Management Decision

Effects of intellectual capital on innovative performance: The role of knowledge-based dynamic capability

Yuqian Han Dayuan Li

Received 10 August 2013
Revised 2 June 2014
Accepted 4 June 2014

Effects of intellectual capital on innovative performance

The role of knowledge-based dynamic capability

Yuqian Han
School of Management, Xiamen University, Xiamen, China, and
Dayuan Li
School of Business, Central South University, Changsha, China

Abstract

Purpose – The purpose of this paper is to demonstrate the relationship between intellectual capital and innovative performance, and to specify the boundary conditions and mechanisms of the relationship from a knowledge-based dynamic capability perspective.

Design/methodology/approach – This study empirically analyzes the impact of intellectual capital on innovative performance and the role knowledge-based dynamic capability plays with a sample of 217 firms in China. To test the research hypotheses, regression analysis is applied.

Findings – The results show that intellectual capital positively affects innovative performance, and knowledge-based dynamic capability is a mediator rather than a moderator which partly mediates the relationship between intellectual capital and innovative performance.

Practical implications – The findings suggest that realizing superior innovative performance is dependent on a firm's intellectual capital and its ability to sense opportunities and threats, to make timely and correct decisions, and to facilitate necessary changes efficiently.

Originality/value – This study is the first to clarify whether knowledge-based dynamic capability plays a moderating role or a mediating role between intellectual capital and innovative performance. The present study thus helps move forward the understanding on the conditions and mechanisms of the effects of intellectual capital.

Keywords Relational capital, Human capital, Intellectual capital, Innovative performance, Knowledge-based dynamic capability, Structural capital

Paper type Research paper

1. Introduction

With the advent of knowledge economy, the environment for firms' survival and growth has undergone turbulent change, making intellectual capital serves as a more important role in achieving superior performance (Nahapiet and Ghoshal, 1998; Serenko and Bontis, 2013; Stewart, 1997). Though there is a lot of academic research on intellectual capital and its effect, current studies still cannot explain why some firms, with experienced top management teams and employees, sophisticated organizational processes and information systems, intimate connection with customers and suppliers, still failed to manifest satisfying innovative performance. For example, the team of General Motors, headed by Wagner, is nothing less than outstanding, but still filed for bankruptcy protection. Firms with the same level of intellectual capital might not

The research is substantially supported by National Natural Science Foundation of China (Nos 71202055, 71372064), the Innovative Research Group National Science Foundation of China (No. 71221061), Key Projects of Philosophy and Social Sciences Research of Ministry of Education of China (No. 13JZD0016).

Management Decision
Vol. 53 No. 1, 2015
pp. 40-56

0025-1747
DOI 10.1108/MD-08-2013-0411

derive equal benefits, because they differ in their ability of sensing, seizing and reconfiguring such capital (Hsu and Wang, 2012). The ability mentioned above is one of the most researched concepts in strategic management in recent decades, dynamic capability (Teece *et al.*, 1997).

Dynamic capability, which is referred to a higher-level competence that determines the firm's ability to integrate, build and reconfigure internal and external resources and capacity to adapt to or shape the changing environment (Teece, 2007, 2012; Teece *et al.*, 1997) is one of the most vibrant topics in strategic management with more than 1,000 articles published on this topic over the last ten years (Peteraf *et al.*, 2013). The most seminal papers on dynamic capability (Eisenhardt and Martin, 2000; Teece *et al.*, 1997) are among the highest cited in strategic management publications (Vogel and Güttel, 2013). Recently, combining knowledge management and dynamic capability perspectives, the concept of knowledge-based dynamic capability is introduced and explored (Denford, 2013; Nielsen, 2006; Wang *et al.*, 2007; Zheng *et al.*, 2011).

Though there is a wealth of literature on both intellectual capital and dynamic capability, the two concepts are seldom considered together. Only a few scholars explore how dynamic capability works in the relationship between intellectual capital and performance lately. Among the few studies, Hsu and Wang (2012) conclude a mediating role, while Wu *et al.* (2007) evidence a moderating effect. This raises a central question: what role does dynamic capability exactly play?

Emerging economies are assuming an increasingly prominent position in the world (Hoskisson *et al.*, 2000; Wright *et al.*, 2005). China is considered to be the largest emerging economy, which provides both a laboratory and a challenge for investigating the relationship between firm resources and performance as firms develop resources and strategies that fit their particular context (Xu and Meyer, 2013). However, current studies of this area are mainly based upon the analysis of firms in developed markets and little is known among emerging economies. Thus, emerging economy such as China provides a rich setting for examining what intellectual capital and knowledge-based dynamic capability are as well as their relationships with innovative performance.

To address these research gaps, from a knowledge-based dynamic capability perspective, this paper aims to investigate what relationship between intellectual capital and innovative performance is, and whether knowledge-based dynamic capability serves as a moderator or a mediator in the Chinese context. Since China shares many characteristics with other emerging economies (Zhou and Li, 2010), this research helps advance our knowledge as to how important a role intellectual capital plays and clarifies the debate on the effect of dynamic capability in other emerging contexts.

The rest of the paper is structured as follows: the theoretical background is presented next. Subsequently, research hypotheses are developed. Then, the study methodology including methods and data are discussed. Thereafter, the empirical results are presented. Finally, the discussion and conclusions including contributions, implications, limitations and future research directions are proposed.

2. Theoretical background

2.1 Intellectual capital

Intellectual capital is the sum of all knowledge or a set of intangibles firms utilize for superior performance (Nahapiet and Ghoshal, 1998; Roos and Roos, 1997; Subramaniam and Youndt, 2005). Though a young field for just over two decades, it has become an attractive and productive area of study with its own conceptualizations,

theories, refereed journals and academic courses (Serenko and Bontis, 2009, 2013; Serenko *et al.*, 2010).

