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Abstract

This study provides a theoretical framework and empirical evidence to argue that a knowledge management process under the open innovation paradigm brings a viable solution for firms, especially those in transition economies, to acquire valuable knowledge-based dynamic capabilities to respond to environmental changes and achieve desirable organizational performance. These knowledge-based capabilities in turn enable firms to enhance their economic performance in terms of productivity and profitability. Dynamic capabilities act as an intermediary that bridges firms' open innovation efforts and their economic realization. Local institutional quality plays an important moderating role in this process. Micro-sized firms have not consistently obtained the expected economic benefits from their open innovation efforts, which requires more policy attention. For empirical evidence, we consider a comprehensive range of measures for open innovation and dynamic capabilities. Our proposed hypotheses are tested in a set of seemingly unrelated equations by combining two datasets from the Vietnam SME survey and the Provincial Competitiveness Index survey. As a robustness check, we estimate the performance equation applying fixed effect regression and one-year lag structure.

Key words: open innovation, dynamic capabilities, knowledge management, institutional quality, productivity, profitability, transition countries.

JEL Classification: D22, L10, L20, L26, O30

1. Introduction

The global knowledge economy has triggered an increase in the intensity of competition in both domestic and global world market, together with a wider technological and development gap between advanced and transition countries. Notwithstanding this gap, innovation has been a constant feature of our tales of transition and transformation. Nevertheless, throughout the 1990s, while innovation was perceived to be an end of development in advanced countries, it was seen as a means to improve basic needs and overcome multiple challenges of development in emerging countries. Only recently has innovation been considered as a major force in economic growth for transition countries (Chataway et al., 2014). Given the distinctive transition context, the well-researched question "what drives innovation?" constitutes an important issue for policy makers. On one hand, historical experience supports the claim that innovation in transition countries can be accelerated by exploiting existing knowledge and know-how from advanced countries or by facilitating the exchange of both external and local knowledge within a country (Zanello et al., 2015). On the other hand, the impact of innovation on economic performance is contingent on the nature and quality of institutions (Carbonara et al., 2016; Urban, 2016). Every economy, ideally, should provide a range of favourable institutions including a strong national innovation ecosystem to encourage and support innovation efforts. However, transition economies have significant institutional voids (Meyer and Peng, 2016) and marked institutional diversity, with the pace of institutional restructuring not consistent across or within countries and important regional variations in institutional quality (Tran, 2019; Tran and Santarelli, 2020).

Two main approaches shape the management literature on the drivers of innovation: the market-based view and the resource-based view. While the market-based view argues that innovation opportunities emerge from the marketplace, and thus market conditions facilitate or constrain the extent of firm innovation activity, the resource-based view emphasizes the role of firms' own resources as a stable foundation to formulate innovation strategies and shape the market in accordance with their own view (Eisenhardt and Marktin, 2000). In an increasingly connected world of distributed knowledge, it is essential to combine the two views to study how firms access, acquire, and develop new knowledge from external market and internal resource base to advance their technology competence and improve innovation performance (Lyu et al., 2019). Knowledge management has been identified in the management literature as a prerequisite of firm's innovation success (Martinez-Conesa et al., 2017). Adopting this logic, the open innovation paradigm centres around how firms manage the inflows and

outflows of knowledge through inter-organizational relationships to foster innovation outcomes and sustain competitive edges[1]. Implementing open innovation is indeed all about knowledge management, which fosters the diffusion, sharing and transfer of knowledge within the firm, and between the firm and the external environment (Chiaroni et al, 2011; Shujahat et al., 2017; Lai et al., 2014; Chen et al., 2012).

In the economic literature, the study of the drivers of innovation has mostly focused on the heterogeneous nature of the investigated sectors and firms. The 'localized technological change' approach put forward by Antonelli (1998) claims that firms are induced to innovate by disequilibrium conditions emerging in the product and the factor markets. Accordingly, the introduction of total factor productivity-increasing technological changes affects the efficiency of a given production technique, defined by its factor intensity. The 'history-friendly' modelling approach developed by Malerba et al. (1999; for an overview of the impact on the relevant literature cf. Capone et al., 2019) explains the idiosyncratic patterns of evolution of different industries by focusing on the characteristics of technological opportunities, the institutional arrangement governing the appropriability of innovations, the cumulative nature of technological change, and the cross-industry relationships. Starting from these path-breaking conceptual framework, numerous empirical studies have highlighted the importance of demand, firm- and industry-specific factors as determinants of the observed specificities in the attitude towards innovation exhibited by different firms and industries (cf., among others, Kleinknecht and Verspagen, 1990; Piva and Vivarelli, 2007; Pellegrino and Piva, 2020).

Research about knowledge management under the open innovation paradigm is to a large extent complementary to the economic approaches sketched out above. In fact, it has so far mainly focused on path-dependent development of knowledge. Such path-dependent knowledge is inherently resistant to institutional changes and unable to help firms respond to radical environmental turbulence in a transitional context (Zahra et al., 2006). It is recommended that stepping beyond path-dependent knowledge, firms in transition countries adopt an integrated and dynamic knowledge management process to continuously incorporate external knowledge as a way to bring in essential organizational capabilities, enhance economic performance and produce long-term competitive advantages (Andreeva and Kianto, 2011). In addressing the effect of institutional factors on the relationship between knowledge management and venture innovation in transition economies we make four contributions. First,

[1] For a review, see West et al. (2014) and West and Bogers (2017)

we leverage the three management theories to submit an integrated framework which comprises elements of the open innovation paradigm, dynamic capability theory, institutional theory, with the aim to explore the knowledge process that transforms knowledge created from open innovation process into fruitful knowledge-based dynamic capabilities. In other words, dynamic capability plays the mediating role on the relationship between open innovation knowledge management and firm performance. Although there is a general agreement on the benefits of open innovation, a number of studies also claim that the chosen open innovation system might not yield the desired return (Alegre et al., 2013). We argue that a value-adding open innovation system requires a clear decision-marking framework that takes into account the link between knowledge management through open innovation practices and dynamic capabilities.

Second, following the economic literature on institutional context (Dosi, 1988; Nelson, 1993; Malerba, 2005; Carbonara et al., 2016; Tran, 2019, Dosi et al., 2020) and the management literature on open innovation and dynamic capability (Chaston and Scott, 2012; Huang et al., 2015; Pilav-Velic and Marjanovic, 2016; Kearney, 2012; Dong et al., 2016; Kumar et al., 2013; Goedhuys and Sleuwaegen, 2016) we use the context of a fast-growing transition economy characterized by increasing competition and under-developed institutions to explore how institutional forces influence firms who currently operate below the technology frontier with lower levels of managerial and production skills in adopting open innovation practices.

Third, in the light of the high failure rates in open innovation (Gassmann et al., 2010), we suggest that the whole open innovation-dynamic capability-performance process is moderated by local institutional quality. Dynamic and diverse local institutions are an intrinsic characteristic of transition economies (Meyer and Peng, 2016). Using a unique dataset and an index indicating provincial institutional quality, we examine the moderating role of institutions on this process. While significant progress has been made to improve the general business institution, firms in transition countries continue to face numerous challenges that impede their innovation activities and value realization (Bradley et al., 2012). As such, our study empirically investigates how regional institutional environment interacts with firm-level knowledge to extract value from their open innovation.

Finally, while it is relatively easy for established firms to build up their competitive advantage from knowledge and technological skills embedded in innovations being offered in

marketplace, this is challenging for small- and medium-size enterprises (SMEs), given their limited involvement in formal R&D activities (cf., among others, Ortega-Argilés et al., 2009; Expòsito and Sanchis-Llopis, 2019). Thus, we extend our study to an under-researched context: manufacturing SMEs. We use an 8-year panel of Vietnamese manufacturing SMEs from 2007 to 2014 and apply advanced methodologies that control for the mediation effect of dynamic capability. Our results reinforce previous calls for better understanding of firms' networking strategies and dynamic capabilities in understudied contexts in order to effectively assist their innovation activities.

The organization of the paper is as follows. Section 2 briefly reviews the theory and literature on open innovation, dynamic capabilities and their interaction; and also proposes research hypotheses. Section 3 gives a description of the data used for this paper. Section 4 presents the methods we employ and defines our adopted variables. Section 5 presents the findings of the paper and provides discussion. Section 6 provides a robustness check applying fixed-effect estimation and one-year lag structure. And section 7 concludes.

2. Literature discussion

2.1.Knowledge Management under Open Innovation Paradigm

According to the knowledge-based view of the firm, knowledge is the most strategically important resource at a firm's disposal. In a knowledge-rich environment, firm is conceptualized as a knowledge-bearing entity (Grant, 1996), or a knowledge management institution (Ettlie and Pavlou, 2006), in which collective knowledge is created, acquired, shared, codified, leveraged and utilized through an enabling environment to improve innovativeness and organizational performance (Andreeva and Kianto, 2011; Santoro et al., 2017), and generate sustained competitive advantage because it is socially complex and usually difficult to imitate (Soto-Acosta et al., 2015). As in Teece (1998: 62)'s words, "the competitive advantage of companies in today's economy stems not from market position, but from difficult to replicate knowledge assets and the manner in which they are developed". Two main dimensions are essential in knowledge management, namely enablers and processes. Enablers are mechanisms that facilitate knowledge management technologies, such as tools or channels (infrastructure) codifying and sharing among individuals and teams. In turn, knowledge management processes refer to managing knowledge effectively by the structured coordination of three interrelated, path dependent, cumulative and complementary subprocesses: knowledge

exploration with the "make-or-buy" decision; then knowledge retention with the "integrate-or-relate" issue; and finally knowledge exploitation confronting firms with the "keep-or-sell" problem (Yeh et al., 2006; Lichtenthaler and Lichtenthaler, 2009).

