Market knowledge impacts on product and process innovation: Evidence from travel agencies

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Abstract

Purpose – This paper examines the relationship between the attributes of market knowledge (depth/breadth) and particular types of (process/product) innovation. The mediating mechanism of ambidextrous (exploratory/exploitative) capabilities is also investigated.

Design/methodology/approach – Data from 153 travel agencies from two phases of data collection in Taiwan were analyzed using the structural equation modeling method.

Findings – Market knowledge depth directly and positively impacts on product and process innovation. Market knowledge breadth indirectly and positively impacts on product and process innovation. Ambidextrous capabilities affect process and product innovation and mediate the effect of market knowledge breadth on the two innovations.

Research limitations/implications – This study provides different theoretical views, such as dynamic capability and organizational learning to supplement the explanation of knowledge-based theory in the relationship between market knowledge and innovation.

Practical implications – This study encourages firms to accumulate market knowledge depth and breadth and facilitate ambidextrous capabilities for innovation.

Keywords: market knowledge depth/breadth, process/product innovation, ambidextrous (exploratory/exploitative) capabilities.

1. Introduction

Tourism scholars and managers have acknowledged that how market information affects firm innovation (Jalilvand, Pool, Khodadadi, and Sharifi, 2019; Köseoglu, Morvillo, Altin, and Martino, 2019; Ozseker, 2019). Tourism firms update market information to support innovation and create competitive advantage (Nieves, Quintana, & Osorio, 2014). This suggests that there should be a correlation between market knowledge and innovation, however the cause-effect relationship varies. Tourism scholars have found that market knowledge is important for firm innovation (Köseoglu et al., 2019; Okumus, Köseoglu, Morvillo, & Altin, 2019) and studies in IT have demonstrated that market knowledge negatively impacts on innovation (Kyriakopoulos, Hughes, & Hughes, 2016).

Such inconsistent results could be attributed to the fact these studies may have failed to thoroughly examine the specific aspects of market knowledge, such as knowledge breadth and depth (Bao, Sheng, & Zhou, 2012). Viewing market knowledge in tourism research as a single overall construct when examining its relationship with innovation would actually taint this research (Chen & Lee, 2017; Ferreras-Méndez, Newell, Fernández-Mesa, & Alegre, 2015). A few of studies have explored the relationship between the different attributes of market knowledge on innovation or performance (Bao et al., 2012; Ferreras-Méndez et al., 2015). Tourism studies (i.e., research gap one) should also investigate the relationships between different attributes of market knowledge and innovation.

The inconsistent findings could also be attributed to a failure to examine the different types of innovation (Chang, Bai, & Li, 2015). For example, tourism managers who gained market knowledge from customers might value product innovation (e.g., new tour package), whereas others' value process innovation (e.g., online booking) (Kandampully & Solnet, 2019). If this (second) research gap in the literature is not bridged, it will be less likely to understand which attributes of market knowledge would affect a particular type of innovation.

The third research gap is that the inconsistent findings could also be attributed to a lack of investigation into the effect of potential mediating mechanisms. The value of

knowledge is enhanced by how it is used, learnt, and integrated (Ferreras-Méndez et al., 2015). The causal relationships between market knowledge and innovation need to be examined in a framework of input (knowledge) — process (mediating mechanism) — output (innovation), in order to explain why some tourism firms deliver better innovation performance than others (Mihalache & Mihalache, 2016).

Although past research has examined the effect of ambidextrous capability on innovation, no studies in tourism have investigated the level of reliance in the relationships between diverse attributes of knowledge and innovation on diverse types of ambidextrous capabilities (Ferreras-Méndez et al., 2015; Nieves, Quintana, & Osorio, 2016). Few studies have examined the mediator played by different modes of organizational capabilities on the relationships between different market knowledge schemas and innovation (Martínez-Pérez, García-Villaverde, & Elche, 2016).

This study submits two research questions in response to these issues: (1) What impacts do different market knowledge attributes have on different attributes of innovation? Especially the question seeks to explore which attributes of market knowledge have a relatively significant effect on which specific attributes of innovation? (2) How to mediate the impacts of different attributes of market knowledge on innovation with ambidextrous capability? This study starts with market knowledge and integrates ambidextrous capability as the mediator to test the impact of market knowledge on innovation. Data from travel agencies in Taiwan were analyzed. For future research, scholars could empirically analyze the appropriateness of the model in different industries.

2. Literature

2.1. Market knowledge

According to the knowledge-based view (KBV), competitive success is governed by the capability of organizations to develop knowledge-based assets that create core competencies (Zhou & Li, 2012). The nature of knowledge-based resources is mainly intangible and dynamic, allowing the firm to create value. The concept of market knowledge in the tourism domain has been mentioned (Chen & Huan, 2020) and it was defined as know-how and information of a product-market domain (De Luca &

Atuahene-Gima, 2007).

Chen and Lee (2017), drawing from KBV applied within tourism, proposed the following attributes of market knowledge: depth, breadth, and tacitness. Most studies converge on the notion that breadth and depth dimensions represent fundamental building blocks of firm assets and such a dichotomy offers rich insights into how knowledge attributes differentially influence firm innovation (e.g., Bao et al., 2012). It is necessary to investigate knowledge depth and breadth individually when testing the influence of market knowledge on tourism firm performance (Ferreras-Méndez et al., 2015). Knowledge breadth and depth are two distinct attributes of knowledge base that reveal both the structure and content of the knowledge a firm holds (Zhou & Li, 2012). The current study focuses on investigating the depth and breadth of market knowledge.

