HCWS as the dependent variable with strategic intention of exploratory innovation as the independent variables to test the impact of interactions of TO with strategic intention of exploratory innovations, on HCWS. Table 9 shows that the interaction of strategic intention of exploratory innovation (or its squared term) and TO is insignificant (Model 3: b = -0.750, ns; or b = 0.121, ns), indicating that the likelihood of reverse causality is not serious.

< Insert Table 9 about here >

 Fourth, endogeneity is not only derived from reverse causality, but also originated from measurement errors and omitted variables (Chang et al., 2019). To address these concerns, this study also adopted two-stage least square (2SLS) regression method to further reduce the concerns on endogeneity characterized by cross-sectional data. In the estimation model, the endogeneity between TO and strategic intention of exploratory innovation is not a major concern because TO is the exogenous variable that represents the technological knowledge outside the firms. It is quite difficult for individual firm, especially for individual firm in our sample, to shape TO. Following Chang et al. (2019), industry aggregate HCWS, measured by the aggregate value of other firms’ HCWS excluding the focal firm in a specific industry, is used as the instrumental variable (IV) in this study. The underlying logic is that, the HRM practices adopted by firms will generate spillover effect within their industry, and the focal firm may learn from their peer firms in terms of the best HRM practices given the same industry background and industry-specific knowledge. Consequently, it can facilitate faster learning within industry than cross industry. Thus, focal firm’s adoption of HCWS will be related to HCWS in peer firms, while the HCWS in other firms will not be associated with focal firm’s strategic intention of exploratory innovation.

 The Cragg-Donal Wald F statistics in Table 10 is larger than the threshold value of 10, and industry aggregate HCWS are positively related to focal firm’s HCWS in first stage (Model 1: b = 0.952, p<0.001), meeting the relevance requirement of instrumental and independent variables, and reducing the concern of weak IV. Moreover, the IV is theoretically unrelated to the dependent variables, confirming the exogeneity requirement of IV. 2SLS regression results indicate that HCWS are positively associated with strategic intention of exploratory innovation (Model 2: b = 2.032, p < 0.001), which is consistent with the OLS results, hence reverse causality does not seem to be a major concern in this study.

< Insert Table 10 about here >

 Fifth, following the approach of Deligianni et al. (2019), regression analysis with no control variables or with a reduced set of control variables (i.e., those significant controls in the estimation models) does not demonstrate any significant change in the parameter estimates, which shows that most of the variance in the dependent variables is explained by the focal variables and not the control variables[[10]](#footnote-10).

**6. Discussions and implications**

*6.1 Discussions and theoretical implications*

Extant literature highlights the proactive role of strategic HRM systems on firms’ strategy formulation based on either a prescriptive or a case analysis approach (Andersen & Minbaeva, 2013; Brockbank, 1999). This study empirically tests howHCWS, in conjunction with TO, affect firms’ strategic intention of exploratory innovation by using multi-sourced data from Chinese firms in the hi-tech and manufacturing industries. Our findings have many theoretical implications. First, this study provides initial empirical evidence to the new paradigm where HCWS can *proactively* support the formulation of strategic intention of exploratory innovation. Strategic HRM literature traditionally adopts the ‘*strategy-HRM*’ paradigm to investigate how HRM systems reactively follow and support the *implementation* of firms’ given strategy (Haneda & Ito, 2018; Wright & McMahan, 1992), but the proactive role of HRM systems to enable the *formulation* of firms’ strategy is less emphasized. Despite prior anecdotal evidence that HRM systems can take the proactive role to foster firms’ strategy formulation (Andersen & Minbaeva, 2013; Brockbank, 1999; Stahl et al., 2020), there are no empirical studies to support this argument. This study is among the first to follow the ‘*HRM-strategy*’ paradigm by conceptualizing and empirically examining this argument based on the impact of HCWS on the strategic intention of exploratory innovation. This study shows that HCWS have a positive impact on strategic intention of exploratory innovation when HCWS are used, which is consistent with the theoretical prediction of Brockbank (1999). But our findings go beyond the extant literature by examining the scenario where HCWS are overly utilized.

Second, this study has implication for the HCWS literature by identifying the co-existence of the bright and dark sides of HCWS, namely, the “double-edged sword” effect. Prior research follows two independent research streams by either focusing on the bright side of HCWS (Huslid, 1995; Kang, Snell, & Swart, 2012;), or the dark side of HCWS (Jensen, Patel, & Messersmith, 2013). This study integrates both views into one framework, treating the bright and dark sides of HCWS as simultaneously co-existed. Our findings suggest that HCWS can take a proactive and beneficial role, yet too much HCWS also cause detrimental effect on the formulation of the strategic intention of exploratory innovation. Our separate testing of the three categories of the decomposed HCWS produces relatively consistent results, supporting the robustness of the non-linear relationship and the double-edged sword effect. Therefore, this study challenges the linear assumption of the role of HCWS adopted by extant literature (Takeuchi et al., 2007), and supplements the proactive view of HCWS with a potential dark side effect. Thus, this study provides a more complete understanding of the dual role of HCWS in the formulation of firms’ strategic intention of exploratory innovation.

 Third, this study also has implication for the research of TO in the innovation strategy literature. TO is an important research theme in the innovation strategy literature because it provides external knowledge to firms’ innovation output (Foss, Lyngsie, & Zahra, 2013; Katila & Mang, 2003). Prior research mainly focuses on the role of TO in directly driving firms’ innovation effort (Davies & Walters, 2004; Nieto & Quevedo, 2005), while applying and transforming TO into the innovation process requires the development of firms’ human capital. Thus, innovation strategy literature overlooks how HCWS, as the HRM systems that develop firm-specific knowledge, interact with TO to enable firms’ innovation strategy. This study fills this gap and develops a more comprehensive picture of the internal-external nexus to enable the formulation of strategic intention of exploratory innovation.