Innovation consists of the successful exploitation of new ideas and is therefore associated with the creation and use of knowledge. Knowledge is captured and accumulated through continued external and internal organizational learning (Moustaghfir and Schiuma, 2013; Alegre et al., 2013). Internal learning refers to new knowledge created by a firm's own cumulative experience using its own resources, mainly through R&D activities and implementation of best practices (Zollo and Winter, 2002); whereas external learning refers to new knowledge integrated and created through interactions with external partners (Bapuji and Crossan, 2004). New knowledge coming from both internal and external learning is included in the knowledge base of the firm and is an important input to the innovation process. Inherently, knowledge created today can become tomorrow's rigidities if the firm is not able to adapt knowledge to environmental changes (Newey and Zahra, 2009). In this sense, it has been argued that knowledge management sets path towards external learning in the form of open innovation practices (Vayrynen et al., 2017). In other words, it is essential for firms to constantly update and leverage their collective knowledge through collaboration or networking activities with external partners (Piga and Vivarelli, 2007). However, although open innovation has increasingly been considered "not only as a source of competitive advantage but also as a competitive necessity" (Cheng and Chen, 2013: 450), researchers also suggest that not all types of networks and collaborations make valuable contributions to the innovation performance of firms (Wagner, 2013). The right networks are those that firms can either generate from their knowledge exchange relationships or benefit from unintended knowledge spill-overs from these relationships. Along a firm's interaction direction, inbound open innovation refers to the *ex-ante* utilization of external knowledge to supplement a firm's internal knowledge, while outbound open innovation represents the *ex post* exploitation of internal knowledge through external commercialization of internally created products and services (Chesbrough, 2006; Spithoven et al., 2011). Both inbound and outbound open innovation require firms to efficiently manage their knowledge inflows and outflows across their permeable boundaries to produce value-adding innovations (Harison and Koski, 2010; Huizingh, 2011).

The knowledge accumulated by open innovation practices can assist organizational agility by speeding up new product development and enriching innovation activities to meet nascent market opportunities. Gassman et al. (2010) synthesize the nine functional perspectives

underpinning the open innovation knowledge accumulation process: (1) the *spatial perspective* articulates that the proximity to R&D centers enables firms to increase their absorptive capacity and R&D's internationalization; (2) the *structural perspective* attributes open innovation to the growing trend of R&D outsourcing and alliances to achieve greater specialization through industries' disaggregated value chains; (3) the *user perspective* involves bringing customers into the open innovation process; (4) the *supplier perspective* emphasizes the importance of early integration of suppliers into the open innovation process; (5) the *leveraging perspective* extends open innovation competencies into new market fields beyond the existing market and business; (6) the *process perspective* divides the open innovation process into three processes: outside-in, inside-out and coupled; (7) the *tool perspective* focuses on the required set of instruments, such as communication technologies, in the open innovation process; (8) the *institutional perspective* considers open innovation as "a private-collective innovation model" that involves the government in supporting firm-level innovation efforts and free spill-over of proprietary knowledge; and (9) the *cultural perspective* strengthens the role of an open mindset and positive culture to facilitate open innovation.

Although numerous empirical studies on open innovation integrate some or almost all of these underlying perspectives in their analytical framework (Sofka and Grimpe, 2010; Ili et al., 2010; Robbins and O'Gorman, 2014), none can give us thorough insights into how knowledge created and retained from open innovation brings in the expected relational rents on a continuous basis. This is a serious lacuna in the extant research on open innovation, especially when knowledge management has become the most critical input in the innovation process, and the "locus of innovation" has been shifted to the role of rapidly growing knowledge-based alliances and networks in facilitating organizational learning process (Powell et al., 1996). No matter how efficient knowledge management practices are, they are not sufficient to achieve sustainable innovation rents since competitors will soon succeed in imitating these practices and thereby erode the firm's competitive advantage. In addition, technology and market changes can render a given knowledge management practice obsolete or unsuitable. This calls for the need of developing a dynamic capability to adapt and renew this knowledge management practice so that superior innovation performance can be sustained.

2.2.Knowledge Management Capability as a Dynamic Capability

Two relationship between knowledge management and open innovation raises two main questions: *i)* can open innovation enable firms to enrich or leverage their knowledge

management capability?; *ii)* to what extent can managers explore, retain, and exploit various sources of knowledge at their disposal and turn them into value-creating activities? (Chen and Huang, 2009). Knowledge management capability is a form of dynamic capability which permits firms to adapt their repertoire of organizational knowledge to changing environments by reconfiguring and realigning the processes of knowledge exploration, retention, and exploitation across their boundary (Vanhaverbeke and Cloodt, 2014). Lichtenthaler and Lichtenthaler (2009) identify six knowledge management capabilities: (i) inventive capability enables firms to internally explore or generate new knowledge; (ii) absorptive capacity allows firms to explore and utilize external knowledge; (iii) transformative capability helps firms to internally store knowledge; (iv) connective capability represents the firm's ability to store knowledge in inter-organizational relationships; (v) innovative capability develops new products and services; and (vi) descriptive capacity refers to the outward knowledge transfer.

Approached from an evolutionary perspective as "a learned and stable pattern of collective activity" (Zollo and Winter, 2002), knowledge-based dynamic capability addresses organizational knowledge management towards a higher level of response to knowledge and environmental changes (Ambrosini and Bowman, 2009, Zheng et al., 2011). Firms with strong knowledge management capability are more able to exploit and explore knowledge in learning networks to produce more "knowledge-based innovation" (Costa and Monteiro, 2016: 389), breakthrough products and processes that are valuable for customers and critical for sustaining their competitive advantages (Cheng and Chen, 2013). As a result, as an organization design coordinating various resources and functional units (Wirtz et al., 2010), open innovation may not directly affect a firm's performance by itself. Instead, it enhances knowledge management capability as an intermediary step to leveraging innovation output.

In particular, the three knowledge management subprocesses - exploration, retention and exploitation - are associated with the three respective knowledge management capabilities, acquisition, generation and reconfiguration. First, since pre-accumulated knowledge exists in both explicit and difficult-to-transfer tacit form, the exploration of new knowledge requires the acquisition capability, comprising both inventive and absorptive capacity of Lichtenthaler and Lichtenthaler (2009), which refers to the ability to acquire unrelated knowledge from various channels to assimilate and apply them to new commercial ends (Wu and Chen, 2012). The organizational learning literature suggests that knowledge acquisition capability, as a basis of absorptive capacity, is a key determinant of the accumulation of valuable, tacit, and inimitable knowledge that enables firms to better and more accurately identify new knowledge (Cohen

and Levinthal, 1990). Second, the knowledge retention process requires the generation capability to efficiently transforms existing knowledge in their knowledge repository to novel knowledge through new ways of configuration, many of which rely on virtual or digital organizational interaction and collaboration routines. This knowledge generation capability, as a knowledge-based dynamic capability, contributes to the final value-creating exploitation process (Grigoriou and Rothaermel, 2017) by creating an 'organizational memory' to organize and make important knowledge available wherever and whenever it is needed (Cegarra-Navarro and Sanchez-Polo, 2011). Third, the knowledge exploitation process requires the reconfiguration capability to modify and utilize the expanded knowledge base from the first two processes via inter-organizational linkages. On one hand, reconfiguration is a utilization process through which firms derive benefits and pay-offs from their accumulated and integrated knowledge. On the other hand, reconfiguration involves generating new combinations of newly acquired knowledge or leveraging existing knowledge for new practical uses or in new forms (Jantunen et al., 2005). Therefore, reconfiguration, operating through the continuously repeated recombination of existing and new routines that are dynamically developed in an evolutionary path to fit changing environments (Teece et al., 1997, Salvato, 2003), processes the features of a high-order dynamic capability (Birkinshaw et al., 2016). It requires continuous combination, coordination, and socialization (Van Den Bosch et al., 1999) to enrich the knowledge repository and realize up-to-date innovation opportunities (Macpherson et al., 2004).

2.3.Knowledge-based Dynamic Capability and Economic Performance

As knowledge plays a fundamental role in the success of a firm, unarguably the dynamic knowledge management capability that enables the firm to constantly configure and reconfigure its knowledge accumulated from different sources in response to environmental changes is critical for this realization of success (Castrogiovanni et al., 2016). Indeed, dynamic capability has been long considered as a source of sustainable competitive advantage that enables firms to initiate organizational changes and implement strategies to improve their efficiency and effectiveness in a volatile and dynamic market (Barney, 1991). However, other researchers coming from a different perspective suggest that on one hand the development path dynamic capability despite sharing some common characteristics is unique and distinctive for each firm's context (Eisenhardt and Martin, 2000), leading to diverse organizational performance among individual firms; on the other hand, dynamic capability is just "best practice", valuable and rare, but can be substituted and even imitated by other firms (Eisenhardt

and Martin, 2000: 1106). Further, developing the right configuration of dynamic capability requires significant commitment of managerial resources (Helfat and Peteraf, 2015), which is often beyond the affordable capacity of small and young firms. Thus, contradictory impacts of dynamic capabilities on firm performance have been evidenced depending on methodological treatments, types of performance metrics employed, and whether dynamic capabilities are examined independently or in relation to a context (for a review, see Pezeshkan et al., 2016).

Notwithstanding these empirical contradictions, there has been a common consensus for several aspects. First, it is consistently argued that dynamic capabilities alter the knowledge base of a firm in a positive way (e.g., Di Stefano et al., 2014; Peteraf et al., 2013). Newly altered knowledge become "best practice", rare and valuable despite being imitable and substitutable overtime. As such, firms may create a temporary competitive advantage with these best practices. As long as they are fast enough to update these temporary competitive advantages regularly, they are the best performers in the market. Second, dynamic capability revitalizes a firm's operational capabilities to enhance its efficiency and responsiveness to environmental changes (Drnevich and Kriauciunas, 2011; Teece, 2019). Empirically, dynamic capabilities are found to positively relate to competitive advantage (Teece, 2014), and organizational performance (Pezeshkan et al., 2016).

Most importantly, extant research has not looked into dynamic capability from a knowledge-based perspective, and thus a measure of knowledge-based dynamic capabilities is necessary to validate its effect on economic performance. On one hand, knowledge management capability guarantees more efficient knowledge-based processes and cost reduction. On the other hand, since knowledge management capability does not erode but rather develops in use over time (Pandza et al., 2003), its utilization tends to be tacit and subconscious. This tacit feature requires networking capability in inter-firm collaborations that promotes knowledge sharing, technology transfer, risk and cost sharing with networking partners, (Kale and Singh, 2007; Vaccaro et al., 2010), and clustering capability which enhances the positive effect of network knowledge spillover (Lyu et al., 2019).