2.2. Depth and breadth of market knowledge

The depth of market knowledge refers to the quantity of within-field knowledge a firm possesses or the sum of within-field knowledge that firms possess about a particular market aspect (Ferreras-Méndez et al., 2015). For instance, the depth of market knowledge about the customer characteristic, this knowledge may pertain to customer relationship management, customer profiles, customer preference, and behavior. The example serves to demonstrate the depth of knowledge about customers.

The breadth of market knowledge describes the firm's knowledge about customers or competitors in their respective industries, or other dimensions of market (De Luca & Atuahene-Gima, 2007). Tourism scholars have noted that market knowledge may pertain to, not only customer needs and preferences (i.e., focusing on customer dimension, the depth of market knowledge), but may also include insights of a wide range of diverse competitor types, in tourism upstream or downstream firms (Tolstoy, 2009). Thus, the breadth of knowledge is used as the basis of investigation in this study.

2.3. Innovations of process and product

According to the OSLO Manual, there are four types of innovation encompassing a

wide range of changes in firm activity (OECD, 2018): product innovation, referring to new goods and services or significant improvements in them; process innovation is defined as significant changes in production and delivery methods; marketing innovation, involves changes to product design and packaging, product promotion and placement, and methods for pricing goods and services; and organizational innovation, is based on the introduction of new systems and management methods and new types of work organization and business models.

Tourism products concern both tangible products and intangible services (e.g., Hjalager, 2010). Customers can also perceive good transaction process if a tourism firm can design a good business model (Stylos, 2019). Information and communication technology have been the backbone of much process innovation in tourism and hospitality (Jalilvand et al., 2019). Buhalis (2019) discussed process innovation and product innovation. To facilitate the capacity to distinguish tourism product from process, product innovation is defined as innovation of tangible products and intangible services experienced after transactions and process innovation as innovation perceived by customers during transactions. Process innovation is defined as a significant improvement in production and delivery methods (OECD, 2018).

2.4. The effect of market knowledge depth on different types of innovation

Process innovation is critical for tourism and is mainly triggered by a firm's own set of resources and the accumulation of knowledge (Chathoth, Altinay, Harrington, Okumus, & Chan, 2013). As a result, the firm develops increasingly efficient processes and routines. Market knowledge depth refers to a firm's understanding of the degree or level of strategic actions taken by its customers and competitors. If tourism firms have greater in-depth understanding of the production-to-transaction process of tourism products, they will be more likely to experience superior performance in process innovation in comparison to their competitors. This is because process innovation is extremely knowledge-intensive at the technological level and is enabled by the change of tools and apparatus within the process (Damanpour & Gopalakrishnan, 2001). After accumulating a sufficient depth of market knowledge, firms will be able to find more productive ways to manufacture

services and goods through self-learning (Zhou & Wu, 2010). This study proposes that:

H1-1: Travel agencies' market knowledge depth has positive effect on process innovation.

Scholars have argued that the advantage of firms could be manifested in product innovation (Bao et al., 2012; Prabhu, Chandy, & Ellis, 2005). Firms that have built a thorough understanding of products or services in the market of a particular field (depth of market knowledge), also become knowledgeable about the history and the background of these products or services. Taking a tour package as an example, a thorough understanding of the product would include knowledge of hotel and aircraft facilities and tour guide services. Once such knowledge reaches a sufficient level, it is easier for the firm to envision how products or services may evolve in the future and in turn, seize the opportunity to innovate (Ferreras-Méndez et al., 2015). This study proposes that:

H1-2: Travel agencies' market knowledge depth has positive effect on product innovation.

2.5. The effect of market knowledge breadth on different types of innovation

Business processes involve multiple departments, for example how to conduct transactions with service providers or customers in cash flow and information flow. It may be easier for firms with broad market knowledge to synergize business process flow and engage in the creation of value in the tourism chain (Jalilvand et al., 2019). As market knowledge can come from customers, products, information technology, suppliers, competitors, other stakeholders, or the internet, it will be easier for firms with broader knowledge to establish operational processes that reduce production costs and increase production efficiency (Johnson, Christensen, & Kagermann, 2008). Firms with a broad knowledge base have greater latency to rearrange or integrate different dimensions of the market information to improve opportunity recognition and creative potential (De Luca & Atuahene-Gima, 2007). The study therefore proposes that:

H2-1: Travel agencies' market knowledge breadth has positive effect on process innovation.

Broad market knowledge could mean possessing considerable information over a wide spectrum, which may stimulate the firm's ability to quickly develop new ideas and formulate new product management views (De Luca & Atuahene-Gima, 2007). As firms become knowledgeable about the market landscape (for example up- and down-streaming tourism: airline, hotels, and restaurants), they will be more capable of providing products or services to meet customers' demands (Weidenfeld, Williams, & Butler, 2010). As a firm's self-learning develops and its breadth of knowledge increases, it will be easier for it to deliver innovation once the knowledge breadth reaches certain level (Karim, 2009). The study proposes that:

H2-2: Travel agencies' market knowledge breadth has positive effect on product innovation.

2.6. Ambidextrous capability from dynamic capability theory

The nature of ambidexterity is implicitly recognized in the dynamic capabilities literature, which urges the need to blend the different strategic logic, exploitation and exploration, within a firm (O'Reilly & Tushman, 2008; Teece, 2007). Knowledge exploratory capability refers to the strategy by which an enterprise creates new knowledge or skills from new product market experiences. Knowledge exploitative capability, however, improves and enhances existing knowledge related to the existing products and services. With the accumulation of knowledge, firms rely more on their knowledge integration and transformation capabilities to promote innovation. For instance, in the field of knowledge management, the capability to absorb (absorptive capacity) is believed to facilitate actor engagement in effective organizational learning, knowledge innovation, and application of integrated knowledge resources (Zahra & Geroge, 2002). This study suggests that:

H3-1: Travel agencies' market knowledge (depth/breadth) positively affects ambidextrous (exploratory and exploitative) capabilities.

