Asia Pacific Business Review

ISSN: 1360-2381 (Print) 1743-792X (Online) Journal homepage: https://www.tandfonline.com/loi/fapb20

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**To cite this article:** Quan Chen, Chun-Hsien Wang & Shi-Zheng Huang (2019): Effects of organizational innovation and technological innovation capabilities on firm performance: evidence from firms in China's Pearl River Delta, Asia Pacific Business Review, DOI: 10.1080/13602381.2019.1592339

**To link to this article:** https://doi.org/10.1080/13602381.2019.1592339

Published online: 09 Apr 2019.

ASIA PACIFIC BUSINESS REVIEW
https://doi.org/10.1080/13602381.2019.1592339

Routledge
Taylor & Francis Group



# Effects of organizational innovation and technological innovation capabilities on firm performance: evidence from firms in China's Pearl River Delta

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**ABSTRACT**

This study assesses the relationship between organizational innovation (OI) and technological innovation capabilities (TICs) and analyzes their effect on firm performance. Using a sample of 265 manufacturing firms from the Pearl River Delta in China, we examined whether TICs mediated the effects of OI on firm performance. We also examined how OI moderated the relationship between TICs and firm performance. Results from structural equation modeling (SEM) analyses showed that TICs partially mediated the relationship between OI and firm performance. Similarly, OI partially moderated the relationship between TICs and firm performance. Implications of our findings for research and practice are discussed.

**ARTICLE HISTORY**
Received 5 Octber 2017
Accepted 4 March 2019

**KEYWORDS**
Organizational innovation; Technological innovation capabilities; Firm performance; Pearl River Delta in China

## 1. Introduction

Organizational innovation (OI) is important because it leads to increased firm performance and brings new organizational methods and resources to firms' business practices, workplaces, or innovation activities and thus influences both the nature and the outcomes of innovation (Camisón and Villar-López 2014; Damanpour and Evan 1984; Evangelista and Vezzani 2010; OECD/Eurostat 2005). Although there is general consensus about OI being the source of superior performance and although there are a number of papers that investigate the determinants of process, product, and OI (e.g., Ballot et al. 2015; Evangelista and Vezzani 2010; Camisón and Villar-López 2014; Carboni and Russu 2018; Lee, Lee, and Garrett 2018), less is known about the possible relationships between OI and TICs that lead a firm to attain superior performance. Previous research in this area has tended to focus on process and product innovation merged from the TIC perspective; additionally, variables have been examined in isolation and sometimes have been included with no clear theoretical rationale. This approach has resulted in an extensive list of possible antecedents but few consistent findings; thus, we focus on an OI – TICs – and examine its effect on superior performance.

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In previous work, Damanpour, Szabat, and Evan (1989) and Damanpour and Aravind (2011) developed a theoretical model in which OI was proposed as a critical antecedent of TICs and their performance. Much empirical evidence has significantly emphasized that OI is a crucial innovation activity may continue to support technological innovation (Camisón and Villar-López 2014; Battisti and Stoneman 2010; Armbruster et al. 2008) and that there is a direct correlation between OI and TICs (e.g., Azar and Ciabuschi 2017; Cheng and Yang 2017; Damanpour and Evan 1984; Camisón and Villar-López 2014). We believe that these works are partially based on the implicit assumption in previous studies that OI has a positive and direct relationship with TICs. Furthermore, the extant literature offers complementary views regarding how a firm's OI contributes to TICs and in turn affects their performance. For example, Damanpour, Szabat, and Evan (1989) suggest that firms with well-developed OI are more likely to promote technological innovation activities. Similarly, Sapprasert and Clausen (2012) posit that OI can enable and even enhance the effect of technological innovation. These insights recognize OI as capable of developing and deploying technological innovation and generally recognize the capacity of technological innovation to be curious. To date, however, researchers have not examined the central theoretical role that TICs might play in explaining the relationship between the previously identified antecedents and superior performance.

Our study is particularly important given that prior research has posited that a firm's OI plays an important role in the process of developing innovation. Although previous studies indicate that OI is important, its relationship with technological innovation and their influence on firm performance needs further examination (Sapprasert and Clausen 2012). Therefore, the purpose of this article is to extend previous studies to formulate a new theoretical framework that enables us to address these issues. Precisely, we posited that OI is not only an antecedent factor of TICs but also plays a moderating role in enhancing the relationships between TICs and performance.