Fourth, this study has broader implication for the literature of knowledge sourcing management. Whether simultaneously sourcing internal and external knowledge is beneficial or harmful to firms’ innovation is a long-standing debate in the knowledge management literature (Baik, Kim, & Patel, 2019; Kang, Morris, & Snell, 2007; Zhou, Hong, & Liu, 2013). Although sourcing internal and external knowledge can help firms facilitate strategic renewal and improve innovation performance, it also suffers from high coordination cost originating from identification and assimilation barrier, and potential appropriation concerns (Munoz-Bullon, Sanchez-Bueno, & De Massis, 2020). This study reconciles the conflicting views above by identifying the non-linear and asymmetric interaction of internal and external knowledge sources, i.e., HCWS and TO. This study indicates that when firms seek more TO, HCWS have a decreasingly positive effect on the strategic intention of exploratory innovation, suggesting that, despite more TO can strengthen the positive impact of HCWS, the marginal contribution of such strengthening effect diminishes. In contrast, in the environment with less TO, HCWS demonstrate an increasingly negative impact, indicating that less TO amplifies the negative effect of HCWS, and the marginal contribution of such a worsening effect becomes more salient.

These results are interesting because they show that more and less TO takes the asymmetrically moderating effect. In other words, firms that use HCWS to integrate more TO cannot guarantee to achieve the constant positive or increasingly positive impact (i.e., decreasing positive) on the strategic intention of exploratory innovation. On the contrary, the dark side of HCWS might mitigate the utilization efficiency of external technological knowledge. Nevertheless, firms that use HCWS to seize no or less TO result in increasingly negative effect, suggesting that HCWS will have more detrimental impact if firms do not acquire or acquire less TO. These results demonstrate the complexities of integrating firms’ internal and external knowledge through HCWS and TO.

*6.2 Managerial implications*

This study also offers several practical implications for firms on how to formulate appropriate innovation strategy. Exploratory innovation strategy is relatively risky and uncertain (Ferreira, Coelho, & Moutinho, 2020; Hernández-Espallardo, Sánchez-Pérez, & Segovia-López, 2011), hence HRM systems can be regarded as one mechanism to buffer such risks. Among various types of HRM systems, this study encourages firms to adopt multiple practices of HCWS as a bundle to effectively foster firms’ exploratory innovation strategy. However, this study also suggests firms should be cautious on the overuse of HCWS, and take managerial measures, such as balancing the interests of employers and employees, to reduce employees’ perception of being exploited by HCWS. In sum, our study suggests that managers should carefully weigh the pros and cons of HCWS and take a balanced approach to simultaneously satisfy firms’ innovation objectives and employees’ career ambitions.

 Moreover, this study shows that sourcing technological knowledge is a necessary, but not a sufficient condition, to compensate for the ineffective HCWS. This study further advises firms to seek more TO despite the uncertainty of achieving an increasingly positive effect of HCWS, but refusing to seek TO will exacerbate the negative role of HCWS. This study recommends two approaches to source TO within their industry. One is to seize the scientific-based knowledge by developing strong connection with research institute or university, or keep abreast with the updated technology development by routinely checking the latest scientific publications. The other is to seek market-based knowledge by frequently communicating with suppliers and customers to obtain their feedback. This study shows that the first approach is more important than the second one, because the former not only facilitates the positive effect of HCWS, but also mitigates its negative impact.

*6.3 Limitations and future research*

This study has some limitations that suggest future research directions. First, the cross-sectional design causes concerns about reverse causality and endogeneity in this study. Although the authors addressed these concerns by incorporating instrumental variable and using two-stage least square regression analysis to rule out reverse causality and endogeneity as major concerns in this study, it is suggested that a longitudinal research design may provide a more rigorous test of the hypotheses in future research. Second, following the literature from Kang and Snell (2009), this study argues that HCWS and TO can help firms develop firm-specific knowledge internally and source external technological knowledge, but the authors do not measure these variables directly. Future research should consider incorporating these and other mediating variables in the conceptual model to investigate the underlying mechanism for the process through which HCWS influence firms’ outcomes. An alternative research design, such as case study, can also help unpack such mechanisms.

 Third, besides TO, there may be some other moderating variables that intervene with the association between HCWS and firms’ outcomes. From the contingency perspective of HRM, HRM practices in different industry may also differ, so future research could explore how HCWS impact firms’ innovation strategy formulation in industries with different concentration ratio, uncertainty and complexity. Fourth, China is the biggest emerging market with a unique institutional environment and economic development model. Even though the research context in China can provide additional insight on how HCWS work in non-western countries, future research could compare the impact of HCWS on firms’ outcomes in both Eastern and Western contexts, and test the heterogeneity of the research findings in different countries. Thus, this study recommends conducting similar research in other contexts to test and establish the generalizability of our findings and conclusions.

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**Table 1**

Confirmatory factors analysis – Model comparison

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Models | χ2 | d.f. | RMSEA | CFI | TLI |
| Seven-factor proposed model | 455.401 | 356 | 0.048 | 0.912 | 0.900 |
| Three-factor nested model | 615.805 | 374 | 0.066 | 0.822 | 0.807 |
| Two-factor nested model | 912.245 | 376 | 0.098 | 0.606 | 0.574 |
| One-factor nested model | 1061.779 | 377 | 0.111 | 0.496 | 0.458 |

**Note:** Three-factor model is formed by collapsing the items of HCWS into one factor, and strategic intention of exploratory innovation and technological opportunity as two factors; Two-factor model is formed by additionally collapsing the items of strategic intention of exploratory innovation and technological opportunity into one factor; One-factor model is formed by combining all items into one factor.