There is a variety of classification on intellectual capital typologies, using different terminologies (Curado, 2008; Martín-de-Castro *et al.*, 2011). Among the frameworks, the triple nature of intellectual capital gains certain agreement, among which human capital, relational capital and structural capital are the most common components (Curado, 2008; Martín-de-Castro *et al.*, 2011; Subramaniam and Youndt, 2005), which are also adopted in this study.

Human capital is the knowledge, experience, professional skills and abilities residing with and utilized by a firm's executive teams and staffs (Schultz, 1961; Subramaniam and Youndt, 2005). Relational capital refers to the knowledge embedded within, available through, and utilized by interactions with customers, suppliers, governments and other institutions (Hsu and Wang, 2012; Nahapiet and Ghoshal, 1998), which are prevalent in the emerging economies (Acquaah, 2007). In China, it is described as "guanxi," an important cultural and social element which plays a more important role since relationship building in China follows a virtuous cycle framework, and not linear as in the western countries (Arribas *et al.*, 2013; Park and Luo, 2001; Xin and Pearce, 1996). Structural capital involves the institutionalized knowledge and codified experience residing within and utilized through database, patents, manuals, structures, systems and processes, which can be conceptualized in terms of organizational processes and information systems (Hsu and Wang, 2012; Subramaniam and Youndt, 2005). Organizational process is how staffs make the knowledge resources available in the workplace, while information systems refer to the information technology used in managing knowledge (Hsu and Wang, 2012).

2.2 Knowledge-based dynamic capability

Dynamic capability refers to "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece *et al.*, 1997). Current researches on dynamic capability mainly focus on the definition, antecedents, nature, processes and its relationship to innovative performance (Ambrosini and Bowman, 2009; Li and Liu, 2014; Vogel and Güttel, 2013). In the era of knowledge economy, the concept of knowledge-based dynamic capability is introduced and its typologies, dimensions and the relationship with network embeddedness, knowledge management, performance and so on are explored (Denford, 2013; Nielsen, 2006; Wang *et al.*, 2007; Zheng *et al.*, 2011). From a knowledge-based view, Teece (1998) defines dynamic capability as "the ability to sense and then to seize new opportunities, to reconfigure and protect knowledge assets, competencies, complementary assets and technologies to achieve sustainable competitive advantages." Zahra and George (2002) reconceptualize absorptive capacity as a knowledge-based dynamic capability pertaining to knowledge acquisition, assimilation, transformation and exploitation. Nielsen (2006) proposes that dynamic capability can be seen as sets of knowledge management activities that change, renew and exploit the knowledge-based resources of the company. Wang *et al.* (2007) clearly put forward the concept of "knowledge-based dynamic capability," and define it as a firm's ability to gain competitive advantages through more dynamic applications and adjustments of the firm's knowledge base. Zheng *et al.* (2011) argue that knowledge-based dynamic capability is the ability to acquire, generate and combine knowledge resources to sense, explore and address environment dynamics.

Current frameworks presented in the literature on knowledge-based dynamic capability show some consistency in underlying concepts but conflicts in nomenclature

and application (Denford, 2013). Wang *et al.* (2007) divide it into knowledge absorption, knowledge creation, knowledge storage and knowledge application. Zheng *et al.* (2011) propose that three sub-capabilities, knowledge acquisition, generation and combination, represent knowledge-based dynamic capability. By integrating three dimensions, i.e., internal/external sourcing, exploration/exploitation focus and combinative/absorptive capacity, Denford (2013) identifies a set of eight knowledge-based dynamic capabilities, which are knowledge creating, knowledge integrating, knowledge reconfiguring, knowledge replicating, knowledge developing, knowledge assimilating, knowledge synthesizing and knowledge imitating.

In the context of developed economies, scholars have attached great importance to the role of "market" to the connotation and classification of knowledge-based dynamic capability. Barreto (2010) proposes that a dynamic capability is formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base. Landroguez *et al.* (2011) argue that the interaction and knowledge flow between market orientation, knowledge management and customer relationship management constitutes a knowledge-based dynamic capability. But this may not be the same in the emerging economies which characterized by inefficient markets and active government involvement, "market" may not be an intrinsic dimension of dynamic capability (Li and Liu, 2014; Xu and Meyer, 2013). Thus, based on the literature, integrating the emerging economy setting, from a process perspective, we define knowledge-based dynamic capability as a firm's potential to systematically solve problems through more dynamic applications and adjustments of the firm's knowledge base, formed by knowledge sensing capacity, knowledge seizing capacity and knowledge reconfiguring capacity (Teece, 2007; Helfat *et al.*, 2007; Denford, 2013; Li and Liu, 2014; Wang *et al.*, 2007). Knowledge sensing capacity involves the ability to effectively search and interpret valuable external and internal knowledge which helps firms to scan opportunities and threats in the external environment, to discover advantages and disadvantages of internal knowledge bases, contributing to the improvement of knowledge resource orchestration (Helfat *et al.*, 2007; Li and Liu, 2014; Pandza and Thorpe, 2009; Teece, 1998). Knowledge seizing capacity refers to the ability to quickly and correctly decide whether and how to invest and combine external and internal knowledge resources into opportunities (Teece, 1998, 2007). Lastly, knowledge reconfiguring capacity is the ability to effectively recombine and transform both knowledge resources and organizational structures as the firm grows and environment changes (Denford, 2013; Teece, 2007).

3. Research hypotheses

3.1 Intellectual capital and innovative performance

The resource-based view (RBV) of the firm holds that competitive advantage comes from heterogeneous resources which are valuable, rare, inimitable and non-substitutable (VRIN) (Barney, 1991). Intellectual capital, different from tangible resources such as land, raw material or financial capital that are easily to be obtained through purchasing, is a strategic resource and unique knowledge system formed in the operating processes with VRIN characteristics, helping a firm to gain sustainable advantage (Curado, 2008).