In addition to providing evidence of the effect of OI and TICs on firm performance, our study makes several contributions by elucidating how OI shares and interacts with TICs and a firm's superior performance. **First**, our research thus provides certain insights to resolve the very minimal empirical evidence of the effect of OI and technological innovation on firm performance (Mol and Birkinshaw 2009), especially in emerging China contexts. **Second**, we differentiate between two types of innovation efforts (OI and technological innovation) and argue that OI may have a positive driving effect on TICs. Thus, we provide some insights that may resolve the prior debate. **Third**, by deriving the concept of multidimensional TICs and relating it to innovation efforts, we show that greater innovation capability primarily exists in emerging markets, and thus, we provide more comprehensive insights into the functioning of innovations. For example, an examination of multidimensional TICs in emerging Chinese contexts shows a new mode of thinking about exploiting a firm's innovation setting with its output. **Finally**, to the best of our knowledge, this study is the first that simultaneously examines the differential effects of OI and TICs on firm performance in China's emerging market. Our study elucidates these two dimensions of innovation by determining which dimension is more subject to OI driving and influencing TICs and which is more beneficial for firm performance.

## 2. Theoretical background

### 2.1. Organizational innovation (OI)

Innovation scholars have long argued that for firms to achieve their competitive advantage, executives must be engaged in OI (Damanpour and Evan 1984; Danmanpour 1991; Camisón and Villar-López 2014; Yamin et al. 1997). In the locus of innovation deployment, firms apply new approaches, new skills, new means, or new collaboration relationships. OI is a broad definition that introduces a wide range of activities into an organization to facilitate and achieve innovation outputs. Although OI typically is identified by a broad definition, Damanpour and Evan (1984) state that OI pertains to a product, device, system, process, policy, program, or service that was new to the organization at the time of its adoption. In addition, the OECD (2005) posits that OI refers to the implementation of a new organizational method in a firm's business practices, workplace organization, or external relationships. Consistent with prior literature, OI has often been defined as the number of innovation efforts that firms have adopted (Avlonitis, Kouremenos, and Tzokas 1994; Damanpour 1991; Garcia and Calantone 2002). This perspective implies that the more innovation efforts a firm adopts, the more innovative outcomes that have relevance at the firm. OI is conceptualized as an organization's adoption of a new concept or behavior (Danmanpour 1991; Wood 1998; Zammuto and O'Connor 1992). Conceptually, these views build on the notion of OI as the adoption and acquisition of instruments, methods, and services that are new to a firm in terms of the implementation and management of OI efforts. Accordingly, the concept of OI remains associated with non-technological innovation (e.g., Ballot et al. 2015; Damanpour 1991) and has extended to a wide variety of applications regarding its causes and consequences and its relation to other forms of innovation activities at firm levels (Ballot et al. 2015). Accordingly, these lenses are in alignment with our focus on technological innovation activities, which also identifies an important determinant of firm performance.

Furthermore, certain researchers posit that OI complements other innovation efforts, such as process and product (Camisón and Villar-López 2014; Ballot et al. 2015; Evangelista and Vezzani 2010), service innovation (Evangelista and Vezzani 2010), and technological innovation (Sapprasert and Clausen 2012), indicating that there are strong relationships between OI and firms' other innovation efforts. Although such studies employ different approaches and data, they appear to indicate that non-technological and technological innovation activities are complements (Carboni and Russu 2018) rather than substitutes. Thus, a firm employs OI that involves the adaptation and applications of novel and new ideas, skills, technical, and methods of doing innovations. Therefore, we regard OI as an important method by which firms can intend to capture new instruments, approaches, and managerial methodologies, which combined with other innovation activities will allow firms to make an important contribution to the innovation process.

Although this study has laid an important foundation for subsequent advances in the study of OI, it has not fully met the employment of new ideas, skills, modes, and services as a driving force of innovation action. However, there are two notable exceptions. One is the study by Lumpkin and Dess (1996), who conclude that OI reflects a firm's tendency

to engage in and support new ideas, novel experimentation and creative processes that are likely to result in new products, services or technological processes. The other exception is the study by Garcia and Calantone (2002), who claim that firms engage in newness in the context of OI, which is the capacity of a new innovation to influence a firm's existing marketing resources, technological resources, skills, knowledge, capabilities, or strategy. Given this literature, there are OI inquiries into how a firm's non-technological innovation efforts drive its technological innovation activities; however, empirical studies are lacking.