**Table 2**

Descriptives and correlations

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 Firm age | — |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 Firm size (log) | 0.381 | — |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 High tech | -0.026 | -0.098 | — |  |  |  |  |  |  |  |  |  |  |  |
| 4 Private | 0.084 | 0.097 | -0.083 | — |  |  |  |  |  |  |  |  |  |  |
| 5 SOE | -0.083 | -0.094 | 0.000 | -0.354 | — |  |  |  |  |  |  |  |  |  |
| 6 FIE | -0.025 | -0.021 | -0.087 | -0.364 | -0.230 | — |  |  |  |  |  |  |  |  |
| 7 R&D intensity | 0.116 | 0.136 | -0.009 | 0.092 | -0.118 | 0.018 | — |  |  |  |  |  |  |  |
| 8 Cost leadership strategy | 0.066 | 0.148 | -0.112 | 0.095 | -0.051 | -0.072 | -0.105 | — |  |  |  |  |  |  |
| 9 Industry competition | 0.015 | -0.076 | 0.110 | -0.042 | 0.057 | -0.010 | 0.071 | -0.100 | — |  |  |  |  |  |
| 10 Market attractiveness | 0.061 | -0.010 | -0.038 | 0.075 | -0.074 | -0.018 | -0.021 | 0.015 | 0.077 | — |  |  |  |  |
| 11 Technology appropriation | 0.099 | -0.017 | 0.007 | -0.065 | 0.090 | 0.064 | -0.002 | 0.020 | 0.391 | 0.252 | — |  |  |  |
| 12 HCWS | 0.120 | 0.179 | -0.110 | 0.252 | -0.103 | -0.050 | -0.018 | 0.105 | 0.150 | 0.113 | 0.006 | — |  |  |
| 13 Technological opportunity | 0.002 | 0.039 | -0.047 | -0.010 | 0.060 | -0.022 | 0.029 | 0.136 | 0.231 | 0.195 | 0.177 | 0.245 | — |  |
| 14 Strategic intention of exploratory innovation | 0.086 | -0.099 | 0.016 | 0.094 | -0.077 | 0.013 | -0.034 | -0.076 | 0.159 | 0.267 | 0.118 | 0.243 | 0.186 | — |
| Mean | 11.669 | 5.162 | 0.517 | 0.381 | 0.197 | 0.177 | 3.075 | 3.392 | 3.463 | 3.306 | 3.216 | 3.620 | 3.348 | 3.705 |
| S.D. | 6.322 | 1.598 | 0.501 | 0.487 | 0.399 | 0.383 | 1.041 | 0.795 | 0.626 | 0.727 | 0.670 | 0.424 | 0.712 | 0.634 |

**Note:** HCWS = High commitment work systems

**Table 3**

The OLS regressionresults of HCWS and TO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.011 | (0.009) | 0.008 | (0.009) | 0.009 | (0.009) | 0.011 | (0.008) | 0.010 | (0.008) |
| Firm size (log) | -0.048 | (0.036) | -0.061 | (0.035) | -0.053 | (0.034) | -0.054 | (0.035) | -0.051 | (0.034) | -0.049 | (0.033) |
| High-tech industry | 0.013 | (0.106) | 0.035 | (0.104) | 0.069 | (0.102) | 0.070 | (0.102) | 0.056 | (0.100) | 0.026 | (0.099) |
| Private firm | 0.131 | (0.131) | 0.060 | (0.131) | 0.100 | (0.129) | 0.105 | (0.129) | 0.127 | (0.126) | 0.145 | (0.124) |
| SOE | -0.056 | (0.153) | -0.061 | (0.150) | -0.006 | (0.148) | -0.016 | (0.148) | -0.029 | (0.145) | 0.029 | (0.144) |
| FIE | 0.073 | (0.161) | 0.052 | (0.158) | 0.074 | (0.154) | 0.075 | (0.154) | 0.095 | (0.151) | 0.097 | (0.148) |
| R&D intensity | -0.038 | (0.051) | -0.029 | (0.050) | -0.012 | (0.050) | -0.015 | (0.050) | -0.014 | (0.049) | -0.012 | (0.048) |
| R&D intensity squared | -0.023 | (0.042) | -0.024 | (0.041) | -0.026 | (0.040) | -0.024 | (0.040) | -0.012 | (0.040) | 0.000 | (0.039) |
| Cost leadership strategy | -0.054 | (0.067) | -0.066 | (0.065) | -0.067 | (0.064) | -0.076 | (0.065) | -0.057 | (0.063) | -0.098 | (0.064) |
| Industry competition | 0.132 | (0.091) | 0.083 | (0.091) | 0.077 | (0.089) | 0.063 | (0.090) | 0.064 | (0.088) | 0.063 | (0.086) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.194\*\* | (0.073) | 0.197\*\* | (0.071) | 0.186\* | (0.072) | 0.171\* | (0.070) | 0.178\* | (0.069) |
| Technology appropriation | 0.003 | (0.087) | 0.023 | (0.086) | 0.024 | (0.084) | 0.019 | (0.084) | 0.032 | (0.082) | 0.030 | (0.081) |
| HCWS |  |  | 0.327\* | (0.128) | 0.301\* | (0.126) | 0.277\* | (0.128) | 0.311\* | (0.126) | 0.241 | (0.127) |
| HCWS squared |  |  |  |  | -0.086\*\* | (0.031) | -0.083\*\* | (0.031) | -0.118\*\*\* | (0.033) | -0.061 | (0.040) |
| TO |  |  |  |  |  |  | 0.071 | (0.075) | 0.055 | (0.074) | -0.045 | (0.083) |
| HCWS X TO |  |  |  |  |  |  |  |  | 0.126\*\* | (0.047) | 0.177\*\*\* | (0.050) |
| HCWS squared X TO |  |  |  |  |  |  |  |  |  |  | 0.064\* | (0.026) |
| Constant | 2.912\*\*\* | (0.505) | 2.003\*\* | (0.610) | 2.086\*\*\* | (0.596) | 2.068\*\*\* | (0.596) | 1.890\*\* | (0.586) | 2.525\*\*\* | (0.629) |
| R square | 0.129 |  | 0.169 |  | 0.216 |  | 0.221 |  | 0.262 |  | 0.296 |  |