2.7. Ambidextrous capability as a mediator

According to the dynamic capability theory and competence-based views, a firm's capabilities are a mechanism that transforms resources into outputs (e.g., innovation and performance; Teece, 2007). Exploratory and exploitative capabilities can facilitate an increase in firms' competence and in turn, increase innovation (Tzokas, Kim, Akbar, & Al-Dajani, 2015). Path dependence also exists between the development process and output results. During the resource-transformation process and with the application of absorptive capacity, a firm's attributes and stocks of knowledge resources at one stage could influence the attributes of knowledge resources and the firm's developmental direction at the next stage. This study suggests that:

H3-2: The impact of market knowledge (depth/breadth) on process and product innovation will be mediated by ambidextrous (exploratory and exploitative) capabilities.

3. Method

3.1. Sample

This study utilized a sample of travel agencies in Taiwan. Within a globalized environment, travel agencies exist in a highly information-oriented industry that requires travel providers to be well-equipped with market knowledge (Díaz-Chao, Miralbell-Izard, & Torrent-Sellens, 2016). The survey recipients consisted of key managers. This study sent official letters to travel agencies to confirm that they were contacted, and their assistance was kindly invited. A questionnaire was mailed to each informant (first wave of data collection). One month after the mailing, this study mailed a duplicate questionnaire for any non-respondents and invited them to answer and return the questionnaire (second wave of data collection).

The study received 153 responses from the two waves of data collection. Nieves et al. (2014) investigated the relationship between knowledge resources and innovation in the hotel industry and data collection achieved the return of 112 questionnaires, of which, only 109 were valid. Compared with the sample size of other studies, this study's response rate of 153 responses was acceptable.

3.2. Measures

The current study comprised six constructs: the depth and breadth of market knowledge (Zhou & Li, 2012), exploitative and explorative capabilities (Tzokas et al, 2015), and process and product innovation (Chang et al., 2015; Paladino, 2008). Each of the constructs had three indicators. The responses ranged from 1= strongly disagree to 7= strongly agree (see Table 1). Although the measurement scales of the survey were established from the existing literature indicating good content validity, back translation was performed to ensure the accuracy of the translation (Brislin, 1970). No significant differences from two waves of data were found using *t* tests at the 0.05 level, non-response bias was not considered an issue (Armstrong & Overton, 1977).

Table 1 here

3.3. Control variables

The firm size, capital, and age of travel agencies were used as control variables. Large travel agencies might have greater resources, which can in turn enhance overall performance. Firm capital refers to assets, the resources that provide an organization with its competitive advantage. Firm age was included as a control variable for firm knowledge, the older the travel agency, the more likely it was to have superior knowledge or experience.

4. Results

4.1. Profile of respondents

Among the 153 travel agencies, 79.1% possessed capital of less than NTD$20 million. The majority (90.8%) reported having less than 50 employees or between 51 and 100 employees, and approximately 90% of the travel agencies reported turnover of less than NTD$10 billion. One-third of the travel agencies had been conducting business for less than five years, while the remaining had been in business between 6 - 10 years.

4.2. Reliability and validity

To analyze the data, structural equation modeling was applied, using the LISREL

program 8.80. All construct reliability values were greater than 0.70 (Hair, Anderson, Tatham, & Black, 1998) (see Table 1 for the confirmatory factor analysis, CFA). Convergent and discriminant validity were also assessed, and the standardized factor weights of all the elements measured were greater than 0.5, indicating statistical significance for all elements (Hair et al., 1998). The average variance extracted (AVE) was greater than 0.50, while the composite reliability exceeded 0.6. The measures demonstrated adequate convergent validity.

To evaluate discriminant validity, the AVE root mean square of the various constructs was between 0.82 and 0.91, and was much greater than their correlation coefficients, which indicates reasonable discriminant validity (see Table 2). The measurement model test also produced the following results: χ^2/df (193.761/120) = 1.615, CFI= 0.988, NNFI= 0.985, IFI= 0.988, and RMSEA= 0.064.

Table 2 here

4.3. Common method variance

This study used CFA to implement Harmon's single-factor test. CFA can model all the manifested items as indicators of a single-factor that represents the methodology's effects (Malhotra, Kim, & Patil, 2006). In the single-factor model of the current study, one item failed the criterion for the measurement (t = 1.96, $p < 0.05$). The fitness indices (χ^2/df (1176.888/135) = 8.718, RMSEA = 0.228, CFI = 0.861, GFI = 0.531, and NNFI = 0.843) did not show a more acceptable outcome than the current model. Subsequently, common method bias is unlikely to be a concern.

4.4. Hypothesis tests

Market knowledge depth was positively and significantly associated with process and product innovation (γ = 0.174, t = 2.319; γ = 0.205, t = 2.376), supporting H1-1 and H1-2. Market knowledge breadth was not significantly associated with on process innovation (γ= −0.076, t = −0.595) and product innovation (γ= −0.118, t = −0.802), suggesting that H2-1

and H2-2 were not supported. The results will be discussed later regarding the total effect and indirect analyses as well as the robustness check.

For market knowledge, ambidextrous capabilities linkage and market knowledge depth had a non-significant effect on exploitative and explorative capabilities (γ = -0.027, t = -0.303; γ = 0.001, t = 0.015), whereas market knowledge breadth had a significant and positive effect on exploitative and explorative capabilities (γ = 0.780, t = 7.390; γ = 0.646, t = 5.971), partially supporting H3-1.