2.4.Institutional Quality as the Moderating Factor

As the role of government tends to be much more influential in emerging and transition economies, institution-based theorizing has increasingly dominated both scholarly studies and policy debates in these economies (Barasa et al., 2017; Tran, 2019). Defined as formal and informal 'rules of the game' created to regulate and monitor business activities (Oliver, 1997),

institutions have been found to explain open innovation through laws, regulations and policies (Wang et al., 2015). On one hand, as a risky and long-term investment, open innovation is affected by agency problem that incurs high transaction costs and financial constraints. On the other hand, successful open innovation requires the development of the critical knowledge management capability, which is contingent on the availability of various knowledge-sharing channels or innovation intermediaries (Wu et al., 2016), and the ease of flexible coordination among network partners (Alonso and Garcimartin, 2013). Effective institutional environment stimulates firms' open innovation and strengthens their knowledge-based dynamic capability by reducing agency problem among decision makers, mitigating transaction costs, minimizing risks and uncertainty, and thereby help to optimize open innovation efforts (Wu et al., 2016). Moreover, strong institutions provide good governance such as strong IPRs to enhance incentives and supports for innovations, R&D collaborations, and knowledge sharing (Alam et al., 2019; Belitski et al., 2019). Empirical studies have shown that the most important factors forcing firms to innovate is the effectiveness of the institutional system (Seitz and Watzinger, 2017). However, how institutions influence the outcome of open innovation knowledge management, as well as moderate the effect of open innovation outcome on economic performance is still beyond our knowledge

During the initial transition period, firms were confronted by two institutional logics: that of the still dominant planned economy and the emerging logic of the market economy. Transformation from the old planned institutions to the new market institutions left significant institutional deficiencies (Puffer et al., 2010; Meyer and Peng, 2016): an under-developed property rights regime and a weak and fragile legal system (Khanna et al., 2005); sluggish labor and capital markets (Hoskisson et al., 2000); an excessive regulatory burden with high transaction costs, information asymmetries and bureaucratic corruption (Luo and Junkunc, 2008), which makes it more difficult to extract value from a firm's knowledge repository for open innovation and realize desirable relational rents from its collaborations (Meyer et al., 2009). Nguyen and Jaramillo (2014) analyze data for more than 6000 firms in middle- and low-income countries, finding that institutional quality lowers the return to innovation. Further, due to outdated or resource-constrained national innovation systems that fail to provide efficient knowledge sharing channels (Zanello et al., 2015), firms in transition countries still mainly rely on knowledge flows within their internal organizations, i.e. closed innovation.

As transition progresses, institutions undergo changes and improvement that make them more apt to support market-based transactions (Ahlstrom and Bruton, 2010). Pro-business

market reforms are consistently found to have a strong effect that counterbalances the negative impact of political instability and far-below technological frontier during the transition (Allard et al., 2012). However, institutional development is path dependent and essentially linked to location specific characteristics (Yi et al, 2017). This is reflected in the number of recent studies that have sought to explore within-country institutional differences (e.g. Shi et al., 2012; Peng et al. 2015, Dheer et al. 2015)[2]. As important medium of governance and economic coordination at the meso-level, the pace and quality of institutional development varies across regions or provinces. According to Kaufmann et al. (2011), this institutional development encompasses the process by which a government is selected, monitored and replaced, its capacity to effectively formulate and implement sound policies and the economic and social interactions between citizens and the state are governed. Therefore, the extent to which firms can successfully use their knowledge and resources to innovate is likely to differ between regions (Barasa et al., 2017).

2.5.A Conceptual Integration of Open Innovation Knowledge Management, Knowledge-based Dynamic Capability, and Institutions: Hypotheses.

Consistent with Cohen and Levinthal (1990; cf. also Cohen and Klepper, 1996), one may assume that the complementary nature of internal and external knowledge processes requires an integrative knowledge management to successfully implement open innovation. Likewise, firm must possess knowledge management capabilities to assess and respond rapidly to competitors' actions (Liao et al., 2011). The knowledge management process is divided into three dynamically interrelated subprocesses: knowledge exploration; knowledge retention; and knowledge exploitation. This process is reflected by Gassman et al. (2010)'s nine influential perspectives: spatial, structural, user, supplier, leveraging, process, tool, institutional, and cultural. The effect of knowledge accumulated from open innovation on firm performance is mediated by the development of fruitful knowledge management capability, a type of knowledge-based dynamic capability. We believe the interaction between open innovation knowledge management and knowledge-based dynamic capability is two-way in the sense that the exploration, retention and exploitation of knowledge are involved in the capabilities of searching, sense-making, integrating, generating, utilizing and reconfiguring a firm's

[2] This variety is clearly observed in Vietnam (Nguyen et al., 2013, Tran, 2019). In Vietnam, provincial governments devote resources to improving regional institutional quality with varying intensity and commitment. Levers that can be 'pulled' include the allocation of resources subject to market principles, the percentage of products with market-based prices, and the development of market intermediaries and market-oriented legal systems (Meyer and Nguyen, 2005).

knowledge repository, which are dynamic capabilities. However, in return, the newly reconfigured dynamic capabilities have a loopback effect on what and how the firm will manage its knowledge pool from open innovation activities to achieve the desirable outcomes.

Figure 1 illustrates our theoretical framework: the relationship between a firm's open innovation knowledge management process and economic performance, and the mediating role of newly generated knowledge-based dynamic capabilities on this relationship.

Insert Figure I about here

The knowledge management process under the open innovation paradigm is generally conducted through the interactions among individuals and organizations within knowledge-based network systems. This is essentially a reciprocal process of idea exchange and diffusion in knowledge acquisition, resource integration and accumulation in knowledge retention, and resource application in knowledge exploitation. The corresponding outcomes of the knowledge management process are the three respective knowledge-based dynamic capabilities: acquisition, generation, and utilization. These capabilities in turn are interrelated and complementary in the same way as their embedded knowledge subprocesses, which enable firms to achieve mutually beneficial R&D collaboration, technical learning and building innovative capabilities for long-term competitive advantage (Lin and Chang, 2009). On the basis of the above discussion, we hypothesize:

Hypothesis 1: The open innovation knowledge management process is positively associated with knowledge-based dynamic capabilities of firms.

Hypothesis 2: The knowledge-based dynamic capabilities acquired from the embedding open innovation knowledge management process are positively associated with the organizational performance of firms.

While numerous studies suggest a positive effect of open innovation on entrepreneurial performance of large firms and SMEs (among others, Parida et al., 2012; Verbano et al., 2015; Xia and Roper, 2016), the implication of open innovation for micro-sized firms has not been well-understood (Spithoven et al., 2013; Martinez-Conesa, 2017). Micro firms represent a peculiar source of innovation in a quickly changing transition context. Facing more financial and knowledge constraints in conducting innovations than larger firms, they generally focus on local and niche markets. However, as globalization and internationalization bring in severe

competition that requires micro firms to be dynamic and responsive, it is questionable whether this strategy can be sustained, and whether open innovation provides a viable path allowing them to adapt and prosper in increasingly turbulent and dynamic competitive environments. Moreover, large firms appear to be able to trigger the development of dynamic capabilities in their own networks (Athreye et al., 2009), how about small firms given their limited networking capacity? We claim that micro firms do have advantages over larger firms in that they are less bureaucratic, more flexible and responsive to market needs, and thus are more likely to benefit from external knowledge spill-over (Moilanen et al., 2014), such as generating new innovations and developing organizational capabilities from purchasing licences for the knowledge and technology that they lack (Kim and Park, 2010). We propose the following hypothesis:

Hypothesis 3: The effect of open innovation knowledge management on organizational performance will be stronger for micro-sized firms than for larger firms.

Regulatory institutional environment has a major influence on both innovation activities and economic performance of organizations (Dosi et al., 2020; Tran, 2019). On one hand, because of their limited internal resources, firms may be forced to adopt an open innovation approach to expand their knowledge pool for viable innovations (Urban and Hwindingwi, 2016). But on the other hand, given their vulnerabilities to institutional regulatory constraints and other institutional voids in transition economies, firms tend to either conduct open innovation just enough to survive, but not to thrive; or realize less benefits from their open innovation knowledge management. For instance, poor IPRs in a transitional setting make firms reluctantly share their valuable knowledge and technology with external partners, or high agency problem would deter firms from fully appropriating their innovation outcomes. Institutional restructuring during the transition is seen to increase institutional quality by alleviating regulatory pressures, accelerating market and competitive forces and relaxing direct state control (Bruton et al. 2015). These measures obviously encourage firms, regardless of their size, to conduct more open innovation through collaboration and networking as well as enable them to reap full benefits from their knowledge management practices. Thus, we hypothesize that:

Hypothesis 4: As institutional quality improves, the effect of open innovation knowledge management on organizational performance is stronger.

3. Data Description

For empirical evidence, we extend open innovation and dynamic capability research to Vietnam, a fast-growing transition country. During the transition process, Vietnam has opened and gradually built up a National Innovation System (NIS), catching up with innovation development in advanced countries (Santarelli and Tran, 2017). Despite being in its infancy, the Vietnamese NIS has made encouraging achievements in supporting relatively under-scaled state-owned firms in transforming their closed innovation process to a more open one through the establishment of and investment in formal R&D centers that exchange and diffuse innovation opportunities (Nam et al., 2019). For smaller, private firms with limited resources and capabilities, they normally exploit internal available resources first before moving externally through their limited network of relationships to seek collaboration. These specific contextual barriers may raise questions concerning whether open innovation strategies can be applied beneficially in the context of Vietnam, and how knowledge management in open innovation brings in the expected benefits to firms, especially small private firms. Thus, Vietnam provides an ideal empirical setting to test our proposed hypotheses.