**Note:** Unstandardized parameters with standard error in parentheses. HCWS = High commitment work systems; TO = Technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 4**

The OLS regressionresults of HCWS and SBTO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.011 | (0.009) | 0.008 | (0.009) | 0.009 | (0.009) | 0.011 | (0.008) | 0.010 | (0.008) |
| Firm size (log) | -0.048 | (0.036) | -0.061 | (0.035) | -0.053 | (0.034) | -0.054 | (0.034) | -0.049 | (0.034) | -0.046 | (0.033) |
| High-tech industry | 0.013 | (0.106) | 0.035 | (0.104) | 0.069 | (0.102) | 0.072 | (0.102) | 0.058 | (0.100) | 0.037 | (0.099) |
| Private firm | 0.131 | (0.131) | 0.060 | (0.131) | 0.100 | (0.129) | 0.110 | (0.129) | 0.158 | (0.127) | 0.172 | (0.126) |
| SOE | -0.056 | (0.153) | -0.061 | (0.150) | -0.006 | (0.148) | -0.012 | (0.148) | -0.007 | (0.145) | 0.041 | (0.145) |
| FIE | 0.073 | (0.161) | 0.052 | (0.158) | 0.074 | (0.154) | 0.068 | (0.154) | 0.103 | (0.151) | 0.096 | (0.149) |
| R&D intensity | -0.038 | (0.051) | -0.029 | (0.050) | -0.012 | (0.050) | -0.014 | (0.050) | -0.008 | (0.049) | -0.007 | (0.048) |
| R&D intensity squared | -0.023 | (0.042) | -0.024 | (0.041) | -0.026 | (0.040) | -0.021 | (0.040) | -0.016 | (0.040) | -0.011 | (0.039) |
| Cost leadership strategy | -0.054 | (0.067) | -0.066 | (0.065) | -0.067 | (0.064) | -0.073 | (0.064) | -0.068 | (0.063) | -0.110 | (0.065) |
| Industry competition | 0.132 | (0.091) | 0.083 | (0.091) | 0.077 | (0.089) | 0.076 | (0.089) | 0.083 | (0.087) | 0.085 | (0.086) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.194\*\* | (0.073) | 0.197\*\* | (0.071) | 0.181\* | (0.072) | 0.173\* | (0.071) | 0.177\* | (0.070) |
| Technology appropriation | 0.003 | (0.087) | 0.023 | (0.086) | 0.024 | (0.084) | 0.010 | (0.085) | -0.001 | (0.083) | -0.008 | (0.082) |
| HCWS |  |  | 0.327\* | (0.128) | 0.301\* | (0.126) | 0.274\* | (0.128) | 0.308\* | (0.126) | 0.243 | (0.128) |
| HCWS squared |  |  |  |  | -0.086\*\* | (0.031) | -0.082\*\* | (0.031) | -0.115\*\*\* | (0.033) | -0.059 | (0.042) |
| SBTO |  |  |  |  |  |  | 0.076 | (0.067) | 0.051 | (0.066) | -0.033 | (0.076) |
| HCWS X SBTO |  |  |  |  |  |  |  |  | 0.123\* | (0.048) | 0.152\*\* | (0.049) |
| HCWS squared X SBTO |  |  |  |  |  |  |  |  |  |  | 0.061\* | (0.028) |
| Constant | 2.912\*\*\* | (0.505) | 2.003\*\* | (0.610) | 2.086\*\*\* | (0.596) | 2.055\*\*\* | (0.596) | 1.951\*\* | (0.585) | 2.533\*\*\* | (0.637) |
| R square | 0.129 |  | 0.169 |  | 0.216 |  | 0.224 |  | 0.262 |  | 0.287 |  |

**Note:** Unstandardized parameters with standard error in parentheses. HCWS = High commitment work systems; SBTO = Science-based technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 5**