### 2.2. Technological innovation capabilities (TICs)

There is no widely accepted definition of TICs. From a traditional innovation perspective, TICs were considered the spread concept and level at which they could be explained, in contrast to adopting the complete technological innovation perspective (e.g., Gavin and Aiman-Smith 1995; Wang, Lu, and Chen 2008). Many studies have used many single concepts to describe TICs but rarely define those concepts with precision. For example, Burgelman, Maidique, and Wheelwright (2001) and Shafia et al. (2016) claim that TICs are a multidimensional concept that reflects a firm's innovation action that cannot be measured by a single dimension scale. According to Teece (1986), technological innovation is complementary assets that, in addition to other functional assets, appropriate the rents from their innovation activity. Similarly, Christensen (1995) opposes the one-dimensional approach to establishing technological innovation, holding that innovation instead is aligned with a complementary function such as R&D, manufacturing, or marketing. Indeed, the previous innovation research has ascertained that a single dimension or indicator cannot fully explain the TICs of firms' innovation activities. Although all single indicators are considered, they are unlikely to provide a sufficient explanation for the build-up of TICs that are relevant to firm technological innovation activity. Given that TICs are conceived from innovation in multiple dimensional contexts, we label them as a series of complementary and interaction functions.

Although Flor and Oltra (2004) estimate and evaluate the TICs of Spanish ceramic tile sectors using a series of input-output indicators, their approach remains a single indicator judgment. Indeed, the fundamental aspect of TICs has been referred to and examined under many multiple dimensions because a firm's innovation activity is considered an interactive process determined by a series of technologically relevant subsystems or sub-processes (Teece 1996). Consequently, TICs are a complex concept that create, acquire, and integrate the diverse knowledge and skills required to innovate complex technologies (Kash and Rycroft 2002; Wang, Lu, and Chen 2008). Moreover, the conceptualization of TICs is multidimensional with respect to firms' innovation activity. Innovation researchers have approached the analysis of such a high degree of interdependence with innovation capabilities from multiple perspectives. For example, Guan et al. (2006) argued that firms' TICs are deeply rooted in various organizational functions such as manufacturing, marketing, and strategy planning, learning, and resource allocation. Specifically, TICs can be conceptualized as a set of organizations and sectors and the complementary relationships among them (Markard and Truffer 2008). According to Burgelman, Maidique, and Wheelwright (2004), TICs represent firms' ability to undertake

a set of activities, approaches, and assets to facilitate and support the deployment of their innovative strategy. The enhancement of TICs requires continuous engagement in comprehensive sets of organizational functions in innovation development.

Furthermore, various researchers have made attempts to study technological innovation empirically to describe and understand its structure, component and dimension from a comprehensive perspective. A substantial body of literature on technological innovation studies suggests that conceptions of TICs are complex and multidimensionally conceptual (Achilladelis and Antonakis 2001; Markard and Truffer 2008; Wang, Lu, and Chen 2008; Yam et al. 2011). In such arguments, one can expect the concept of technological innovation to be extended to the multidimensional, since consideration of TIC as a single dimension is insufficient to reflect firms' innovation capability. Depending on the multiple dimensions of TICs, recent studies have posited that they may involve learning, R&D, resource allocation, manufacturing, marketing, organization, and decision-making (Adler and Shenbar 1990; Guan et al. 2006; Romijn and Albaladejo 2002; Yam et al. 2004). These concepts provide an extremely useful framework for establishing TICs that has offered numerous plausible technological innovation explanations for the usage and adaptation of existing technological and innovation knowledge based on the aspects of a firm. Among a broad set of technologies and innovative concepts, technological innovation underlies a firm's ability to sustain competitive advantage. Furthermore, this study combines key conceptual and empirical points from the comparative research to examine and construct a complete perspective on well-developed TICs. A brief clarification of TIC concepts from previous studies is then employed in this study to obtain well-defined and objective TICs that provide useful theoretical rationales for anticipating and explaining the influence of TICs on the innovation development process.