Human capital is both supportive and necessary for innovative performance since staff's knowledge, experience and skills are crucial in today's fast-paced, ever-changing environment (Hsu and Wang, 2012; Subramaniam and Youndt, 2005). High-quality

talents with good education and sophisticated skills can develop increased cognitive abilities, leading to more productive and efficient activity to improve their job performance, which helps enterprises to have better entrepreneurial judgment, run business more smoothly and ultimately improve the firm's innovative performance (Martín-de-Castro *et al.*, 2011).

Relational capital is concerned with the mobilization of resources through a social structure and is regarded as one of the key factors in understanding value creation (Subramaniam and Youndt, 2005). A firm can gain important information or support from its customers, suppliers and other stakeholders. Also, a firm's relational capital directly affects the combine-and-exchange process and provides relatively easy access to network resources (Nahapiet and Ghoshal, 1998). As the literature shows, both business and government ties lead to both economic and operational performance (Luo *et al.*, 2012). Firms will get improved innovative performance through close and embedded relationships with customers, especially those manufacturing firms having closer relationships with suppliers can develop new products faster with less costs to positively influence innovative performance (Bonner and Walker, 2004). Empirical studies also show that relational capital increase innovative performance for firms in China and other emerging economies (Batjargal, 2003; Luo, 2003).

Structural capital includes organizational processes and information systems (Hsu and Wang, 2012; Martín-de-Castro *et al.*, 2011). Organizational processes help a firm to coordinate its strategy, structure, culture, routine and so on to improve operating efficiency, while advanced information systems contribute to collecting more information to assist decision making and eventually leading to improved efficiency and profitability. As recent literature suggests, a unique routine or process for performing tasks and activities is a potential source of innovative performance, those firms with poor procedures and systems will not achieve their potential, while with strong structural capital, firms' value creation activities will be more efficient and effective (Bontis, 1998; Widener, 2006).

In sum, intellectual capital helps to improve innovative performance and value creation, therefore we posit the following hypothesis:

H1. Intellectual capital has a positive impact on innovative performance.

3.2 Mediating role of knowledge-based dynamic capability

Intellectual capital alone is not enough to gain innovative performance, but needs to be leveraged through the transformational capabilities to convert resources into outputs (Hsu and Wang, 2012; Szulanski, 1996). Especially in a turbulent circumstance, high innovative performance cannot be guaranteed by simply equipping with intellectual capital because of disruptive and unpredictable changes (Eisenhardt and Martin, 2000). According to the "resource-capability-advantage" framework of RBV (Barney, 1991), we propose that, in the information age with dynamic environmental change, not only intellectual capital, but also knowledge-based dynamic capability is an important source of innovative performance (Hsu and Wang, 2012).

Human capital allows a firm to reduce decision-making errors, thereby improving innovative performance (Luthans and Youssef, 2004). Firms with abundant human capital can be more initiative to perceive environment change, more efficiently and effectively to communicate with each other, more rapid to grasp opportunities and avoid threats, more ready to reach consensus for reconfiguration. On the contrary, if a firm lacks human capital, capability may fail to be cultivated and the ideal performance

may be difficult to be achieved. Moreover, human capital itself is not independent of context but needs to be adapted to the ever-changing environment (Chadwick and Dabu, 2009). The relational capital developed with customers, suppliers and other stakeholders can generate competitive capabilities to gain sustainable advantage (Zhang and Wu, 2013). For example, by developing long-term partnerships with suppliers, Hewlett Packard and other Silicon Valley firms effectively redeploy and reconfigure their resources to adapt to environmental changes (Saxenian, 1994). Especially in China, guanxi is a key business facilitator and powerful strategic tool which contributes to both resource-bridging capability and adaptive capability (Arribas *et al.*, 2013; Chen and Wu, 2011; Luo *et al.*, 2012). Structural capital is the knowledge embedded in the organization through organizational routines, practices and processes (Jansen *et al.*, 2009), which *per se* cannot be the source of innovative performance in dynamic environment, unless it is applied sooner and more astutely than competitors to create capability configurations (Hsu and Wang, 2012).

In short, as a higher-level competence, knowledge-based dynamic capability is created through intellectual capital and determines how it can be aligned and realigned to match the requirements of the environment (Hsu and Wang, 2012; Teece, 2012). This leads to the following hypothesis:

H2. Knowledge-based dynamic capability positively mediates the relationship between intellectual capital and innovative performance.

3.3 Moderating role of knowledge-based dynamic capability

To make intellectual capital more effective, firms must be aware of the changes in the environment and develop different levels of dynamic capability accordingly (Wu *et al.*, 2007). For firms with high level of knowledge-based dynamic capability, it is more possible to make a sound sense and response toward the intellectual capital emerged from the years of operating, thus helping it to play a more important role. While firms with low level of knowledge-based dynamic capability, it is more difficult to sense the necessity for change and carry out adaptable adjustments, which impedes the impact of intellectual capital on innovative performance improvement. Thus, heterogeneity in the level of dynamic capability leads to differences in the benefits from otherwise similar stocks of intellectual capital.

To be more specifically, since knowledge-based dynamic capability facilitates effective adjustments, the prior business knowledge and current training are likely to interact with the capability of acquiring internal and external skills to adapt for the changing environment and transform them into a robust base for organizational performance, so that the positive influence of human capital on innovative performance is strengthened (Cohen and Levinthal, 1990; Zahra and George, 2002).

Also, firms with high level of knowledge-based dynamic capability will be better situated to effectively assimilate and integrate the relational capital that they have acquired over time, and can leverage external knowledge accessed from networks to develop innovative products. In contrast, the firm lacking knowledge-based dynamic capability can hardly assimilate and apply the external knowledge, even with networks provided. Several empirical studies have reported that dynamic capability improves the relationship between relational capital and innovative performance (Tsai, 2001; Wu *et al.*, 2007).

In the increasingly uncertain circumstances, firms need to strengthen their knowledge-based dynamic capability to learn how to integrate environmental issues

into their organizational processes. Therefore, firms with a high knowledge-based dynamic capability will be able to translate a set of shared understandings and collective action into new processes, accelerate their learning about environmental issues and will be better positioned to use that knowledge to improve strategic adaptability (Wu *et al.*, 2007), so that the positive relationship between structural capital and organizational performance is strengthened.