The OLS regressionresults of HCWS and MBTO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.011 | (0.009) | 0.008 | (0.009) | 0.008 | (0.009) | 0.010 | (0.008) | 0.009 | (0.008) |
| Firm size (log) | -0.048 | (0.036) | -0.061 | (0.035) | -0.053 | (0.034) | -0.053 | (0.035) | -0.048 | (0.033) | -0.044 | (0.034) |
| High-tech industry | 0.013 | (0.106) | 0.035 | (0.104) | 0.069 | (0.102) | 0.071 | (0.103) | 0.041 | (0.099) | 0.040 | (0.099) |
| Private firm | 0.131 | (0.131) | 0.060 | (0.131) | 0.100 | (0.129) | 0.100 | (0.129) | 0.158 | (0.125) | 0.163 | (0.125) |
| SOE | -0.056 | (0.153) | -0.061 | (0.150) | -0.006 | (0.148) | -0.010 | (0.150) | 0.055 | (0.146) | 0.055 | (0.146) |
| FIE | 0.073 | (0.161) | 0.052 | (0.158) | 0.074 | (0.154) | 0.074 | (0.154) | 0.107 | (0.149) | 0.098 | (0.149) |
| R&D intensity | -0.038 | (0.051) | -0.029 | (0.050) | -0.012 | (0.050) | -0.013 | (0.050) | -0.008 | (0.048) | -0.009 | (0.048) |
| R&D intensity squared | -0.023 | (0.042) | -0.024 | (0.041) | -0.026 | (0.040) | -0.026 | (0.041) | -0.000 | (0.040) | 0.002 | (0.040) |
| Cost leadership strategy | -0.054 | (0.067) | -0.066 | (0.065) | -0.067 | (0.064) | -0.068 | (0.064) | -0.108 | (0.063) | -0.099 | (0.063) |
| Industry competition | 0.132 | (0.091) | 0.083 | (0.091) | 0.077 | (0.089) | 0.073 | (0.092) | 0.033 | (0.089) | 0.041 | (0.089) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.194\*\* | (0.073) | 0.197\*\* | (0.071) | 0.195\*\* | (0.072) | 0.179\* | (0.069) | 0.178\* | (0.069) |
| Technology appropriation | 0.003 | (0.087) | 0.023 | (0.086) | 0.024 | (0.084) | 0.024 | (0.084) | 0.035 | (0.081) | 0.038 | (0.081) |
| HCWS |  |  | 0.327\* | (0.128) | 0.301\* | (0.126) | 0.296\* | (0.129) | 0.297\* | (0.124) | 0.276\* | (0.125) |
| HCWS squared |  |  |  |  | -0.086\*\* | (0.031) | -0.086\*\* | (0.031) | -0.092\*\* | (0.030) | -0.096\*\* | (0.030) |
| MBTO |  |  |  |  |  |  | 0.013 | (0.073) | -0.001 | (0.070) | -0.056 | (0.088) |
| HCWS X MBTO |  |  |  |  |  |  |  |  | 0.200\*\*\* | (0.058) | 0.199\*\*\* | (0.058) |
| HCWS squared X MBTO |  |  |  |  |  |  |  |  |  |  | 0.051 | (0.049) |
| Constant | 2.912\*\*\* | (0.505) | 2.003\*\* | (0.610) | 2.086\*\*\* | (0.596) | 2.084\*\*\* | (0.598) | 2.266\*\*\* | (0.577) | 2.457\*\*\* | (0.606) |
| R square | 0.129 |  | 0.169 |  | 0.216 |  | 0.216 |  | 0.281 |  | 0.287 |  |

**Note:** Unstandardized parameters with standard error in parentheses. HCWS = High commitment work systems; MBTO = Market-based technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 6**

The OLS regressionresults of opportunity-based HRM practices and TO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.012 | (0.009) | 0.011 | (0.009) | 0.012 | (0.009) | 0.014 | (0.009) | 0.013 | (0.009) |
| Firm size (log) | -0.048 | (0.036) | -0.051 | (0.036) | -0.058 | (0.035) | -0.059 | (0.035) | -0.068 | (0.035) | -0.063 | (0.035) |
| High-tech industry | 0.013 | (0.106) | 0.011 | (0.106) | 0.041 | (0.105) | 0.046 | (0.104) | 0.020 | (0.104) | 0.004 | (0.103) |
| Private firm | 0.131 | (0.131) | 0.129 | (0.131) | 0.153 | (0.129) | 0.154 | (0.128) | 0.173 | (0.127) | 0.182 | (0.126) |
| SOE | -0.056 | (0.153) | -0.054 | (0.154) | -0.019 | (0.152) | -0.034 | (0.151) | -0.054 | (0.150) | -0.030 | (0.148) |
| FIE | 0.073 | (0.161) | 0.071 | (0.161) | 0.041 | (0.158) | 0.044 | (0.158) | 0.034 | (0.156) | 0.043 | (0.154) |
| R&D intensity | -0.038 | (0.051) | -0.035 | (0.052) | -0.017 | (0.051) | -0.021 | (0.051) | -0.017 | (0.051) | -0.009 | (0.050) |
| R&D intensity squared | -0.023 | (0.042) | -0.022 | (0.042) | -0.018 | (0.042) | -0.016 | (0.041) | 0.003 | (0.042) | 0.019 | (0.042) |
| Cost leadership strategy | -0.054 | (0.067) | -0.055 | (0.067) | -0.067 | (0.066) | -0.081 | (0.066) | -0.068 | (0.066) | -0.088 | (0.065) |
| Industry competition | 0.132 | (0.091) | 0.120 | (0.094) | 0.089 | (0.093) | 0.067 | (0.094) | 0.053 | (0.094) | 0.074 | (0.093) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.207\*\* | (0.075) | 0.217\*\* | (0.074) | 0.199\*\* | (0.075) | 0.194\*\* | (0.074) | 0.194\*\* | (0.073) |
| Technology appropriation | 0.003 | (0.087) | 0.009 | (0.088) | 0.016 | (0.087) | 0.008 | (0.087) | 0.015 | (0.086) | 0.006 | (0.085) |
| Opportunity-based HRM practices |  |  | 0.056 | (0.121) | 0.025 | (0.119) | 0.012 | (0.119) | 0.052 | (0.119) | 0.002 | (0.120) |
| Opportunity-based squared |  |  |  |  | -0.090\* | (0.035) | -0.085\* | (0.035) | -0.115\*\* | (0.038) | -0.090\* | (0.039) |
| TO |  |  |  |  |  |  | 0.109 | (0.076) | 0.077 | (0.077) | -0.031 | (0.090) |
| Opportunity-based X TO |  |  |  |  |  |  |  |  | 0.104 | (0.054) | 0.156\*\* | (0.059) |
| Opportunity-based squared X TO |  |  |  |  |  |  |  |  |  |  | 0.061\* | (0.028) |
| Constant | 2.912\*\*\* | (0.505) | 2.769\*\*\* | (0.592) | 3.008\*\*\* | (0.588) | 2.900\*\*\* | (0.590) | 2.885\*\*\* | (0.585) | 3.372\*\*\* | (0.618) |
| R square | 0.129 |  | 0.130 |  | 0.171 |  | 0.184 |  | 0.207 |  | 0.235 |  |

**Note:** Unstandardized parameters with standard error in parentheses. TO = Technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 7**