## 3. Theory and hypotheses

The base model of this theoretical concept framework is shown in Figure 1. This model postulates that TICs have a mediating effect on the relationship between OI and firm performance. This concept is included in the model and explained in the next section. Our theoretical concept framework was adopted from Camisón and Villar-López (2014) and Yam et al. (2011), in which OI is the enabler, TICs are the innovation capabilities

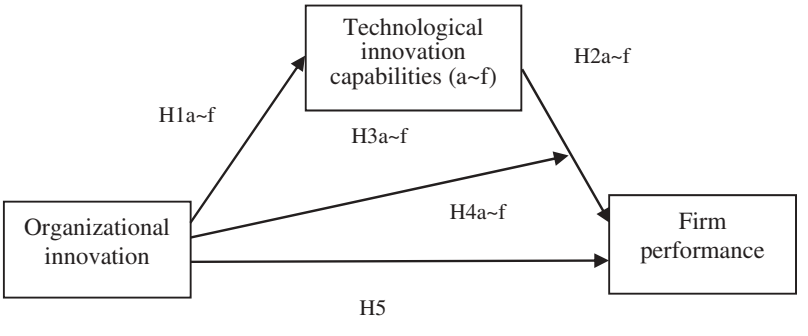


**Figure 1.** Theoretical conceptual framework.

mediator, and FP is the performance outcomes at the firm level. Although these OI researchers provide interesting insights and useful suggestions related to how OI can enhance technology innovation ability, relatively few studies examine the moderating role of OI in TICs and firm performance. In this study, we suggest that individual firms that possess a higher level of OI adoption can better leverage their TICs to achieve superior performance. In accordance with this line of inquiry, one main object of this study is to examine the moderating role of OI on enhancing TICs' beneficial effects on firm performance. Thus, we develop an enable-capabilities-performance framework as our theoretical model. Our model simultaneously incorporates both OI and TIC dimensions. Our model also simultaneously explores OI as an antecedent and firm performance as a consequence of TICs. We derive our hypotheses from empirical research that has conceptualized TICs as the combined construct of a series of innovation-related capabilities (e.g., Achilladelis and Antonakis 2001; Adler and Shenbar 1990; Guan et al. 2006; Romijn and Albaladejo 2002; Yam et al. 2004). Accordingly, because of the lack of an empirical basis, we do not propose different hypotheses for the separate dimensions of TICs, which include the following capabilities: (a) learning, (b) R&D, (c) resource allocation, (d) manufacturing, (e) marketing capability, and (f) strategy planning.

### 3.1. The impact of OI on TICs

According to OI theory, firms that adopt new and external knowledge may simultaneously determine technological exploitation and applications in an innovative system (Damanpour and Evan 1984). OI can foster TICs because it involves the adaptation and acquisition of the new methodologies, skills, and methods that support innovation needs (Damanpour 1991; Camisón and Villar-López 2014). In accordance with previous studies (e.g., Damanpour and Evan 1984; Kimberly and Evanisko 1981; Camisón and Villar-López 2014), we hypothesize that OI has a positive impact on the seven dimensions of TICs. OI relates to the collection of new methods, instruments, and managerial information regarding firms engaged in their innovation deployment as they actually implemented these new concepts into the firm (Damanpour and Evan 1984; Kimberly and Evanisko 1981). An innovative-oriented firm in the context of a rapidly changing emerging market needs innovative-related capabilities to improve its TICs through the technological interrelatedness between different sections and sub-systems (Teece 1996). Thus, a firm tends to facilitate innovation to complement other innovation capabilities (Sapprasert and Clausen 2012). For example, Damanpour, Szabat, and Evan (1989) studied U.S. firms and found that a firm that undertakes well-developed OI may promote technological innovation activities. However, researchers have recognized that a 'complementary relationship' often extends to OI in which firms connect with various innovation efforts (Battisti and Stoneman 2010; Carboni and Russu 2018; Damanpour, Walker, and Avellaneda 2009; Martínez-Ros and Labeaga 2009; Piva, Santarelli, and Vivarelli 2005). This process not only improves the firm's existing routines and operations but also allows it to acquire, exploit, and assimilate new ways, skills, technologies, and capabilities in technologically based innovation activities.