In sum, firms with high-level knowledge-based dynamic capability will be able to effectively integrate and progressively exploit the intellectual capital they have already acquired. Or to say, knowledge-based dynamic capability may enhance the positive innovative performance implications of intellectual capital (Wu *et al.*, 2007). Hence, we propose the following hypothesis:

H3. Knowledge-based dynamic capability positively moderates the relationship between intellectual capital and innovative performance.

4. Research design

4.1 Samples

We collect data based on survey in the context of China. The questionnaire items are measured by five-point Likert scale rating from strongly disagree to strongly agree. Through extensive literature review, the first draft of the questionnaire is developed. Then, three professors majoring in strategic management and knowledge management are invited to check the content validity. After that, six CEOs from pharmaceutical firms are consulted to revise the measurement items. Feedbacks from these scholars and CEOs are incorporated into a revised version of the questionnaire. Then, the revised questionnaire is sent out to 35 manufacturing firms for a pilot study.

After all these adaptations, the final questionnaire is sent and data are collected through the following ways, each firm with one respondent: 350 questionnaires are mailed by post with prepaid reply envelopes to middle or senior managers in firms; and 300 questionnaires are handed out to MBA/EMBA students who are managers in firms and take training courses during weekends.

A total of 650 questionnaires are distributed and 269 copies are received, with a 41.3 percent response rate. Among these firms 52 are excluded since the information provided is incomplete, thus with 217 valid questionnaires, giving a 33.3 percent valid rate. In the valid questionnaires, 37.8 percent of the respondent firms have 100 or fewer employees, 57.6 percent are privately owned.

4.2 Variables

4.2.1 Intellectual capital. This study divides intellectual capital into human capital, structural capital and relational capital. To measure human capital, according to Subramaniam and Youndt (2005), we design three items to reflect education, work experience and training of employees. As to relational capital, we develop three items to get an understanding of the interaction with customers, suppliers and partners (Bollen *et al.*, 2005). For structural capital, we design three items to describe organizational processes and information systems in accordance of Wu *et al.* (2007). According to the aggregate model proposed by Law *et al.* (1998), we measure intellectual capital as the sum of these three dimensions.

4.2.2 Knowledge-based dynamic capability. As mentioned earlier, we explicate knowledge-based dynamic capability as knowledge sensing capacity, knowledge

seizing capacity and knowledge reconfiguring capacity. To measure them, we design seven items to reflect knowledge acquisition, interpretation, deployment and reconfiguration according to current literature (Roberts and Grover, 2012; Wang *et al.*, 2007; Zheng *et al.*, 2011).

4.2.3 Innovative performance. Most scholars in developed countries get used to obtain data for innovative performance from public database, but it is not quite easy to get such accurate data of an enterprise in China yet (Li and Liu, 2014). Therefore we use questionnaires to measure innovative performance, with five items designed to, respectively, reflect the amount of new products, the speed of new product launching, new product operating cost, new product sales revenue and new product market share compared with competitors in the last three years (Roberts and Grover, 2012; Wu *et al.*, 2007).

4.2.4 Control variables. We take size and ownership as control variables (Subramaniam and Youndt, 2005; Tan and Litschert, 1994). Following Li and Liu (2014), firm size is measured as the number of employees and divided into five groups ("1" = less than 100 employees, "2" = 101-300 employees, "3" = 301-1,000 employees, "4" = 1,001-3,000 employees, "5" = over 3,000 employees). Ownership is measured and divided into three groups ("1" denotes private owned, "2" with state-owned, "3" with foreign owned).

The appendix shows all the measurement items of variables. Table I presents the descriptive statistics and correlations.

5. Results

5.1 Descriptive statistics

The most important descriptive statistics, including the means, standard deviations and Pearson correlation coefficients, are calculated and shown in Table I. Data in the table suggest that innovative performance is significantly correlated with both intellectual capital and knowledge-based dynamic capability ($p < 0.001$). Moreover, intellectual capital is positively related to knowledge-based dynamic capability.

5.2 Reliability and validity

We use Cronbach's α to test the variable reliability and set the critical level as 0.70. As shown in the appendix, the reliability test suggests that even the minimum Cronbach's α (0.769) is above 0.70, indicating high internal consistency. The KMO value of each scale exceeds the recommended value of 0.60 and Bartlett's test of sphericity is significant ($p < 0.001$), showing great validity.

	Mean	SD	1	2	3	4	5
Size	2.369	1.418	1.000				
Ownership	1.631	0.807	0.285***	1.000			
Intellectual capital (IC)	3.468	0.693	0.085	−0.010	1.000		
Knowledge-based dynamic capability (KBDC)	3.634	0.658	0.139*	−0.003	0.680***	1.000	
Innovative performance	3.388	0.731	0.201**	0.044	0.649***	0.645***	1.000

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table I. Descriptive statistics and correlations

5.3 Common method bias

Since both the dependent variable and independent variables are measured through the same instrument, the common method effects may bias the relationships. Therefore, we perform Harman's one-factor test to assess the extent of common methods bias (Podsakoff and Organ, 1986). An unrotated factor analysis using the eigenvalue >1 criterion reveals four distinct factors that account for 62.23 percent of the variance, and the first factor captures 33.36 percent of the variance in the data. Since no single factor emerges and the first factor does not account for most of the variance, common method bias is not an issue in this study.

5.4 Hypothesis testing

5.4.1 Main effect. H1 proposes that intellectual capital has a positive impact on innovative performance, which we set as the main effect. To test it, we set innovative performance as the dependent variable, and add control variables, then independent variable (intellectual capital) into the model. Hierarchical regression results are shown in Table II.