The mediators of ambidextrous capability were tested by total and indirect effect testing (Preacher & Hayes 2004). The test indicated that market knowledge depth was positively associated with process innovation (γ = 0.165, t = 1.720) and product innovation (γ = 0.197, t = 1.911) in total effect, but market knowledge depth did not have significant indirect influence on process innovation (γ = −0.009, t = −0.130) and product innovation (γ = −0.008, t = −0.137). The influence of market knowledge depth on innovation was unlikely to be mediated by ambidextrous capabilities.

By conducting indirect effect analysis, market knowledge breadth was indirectly and positively associated with process innovation (γ = 0.651, t = 5.424) and product innovation (γ = 0.594, t = 4.689). Regarding the total direct effect, the impact of market knowledge breadth on process innovation (γ = 0.575, t = 5.581) and product innovation (γ = 0.476, t = 4.464) was supported. As previously tested, market knowledge breadth had a significantly positive impact on both exploitative and explorative capabilities. In terms of the magnitude of impact, the direct influence of market knowledge breadth on exploitative capability was greater than on explorative capability.

Exploitative and explorative capabilities had a direct positive influence on process innovation (β = 0.359, t = 3.858; β = 0.575, t = 7.262, respectively) and on product innovation (β = 0.340, t = 3.194; β = 0.509, t = 5.789, respectively). Two innovations influenced by market knowledge breadth were mediated by ambidextrous capabilities. Two innovations influenced by market knowledge depth were not mediated by ambidextrous capabilities, partially supporting H3-2 (see Table 3 and Figure 2).

In relation to the effect of control variables, both firm size ($\gamma = 0.304$, $t = 2.706$) and age ($\gamma = -0.313$, $t = -3.573$) were significantly associated with process innovation but not associated with product innovation. The results are discussed in Section 4.6.

Table 3 and Figure 2 here

4.5. Robust check

This study also constructed bias-corrected confidence intervals using a bootstrap re-sampling method (Table 3). For the indirect effect of market knowledge breadth on process and product innovation, the confidence interval of the estimation coefficient under the original structural model does not contain zero, confirming the significance of the indirect effect, creating greater confidence in the empirical results

This study also compared the hypothesized model with several rival models. As shown in Table 4, findings are consistent with the previous analyses of the total and indirect effects. The results showed that the original Model (a) was more favorable than the other models (Bollen & Long, 1992). The study also investigated the moderating effect of ambidextrous capabilities. The empirical evidences indicated that ambidextrous capabilities and market knowledge had a significant positive influence on two of the innovations, but the model applying ambidextrous capabilities as a moderator turned out to be inapplicable. This study's proposed model provided better results, which indicates that the hypotheses in this research model contained good goodness-of-fit.

Table 4 here

4.6. Discussion

This study extends the explanatory power of the KBV by elucidating the different influences of knowledge attributes on different types of innovation. Market knowledge depth directly affects process and product innovation. Market knowledge breadth indirectly and positively affects two innovations, indicating that it is necessary to explore the relationships between the various attributes of market knowledge and types of innovation.

Market knowledge depth and breadth do not have an equal and significant effect on innovation. Scholars have proposed a model which suggests knowledge and knowledge-based processes play a role in fostering innovation in the hotel industry (Nieves et al., 2016). Ferreras-Méndez et al. (2015) also found that a non-significant knowledge-innovation linkage can be mediated by organizational absorptive capacity. This study combines the perspective of ambidextrous capabilities and KBV and employs the logic of resource (input) – process – performance (output). The empirical evidences show that the mediating effect of exploitative capability is greater from the exploitative capability between market knowledge breadth and the two innovations. This corresponds with recent studies and provides insights as to why the influence of knowledge is sometimes insignificant to firm performance.

In relation to the positive impact of firm size on process innovation, the result may suggest that the scale of a firm indicates greater division of departments and the complete value activities, and the capacity to re-establish operational processes. The negative impact of firm age on process innovation may be the result of firm age, where existing resource inertia and routine inertia may produce resistance to initiate change.

5. Conclusion

5.1. Theoretical contributions

Although scholars continue to engage in studies that investigate the relationships between knowledge and innovation, research continues to yield inconsistent results. This topic is the focal point of this study and is a question yet to be addressed by practitioners in the industry. This study marks the first endeavor to adopt a KBV and explore the ambidextrous capability perspective, from dynamic capabilities theory, in an attempt to create a theoretical framework of knowledge—dynamic capability—innovation, and test related causal relationships between various attributes of the constructs. This article not only applies current theories but also offers a research foundation based on empirical result for subsequent research.

The study findings illustrate that while market knowledge depth has a significant effect on both types of innovation, market knowledge breadth does not. This conclusion addresses the issue of inconsistent results on the impacts of market knowledge on innovation within the previous research, where market knowledge and innovation were seen as a singular construct, masking the true effect. The inconsistency in the study findings in relation to the impact of market knowledge on innovation could also be attributed to not testing innovation more thoroughly. In terms of the influence of market knowledge breadth on innovation, exploitative capability has a greater pronounced mediating influence than exploratory capability. This empirical evidence not only explicates why market knowledge has not been found to positively effect on innovation (and why any such effect, when found, has been inconsistent), but also reveals that a specific type of ambidextrous capability could better mediate the effect of a certain market knowledge attribute on innovation.

Dynamic capabilities indicate the process of firms employing resources, more particularly, how firms integrate, reorganize, acquire, and release these resources. Accordingly, the knowledge resources firms possess, can only effectively influence firm innovation with the intervention of the mediating mechanism of ambidextrous capabilities. This study provides different theoretical viewpoints, such as dynamic capability and organizational learning to supplement the explanation of KBV in the market knowledge—innovation linkage.