Building on the seminal work indicating that OI is beneficial for technological innovation (i.e., Damanpour, Szabat, and Evan 1989; Damanpour and Evan 1984), introducing new approaches, knowledge, and capabilities to facilitate operation effectivity leads to

enhanced innovation capability which, in turn, creates an appropriate innovation environment for the adoption of technological innovation. Camisón and Villar-López (2014) posit that OI is an important antecedent of technological innovation (process and product innovation) efforts, and they find support for this proposition; however, Camisón and Villar-López's (2014) empirical research finds that OI can significantly influence technological innovation. Nevertheless, the relation of OI adoption to new technological innovation often remains underappreciated (Damanpour and Evan 1984). Only minimal previous research has examined the role of OI in accessing and applying new methods and technical innovation in innovation striving (Camisón and Villar-López 2014; Damanpour 1991; Damanpour, Szabat, and Evan 1989); the researchers do not address the role of OI in leveraging TICs in innovation deployment. Furthermore, some research indicates that firms will be more likely to enhance and facilitate the adoption of technological innovation when they have a flexible organization strategy, structure, and administrative procedures; in addition, new systems and methods improve an organization's communication, information sharing, collaboration and innovativeness (Azar and Ciabuschi 2017; Damanpour and Aravind 2011; Damanpour and Evan 1984; Damanpour, Szabat, and Evan 1989; OECD 2005). According to these arguments, we intend to increase our understanding of their relationship by fine graining the effects of OI on TICs. Firms with well-developed OI are more likely to pursue technologically based innovation activity. Firms with a strong OI are capable of adopting, exploiting, and assimilating new knowledge, combining it with related knowledge, and exploiting the new knowledge in technological innovation. Consequently, firms make efforts to increase OI capacities to adopt, exploit, and assimilate new and knowledge and capability, which contributes to achieving highly effective utilization of technological innovation. Damanpour and Evan (1984) posited that firms adopt OI results to a high extent in technological innovation. Firms that possess well-developed OI are likely to have better capabilities of exploiting new technology, which can support the degree of exploitation and application of innovations, which can result in nourishing the development and promotion of technological innovation. Therefore,

*H1: OI positively influences the following capabilities: (a) learning, (b) R&D, (c) resource allocation, (d) manufacturing, (e) marketing, and (f) strategy planning.*

### 3.2. The impact of TICs on firm performance

According to Damanpour, Szabat, and Evan (1989), firms' successful implementation of technological innovations depends on adopting OIs. From this perspective, TICs are similar to those of natural OI in adopting new methods and a new business model, both of which are of equal importance to firms' innovation activities. Previous studies also suggest that firms that adopt technological innovation require new organizational procedures, capabilities, and managerial skills (Chandy, Prabhu, and Antia 2003; McDermott and O'Connor 2002; O'Connor and Veryzer 2001), which then influence their innovation outcomes. Thus, firms embrace TICs as an ongoing effort to develop stronger innovation capabilities, creating an innovation instrument for firms' utilization of useful capabilities in deploying their innovations. To understand the benefits of linking organizational capabilities and technological capabilities, Brown and Fai (2006)

propose that to achieve the successful development of innovation processes, firms must align with strategic implementation to achieve innovation objectives. Therefore, a firm's TICs have frequently been suggested as a means of facilitating and supporting an innovation strategy (Burgelman, Maidique, and Wheelwright 2004) to continuously increase firm competitiveness (Yam et al. 2004). Therefore, TICs are the main source of a firm's competitive advantages (Teece 1996). Firms use TICs to gain overall capabilities in innovation, leading to superior performance (Cohen and Levinthal 1990; Chandy, Prabhu, and Antia 2003; McDermott and O'Connor 2002; Rosnberg and Frischtak 1985; Yam et al. 2011). Therefore, we expect that a firm's possession of well-developed TICs makes a substantial contribution to firm performance.

Utilizing the perspective of the complementarities-in-use (e.g., Ballot et al. 2015; Galia and Legros 2004; Reichstein and Salter 2006), these researchers suggest that TICs stem from linking a series of activities such that a firm that employs one capability often requires the addition of another capability. In the context of TICs, a firm must find a suitable fit between various innovation capabilities, suggesting a mutual and beneficial interaction. Researchers investigating complementarities-in-use have sought both to identify relatedness in the use of various innovation capabilities and to show that certain innovation capabilities often tend to be linked. Therefore, we use the complementarities perspective to show that the series of various components of TICs are interdependent and interactive, thus fostering innovation efforts and in turn, contributing to performance outcomes. These interdependent interactives are believed to be naturally fully complementary from connecting and interrelating the components and functions of TICs to appropriate the rents from innovation (Chiesa, Coughlan, and Voss 1996; Christensen 1995). Firm TICs can be recognized as an overall perspective to capture the essence of innovation activities, which include multi-component technologies and capabilities (Garcia and Calantone 2002; OECD 1991). As Teece (1986) notes, TICs spur superior firm-level performance when they integrate a series of innovation resources. Guan et al. (2006) similarly suggest that the components of TICs jointly affect firm competitiveness performance. Similarly, Yam et al.'s (2011) study showed that TICs are interactive and complement a firm's innovation capabilities, thus potentially reinforcing its innovation outputs. Accordingly, the link between TICs and firm performance may be obvious, and the implementation of proper TICs can contribute to performance outcomes. Overall, we expect firm performance to be positively affected by holistic TICs because all features, functions, and attributes are relative to each other and are naturally complementary. All the dimensions and components of TICs are complementary to each other and therefore are more likely to support innovative interactions and innovation activities that enhance firm performance. Thus,