Table II indicates that Model 4 is obviously better than Model 3 after introducing the independent variable. The adjusted R^2 rises from 0.032 to 0.435 and the F value from 4.517 to 56.425, which is apparently significant on a statistical basis ($p < 0.001$). Intellectual capital shows a positive effect on innovative performance notably ($\beta = 0.637$, $p < 0.001$), demonstrating that higher intellectual capital corresponds to higher performance. So *H1* is supported, i.e., intellectual capital has a positive impact on innovative performance.

5.4.2 Mediating effect. This study takes the following regression equations as proposed by Baron and Kenny (1986) to test mediating effect, which consists of four steps. First, we test whether the dependent variable is significantly affected by the independent variable; second, we test whether the mediator is significantly affected by the independent variable; third, we test whether the dependent variable is significantly affected by the mediator; and fourth, we test whether the independent variable still significantly affects the dependent variable when the mediator is put in

	KBDC			Innovative performance			
Variables	M1	M2	M3	M4	M5	M6	M7
Control variables							
Size	0.152	0.088	0.205**	0.144**	0.109*	0.112*	0.117*
Ownership	−0.046	−0.021	−0.014	0.009	0.015	0.017	0.016
Independent variable							
IC		0.673***		0.637***		0.394***	0.389***
Mediating/ moderating variable							
KBDC					0.629***	0.361***	0.355***
Interaction							
IC×KBDC							−0.033
Adjusted R^2	0.012	0.462	0.032	0.435	0.420	0.503	0.501
F	2.321	62.907***	4.517	56.425***	53.176***	55.558***	44.41***

Notes: $n = 217$. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table II. Hierarchical regression results

the equation meanwhile. If the effects are significant in the first three steps, and not significant or still significant but the β coefficient decreases in Step 4, we say there is a mediating effect.

For Step 1, Model 4 in Table II demonstrates a significant positive relationship between intellectual capital and innovative performance ($\beta = 0.637$, $p < 0.001$) as we have proved in the main effect test above. As to Step 2, Model 2 also shows that intellectual capital is significantly related to knowledge-based dynamic capability when taking control variables into account ($\beta = 0.673$, $p < 0.001$). For Step 3, Model 5 suggests that the effect of knowledge-based dynamic capability on innovative performance is significantly positive ($\beta = 0.629$, $p < 0.001$). As to Step 4, Model 6 shows that the β coefficient of intellectual capital to innovative performance is still significant but has decreased, compared the data in Model 4 ($\beta' = 0.394 < \beta = 0.637$, $p < 0.001$), while the influence of knowledge-based dynamic capability to innovative performance is significant ($\beta = 0.361$, $p < 0.001$). Given the above, we can conclude that knowledge-based dynamic capability not absolutely but partly mediates the relationship between intellectual capital and innovative performance, thus *H2* is supported.

5.4.3 Moderating effect. *H3* puts forward that knowledge-based dynamic capability plays a moderating role between intellectual capital and innovative performance. To test this assumption, we first need to standardize the independent variable and moderator to prevent the situation that variables measured at different scales do not contribute equally to the analysis, then create an interaction term of the standardized variables. After these procedures, we put the dependent variable in the equation, then add control variables, the independent variable and the moderator in sequence, finally we introduce the standardized interaction term of the independent variable and the moderator. Model 7 in Table II shows that knowledge-based dynamic capability does not moderate the relationship between intellectual capital and innovative performance ($\beta = -0.033$, $p > 0.05$). Therefore, *H3* is not supported.

5.5 Robustness test

We undertake further analysis to check the robustness of the results. Since firm age and industry may affect the relationships, we repeat all of the above regressions after controlling for the two variables. Firm age is classified into five groups (i.e. "1" denotes firms established less than five years, "2" aged between six and ten years, "3" aged between 11 and 15 years, "4" aged between 16 and 20 years, "5" aged over 20 years). Industry is measured by a dummy variable, coded 1 for manufacturing and 0 for service. The results shown in Table III are not altered materially, with the relationships among intellectual capital, knowledge-based dynamic capability and innovative performance still being present.

We also repeat the regression by optimal scaling techniques. Since on both sides of the equation we have five- point Likert scale variables which are indeed ordinal, optimal scaling technique is an alternative approach. The results shown in Table IV provide evidence that our findings are still held, and there is no qualitatively difference across the two approaches, indicating the robustness of our hypothesis testing.

6. Discussion and conclusion

The literature has long taken the position that the relationship between intellectual capital and innovative performance is positively related, but the question of what contributes to the achievement of intellectual capital in the dynamic environment and

Variables	KBDC		Innovative performance				
	M1	M2	M3	M4	M5	M6	M7
Control variables							
Age	0.023	−0.010	0.124	0.095	0.108	0.100	0.096
Industry	0.007	−0.008	0.006	−0.007	0.001	−0.003	−0.002
Size	0.103	0.055	0.128	0.088	0.059	0.063	0.069
Ownership	−0.062	−0.036	−0.012	0.010	0.029	0.026	0.024
Independent variable							
IC		0.745***		0.634***		0.303***	0.296***
Mediating/ moderating variable							
KBDC					0.671***	0.445***	0.442***
Interaction							
IC×KBDC							−0.029
Adjusted R^2	−0.004	0.553	0.032	0.435	0.483	0.522	0.520
F	0.761	54.527***	2.811*	34.315***	41.305***	40.235***	34.427***

Notes: $n = 217$. *$p < 0.05$; ***$p < 0.001$

Table III.
Hierarchical regression results with two more control variables

Variables	KBDC		Innovative performance				
	M1	M2	M3	M4	M5	M6	M7
Control variables							
Size	0.332*	0.135	0.330***	0.252***	0.181***	0.190*	0.193***
Ownership	0.136	−0.089*	0.218***	0.105*	0.076*	0.066	0.068
Independent variable							
IC		0.692***		0.585***		0.273***	0.469***
Mediating/ moderating variable							
KBDC					0.647***	0.455***	0.245***
Interaction							
IC×KBDC							−0.193
Adjusted R^2	0.087	0.515	0.110	0.434	0.492	0.522	0.527
F	6.145***	29.678***	7.694***	28.561***	27.156***	22.468***	18.170***

Notes: $n = 217$. *$p < 0.05$; ***$p < 0.001$

Table IV.
Optimal scaling regression results

information era has remained largely unanswered. This study, therefore, investigates the intellectual capital-innovative performance relationship and incorporates the concept of knowledge-based dynamic capability in the Chinese context. We develop a model that consists of both mediating and moderating effects. The empirical results show that intellectual capital does positively affect innovative performance, and knowledge-based dynamic capability acts as a mediator rather than a moderator. The findings have several theoretical contributions and practical implications.