The OLS regressionresults of ability-based HRM practices and TO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.010 | (0.009) | 0.008 | (0.009) | 0.009 | (0.009) | 0.011 | (0.009) | 0.011 | (0.008) |
| Firm size (log) | -0.048 | (0.036) | -0.055 | (0.035) | -0.045 | (0.035) | -0.047 | (0.035) | -0.043 | (0.035) | -0.046 | (0.034) |
| High-tech industry | 0.013 | (0.106) | 0.038 | (0.105) | 0.071 | (0.105) | 0.072 | (0.104) | 0.061 | (0.103) | 0.032 | (0.102) |
| Private firm | 0.131 | (0.131) | 0.072 | (0.132) | 0.107 | (0.131) | 0.112 | (0.131) | 0.137 | (0.129) | 0.148 | (0.127) |
| SOE | -0.056 | (0.153) | -0.056 | (0.152) | -0.021 | (0.150) | -0.034 | (0.150) | -0.046 | (0.148) | 0.012 | (0.148) |
| FIE | 0.073 | (0.161) | 0.064 | (0.159) | 0.096 | (0.157) | 0.096 | (0.157) | 0.125 | (0.155) | 0.119 | (0.152) |
| R&D intensity | -0.038 | (0.051) | -0.036 | (0.051) | -0.029 | (0.050) | -0.032 | (0.050) | -0.040 | (0.049) | -0.031 | (0.049) |
| R&D intensity squared | -0.023 | (0.042) | -0.027 | (0.042) | -0.034 | (0.041) | -0.031 | (0.041) | -0.025 | (0.041) | -0.016 | (0.040) |
| Cost leadership strategy | -0.054 | (0.067) | -0.069 | (0.066) | -0.061 | (0.065) | -0.073 | (0.066) | -0.050 | (0.066) | -0.083 | (0.066) |
| Industry competition | 0.132 | (0.091) | 0.097 | (0.091) | 0.095 | (0.090) | 0.076 | (0.091) | 0.094 | (0.090) | 0.093 | (0.088) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.204\*\* | (0.073) | 0.207\*\* | (0.072) | 0.191\*\* | (0.073) | 0.177\* | (0.072) | 0.181\* | (0.071) |
| Technology appropriation | 0.003 | (0.087) | 0.019 | (0.087) | 0.013 | (0.085) | 0.007 | (0.085) | 0.011 | (0.084) | 0.013 | (0.083) |
| Ability-based HRM practices |  |  | 0.237\* | (0.112) | 0.253\* | (0.111) | 0.232\* | (0.112) | 0.240\* | (0.110) | 0.174 | (0.113) |
| Ability-based squared |  |  |  |  | -0.069\* | (0.031) | -0.066\* | (0.031) | -0.092\*\* | (0.033) | -0.060 | (0.035) |
| TO |  |  |  |  |  |  | 0.093 | (0.076) | 0.090 | (0.074) | 0.002 | (0.083) |
| Ability-based X TO |  |  |  |  |  |  |  |  | 0.108\* | (0.047) | 0.130\*\* | (0.047) |
| Ability-based squared X TO |  |  |  |  |  |  |  |  |  |  | 0.053\* | (0.024) |
| Constant | 2.912\*\*\* | (0.505) | 2.245\*\*\* | (0.590) | 2.157\*\*\* | (0.583) | 2.108\*\*\* | (0.583) | 1.961\*\*\* | (0.577) | 2.544\*\*\* | (0.626) |
| R square | 0.129 |  | 0.157 |  | 0.188 |  | 0.197 |  | 0.229 |  | 0.257 |  |

**Note:** Unstandardized parameters with standard error in parentheses. TO = Technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 8**

The OLS regressionresults of motivation-based HRM practices and TO on strategic intention of exploratory innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  | Model 4 |  | Model 5 |  | Model 6 |  |
| Firm age | 0.012 | (0.009) | 0.012 | (0.009) | 0.010 | (0.008) | 0.011 | (0.008) | 0.012 | (0.008) | 0.010 | (0.008) |
| Firm size (log) | -0.048 | (0.036) | -0.065 | (0.035) | -0.057 | (0.034) | -0.058 | (0.034) | -0.053 | (0.034) | -0.049 | (0.033) |
| High-tech industry | 0.013 | (0.106) | 0.044 | (0.102) | 0.065 | (0.101) | 0.066 | (0.101) | 0.062 | (0.100) | 0.054 | (0.098) |
| Private firm | 0.131 | (0.131) | 0.027 | (0.130) | 0.065 | (0.128) | 0.072 | (0.128) | 0.079 | (0.128) | 0.106 | (0.126) |
| SOE | -0.056 | (0.153) | -0.083 | (0.148) | -0.037 | (0.146) | -0.043 | (0.146) | -0.052 | (0.146) | 0.014 | (0.146) |
| FIE | 0.073 | (0.161) | 0.035 | (0.155) | 0.047 | (0.152) | 0.050 | (0.152) | 0.056 | (0.151) | 0.065 | (0.149) |
| R&D intensity | -0.038 | (0.051) | -0.027 | (0.050) | -0.020 | (0.049) | -0.022 | (0.049) | -0.020 | (0.048) | -0.012 | (0.048) |
| R&D intensity squared | -0.023 | (0.042) | -0.022 | (0.041) | -0.025 | (0.040) | -0.024 | (0.040) | -0.020 | (0.040) | -0.014 | (0.039) |
| Cost leadership strategy | -0.054 | (0.067) | -0.060 | (0.064) | -0.057 | (0.063) | -0.065 | (0.064) | -0.059 | (0.063) | -0.094 | (0.064) |
| Industry competition | 0.132 | (0.091) | 0.096 | (0.088) | 0.101 | (0.086) | 0.089 | (0.088) | 0.083 | (0.087) | 0.065 | (0.086) |
| Market attractiveness | 0.213\*\* | (0.074) | 0.199\*\* | (0.071) | 0.182\* | (0.070) | 0.173\* | (0.071) | 0.162\* | (0.071) | 0.177\* | (0.070) |
| Technology appropriation | 0.003 | (0.087) | 0.013 | (0.084) | 0.029 | (0.083) | 0.026 | (0.083) | 0.038 | (0.083) | 0.036 | (0.081) |
| Motivation-based HRM practices |  |  | 0.335\*\* | (0.101) | 0.278\*\* | (0.101) | 0.258\* | (0.104) | 0.267\* | (0.104) | 0.244\* | (0.103) |
| Motivation-based squared |  |  |  |  | -0.090\*\* | (0.034) | -0.089\* | (0.034) | -0.102\*\* | (0.035) | -0.081\* | (0.036) |
| TO |  |  |  |  |  |  | 0.057 | (0.075) | 0.059 | (0.075) | -0.049 | (0.086) |
| Motivation-based X TO |  |  |  |  |  |  |  |  | 0.075 | (0.046) | 0.126\* | (0.050) |
| Motivation-based squared X TO |  |  |  |  |  |  |  |  |  |  | 0.068\* | (0.029) |
| Constant | 2.912\*\*\* | (0.505) | 1.937\*\*\* | (0.568) | 2.136\*\*\* | (0.561) | 2.124\*\*\* | (0.562) | 2.038\*\*\* | (0.561) | 2.542\*\*\* | (0.591) |
| R square | 0.129 |  | 0.196 |  | 0.236 |  | 0.240 |  | 0.255 |  | 0.286 |  |