5.2. Management practices

Jalilvand et al. (2019) stated IT and knowledge management contribute to the service supply chain through the coordination, collaboration, and efficiency of actors within the hospitality industry. Knowledge acquired through external network relationships is widely accepted as one of the most important resources for a firm to be innovative. This study suggests that travel agencies would benefit from greater communication with hotels, restaurants, and other service providers. Through communication, the depth and breadth of knowledge can be enhanced.

New technologies or new knowledge, such as big data and mobile technologies, have become increasingly available in the market. Tourism firms that are aware of, and adopt technologies to retrieve, collect, analyze, report, and visualize market information (Mariani, 2019), will benefit from an accumulation market knowledge depth and breadth.

Given that the scale of the travel industry is not as large as that of the aviation and hotel industries, relevant government tourism agencies could conduct workshops to cultivate ambidextrous capabilities within the tourism industry to enhance innovation. This study also recommends that tourism firms encourage trial-and-error to accumulate exploratory capability. Managers that encourage employees to take risks, reward projects proposed by employees, and who facilitate brainstorming activities may experience greater innovation. To accumulate exploitative capability, job rotation can be implemented for senior-level managers allowing them to accumulate greater experience and capabilities with which to apply learning. For the general staff, travel agencies could establish cross-functional projects to allow employees from different departments to learn from others in order to maximize the potential value of market knowledge.

Ambidexterity advocates that firms can strike a balance between exploratory and exploitative capability and pursue both strategic actions simultaneously. Only through outside-in and inside-out learning capabilities, can tourism firms adapt to environmental changes and facilitate innovation (Zhou & Li, 2012). Within the context of COVID-19, tourism and hospitality managers should not only search the market knowledge of their product-market domain, but also display ambidexterity capability to realize additional knowledge to adapt to a changing business environment.

5.3. Limitations and recommendations

Due to the cross-sectional nature of the data, longitudinal studies are needed to ascertain causality. The empirical results were only obtained from travel industry in Taiwan (Asia). Future research should test for tourism (e.g., hotel or airline industries) or nationality bias (e.g., in the United States or Europe) to overcome context-specific issues. This study utilized the depth and breadth of knowledge to represent the antecedents of innovation and did not investigate the effect on marketing and organizational innovation

(OECD, 2018). Further research is needed to conduct a comparative study between other attributes of knowledge (tacit or explicit) and the various types of innovation. Future studies could adopt a mediator and moderator perspective with other tourism industries. Within the context of COVID-19, tourism firms face a "new to the world" phenomenon and it is necessary for radical innovations. Other knowledge sources could very well be outside of the tourism industry, and could be considered for future work (Gallouj & Savona, 2009).