Our empirical tests rely on a combination of two datasets. The first dataset is an 8-year panel of Vietnamese small and medium private manufacturing enterprises from 2007 to 2014, which is extracted from three waves of the Danish International Development Agency (DANIDA) surveys (carried out in 2011, 2013, and 2015). The surveys are designed to provide detailed information on both sampled entrepreneurs and their firms as representatives of the private sector in Vietnam[3]. To clean the data, all firms with missing, negative or zero total assets, sales and labor force are dropped. The outliers are controlled by censoring the top and bottom 1% of observations in the distributions of each variable. The final sample consists of 19,933 observations covering 3,965 firms, of which nearly 50 percent (1,982) had some investments into innovation activities. Among these innovation-intensive firms, 54 percent invested in upgrading machines and equipment, nearly 5% invested in training technical employees, and only 4% invested in R&D and patent activities. The remaining is for land, buildings and other businesses. The three largest sectors in terms of number of enterprises are food and beverages, fabricated metal products and manufacturing of wood products. Table 1 documents a tabulation of legal ownership and firm size of our sample. 60 percent of the sampled firms are household enterprises, of which up to 93 percent are at micro-sized. Some 70 percent of sampled firms are registered at micro-sized, as compared to 29 percent as small-

[3] Detailed description of data, sampling methods and associated projects can be obtained from https://www.wider.unu.edu/project/structural-transformation-and-inclusive-growth-viet-nam

sized firms and less than 1 percent as medium-sized ones. Limited liability and joint stock companies are generally larger than other ownership types.

The second dataset that we use for our analysis is the Provincial Competitiveness Index (PCI) data assessing and ranking the economic governance quality of provincial authorities in creating a favourable business environment for the development of the private sector. This annual survey is a product of the collaboration between Vietnam Chamber of Commerce (VCCI) and the U.S Agency for International Development (USAID). PCI is a provincial institutional index, a weighted average of the 9 sub-indices, each measuring a different aspect of local formal or informal governance[4].

Table 1: Number of enterprises by legal ownership and size

	Micro	Small	Medium	Total
Household enterprises	2,219	175	0	2,394 (60.38)
Private / sole proprietorship	152	142	1	295 (7.44)
Collective/ partnership	29	69	1	99 (2.5)
Limited liability companies	343	621	19	983 (24.79)
Joint stock companies	47	140	7	194 (4.9)
Total	2,790 (70.37)	1,147 (28.93)	28 (0.71)	3,965 (100) (100)

Note: Percentage in parentheses. Micro-sized: less than 10 employees; Small-sized: less than 200 employees; Medium-sized: less than 300 employees.

4. Methodology

4.1.Variables and measures

Dependent variables: Firms can be innovating not just by producing innovation outputs, but also by investing in knowledge-building activities to improve profitability and productivity (Crepon et al., 1998; Lundvall et al., 2010; Castellacci, 2011; Ugur et al., 2016). We utilize a combination of both productivity and profitability performance measures. For productivity measure, we adopt the Levinsohn and Petrin (2003) methodology to predict firms' total factor productivity (TFP) from revenue (or value added), labor cost, capital and intermediate inputs[5]. For profitability measure, we use the common return on sales (ROS) as a ratio of operating profit to total sales.

[4] Data of PCI index and information about the methodology and reports can be obtained from http://eng.pcivietnam.org/pci-data-c16.html. See Tran (2019) for some descriptive and statistical exploration of the index.

[5] Using TFP as a productivity measure has two advantages: (i) taking into account the possibility of substitution in the use of production factors (labor, capital, materials); (ii) taking into account the technical change by industry and the role of intermediate inputs in production (OECD, 2005)

If dynamic capabilities are hypothesized to affect performance, their measures should be independent of performance (to prevent potential endogeneity). Following Teece et al. (1997) and Eisenhardt and Martin (2000), we see dynamic capabilities as organizational-level intangible knowledge, which also receives more theoretical justifications (Di Stefano et al., 2014). Corresponding to these three stages of the open innovation knowledge management process, the three respective dynamic capabilities are measured as follows:

(i) acquisition capability is measured by *innovation intensity*, the ratio of innovation investment to total sales (Santarelli and Tran, 2017), and *professionals share*, the share of professionals possessing college and university degrees to total labor force (Veugelers, 1997; Gao et al., 2008). These two variables reflect both financial and human perspectives of the firm's ability of acquiring knowledge and innovation inputs;

(ii) generation capability is reflected by the firm's ability of transforming innovation inputs into *innovation outputs*, measured as the number of innovation types conducted, ranging from one to all three types: new products, improvement of existing products, and new process/technology;

(ii) utilization capability is indicated by a dummy attaining 1 if the firm achieves *successful innovation output*. This reflects the firm's capabilities not only in generating new ideas and knowledge embedded in innovation outputs, but also in successfully utilizing these outputs for fruitful applications.

Independent variables: Open innovation knowledge management activities are reflected in nine perspectives suggested in Gassmann et al. (2010).

(i) the spatial perspective values the proximity to regional/provincial R&D centres to facilitate firms' access to resources and competencies. This is measured by a dummy indicating if the firm is located in Hanoi or Hochiminh city where the majority of colleges, universities, research institutes, public service providers and formal business associations are situated;

(ii) the process perspective consists of three core processes (Gassmann and Enkel, 2004: 6): (1) the inside-out process, or the outflow of resources and knowledge, is measured by *technology investment* - if the firm had made any investment in developing production technology, machine, equipment, infrastructure or skills for contract partners (customers and/or suppliers); (2) the outside-in process, or the inflow of resources and knowledge, is measured by *technology transfer* - if the firm had received technology transfer from suppliers and/or

customers; and (iii) the coupled process, or "coupling the outside-in and inside-out processes by working in alliances with complementary partners", is measured by the number of *formal business associations* that the firm holds membership.

(iii) the user perspective emphasizes the engagement of customers in the innovation knowledge management process, which is reflected by *customer network size,* the proportion of the firm's social network members as its customers[6].

(iv) the supplier perspective focuses on the engagement of suppliers in the innovation knowledge management process. Similar to the user perspective, we adopt *supplier network size* – the proportion of the firm's social network members as its suppliers. As sources of knowledge, suppliers and customers often provide critical feedback relevant to innovation (Garriga et al., 2013), enhance firms' knowledge base, capabilities, and competitiveness (Albort-Morant et al., 2016).

(v) the structural perspective observes a strong trend towards more R&D outsourcing and alliances (Cassiman and Veugelers, 2002; Hagedoorn and Duysters, 2002) to enrich and maintain firms' knowledge repository. This perspective is measured by two dummies indicating if the firm *outsources* its production and/or acts as a *subcontractor* for other firms.

(vi) the institutional perspective encourages the access to public financial resources and the free exposure of inventions and knowledge to support firms' own innovation efforts. The perspective is reflected by two variables: *government finance*, the likelihood that the government provides financial and technical assistance for the firm's innovation activities, and *political network*, the number of social network members as politicians and civil servants.

(vii) the cultural perspective values an open mindset that sustains continuous collaboration for knowledge sharing. It is reflected by a dummy that indicates if *feedback* from customers regarding standards of production and product quality plays a crucial role in the firm's innovation process.

(viii) the tool perspective stresses the important of a relevant set of instruments and tools used to facilitate knowledge flows in the innovation process. We use a dummy indicating if the firm sells products and/or buys input materials via *e-trading* with the help of modern information and communication technology.

[6] Social network members are those who have regular contacts with and are able to assist the firm in issues related to its operation.

(ix) the leveraging perspective creates new revenue streams by commercializing internally created technology and intellectual property outside of the firm. It is measured by a dummy that equals 1 if the firm plans to *diversify* into new product lines or new market fields exploiting its technology and production process in near future.

Provincial institutional quality is reflected by *PCI index*. In a high-PCI province, open innovation should be significantly promoted because the market environment and infrastructure allow firms to develop connections and networks with external partners.

Control variables

We control for the effects of firm-level demographic characteristics: *firm size* (measured by natural logarithm of total assets and a dummy to differentiate micro-sized firms from SMEs), *firm age*, *ownership types* (collective, private, limited liability, joint stock, foreign-invested), *export* (if the firm is engaged in exporting their products), *diversification* (if the firm is a diversified one), and *indebtedness* (debt ratio of the firm)[7]. Sector-level control variables consist of 20 sectors where the sampled firms operate.

Table 2 presents the descriptive statistics and Table 3 gives a pair-wise correlation matrix of adopted variables.

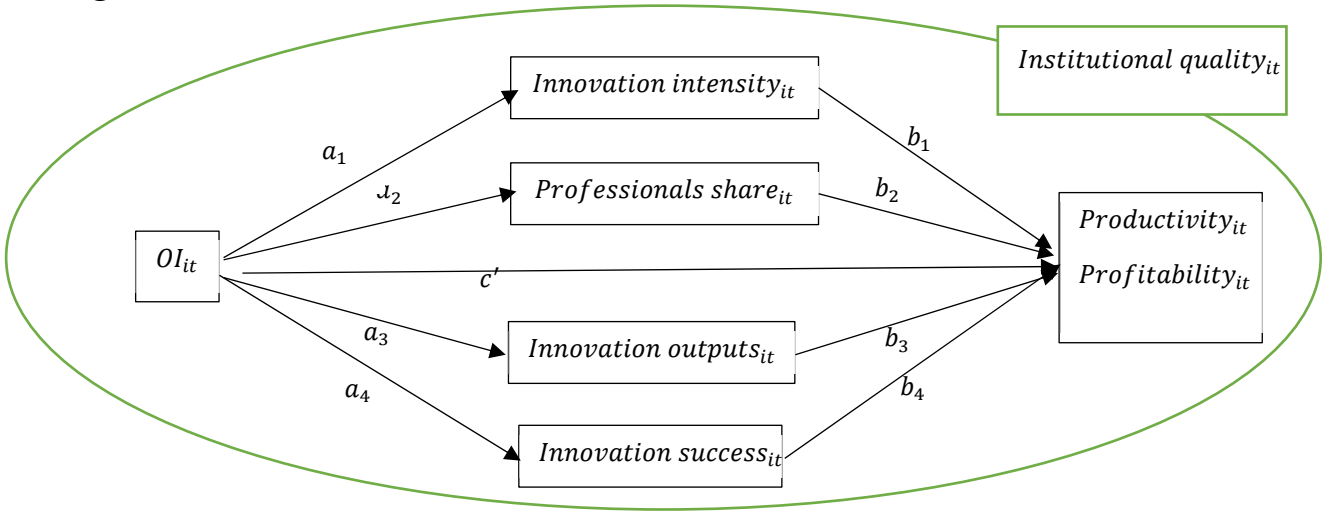
Insert Table II and Table III about here

4.2.Estimation models

Since the effect of open innovation on firm performance goes through the mediating dynamic capability measures, it is necessary to isolate the effects of selection bias and endogeneity. We use non-linear simultaneous equations to form a system of six equations based on the Preacher and Hayes (2008)'s approach. Our model has four mediators as below:

[7] Control variables are chosen based on the review of Alam et al., (2019) for the determinants of innovation activities.