*H2: The following TICs enhance firm performance: (a) learning, (b) R&D, (c) resource allocation, (d) manufacturing, (e) marketing, and (f) strategy planning.*

### 3.3. The mediating role of TICs

The above hypotheses combine to form a mediating role of TICs. We theorize that OI is positively related to firm performance. However, we think that TICs mediate the OI–firm performance relationship. This mediated relationship explains how OI is ultimately translated into performance in the innovativeness of firms. When firms engage in

a state of OI activity, they have the motivation to actively take advantage of it to complete the tasks of their innovation efforts (Armbruster et al. 2008). As prior literature has posited, even if an individual firm wants to have superior performance, it needs to engage in TICs to promote completion of the technologically based innovation activity (Damanpour and Evan 1984; Kimberly and Evanisko 1981) because the main OI activity of firms had been identified as a prerequisite for TICs in prior evidence (Damanpour and Aravind 2011). That is, the role of OI is to promote TIC development (Armbruster et al. 2008), which can favor the development of the ability to perform a technical function. Returning specifically to OI activity, when OI is high, firms are likely to implement new methods for organizing routines and procedures (OECD 2005); such OI simultaneously promotes them to work with TIC efforts, which ultimately leads to higher firm performance. Based on the above discussions, we propose:

*H3: Technological capabilities including (a) learning capability, (b) R&D capability, (c) resource allocation capability, (d) manufacturing capability, (e) marketing capability, and (f) strategy planning capability will mediate the relationship between OI and firm performance.*

### 3.4. Joint effects of OI and TICs

As previously noted, we expect OI and TICs to interact with each other to influence firm performance. One intriguing possibility is that OI moderates the effect of a firm's TICs on firm performance. The prior research has shown that OI can have an enabling effect by influencing both an individual firm's TIC and how that capacity is leveraged and implemented (Damanpour 1991; Wolfe 1994). We propose that greater OI adoption is better able to leverage TICs to increase firms' innovativeness for two reasons. First, researchers have argued that firms high in OI adoption have a greater ability to engage in new skills, methods, practices, and external relations (Armbruster et al. 2008; OECD/Eurostat 2005; Damanpour and Evan 1984). These manifestations of high OI adoption may propel the adopting organizations to emphasize the implementation of technology-based innovation in their innovation development as a means to enhance innovativeness. Second, leveraging TICs requires possessing a strong ability to influence a diverse and novel body of knowledge and technology that will serve as the seed for future innovation developments (Nelson and Winter 1982). Firms that are high in OI are more likely to gain greater access to diverse and heterogeneous technologies than firms with less OI adoption. Because firms that are high in OI adoption have a higher level of implementation of ideas or behavior (Damanpour 1996), they should be better able to produce the benefits of complementarities-in-performance that may arise from the joint application of OI and TICs that are greater than their individual parts (Ballot et al. 2015). Although a firm has high OI adoption practices, the ability to move from technology-based knowledge and skills to exploiting these resources may benefit from the stronger effects of OI adoption. The extent to which a firm undertakes the transfer of the OI practice is thus likely to enhance the transformation from technology-based knowledge and skills to innovation development. This statement implies a moderating effect where the relationship between TICs and firm performance is quite strong at high levels of OI adoption. Furthermore, individual firms that are high in OI are likely to absorb external

resources and be more able to cope with novel technologies and new organizational managerial methodologies that are associated with an increased amount of technologies and information, positively affecting their performance.