**Note:** Unstandardized parameters with standard error in parentheses. TO = Technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 9**

The OLS regressionresults of strategic intention of exploratory innovation and TO on HCWS (*post-hoc* test)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variables | Model 1 |  | Model 2 |  | Model 3 |  |
| Firm age | 0.003 | (0.006) | 0.002 | (0.006) | 0.003 | (0.006) |
| Firm size (log) | 0.039 | (0.023) | 0.042 | (0.023) | 0.039 | (0.023) |
| High-tech industry | -0.070 | (0.070) | -0.071 | (0.068) | -0.071 | (0.067) |
| Private firm | 0.217\* | (0.086) | 0.197\* | (0.085) | 0.226\*\* | (0.085) |
| SOE | 0.016 | (0.101) | 0.028 | (0.099) | 0.033 | (0.099) |
| FIE | 0.064 | (0.106) | 0.068 | (0.105) | 0.080 | (0.103) |
| R&D intensity | -0.029 | (0.034) | -0.023 | (0.033) | -0.028 | (0.033) |
| R&D intensity squared | 0.003 | (0.028) | 0.008 | (0.027) | 0.005 | (0.027) |
| Cost leadership strategy | 0.036 | (0.044) | 0.048 | (0.043) | 0.017 | (0.045) |
| Industry competition | 0.151\* | (0.060) | 0.139\* | (0.059) | 0.110 | (0.059) |
| Market attractiveness | 0.056 | (0.049) | 0.025 | (0.049) | -0.002 | (0.050) |
| Technology appropriation | -0.062 | (0.058) | -0.066 | (0.056) | -0.050 | (0.057) |
| Strategic intention of exploratory innovation |  |  | -0.314 | (0.421) | 2.411 | (1.826) |
| Exploratory innovation squared |  |  | 0.063 | (0.058) | -0.378 | (0.267) |
| TO |  |  |  |  | 1.174 | (0.902) |
| Exploratory innovation X TO |  |  |  |  | -0.750 | (0.536) |
| Exploratory squared X TO |  |  |  |  | 0.121 | (0.077) |
| Constant | 2.779\*\*\* | (0.333) | 3.139\*\*\* | (0.796) | -0.836 | (3.037) |
| R square | 0.152 |  | 0.198 |  | 0.246 |  |

**Note:** Unstandardized parameters with standard error in parentheses. HCWS = High commitment work systems; TO = Technological opportunity. \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Table 10**

IV **(**2SLS)estimation results of HCWS on strategic intention of exploratory innovation (*post-hoc* test)

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | First stage |  | Second stage |
|  | HCWS |  | Strategic intention of exploratory innovation |
|  | Model 1 |  | Model 2 |  |
| Firm age | 0.000 | (0.005) | 0.008 | (0.013) |
| Firm size (log) | 0.050\* | (0.022) | -0.130\* | (0.057) |
| High-tech industry | -0.053 | (0.065) | 0.132 | (0.157) |
| Private firm | 0.194\* | (0.081) | -0.322 | (0.231) |
| SOE | 0.074 | (0.094) | -0.128 | (0.225) |
| FIE | 0.063 | (0.098) | -0.055 | (0.233) |
| R&D intensity | -0.029 | (0.031) | 0.015 | (0.075) |
| R&D intensity squared | 0.000 | (0.026) | -0.025 | (0.061) |
| Cost leadership strategy | -0.005 | (0.042) | -0.098 | (0.099) |
| Industry competition | 0.112\* | (0.056) | -0.165 | (0.155) |
| Market attractiveness | 0.018 | (0.047) | 0.093 | (0.113) |
| Technology appropriation | -0.086 | (0.054) | 0.121 | (0.132) |
| Industry aggregate HCWS | 0.952\*\*\* | (0.248) |  |  |
| HCWS |  |  | 2.032\*\*\* | (0.612) |
| Constant | -0.214 | (0.868) | -2.808 | (1.920) |
| R square | 0.129 |  | -1.018 |  |
| F value |  |  | 14.764 |  |

**Note:** Unstandardized parameters with standard error in parentheses. HCWS = High commitment work systems \* *p* < .05 (two-tailed); \*\* *p*< 0.01 (two-tailed); \*\*\* *p*< 0.001 (two-tailed).