Figure 2: Estimation model



OI_{it} presents the 9 functional perspectives reflecting the three-staged open innovation knowledge management process of firm i in year t. $Innovation\ intensity_{it}$, $Professionals\ share_{it}$, $Innovation\ outputs_{it}$, and $Innovation\ success_{it}$ indicate the three corresponding knowledge-based dynamic capabilities of firm i in year t. $Productivity_{it}$ and $Profitability_{it}$ reflects the economic performance of firm i in year t. a_1, a_2, a_3, and a_4 represent the regression coefficients for the independent variables $OI_{it}$when each mediator variable is regressed on all measures of OI_{it} respectively. b_1, b_2, b_3, and b_4 are the coefficients for the mediator variables when $Productivity_{it}$ and $Profitability_{it}$ take turn to be regressed on all mediators. The direct effect of OI_{it} perspectives on $Productivity_{it}$ and $Profitability_{it}$ is c', while the indirect effect of OI_{it} through mediators can then be quantified as the product of a and b. Thus, the total effect of OI_{it} on $Productivity_{it}$ and $Profitability_{it}$ can be expressed as the sum of the direct and indirect effects: $c = c' + ab$. $Institutional\ quality_{it}$ presents the moderating quality of the provincial institution where firm i is operating in year t.

We perform the Sobel-Goodman mediation test to check if dynamic capability measures carry the influence of open innovation to economic performance. The proportion of total effect that is mediated ranges from 0.018 for the mediation effect of *customer feedback* (cultural perspective) to 0.821 for the mediation effect of *technology transfer* (process perspective). In other words, the mediation effect of dynamic capabilities is statistically significant with approximately 2% to 82% of the total effect being mediated. Combining all the individual mediation effects, the overall effect of open innovation that dynamic capability carries on TFP is 17% and on ROS is 45% (see Table 4).

For a robustness check of the results from the main analysis, we first run the panel fixed-effect estimation to take into account the unobservable firm-specific characteristics (such as managerial capabilities or personality traits) possibly affecting both dynamic capabilities (the independent variables) and economic performance (the dependent variables), which may potentially results in endogeneity issues that bias our estimation. We then time lag the independent variables by one year in order to disentangle causes and effects.

5. Estimation results

5.1. The Open Innovation Knowledge Management – Dynamic Capability linkage

Table 3 presents the estimation results of the relationship between open innovation and knowledge-based dynamic capabilities. Columns 1, 2, 3 and 4 display results where innovation intensity, share of professional employees, innovation outputs, and innovation success are used as proxies for the three types of knowledge-based dynamic capabilities.

Insert Table III about here

Across the four columns, except for the negative effect of *R&D proximity* on *innovation intensity*, and of *political network* on *innovation success*, the coefficients of all measures of the nine OI knowledge management perspectives are positively associated with four dynamic capability measures, which supports Hypothesis 1. Obviously, firms locating close to R&D and research centres can benefit from knowledge spillover and complementarity R&D efforts to stimulate their own rate of innovation, and thus would no longer need to invest substantially into enhancing R&D capacity (Santarelli and Tran, 2012). However, proximity to R&D centres does require firms to have a larger human resource pool, i.e. technical employees with relevant technical degrees and training, to convert tacit spilled-over knowledge into explicit innovation output and commercialize them successfully. Further, although political network enables firms to strengthen their legitimate power to gain access and acquire various knowledge sources, it does not necessarily facilitate the successful utilization of new knowledge which requires more self-effort, clearly defined focus and process with proper governance.

The statistically significant effects of *technology investment*, *technology transfer*, and *business association membership* generally suggest that open innovation process, regardless of

knowledge flow direction (inside out, outside in or coupled), substantially strengthens all three types of dynamic capabilities of a firm. Holding other factors constant, if a firm invests into new technology development of their contracted partners, it is likely to have around 1% higher share of technical employees, innovation intensity higher by 0.4%, a 20% increase in the probability of conducting one more innovation output, and a 7.3% increase in the odds of achieving successful innovations compared to those who are not involved in technology investment. Similarly, holding membership of one more formal business association is expected to increase a firm's share of technical employees by 1.1%, innovation intensity by 0.3%, the likelihood of possessing one more innovation output by 10.7%, and odds of innovation success by 5.2%, whereas the outside-in process of acquiring new technology transferred from contracted partners would raise a firm's technical share 0.4% (although this is insignificant), R&D intensity 0.8%, and probability of conducting another innovation output 10%. It is worth noting that since 99% of our sampled firms are micro- and small-sized firms, the economic effects of numerically small estimated coefficients are actually not insignificant.

Both the supplier and user perspective exert a positive effect on a firm's dynamic capabilities. Suppliers given their knowledge about technology and market opportunities for the inputs help firms acquire the best inputs and utilize them successfully. In another survey question, 75% of respondents report that it is easy for them to switch to other suppliers. As a rapidly emerging market, Vietnam produces an abundance of business opportunities that significantly attract both local and foreign new entrants (Venard, 1998); obviously firms can enjoy a great diversity of raw materials and inputs from various suppliers, and exploit this diversity to harness their organizational capabilities. On the other hand, the larger the size of customer network in regular contacts, the more market knowledge a firm can access and integrate into its innovation activities, the more it commits to higher innovation investment for knowledge acquisition. Customers with increasingly sophisticated demands place continuous pressure on firms to adjust and improve their technology to produce more sustainable and value-adding innovations.

Unsurprisingly, modern information and communication technology is very important to the integration of new knowledge and maintenance of a continuously updated knowledge pool. It facilitates interfirm networking activities, outsourcing, investments, and technology transfer throughout the knowledge management process, and it thus enables firms to respond rapidly to market changes and capture any newly arising entrepreneurial opportunities. The statistically significant and positive coefficients of *e-trading*, i.e. firms applying internet and modern ICT

in buy and selling activities, in all four equations support our hypothesis. An open organizational culture that considers customer feedback as a valuable knowledge source for innovation is also found to be an ideal cradle for various types of dynamic capabilities. As expected, firms engaging in outsourcing and subcontracting are more exposed to external sources of knowledge and technology, and thus are more likely to be endowed with stronger dynamic capabilities. Nevertheless, since outsourcing firms have subcontractors to take over a part or the whole of their R&D, they may not need to employ many technical employees but require large investments to finance the outsourcing. This explains for the significant effect of *outsourcing* on *innovation intensity*, but insignificant effect on *professional share*.

Finally, the OI leveraging perspective, proxied by the likelihood of launching a new innovation project (either a new product line or new production process) exploiting externally accumulated knowledge in near future, stimulates firms to develop all three types of dynamic capabilities. Inherently, for such an ambitious innovation plan, the firm needs to be equipped with sufficient knowledge and capabilities: not only a large pool of financial and human resources to realize innovation opportunities, acquire and adjust external knowledge to exploit the opportunities, but also the capability to generate innovations and commercialize them in the target market successfully. Of the three knowledge-based dynamic capabilities, the generation capability has the highest economic effect: firms planning to launch a new product or technology in near future are 29% more likely to have one more innovation output at present.

Among the control variables, export firms are found to have fewer acquisition capabilities since most export firms in Vietnam operate as contractors or subcontractors producing standard products with pre-assigned designs. But given the higher chance of receiving advanced knowledge and technology transferred from foreign partners, they are still able to produce more innovation outcomes than non-exporters. In general, younger firms have higher acquisition and generation capabilities, but older firms can exploit their market experience to commercialize and appropriate innovations more successfully. In terms of asset size, smaller firms possess fewer dynamic capabilities to deal with environmental turbulence than their larger counterparts. Indebted firms and diversified firms all have significantly stronger dynamic capabilities. As Tran and Santarelli (2014) suggested, capital constrained firms in Vietnam are in need of further loans because they lack investment to exploit newly realized entrepreneurial opportunities, rather than to cover operational expenses. Finally, the PCI index reflects the quality of the local institutions of a province: the higher the PCI is, the higher the institutional quality is. The significantly positive coefficient of the PCI index indicates the important role

of favourable local institutions in boosting the development of knowledge management dynamic capabilities. Firms are able to realize significant benefits from their open innovation efforts in an environment of well-functioning institutions, which partly supports Hypothesis 4

5.2. The Knowledge-based Dynamic Capability and Economic Performance linkage

Table 4 presents the estimation results of the performance equation. Firm-level performance is measured by productivity and profitability. For each performance measure, we present both the direct and indirect effect of the three knowledge-based dynamic capabilities.

Insert Table IV about here

Except for the negative effect of innovation intensity on firms' productivity, we consistently find a significantly positive effect for all the other measures of the three types of dynamic capabilities on firm-level economic performance, which partly supports Hypothesis 2. Examining the relationship between spending on R&D and TFP for firms in U.K., Wakelin (2001) claims that the impact of R&D spending on the productivity of firms is low and loses significance when industry-level fixed effects are controlled. Benavente (2002) finds out for the case of Chile that productivity is not affected by spending on R&D and innovation. For Chinese firms, Zhang et al. (2011) suggest that R&D spending only stimulates productivity for high-tech firms and this relationship varies significantly across regions. Mei et al. (2019) also claim that R&D intensity weakens the positive effects of knowledge source linkages on Chinese SMEs' innovation performance. In light of these findings, it is unsurprising that spending on innovation could have an adverse impact on productivity in Vietnam when the majority of our firms are small, not high-tech and sectoral fixed effects are controlled.