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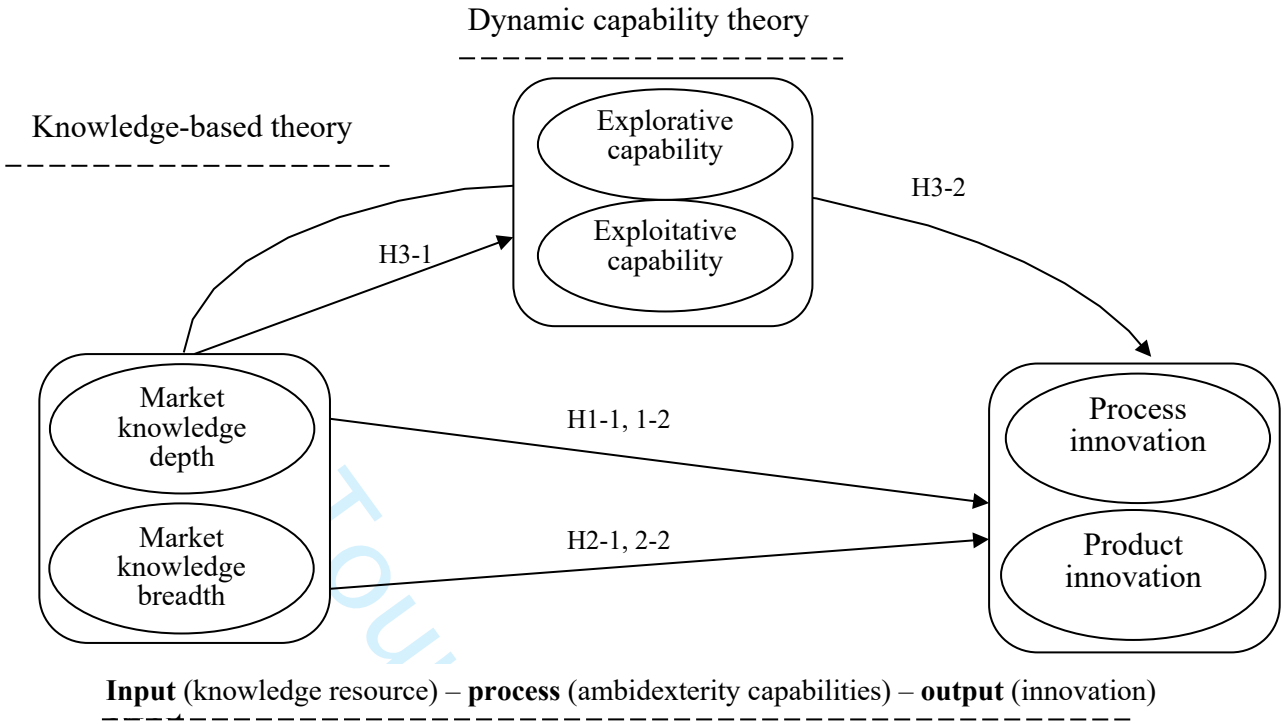
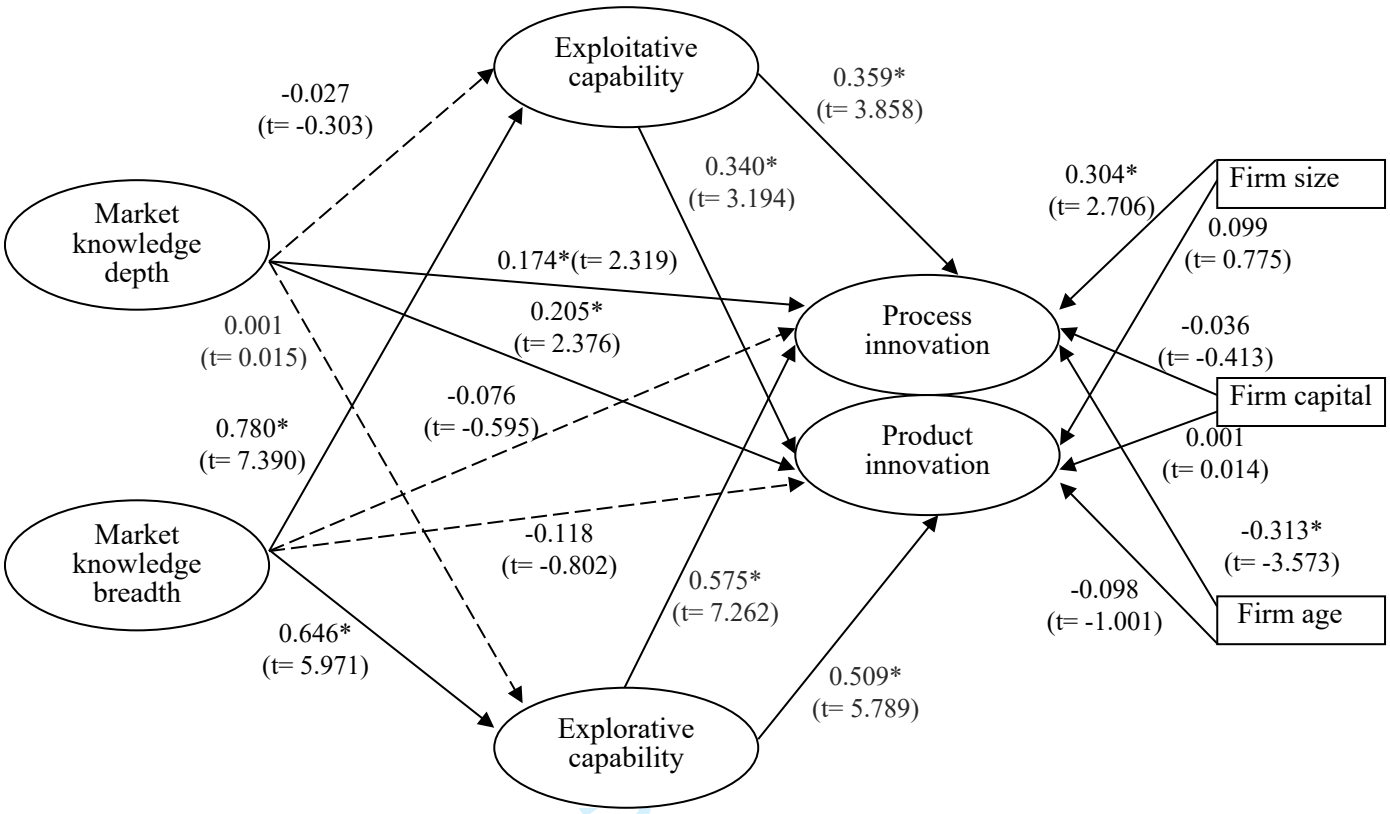


Fig 1. Research model and hypotheses



NOTE:

χ^2/df= 1.474 (241.689/164); RMSEA= 0.056; CFI= 0.987; NNFI= 0.983; IFI= 0.987; GFI= 0.868

The total effect of MKdp on PCin: 0.165* (t= 1.720); on PDin: 0.197* (t= 1.949)

The total effect of MKbr on PCin: 0.575* (t= 5.581); on PDin: 0.476* (t= 4.464)

The indirect effect of MKdp on PCin: -0.009* (t= -0.130); on PDin: -0.008* (t= -0.137)

The indirect effect of MKbr on PCin: 0.651* (t= 5.424); on PDin: 0.594* (t= 4.698)

* p<0.05, t> 1.65 (one-tail)

Fig 2. Operational model and test results

Table 1
Measurement items and CFA results

Construct	Item	Crobach's α	CFA				
			SFL	t value	SMC	AVE	CR
Market knowledge depth		0.91				0.78	0.92
	We are highly familiar with this industry.		0.90	13.89	0.81		
	We have acquired a great deal of experience in this industry.		0.91	14.12	0.82		
	The knowledge of our firm in this industry is thorough.		0.85	12.72	0.72		
Market knowledge breadth		0.85				0.67	0.86
	We possess market information from a diversified customer portfolio.		0.87	12.06	0.76		
	We have accumulated knowledge of multiple market segments.		0.90	13.82	0.82		
	Our R&D expertise consists of knowledge from a variety of backgrounds.		0.66	8.86	0.44		
Exploitative capability		0.93				0.82	0.93
	We are proficient in transforming knowledge and technologies into new products.		0.84	12.62	0.70		
	We regularly apply knowledge and technologies in new products.		0.94	15.26	0.89		
	We constantly consider how to better exploit new knowledge and technologies.		0.93	14.89	0.86		
Explorative capability		0.94				0.83	0.94
	We frequently scan the environment for new knowledge and technologies.		0.87	13.31	0.75		
	We observe knowledge and technological trends.		0.92	14.65	0.84		
	We observe in detail external sources of new knowledge and technologies.		0.94	15.33	0.89		
Process innovation		0.92				0.80	0.92
	We are constantly improving our business processes.		0.91	14.36	0.83		
	Our company changes production methods at great speed in comparison with our competitors.		0.89	13.85	0.79		
	During the past five years, our company has developed many new management approaches.		0.88	13.52	0.77		
Product innovation		0.94				0.84	0.94
	The quality of this new product is superior to that of our competitors.		0.92	14.56	0.84		
	This product design (in terms of functionality and features) is superior to that of our competitors.		0.92	14.80	0.85		
	Overall, we have an advantage over our competitors in terms of this new product that we offer our customers.		0.91	14.39	0.83		