**Fig. 1.** The inverted U-shaped effect of HCWS on strategic intention of exploratory innovation.

**Fig. 2.** The interactive effect of HCWS and TO on strategic intention of exploratory innovation.

**Fig. 3.** The interactive effect of HCWS and SBTO on strategic intention of exploratory innovation.

**Fig. 4.** The interactive effect of HCWS and MBTO on strategic intention of exploratory innovation.

**Fig. 5.** The interactive effect of opportunity-based HRM practices and TO on strategic intention of exploratory innovation.

**Fig. 6.** The interactive effect of ability-based HRM practices and TO on strategic intention of exploratory innovation.

**Fig. 7.** The interactive effect of ability-based HRM practices and TO on strategic intention of exploratory innovation.

**Appendix I. Scale items and psychometric properties**

**High commitment work systems (HCWS)**

CHROs were required to assess “To what extent do you agree with the following items describing your firm’s HRM practices applicable to core-knowledge employees during past three years?” (1=strongly disagree to 5=strongly agree)

|  |  |  |
| --- | --- | --- |
|  | ***In our firm, those employees perform jobs that*** | ***Reliability*** |
| 1 | Allow them to routinely make changes in the way they perform their jobs.  | 0.834 |
| 2 | Empower them to make decisions. |
| 3 | Have a high degree of job security. |
| 4 | Include a wide variety of tasks. |
| 5 | Involve job rotation. |
|  | ***In our firm, the recruitment/selection process for those employees*** |
| 6 | Emphasizes promotion from within the firm. |
| 7 | Focuses on selecting the best all-around candidate, regardless of the specific job. |
| 8 | Focuses on their ability to contribute to the firm’s strategic objectives. |
| 9 | Places priority on their potential to learn (e.g., aptitude). |
|  | ***In our firm, our training activities for those employees*** |
| 10 | Are comprehensive. |
| 11 | Are continuous. |
| 12 | Require extensive investments of time/money. |
| 13 | Strive to develop firm-specific skills/knowledge. |
|  | ***In our firm, performance appraisals for those employees*** |
| 14 | Are based on input from multiple resources (peers, subordinates, etc.).  |
| 15 | Emphasize employee learning. |
| 16 | Focus on their contribution to our firm’s strategic objectives.  |
| 17 | Include developmental feedback. |
|  | ***In our firm, compensation/rewards for those employees*** |
| 18 | Include an extensive benefits package. |
| 19 | Include employee stock ownership programs (ESOP, etc.). |
| 20 | Provide incentives for new ideas. |

**Technological opportunity**

CEOs were required to assess “To what extent do you agree with the situations in your industry over the last three years?” (1=strongly disagree to 5=strongly agree)

|  |  |  |
| --- | --- | --- |
|  |  | ***Reliability*** |
| 1 | Research institutes are useful sources of new technology for this industry. | 0.864 |
| 2 | Universities are useful sources of technology for this industry. |
| 3 | Research and development carried out by our customers very often helps us to improve firm’s products and processes. |
| 4 | Research and development carried out by our suppliers very often helps us to improve firm’s products and processes. |
| 5 | Research and development carried out by our industry association very often helps us to improve firm’s products and processes. |

Strategic intention of exploratory innovation

CTOs were required to evaluate “To what extent do you agree with the items describing your firm’s current innovation strategy” (1=strongly disagree to 5=strongly agree)

|  |  |  |
| --- | --- | --- |
|  | Strategic intention of exploratory innovation | ***Reliability*** |
| 1 | Our firm’s strategic objective is to introduce new generation of products. | 0.796 |
| 2 | Our firm’s strategic objective is to extend product range. |
| 3 | Our firm’s strategic objective is to open up new market. |
| 4 | Our firm’s strategic objective is to enter new technology fields. |

1. Compared to peripheral (contract) employees, core-knowledge employees have the highest level of uniqueness and strategic value. Firms would rely on a knowledge-based employment mode that emphasizes internal development and long-term employee commitment (Lepak & Snell, 2002). [↑](#footnote-ref-1)
2. Thanks a lot for the suggestion from the anonymous reviewers on this point. [↑](#footnote-ref-2)
3. Science-based and market-based knowledge are defined according to their origin of source. Science-based knowledge is the scientific knowledge sourced from science-based TO, such as universities, public research institutions or scientific publication. Market-based knowledge is the knowledge that is proximate to the market, which is sourced from market-based TO, such as competitors, suppliers or customers (Schneider, 2009). [↑](#footnote-ref-3)
4. Given the inability to directly compare the returned and unreturned samples in the survey, comparing the early and late response is an alternative option to address the concern of non-response bias in extant literature (Cao, Simsek, & Zhang, 2010) [↑](#footnote-ref-4)
5. This scale is derived from Homburg, Krohmer, & Workman. Jr. (1999), with Cronbach’s alpha of 0.747, indicating acceptable reliability. [↑](#footnote-ref-5)
6. These three scales were derived from Davies &Walters (2004). The Cronbach’s alpha of industry competitiveness, market attractiveness and technology appropriation were 0.802, 0.847 and 0.766, respectively, suggesting good reliability. [↑](#footnote-ref-6)
7. Given the page limit, the results were not reported here, but are available on request. [↑](#footnote-ref-7)
8. We thank the anonymous reviewers for their suggestion on this point. [↑](#footnote-ref-8)
9. The basic idea of Landis and Dunlap (2000) is that if the interaction of dependent variable and moderating variable is not significant related to independent variable, it suggests that the reverse causality of the interaction effect is not serious. [↑](#footnote-ref-9)
10. Given the page limit, the results were not reported, however, are available on request. [↑](#footnote-ref-10)