6.1 Theoretical contributions

This research contributes to the theory in the following three ways. First, this study demonstrates how the effect of intellectual capital is realized. Academic research on intellectual capital and its effect has been quite rich, but researchers rarely explore into how it is realized and seldom distinguish "static" capital from "dynamic" leveraging capability. In a dynamic environment, intellectual capital perspective is difficult to explain why some companies can effectively respond to the rapid changes in environment while some others go into bankruptcy. We extend prior static research into the turbulent environment and explore how and when intellectual capital is related to innovative performance with a knowledge-based dynamic capability perspective. Our empirical results show that intellectual capital is positively related to innovative performance, and knowledge-based dynamic capability mediates the relationship, which clarifies the mechanism of the effect of intellectual capital on innovative performance.

Second, this study clarifies the debate of what role knowledge-based dynamic capability plays between intellectual capital and innovative performance. The literature is not conclusive on whether dynamic capability is a moderator or a mediator. In line with Hsu and Wang (2012), the empirical results of this study support a mediating role, indicating knowledge-based dynamic capability acts like a transformer that converts the benefits of intellectual capital into innovative performance. Also, the insignificant moderating effect indicates that the consequence of intellectual capital is immune from the level of knowledge-based dynamic capability, or to say, no matter how strong or weak a firm's knowledge-based dynamic capability is, intellectual capital is significantly related to innovative performance.

Third, the findings could deepen our understanding of the effect and mechanism of intellectual capital through the unique context, China. Most of previous studies are based on firms in developed economies, which may not be fully applicable to the emerging economies (Lin and Germain, 2003). Also, China exhibits many common features with other emerging economies such as underdeveloped market-supporting institutions, weak laws and rapid change (Acquaah, 2007; Hoskisson *et al.*, 2000), and the findings of this study therefore provide useful implications for firms in the similar settings (Li and Liu, 2014; Zhou and Li, 2010).

6.2 Practical implications

From a practical perspective, the results hold important implications for managers. First, we find that innovative performance needs more professional intellectual capital, indicating that firms should highly emphasis on the exploration and exploitation of intellectual capital. More specifically, firms should train employees systematically and enrich their work experience to improve human capital, develop close relationship with their stakeholders to enhance relational capital and design efficient processes and information systems to improve structural capital.

A second implication is that the importance of developing knowledge-based dynamic capability can never be neglected. With the dawn of the information era in emerging economies, knowledge-based dynamic capability plays a vital role since it acts not only as a direct source, but also a bridge of intellectual capital to innovative performance. So, firms must foster and make full use of knowledge-based dynamic capability, be sensitive to tiny external environment change, be equipped with the ability of knowledge searching and interpreting, be able to discover opportunities

and threats, be flexible in strategic decision-making based on demand, and be efficient to reconfigure their knowledge-based resources as necessary.

6.3 Limitations and future directions

Despite the contributions and implications, this study has several limitations and awaits future research. First, in exploring when and how intellectual capital is related to innovative performance, we only investigate the effect of knowledge-based dynamic capability, with many other context variables such as culture, environmental uncertainty and industrial growth are not examined. New research designs could be made to examine these factors altogether to obtain a more comprehensive understanding of the mechanisms and conditions. Second, the concepts utilized for reference are from western perspectives, while the context examined is in China, and more attention should be paid to cross-context theorizing (Whetten, 2009). Third, our theoretical model is examined with sectional rather than longitudinal data, which may be unable to reflect the real causal relationship because of the time-lag effect, and the use of panel data could be the future direction.

References

Acquaah, M. (2007), "Managerial social capital, strategic orientation, and organizational performance in an emerging economy", *Strategic Management Journal*, Vol. 28 No. 12, pp. 1235-1255.

Ambrosini, V. and Bowman, C. (2009), "What are dynamic capabilities and are they a useful construct in strategic management?", *International Journal of Management Reviews*, Vol. 11 No. 1, pp. 29-49.

Arribas, I., Hernández, P. and Vila, J.E. (2013), "Guanxi, performance and innovation in entrepreneurial service projects", *Management Decision*, Vol. 51 No. 1, pp. 173-183.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No. 1, pp. 99-120.

Barreto, I. (2010), "Dynamic capabilities: a review of past research and an agenda for the future", *Journal of Management Studies*, Vol. 36 No. 1, pp. 256-280.

Baron, R.M. and Kenny, D.A. (1986), "The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, Vol. 51 No. 6, pp. 1173-1182.

Batjargal, B. (2003), "Social capital and entrepreneurial performance in Russia: a longitudinal study", *Organization Studies*, Vol. 24 No. 4, pp. 535-556.

Bollen, L., Vergauwen, P. and Schnieders, S. (2005), "Linking intellectual capital and intellectual property to company performance", *Management Decision*, Vol. 43 No. 9, pp. 1161-1185.

Bonner, J.M. and Walker, O.C. (2004), "Selecting influential business-to-business customers in new product development: relational embeddedness and knowledge heterogeneity considerations", *Journal of Product Innovation Management*, Vol. 21 No. 3, pp. 155-169.

Bontis, N. (1998), "Intellectual capital: an exploratory study that develops measures and models", *Management Decision*, Vol. 36 No. 2, pp. 63-76.