To test Hypothesis 3, which posited that the effect of the open innovation knowledge management process on economic performance would be greater for smaller firms, we add interaction terms between micro-sized firms and each type of dynamic capability to evaluate the moderating effect of firm size on the dynamic capabilities – economic performance relationship. We receive a consistent finding that micro-sized firms significantly outperform their larger counterparts in terms of both profitability and productivity. However, it is not strongly evident that those micro firms possessing strong dynamic capabilities could leverage their economic performance accordingly. The performance varies significantly depending which dynamic capability they possess. In particular, micro firms produce stronger economic

performance if they focus their investment on R&D, technology and skill upgrading (innovation investment), rather than on recruiting more professional employees (professionals share). Generation capability and utilization capability also produce opposite economic implications for micro firms. It is the quality of innovation outcomes, successful commercialization, rather than the quantity, number of innovation outcomes, that contributes to their outperformance in both productivity and profitability. Therefore, these inconclusive findings do not allow us to support Hypothesis 3. However, they somewhat align with the earlier finding of Santarelli and Tran (2017) suggesting that the combination of newness, smallness, and innovativeness in young innovative firms does not bring the expected high entrepreneurial performance in Vietnam as compared to more advanced countries due to the country's poor institutional system that impedes a level playing field for all participating agents. Nevertheless, the significant and positive effect of *innovation intensity* and *innovation success* on micro firms' economic performance does suggest the importance of new knowledge resulting from financial investment and innovation commercialization as a valuable source of dynamic capabilities to compensate for deficits arising from their newness and smallness.

To test Hypothesis 4, which posited that the effect of the open innovation knowledge management process on economic performance would be stronger as the quality of local institutional improves, we add interaction terms between the institutional quality index PCI and each type of dynamic capability to evaluate the moderating effect of institutional quality on the dynamic capabilities – economic performance relationship. We receive a consistent finding that firms residing in high-quality institutional environment are more likely to obtain greater profit and higher productivity (given statistically positive estimated coefficients of PCI). A higher quality of local governance removes policy bias against SMEs and provides a level playing field for all economic agents, and thus reduces their exit hazards to pave the way for remarkable economic achievements. Moreover, the consistently positive interaction coefficients confirm that knowledge management dynamic capabilities have a stronger positive effect on firms' economic performance in high-quality institutional settings although the effect of innovation outputs is not statistically significant. Firms located in a higher quality institution can leverage more benefits of their innovation investment and technical human resources to boost both profitability and productivity. Generation capability and utilization capability also produce a stronger (despite insignificant) economic implication for firms as institutional quality improves. Therefore, these consistent findings allow us to support Hypothesis 4.

Among firm-level control variables, we consistently find the superior economic performance of smaller and younger firms compared to larger and older counterparts. Consistent with the case of Vietnamese family firms in Tran and Santarelli (2014), indebted (or financial constrained) firms are found to be more productive and profitable. Export and diversification help enhance firms' productivity significantly.

6. Robustness Check

Table 5 presents the estimation results of the robustness check for the performance equation applying fixed effect regression and one-year lag structure.

Insert Table V about here

In general, when firm-level fixed effects are controlled the robustness estimation results are consistent with the main results in terms of effect direction but are relatively less statistical significance. Except for the negative effect of innovation intensity on firms' productivity, we consistently find a significantly positive effect for all the other measures of the three types of dynamic capabilities on firm-level economic performance, which consistently supports Hypothesis 2. Micro-sized firms are found to be less productive than their larger counterparts, but they significantly outperform their larger counterparts in terms of productivity. We are also not able to find clear-cut evidence that those micro firms possessing strong dynamic capabilities could leverage their economic performance accordingly. In particular, micro firms produce stronger economic performance if they have higher innovation intensity and more successful innovation commercialization. Although we fail to support Hypothesis 3, the significant and positive effect of innovation intensity and innovation success on micro firms' economic performance does suggest the importance of new knowledge accumulated from innovation investment and commercialization as a valuable source of dynamic capabilities for their survival.

With respect to Hypothesis 4, we receive a consistent finding that firms residing in high-quality institutional environment are more profitable and productive (given statistically positive estimated coefficients of PCI). Moreover, the consistently positive interaction coefficients confirm that knowledge management dynamic capabilities have a stronger positive effect on firms' economic performance in high-quality institutional settings. However,

although results from fixed-effect estimation are consistent with the main results above, their effects are not strongly statistically significant; and thus, we cannot strongly support Hypothesis 4.

It is worth noting that when one-year lag structure is taken into account, dynamic capabilities lose their statistical significance. This is unsurprising as Vietnam is characterized by a very dynamic business environment with the strong "revolving door" effect that eliminate efficiently "bad entries" possessing poor dynamic capabilities (Santarelli and Tran, 2012: 656). In other words, the causal relationship between dynamic capabilities and firm performance is stronger in short-term (i.e. in the current year). The fixed-effect estimation of control variables is generally consistent with the main model estimation except the estimation of firm age and firm size. While firm age is marginally negatively associated with firm-level profitability in the main model analysis, it is significantly positively related to both productivity and profitability performance. Further, while smaller firms are both more productive and more profitable than their larger counterparts in the main model, they are only more profitable in the fixed-effect model. Finally, ownership types are no longer significant in the performance equation when firm-level fixed effects are controlled.

7. Discussion and Conclusions

This study seeks to theoretically connect the knowledge management process under the open innovation paradigm, knowledge-based dynamic capability, and institutional quality with the localized technological change and the history-friendly modelling economic approaches to innovation in a framework exploring firm-level innovation activities and economic performance. The open innovation knowledge management process creates an efficient channel for firms to acquire beneficial knowledge-based dynamic capabilities. These capabilities in turn enable firms to enhance their economic performance and achieve long-term competitive advantages. In other words, dynamic capabilities act as mediators that facilitate or impede the economic realization of firms' knowledge management efforts in their open innovation activities. This mediation process is moderated by the quality of local institutional environment. We extend the empirical analysis of our theoretical framework to Vietnam, which provides a relevant and distinctive context of a fast-growing transition country.

Considering a comprehensive range of measures for the knowledge management process under the open innovation paradigm and the resulting knowledge-based dynamic capabilities, our estimation results significantly support Hypotheses 1, 2, and 4, but fail to support the third

one. In particular, it is statistically evident that the nine open innovation functional perspectives identified by Gassmann et al. (2010) (spatial, leveraging, structural, institutional, cultural, process, user, supplier, and tool) enhance firms' dynamic capabilities so that they can be responsive to institutional changes in the volatile environment of a transition country. These newly developed dynamic capabilities in turn enable firms to foster their economic performance productively and profitably. Regarding the position of micro-sized firms throughout the whole open innovation - performance process, although they significantly outperform their larger counterparts, they fail to benefit from the full-scale exploitation of their accumulated dynamic capabilities to enhance their economic performance. In fact, contrary to evidences in advanced countries, innovation activities are somewhat too costly and luxurious for small and young firms in transition countries, as their innovation efforts actually erode their profitability and growth (Santarelli and Tran, 2017). However, we did find evidence of the important role of financial investment in R&D, technology and skill upgrading in acquisition capability and innovation commercialization in utilization capability to leverage SMEs' economic performance. We also consistently find the positive moderating effect of institutional quality on the dynamic capability – economic performance relationship. A higher quality of local institutions allows firms to better exploit their newly developed dynamic capabilities to obtain remarkable economic achievements.

In summary, we claim that the effective adoption of an open innovation knowledge management process could enable firms in transition countries to acquire desirable knowledge-based dynamic capabilities, which have been found to be a powerful engine for superior economic performance. However, although the significance of external knowledge sources in building up firms' capacities to respond competitively to a rapidly changing environment has been widely confirmed, acquiring dynamic capabilities is not easy as there may be hurdles at both ends of the transfer (Griffith et al., 2005). Future research should continue exploring these hurdles and many other reasons that explain for the divergence in the form and effectiveness of open innovation activities between established and transition economies.

The results have important policy implications. For the last twenty years, transition countries have been increasingly engaged in international economic integration. There is no doubt that these countries' successful integration into the global economy and their sustained success in international competition depends on an effective combination of science, technology and innovation, i.e., a system of innovation. Our findings suggest that the government does play a crucial role in establishing a national system of innovation. One of the

important measures implied in our findings is that to grow the country's National System of Innovation to its full potential, transition countries should encourage and stimulate open innovations through various intra- and inter-organizational collaboration channels, especially among micro-sized firms. This approach will help them build strong and useful organizational capabilities used in responding rapidly to market changes during the transition process. Second, a favourable environment should be created for firms in general and new entrepreneurial firms in particular. This system should strengthen linkages between universities, research institutions and the productive sectors. Third, public policy makers need to enhance institutional framework in transition countries to support innovation performance by developing pro-entrepreneurship policy, entrepreneur-friendly regulations and enabling institutional conditions that render political and economic stability, efficient market selection process.