Note: SFL= standard factor loading

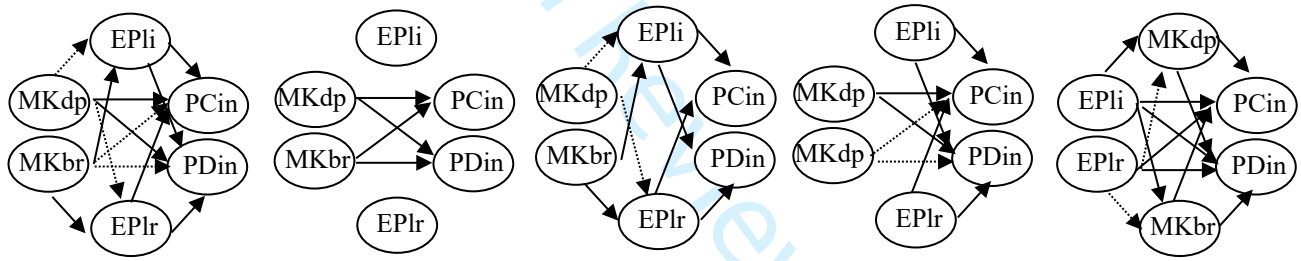
Table 2
The correlations of all variables

Construct	Mean	S.D	1	2	3	4	5	6	7	8	9
Market knowledge depth	6.013	0.861	***(.88)*** 1								
Market knowledge breadth	5.388	1.023	0.554*	***(.82)*** 1							
Explorative capability	5.190	1.191	0.469*	0.674*	***(.90)*** 1						
Exploitative capability	5.159	1.155	0.382*	0.547*	0.636*	***(.91)*** 1					
Process innovation	5.401	1.110	0.455*	0.555*	0.671*	0.738*	***(.89)*** 1				
Product innovation	5.547	1.077	0.443*	0.508*	0.630*	0.657*	0.732*	***(.91)*** 1			
Firm size	1.205	0.742	0.194*	0.139	0.104	0.053	0.186	0.134	1		
Firm capital	1.460	1.191	0.193*	0.113	0.059	0.047	0.183	0.138	0.846	1	
Firm age	3.707	2.045	0.043	0.018	-0.017	-0.090	-0.103	0.013	0.344	0.335	1

Note:
( ) reports the square root of AVE; * $p < .05$
Firm size:
1= 50 employees or below, 2=50– (under) 100 employees, 3= 100– (under) 500 employees, 4=500– (under) 1000 employees, 5= 1000– (under) 2000 employees, and 6= higher than 2,000 employees
Firm capital:
1= under NT 20 million dollars, 2= NT 20–(under) 40 million dollars, 3= NT 40– (under) 60 million dollars, 4= NT 60–(under) 80 million dollars, 5= NT 80– (under) 100 million dollars, and 6= over 100 million dollars
Firm age:
1= under 5 years, 2= 5– (under) 10 years, 3= 10– (under) 15 years, 4= 15– (under) 20 years, 5= 20– (under) 25 years, 6= 25– (under) 30 years, and 7=over 30 years

Table 3
Summary of model comparisons

Path	Proposal model(a)		Model(b)		Model(c)		Model(d)		Model(e)	
	Coefficient	t value	Coefficient	t value	Coefficient	t value	Coefficient	t value	Coefficient	t value
MKdp → EPli	-0.027	-0.303	---	---	-0.008	-0.088	---	---	EPli→MKdp **0.386***	3.392
MKdp → EPlr	0.001	0.015	---	---	0.029	0.296	---	---	EPli→MKbr **0.633***	6.121
MKbr → EPli (◯)	**0.780***	**7.390**	---	---	**0.764***	**7.226**	---	---	EPlr→MKdp 0.152	1.361
MKbr → EPlr (◯)	**0.646***	**5.971**	---	---	**0.624***	**5.794**	---	---	EPlr→MKbr 0.149	1.583
MKdp → PCin (◯)	**0.174***	**2.319**	**0.169***	**1.776**	---	---	**0.184***	**2.168**	**0.140***	**2.343**
MKdp →PDin (◯)	**0.205***	**2.376**	**0.195***	**1.945**	---	---	**0.221***	**2.331**	**0.169***	**2.436**
MKbr→ PCin (△)	-0.076	-0.595	**0.547***	**5.359**	---	---	0.023	0.272	-0.008	-0.102
MKbr →PDin (△)	-0.118	-0.802	**0.469***	**4.443**	---	---	-0.032	-0.338	-0.050	-0.514
EPli → PCin (◯)	**0.359***	**3.858**	---	---	**0.373***	**5.543**	**0.372***	**5.601**	**0.308***	**3.161**
EPli →PDin (◯)	**0.340***	**3.194**	---	---	**0.340***	**4.495**	**0.335***	**4.639**	**0.298***	**2.633**
EPlr → PCin (◯)	**0.575***	**7.262**	---	---	**0.593***	**8.311**	**0.645***	**8.890**	**0.535***	**6.627**
EPlr → PDin (◯)	**0.509***	**5.789**	---	---	**0.523***	**6.690**	**0.550***	**7.243**	**0.475***	**5.232**
Firm size → PCin	0.304*	2.706	0.406*	2.739	0.279*	2.414	0.357*	2.673	0.285*	2.647
Firm size → PDin	0.099	0.775	0.196	1.277	0.069	0.525	0.113	0.772	0.089	0.720
Firm capital → PCin	-0.036	-0.413	-0.013	-0.111	-0.032	-0.356	-0.040	-0.393	-0.037	-0.442
Firm capital → PDin	0.001	0.014	0.025	0.205	0.005	0.049	0.002	0.017	-0.001	-0.012
Firm age → PCin	-0.313*	-3.573	-0.416*	-3.593	-0.303*	-3.344	-0.371*	-3.547	-0.297*	-3.528
Firm age → PDin	-0.098	-1.001	0.202*	-1.698	-0.087	-0.853	-0.116	-1.019	-0.093	0.973
X^2/df	241.689/164	=1.474	127.810/73	=1.751	251.541/168	=1.497	374.111/16	=2.227	250.604/164	=1.528
RMSEA	0.056		0.071		0.058		8		0.059	
IFI	0.987		0.978		0.986		0.091		0.987	
CFI	0.987		0.977		0.986		0.966		0.987	
NNFI	0.983		0.967		0.983		0.966		0.983	
	(***dominating***)						0.957			