Chadwick, C. and Dabu, A. (2009), "Human resources, human resource management, and the competitive advantage of firms: toward a more comprehensive model of causal linkages", *Organization Science*, Vol. 20 No. 1, pp. 253-272.

Chen, X. and Wu, J. (2011), "Do different guanxi types affect capability building differently? A contingency view", *Industrial Marketing Management*, Vol. 40 No. 4, pp. 581-592.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-152.

Curado, C. (2008), "Perceptions of knowledge management and intellectual capital in the banking industry", *Journal of Knowledge Management*, Vol. 12 No. 3, pp. 141-155.

Denford, J.S. (2013), "Building knowledge: developing a knowledge-based dynamic capabilities typology", *Journal of Knowledge Management*, Vol. 17 No. 2, pp. 175-194.

Eisenhardt, K.M. and Martin, J.A. (2000), "Dynamic capabilities: what are they?", *Strategic Management Journal*, Vol. 21 Nos 10/11, pp. 1105-1121.

Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J. and Winter, S.G. (2007), *Dynamic Capabilities:Understanding Strategic Change in Organizations*, Blackwell Publishing, Oxford.

Hoskisson, R.E., Eden, L., Lau, C.M. and Wright, M. (2000), "Strategy in emerging economies", *Academy of Management Journal*, Vol. 43 No. 3, pp. 249-267.

Hsu, L.C. and Wang, C.H. (2012), "Clarifying the effect of intellectual capital on performance: the mediating role of dynamic capability", *British Journal of Management*, Vol. 23 No. 2, pp. 179-205.

Jansen, J.J., Tempelaar, M.P., Van den Bosch, F.A. and Volberda, H.W. (2009), "Structural differentiation and ambidexterity: the mediating role of integration mechanisms", *Organization Science*, Vol. 20 No. 4, pp. 797-811.

Landroguez, S.M., Castro, C.B. and Cepeda-Carrión, G. (2011), "Creating dynamic capabilities to increase customer value", *Management Decision*, Vol. 49 No. 7, pp. 1141-1159.

Law, K.S., Wong, C.S. and Mobley, W.H. (1998), "Toward a taxonomy of multidimensional constructs", *Academy of Management Review*, Vol. 23 No. 4, pp. 741-755.

Li, D. and Liu, J. (2014), "Dynamic capabilities, environmental dynamism, and competitive advantage: evidence from China", *Journal of Business Research*, Vol. 67 No. 1, pp. 2793-2799.

Lin, X. and Germain, R. (2003), "Organizational structure, context, customer orientation, and performance: lessons from Chinese state-owned enterprises", *Strategic Management Journal*, Vol. 24 No. 11, pp. 1131-1151.

Luo, Y. (2003), "Industrial dynamics and managerial networking in an emerging market: the case of China", *Strategic Management Journal*, Vol. 24 No. 13, pp. 1315-1327.

Luo, Y., Huang, Y. and Wang, S.L. (2012), "Guanxi and organizational performance: a meta-analysis", *Management and Organization Review*, Vol. 8 No. 1, pp. 139-172.

Luthans, F. and Youssef, C.M. (2004), "Human, social, and now positive psychological capital management: investing in people for competitive advantage", *Organizational Dynamics*, Vol. 33 No. 2, pp. 143-160.

Martín-de-Castro, G., Delgado-Verde, M., López-Sáez, P. and Navas-López, J.E. (2011), "Towards 'an intellectual capital-based view of the firm': origins and nature", *Journal of Business Ethics*, Vol. 98 No. 4, pp. 649-662.

Nahapiet, J. and Ghoshal, S. (1998), "Social capital, intellectual capital, and the organizational advantage", *Academy of Management Review*, Vol. 23 No. 2, pp. 242-266.

Nielsen, A.P. (2006), "Understanding dynamic capabilities through knowledge management", *Journal of Knowledge Management*, Vol. 10 No. 4, pp. 59-71.

Pandza, K. and Thorpe, R. (2009), "Creative search and strategic sense-making: missing dimensions in the concept of dynamic capabilities", *British Journal of Management*, Vol. 20 No. S1, pp. S118-S131.

Park, S.H. and Luo, Y. (2001), "Guanxi and organizational dynamics: organizational networking in Chinese firms", *Strategic Management Journal*, Vol. 22 No. 5, pp. 455-477.

Peteraf, M., Di Stefano, G. and Verona, G. (2013), "The elephant in the room of dynamic capabilities: bringing two diverging conversations together", *Strategic Management Journal*, Vol. 34 No. 12, pp. 1389-1410.

Podsakoff, P.M. and Organ, D.W. (1986), "Self-reports in organizational research: problems and prospects", *Journal of Management*, Vol. 12 No. 4, pp. 531-544.

Roberts, N. and Grover, V. (2012), "Investigating firm's customer agility and firm performance: the importance of aligning sense and respond capabilities", *Journal of Business Research*, Vol. 65 No. 5, pp. 579-585.

Roos, G. and Roos, J. (1997), "Measuring your company's intellectual performance", *Long Range Planning*, Vol. 30 No. 3, pp. 413-426.

Saxenian, A. (1994), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, Cambridge, MA.

Schultz, T.W. (1961), "Investment in human capital", *The American Economic Review*, Vol. 51 No. 1, pp. 1-17.

Serenko, A. and Bontis, N. (2009), "Global ranking of knowledge management and intellectual capital academic journals", *Journal of Knowledge Management*, Vol. 13 No. 1, pp. 4-15.

Serenko, A. and Bontis, N. (2013), "Global ranking of knowledge management and intellectual capital academic journals: 2013 update", *Journal of Knowledge Management*, Vol. 17 No. 2, pp. 307-326.

Serenko, A., Bontis, N., Booker, L., Sadeddin, K. and Hardie, T. (2010), "A scientometric analysis of knowledge management and intellectual capital academic literature (1994-2008)", *Journal of Knowledge Management*, Vol. 14 No. 1, pp. 3-23.