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Figures and Tables

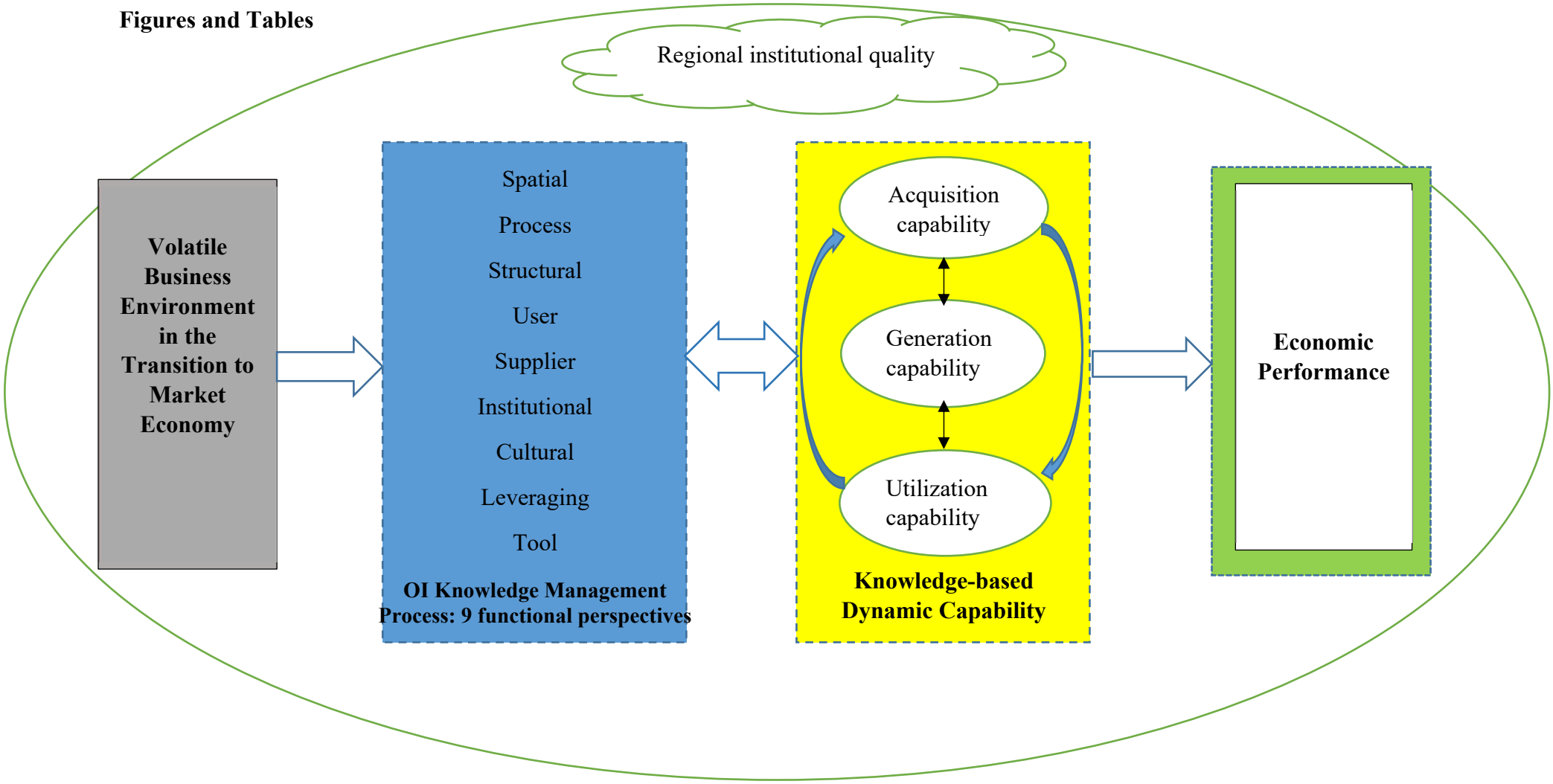

Figure 1: The Conceptual Framework

Table 1: Descriptive statistics

Variables	Proxies	Measures	Mean	Std Dev	Min	Max
Economic performance	Productivity	Total factor productivity (TFP): The Levinsohn and Petrin (2003) productivity method	26.381	12.396	1.624	319.5
	Profitability	Return on sales (ROS): the ratio of operating profit to total sales	0.212	0.129	-2.34	3.081
Knowledge acquisition capability	Innovation intensity	The ratio of investment in machine/equipment, R&D, patent, and human capital upgrading to total sales	0.012	0.044	0	3.334
	Professionals share	The share of professionals (engineers, accountants, economists, technicians) with university and college degree in the total labor force of the firm	0.034	0.074	0	0.952
Knowledge generation capability	Innovation outputs	The number of innovation types conducted from the three types: (i) introducing new product groups (different ISIC 4-digit code), (ii) making improvements of existing products (within one ISIC 4-digit code), and (iii) introducing new production process/ new technology	0.449	0.663	0	3
Knowledge utilization capability	Innovation success	The likelihood of achieving successful innovation outcomes (new product, product improvement, new production process)	0.109	0.311	0	1
Open Innovation	Spatial perspective	R&D proximity: the likelihood of locating in Hanoi and Hochiminh city, the two largest centres of colleges, universities and research institutes in Vietnam	0.355	0.478	0	1
	Process perspective	Inside out: technology investment, a dummy attains 1 if the firm makes investment in production, technology and training of customers and/or suppliers	0.078	0.268	0	1
		Outside in: technology transfer, a dummy attains 1 if the firm receives technology transfer from suppliers and/or customers	0.016	0.127	0	1
		Coupled: association membership, the number of formal business associations that the firm holds membership	0.143	0.457	0	7
	Supplier perspective	Supplier netsize: the proportion of social network members as the firm's suppliers	0.204	0.151	0	1
	User perspective	Customer netsize: the proportion of social network members as the firm's customers	0.549	0.231	0	1
	Structural perspective	Outsource: a dummy attains 1 if the firm outsource production	0.047	0.211	0	1
		Subcontract: a dummy attains 1 if the firm produces as a subcontractor	0.102	0.302	0	1
	Institutional perspective	Government finance: a dummy attains 1 if the government provides financial and technical assistance for the firm's innovation activities	0.159	0.366	0	1
		Political network: the number of social network members as politicians and civil servants	1.464	1.227	0	4
	Cultural perspective	Customer feedback: A dummy attains 1 if customers' feedback regarding standards of production and product quality is crucial for the firm.	0.066	0.248	0	1
	Tool perspective	E-trading: the likelihood that the firm sells products and/or buys input materials via e-trading with the help of ICT	0.067	0.249	0	1

	Leveraging perspective	New project: A dummy attains 1 if the firm plans to start up new product lines in new market fields and/or new technology in near future.	0.293	0.455	0	1
Institutional quality	Provincial competitiveness index	The provincial competitiveness index comprises ten sub-indices reflecting economic governance areas that affect private sector development.	57.381	4.414	45.09	67.12
Firm-level control variables	Firm age	The number of years that the firm is in continuous operation since inception	13.308	10.337	0	75
	Firm size	The natural logarithm of total assets of the firm	13.995	1.773	6.214	20.641
		Micro-sized: A dummy attains 1 if the firm is a micro-sized one (less than 10 employees)	0.696	0.459	0	1
	Export	A dummy attains 1 if the firm is engaged in exporting their products	0.062	0.241	0	1
	Diversification	A dummy attains 1 if the firm is a diversified firm, operating in more than 1 four-digit VSIC industry.	0.124	0.329	0	1
	Indebtedness	Debt ratio: the ratio of debt to total assets of the firm	0.081	0.212	0	7.764
	Ownership types	1. Collective; 2. Private; 3. Limited liability; 4. Joint stock; 5. Foreign-invested				
Sector-level control variables	Sector	Firms are categorized in 20 sectors (food and beverages, tobacco, textiles, leather, wood, paper, etc.)				

Table 2: Pairwise Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(1)	1.00																								
(2)	.05*	1.00																							
(3)	-.04*	-.04*	1.00																						
(4)	.21*	-.14*	.07*	1.00																					
(5)	.08*	-.08*	.09*	.13*	1.00																				
(6)	.05*	-.04*	.03*	.07*	.48*	1.00																			
(7)	.17*	-.02*	-.05*	.21*	.07*	.01	1.00																		
(8)	.08*	-.06*	.03*	.09*	.14*	.10*	-.01	1.00																	
(9)	.05*	-.02	.01	.07*	.08*	.05*	.04*	.44*	1.00																
(10)	.12*	-.08*	.08*	.17*	.15*	.07*	-.05*	.09*	.04*	1.00															
(11)	.06*	-.11*	.07*	.15*	.14*	.02*	.08*	.06*	.03*	.12*	1.00														
(12)	.04*	-.07*	.08*	.05*	.12*	.02*	-.05*	.05*	.02*	.14*	.19*	1.00													
(13)	.06*	-.06*	.06*	.08*	.12*	.06*	.01	.06*	.03*	.10*	.06*	.04*	1.00												
(14)	.01	-.02*	.05*	.03*	.09*	.07*	-.01	.05*	.04*	.03*	.05*	.05*	.16*	1.00											
(15)	.17*	-.06*	.06*	.18*	.13*	.09*	.12*	.16*	.10*	.16*	.09*	.06*	.11*	.06*	1.00										
(16)	-.02	.02	-.05*	-.05*	-.06*	-.02*	.03*	-.06*	-.04*	-.07*	-.13*	-.00	-.07*	-.07*	-.04*	1.00									
(17)	-.00	.02*	-.00	.02	.02	-.02	.03*	.04*	.04*	-.00	-.12*	-.03*	-.00	.01	.03*	-.33*	1.00								
(18)	.09*	-.09*	.07*	.14*	.27*	.10*	.10*	.09*	.05*	.13*	.10*	.11*	.09*	.07*	.10*	-.06*	.03*	1.00							
(19)	.18*	-.08*	.03*	.21*	.15*	.10*	.11*	.08*	.06*	.16*	.07*	.05*	.10*	.05*	.22*	-.03*	.01	.11*	1.00						
(20)	-.06*	.09*	-.05*	-.16*	-.09*	-.00	-.19*	-.00	-.01	-.00	-.04*	-.03*	-.03*	-.02	-.03*	.00	-.03*	-.12*	-.07*	1.00					
(21)	.42*	-.25*	.09*	.39*	.19*	.13*	.40*	.14*	.09*	.23*	.18*	.05*	.11*	.07*	.24*	-.09*	.02	.23*	.26*	-.13*	1.00				
(22)	.16*	-.10*	.20*	.15*	.09*	.05*	-.01	.05*	.01	.10*	.07*	.06*	.07*	.03*	.09*	-.08*	.01	.08*	.11*	-.08*	.10*	1.00			
(23)	.21*	-.08*	.03*	.15*	.14*	.07*	.12*	.11*	.09*	.22*	.07*	.06*	.16*	.06*	.28*	-.12*	.06*	.11*	.24*	-.05*	.26*	.11*	1.00		
(24)	.04*	-.04*	.06*	.010*	.16*	.09*	-.06*	.01	.02	.06*	.06*	.04*	.06*	.08*	.03*	-.03*	.03*	.03*	.07*	-.02*	.06*	.08*	.01	1.00	
(25)	.09*	.01	-.05*	.07*	.01	.07*	.47*	.06*	.04*	-.10*	-.05*	-.13*	-.03*	-.01	.04*	.02*	.06*	.03*	.05*	-.09*	.23*	-.04*	.06*	-.07*	1.00

*: significant at 1% level

(1) Productivity TFP; (2) Profitability ROS; (3) Innovation intensity; (4) Professionals share; (5) Innovation outputs; (6) Innovation success; (7) R&D proximity (spatial); (8) Technology invest (process); (9) Technology transfer (process); (10) Biz association membership (process); (11) Political network (institutional); (12) Government financial support (institutional); (13) Outsource (structural); (14) Subcontract (structural); (15) Customer feedback (cultural); (16) Customer network size (user); (17) Supplier network size (supplier); (18) New innovation project (leveraging); (19) Etrading (tools); (20) Firm age; (21) Firm size; (22) Debt ratio; (23) Export; (24) Diversification; (25) Institutional PCI index.