Bootstrapt approach	Proposal model(a)		original		1,000 times		1,500 times		2,000 times	
Path	Coefficient	t value	CI (low)	CI (up)	CI (low)	CI (up)	CI (low)	CI (up)	CI (low)	CI (up)
MKdp → PCin (med test)	-0.009	-0.130	-0.603	0.325	-0.559	0.033	-0.181	0.166	-0.472	0.323
MKdp → PDin (med test)	-0.008	-0.137	-0.543	0.251	-0.517	0.242	-0.154	0.140	-0.485	0.253
MKbr→ PCin (med test)	**0.651**	**5.424**	**0.318**	**1.573**	**0.354**	**1.504**	**0.435**	**0.946**	**0.333**	**1.397**
MKbr →PDin (med test)	**0.594**	**4.689**	**0.248**	**1.546**	**0.264**	**1.445**	**0.333**	**0.846**	**0.234**	**1.417**

NOTE:
(◯) as empirical support for hypothesis
(△) as mix support for hypothesis
MKdp as market knowledge depth
MKbr as market knowledge breadth
EPli as exploitative capability
EPlr as explorative capability
PDin as product innovation
PCin as process innovation
* p<0.05, t> 1.65 (one-tail)

Table 4

The moderators of ambidextrous capabilities in market knowledge depth—innovation linkage

To process innovation		Model 1	Model 2	Model 3	Results	**To product innovation**		Model 1	Model 2	Model 3	Results
R^2		0.070	0.661	0.666	Model 2 is better.	R^2		0.021	0.526	0.532	The model 2 is better.
⊿R^2			**0.592**	0.005		⊿R^2			**0.505**	0.006	
R^2_{adj}		0.050	0.647	0.647		R^2_{adj}		0.001	0.506	0.506	
F-test		3.618	46.205	34.964		F-test		1.060	26.259	19.928	
⊿F (p-value 0.05)			**0.000***	0.342		⊿F (p-value 0.05)			**0.000***	0.382	
Control vars	Size	0.16	0.05	0.06		Control vars	Size	0.08	-0.03	-0.05	
	Capital	0.11	0.12	0.10			Capital	0.09	0.09	0.11	
	Age	-0.20*	-0.12*	-0.13*			Age	-0.04	0.03	0.04	
Antecedents	MKdp		**0.12***	0.09	The result is the same as the original model	Antecedents	MKdp		**0.14***	0.17*	The result is as same as the original model
	EPli		**0.31***	0.31*			EPli		**0.31***	0.30*	
	EPlr		**0.48***	0.48*			EPlr		**0.41***	0.40*	
Interaction	MKdp* EPli			-0.07		Interaction	MKdp* EPli			0.09	
	MKdp* EPlr			-0.01			MKdp* EPlr			-0.01	

The moderators of ambidextrous capabilities in market knowledge breadth—innovation linkage

To process innovation		Model 1	Model 2	Model 3	Results	**To product innovation**		Model 1	Model 2	Model 3	Results
R^2		0.070	0.654	0.656	Model 2 is better.	R^2		0.021	0.514	0.530	The model 2 is better.
⊿R^2			**0.584**	0.002		⊿R^2			**0.493**	0.016	
R^2_{adj}		0.050	0.639	0.636		R^2_{adj}		0.001	0.494	0.503	
F-test		3.618	44.719	33.392		F-test		1.060	25.054	19.746	
⊿F (p-value 0.05)			**0.000***	0.638		⊿F (p-value 0.05)			**0.000***	0.097	
Control variables	Size	0.16	0.04	0.05		Control variables	Size	0.08	-0.03	-0.04	
	Capital	0.11	0.13	0.12			Capital	0.09	0.11	0.11	
	Age	-0.20*	-0.11*	-0.11*			Age	-0.04	0.03	0.05	
Antecedents	MKbr		0.08	0.06	The result is the same as the original model	Antecedents	MKbr		0.06	0.09	The result is as same as the original model
	EPli		**0.31***	0.31			EPli		**0.33***	0.32*	
	EPlr		**0.48***	0.49			EPlr		**0.42***	0.44*	
Interaction	MKbr* EPli			-0.07		Interaction	MKbr* EPli			0.01	
	MKbr* EPlr			0.06			MKbr* EPlr			0.13	

NOTE: * $p<0.05$, $t> 1.65$ (one-tail)