Stewart, T.A. (1997), *Intellectual Capital: The New Wealth of Organizations*, Doubleday/Currency, New York, NY.

Subramaniam, M. and Youndt, M.A. (2005), "The influence of intellectual capital on the types of innovative capabilities", *Academy of Management Journal*, Vol. 48 No. 3, pp. 450-463.

Szulanski, G. (1996), "Exploring internal stickiness: impediments to the transfer of best practice within the firm", *Strategic Management Journal*, Vol. 17 No. S2, pp. S27-S43.

Tan, J.J. and Litschert, R.J. (1994), "Environment-strategy relationship and its performance implications: an empirical study of the Chinese electronics industry", *Strategic Management Journal*, Vol. 15 No. 1, pp. 1-20.

Teece, D.J. (1998), "Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets", *California Management Review*, Vol. 40 No. 3, pp. 55-79.

Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319-1350.

Teece, D.J. (2012), "Dynamic capabilities: routines versus entrepreneurial action", *Journal of Management Studies*, Vol. 49 No. 8, pp. 1395-1401.

Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18 No. 7, pp. 509-533.

Tsai, W. (2001), "Knowledge transfer in intraorganizational networks: effects of network position and absorptive capacity on business unit innovation and performance", *Academy of Management Journal*, Vol. 44 No. 5, pp. 996-1004.

Vogel, R. and Güttel, W.H. (2013), "The dynamic capability view in strategic management: a bibliometric review", *International Journal of Management Reviews*, Vol. 15 No. 4, pp. 426-446.

Wang, E., Klein, G. and Jiang, J.J. (2007), "IT support in manufacturing firms for a knowledge management dynamic capability link to performance", *International Journal of Production Research*, Vol. 45 No. 11, pp. 2419-2434.

Whetten, D.A. (2009), "An examination of the interface between context and theory applied to the study of Chinese organizations", *Management and Organization Review*, Vol. 5 No. 1, pp. 29-55.

Widener, S.K. (2006), "Human capital, pay structure, and the use of performance measures in bonus compensation", *Management Accounting Research*, Vol. 17 No. 2, pp. 198-221.

Wright, M., Filatotchev, I., Hoskisson, R.E. and Peng, M.W. (2005), "Strategy research in emerging economies: challenging the conventional wisdom", *Journal of Management Studies*, Vol. 42 No. 1, pp. 1-33.

Wu, S.H., Lin, L.Y. and Hsu, M.Y. (2007), "Intellectual capital, dynamic capabilities and innovative performance of organisations", *International Journal of Technology Management*, Vol. 39 No. 3, pp. 279-296.

Xin, K.K. and Pearce, J.L. (1996), "Guanxi: connections as substitutes for formal institutional support", *Academy of Management Journal*, Vol. 39 No. 6, pp. 1641-1658.

Xu, D. and Meyer, K.E. (2013), "Linking theory and context: 'strategy research in emerging economies' after Wright *et al.*(2005)", *Journal of Management Studies*, Vol. 50 No. 7, pp. 1322-1346.

Zahra, S.A. and George, G. (2002), "Absorptive capacity: a review, reconceptualization, and extension", *Academy of Management Review*, Vol. 27 No. 2, pp. 185-203.

Zhang, J. and Wu, W. (2013), "Social capital and new product development outcomes: the mediating role of sensing capability in Chinese high-tech firms", *Journal of World Business*, Vol. 48 No. 4, pp. 539-548.

Zheng, S., Zhang, W. and Du, J. (2011), "Knowledge-based dynamic capabilities and innovation in networked environments", *Journal of Knowledge Management*, Vol. 15 No. 6, pp. 1035-1051.

Zhou, K.Z. and Li, C.B. (2010), "How strategic orientations influence the building of dynamic capability in emerging economies", *Journal of Business Research*, Vol. 63 No. 3, pp. 224-231.

Appendix

Items	Factor loading
Intellectual capital	
Human capital	Cronbach's $\alpha = 0.775$
Our employees are well educated	0.834
Our employees are experienced	0.753
Our employees are well trained	0.621
Relational capital	Cronbach's $\alpha = 0.889$
We have close relationship with our customers	0.809
We have close relationship with our suppliers	0.860
We have close relationship with our partners	0.818
Structural capital	Cronbach's $\alpha = 0.769$
We use technology to integrate internal work processes tightly	0.623
We keep complete documentation of the work processes	0.634
Much of our documentation is digitalized	0.908
Knowledge-based dynamic capabilities	Cronbach's $\alpha = 0.844$
Our knowledge helps us to perceive environmental change before competitors	0.554
Our knowledge helps us to fully understand the impact of internal and external environment	0.750
Our knowledge helps us to sense the major potential opportunities and threats	0.746
Our knowledge helps us to make timely decisions to deal with strategic problems	0.757
Our knowledge helps us to remedy quickly to unsatisfactory customers	0.672
We can reconfigure our knowledge resources in time to address environmental change	0.795
Our strategic changes can be efficiently carried out	0.790
Innovative performance	Cronbach's $\alpha = 0.831$
Compared with our competitors in the last three years, we have […]	
Higher amount of new products	0.829
Faster speed of new product launching	0.799
Lower new product operating costs	0.628
Higher new product sales revenue	0.814
Increasingly higher new product market share	0.803

Table AI. Measurement items and validity assessment

About the authors

Yuqian Han is a Graduate Student in Management at the School of Management, Xiamen University in China. Now she is studying in ESCP Europe in Paris for the MEB (Master in Europe Business). Her research interests include corporate strategy and innovation management.

Dayuan Li is an Associate Professor at the Business School of Central South University in China. He received his PhD from the Zhejiang University in China. His current research interests are in the areas of strategic management, technological innovation and green management. He has previously published various papers in English or Chinese which appeared in *Journal of Business Research*, *Nankai Business Review* and IMCAR conference and others. Associate Professor Dayuan Li is the corresponding author and can be contacted at: bigolee@163.com