Table 3: Estimation Results of the Effect of Open Innovation Knowledge Management on Knowledge-based Dynamic Capabilities

Categories	Variables	Acquisition Capability (Innovation intensity)	Acquisition Capability (Professionals share)	Generation Capability (Innovation outputs)	Utilization Capability (Innovation success)
		(1)	(2)	(3)	(4)
OI spatial pers.	Proximity to R&D and research centers	-0.026** (0.001)	0.024** (0.004)	0.016 (0.013)	0.051** (0.007)
OI process perspective	Technology investment (inside out)	0.004** (0.002)	0.009* (0.005)	0.199** (0.021)	0.073** (0.010)
	Technology transfer (outside in)	0.008* (0.004)	0.004 (0.008)	0.101** (0.042)	0.018 (0.021)
	Biz association membership (coupled)	0.003* (0.001)	0.011** (0.004)	0.107** (0.019)	0.052** (0.009)
OI supplier pers.	Size of supplier network	0.014** (0.004)	0.021* (0.01)	0.012 (0.037)	0.074** (0.019)
OI user pers.	Size of customer network	0.014** (0.002)	0.003 (0.007)	0.039 (0.024)	0.001 (0.012)
OI structural perspective	Outsourcing	0.01** (0.002)	0.009 (0.005)	0.135** (0.023)	0.021* (0.011)
	Subcontracting	0.007** (0.002)	0.008* (0.004)	0.083** (0.017)	0.044** (0.008)
OI tool pers.	E-trading	0.005** (0.002)	0.006** (0.002)	0.145** (0.020)	0.058** (0.010)
OI cultural pers.	Customer feedback	0.007** (0.002)	0.006** (0.002)	0.065** (0.021)	0.042** (0.010)
OI institutional perspective	Government financial support	0.017** (0.001)	0.006* (0.003)	0.116** (0.014)	0.004 (0.007)
	Political network	0.002** (0.000)	0.009** (0.001)	0.043** (0.004)	-0.006** (0.002)
OI leveraging	New innovation projects	0.01** (0.001)	0.009** (0.003)	0.293** (0.011)	0.037** (0.006)
Institutional quality	Provincial Competitiveness Index	0.001** (0.000)	0.001** (0.000)	0.003* (0.001)	0.006** (0.001)
Firm-level control	Firm age	-0.0003** (0.000)	-0.001** (0.000)	-0.002** (0.000)	0.001** (0.000)
	Firm size	0.004** (0.000)	0.023** (0.001)	0.012** (0.004)	0.012** (0.002)
	Debt ratio	0.06** (0.002)	0.027** (0.009)	0.073** (0.023)	0.029** (0.012)
	Export	-0.003 (0.002)	-0.006** (0.002)	0.104** (0.021)	0.001 (0.011)
	Diversification	0.009** (0.001)	0.01** (0.004)	0.253** (0.015)	0.061** (0.008)
	Ownership types	F(7) = 9.96**	F (7) = 232**	F(7)= 354**	F(7) = 35**
Sector-level control	Sector	F(20) = 5.25**	F(20) = 9.16**	F(20) = 83**	F(20) = 50**
Intercept		-0.011 (0.011)	0.010 (0.018)	0.213 (0.171)	-0.463** (0.086)
Wald $\chi^2(.)$		$\chi^2(48) = 1274$**	$\chi^2(48) = 6590$**	$\chi^2(48) = 2695$**	$\chi^2(48) = 797.42$**

Note: * significant at 5% level; **: significant at 1% level

Seemingly unrelated estimation approach is adopted for the estimation results.

Table 4: Estimation Results of the Economic Performance Equation

Variables	Productivity (TFP)		Profitability (ROS)	
	Direct effect	Indirect effect	Direct effect	Indirect effect
Acquisition capability (Innovation intensity)	**-4.891** (0.366)**	-0.212 (0.248)	**0.076* (0.038)**	0.001* (0.000)
Acquisition capability (Professional share)	**0.431** (1.729)**	0.169** (0.069)	**0.052** (0.017)**	0.002** (0.001)
Generation capability (Innovation outputs)	**0.796** (0.216)**	0.935** (0.283)	**0.010** (0.002)**	0.013** (0.003)
Utilization capability (Innovation success)	**0.777* (0.423)**	0.132* (0.054)	**0.013** (0.005)**	0.032 (0.023)
Firm age	-0.005 (0.010)		-0.000* (0.000)	
Firm size	-2.288** (0.078)		-0.003** (0.001)	
Debt ratio	6.642** (0.427)		0.018** (0.004)	
Export	3.503** (0.369)		0.004 (0.003)	
Diversification	0.500* (0.261)		0.001 (0.003)	
Micro-sized	2.413** (0.320)		0.033** (0.003)	
Micro * Innovation intensity	**3.129** (0.457)**		**0.113** (0.045)**	
Micro * Professionals share	**-9.383** (2.498)**		**-0.083** (0.025)**	
Micro * Innovation outputs	**-0.645* (0.289)**		**-0.014** (0.003)**	
Micro * Innovation success	**0.517 (0.647)**		**0.020** (0.006)**	
PCI	0.115** (0.028)		0.002** (0.000)	
PCI * Innovation intensity	**0.166** (0.052)**		**0.009* (0.005)**	
PCI * Professionals share	**0.709** (0.266)**		**0.008** (0.003)**	
PCI * Innovation outputs	**0.021 (0.031)**		**0.000 (0.000)**	
PCI * Innovation success	**0.152* (0.078)**		**0.000 (0.001)**	
Ownership types	F(7) = 593.8**		F(7) = 163**	
Sector	F (20) = 66.4**		F(20) = 91**	
Intercept	-13.69** (2.933)		0.034 (0.036)	
Total indirect effects		0.761** (0.167)		0.017** (0.000)
Proportion of total effect that is mediated		0.171		0.448
Wald / LR $\chi^2()$ statistics	$\chi^2(47) = 4557$**		$\chi^2(47) = 1022$**	

*: significant at 5% level; **: significant at 1% level

Table 5: Robustness Check - Estimation Results of the Economic Performance Equation using Fixed-effect regression

Variables	Productivity (TFP)		Profitability (ROS)	
	***t* (1)**	***t-1* (2)**	***t* (3)**	***t-1* (4)**
Acquisition capability (Innovation intensity)	**-3.742** (0.406)**	**-1.499** (0.397)**	**0.119** (0.044)**	**0.051 (0.043)**
Acquisition capability (Professional share)	**0.355* (0.194)**	**0.436 (0.282)**	**0.727** (0.206)**	**0.077* (0.042)**
Generation capability (Innovation outputs)	**1.477** (0.423)**	**1.042 (1.891)**	**0.035* (0.019)**	**0.031 (0.019)**
Utilization capability (Innovation success)	**6.673* (4.091)**	**4.1143 (5.151)**	**0.022** (0.005)**	**0.051 (0.034)**
Firm age	0.053** (0.021)	0.016 (0.014)	0.001** (0.000)	0.000** (0.000)
Firm size	1.479** (0.131)	0.837** (0.145)	-0.001 (0.001)	-0.011** (0.001)
Debt ratio	2.487** (0.454)	1.111* (0.526)	0.021** (0.007)	0.024** (0.005)
Export	0.852 (0.677)	0.428 (0.504)	0.010 (0.007)	0.002 (0.005)
Diversification	0.489* (0.254)	0.541 (0.318)	0.007* (0.003)	0.007* (0.003)
Micro-sized	-1.095** (0.423)	-0.596 (0.482)	0.018** (0.005)	0.045** (0.004)
Micro * Innovation intensity	**2.304** (0.471)**	**1.542** (0.446)**	**0.122** (0.049)**	**0.074 (0.048)**
Micro * Professionals share	**-0.395 (0.305)**	**-0.445 (0.283)**	**-0.054* (0.025)**	**-0.125** (0.031)**
Micro * Innovation outputs	**-0.543* (0.317)**	**0.146 (0.317)**	**-0.008** (0.003)**	**-0.021** (0.003)**
Micro * Innovation success	**0.241 (0.662)**	**0.121* (0.681)**	**0.021** (0.007)**	**0.027** (0.007)**
PCI	0.086* (0.038)	0.002 (0.033)	0.002** (0.000)	0.000 (0.000)
PCI * Innovation intensity	**2.977 (3.779)**	**4.056 (5.092)**	**0.836* (0.407)**	**0.168 (0.551)**
PCI * Professionals share	**0.569* (0.333)**	**0.048 (0.313)**	**0.012** (0.004)**	**0.001 (0.003)**
PCI * Innovation outputs	**0.014 (0.031)**	**0.017 (0.032)**	**0.001 (0.000)**	**0.000 (0.000)**
PCI * Innovation success	**0.110* (0.078)**	**0.086 (0.088)**	**0.001 (0.001)**	**0.001 (0.001)**
Ownership types	F(8) = 1	F(8) = 1.02	F(8) = 1.24	F(8) = 1
Sector	F (20) = 1.76**	F (20) = 2.01**	F(20) = 3.07**	F(20) = 3**
Intercept	-1.835 (7.299)	-1.307 (2.257)	0.124 (0.076)	0.294** (0.021)
Wald / LR $\chi^2()$ statistics	$\chi^2(47) = 9.36$**	$\chi^2(47) = 8.15$**	$\chi^2(47) = 4.59$**	$\chi^2(47) = 3$**

*: significant at 5% level; **: significant at 1% level.