*H4: OI positively moderates the impact of (a) learning capability, (b) R&D capability, (c) resource allocation capability, (d) manufacturing capability, (e) marketing capability, and (f) strategy planning capability on firm performance at the firm level.*

### 3.5. Influence of OI on FP

Firms with strong OI capabilities may generate more value from new ideas, skills, information, and methods than firms with weak OI capabilities. According to the literature on innovation (Damanpour and Evan 1984; Damanpour 1991), firms that possess well-developed OI may return superior performance. Lam (2005) states that a firm benefits in a variety of ways, including adopting new process technology, new systems for administrative routine and new programs for business operations and services, which may increase the possibilities for additional innovation outcomes. Similarly, Gunday et al. (2011) argues that firms engaged in OI activities enhance their overall innovativeness. Damanpour and Aravind (2012) and Hamel (2006) find that firms innovate more and grow faster when they yield new technologies, efficient production techniques, and new products and processes that result from OI activities, all of which increase firm performance. Based on that logic, well-developed OI activities in addition to an innovation development process may generate beneficial synergies that could strengthen the linkage between OI and firm performance. Therefore, based on the above reasoning, we hypothesize the following:

*H5: OI positively affects firm performance.*

## 4. Methodology

### 4.1. Sample and data collection

Our empirical data were collected from China's Pearl River Delta region. The sample frame consisted of firms from a wide range of Pearl River Delta regions for three reasons. First, this region includes a series of industrial development zones in which firms embedded in these zones are more well developed, prominent, and well known than non-embedded firms Despite their short history, these industrial zones have become the most important sources of economic development and regional development in the emerging China (Chin, Liu, and Yang 2016). The growth momentum of China's industrial zones has significantly promoted a market-oriented economy (World Bank 1996), which leads to market growth and allows for a more nuanced understanding of the research question in this study. Second, this region provides a rich context to test our hypotheses because its emerging, rapidly changing market forces firms to engage in innovation striving to conduct their operation and business to meet market needs (Liu, Luo, and Shi

2003). Recently, firms included in the zones are increasingly recognizing the advantages that new knowledge and technology acquisition can bring in terms of innovation excellence. Finally, firms are embedded in the zones in accordance with manufacturing technological aggregation and geographical aggregation, which allows a large number of firms to acquire what they need (Chin and Liu 2017). Accordingly, the administrative offices of the industrial zones provided the complete sample frame for our study.

We collected data about manufacturing firms in these zones using several criteria. First, we searched for the names of all the firms belonging to the different industrial development zones. We chose to study these firms because all focal firms must register with government officials in the industrial zones to apply for grants for their innovation activities. Second, to obtain information about firm-level variables, we chose only entities publicly listed in industrial zones. Third, we selected focal firms whose business activity and information appeared in the industrial zones' reported database. These criteria resulted in a sample of 500 firms from industrial development zones. The survey sample firms included manufacturing firms and servitization firms because servitization firms (service-oriented firms) have become a pervasive business strategy among manufacturers, enabling them to undergird not only customer needs but also their competitive advantage in such emerging markets.

We collected firm-level data through industrial zones in the Pearl River Delta region where we conducted the survey. We contacted senior managers and R&D managers for focal firms using e-mail and phone calls to request their participation because senior managers possess abundant experience in such emerging markets from a strategic perspective. When these senior managers agree to participate in our research, we identify qualified respondents to complete our questionnaire, including R&D, marketing, product, and project managers. In addition, to enhance the survey response rate, all participants from the sample firms were first contacted by telephone and e-mail; two follow-up e-mails were then sent to remind them of their participation. Two weeks later, the same questionnaire was sent as a reminder to all the participants using fax or e-mail. Four weeks after the initial mailing, we sent replacement questionnaires to nonrespondents. After executing the above procedures, a valid sample of 265 firms was obtained, 235 of which were excluded because of incomplete answers and missing data, resulting in a response rate of 53.00 percent. Furthermore, our sample size is greater than the 200 required to employ structural equation modeling (SEM) (Kelloway 1998).

We first develop an English version of the questionnaire, which relies on previous studies. Then, we translate this version into Chinese by different research methods and in turn, back-translate it into English to ensure that the English and Chinese versions achieved equivalent measures. To further ensure the content and facial validity of the measure items, we conducted in-depth interviews with six senior managers with more than seven years of experience in their sectors. These senior managers were identified by their expertise in innovation management during the face-to-face interview process. We asked these senior managers to check the relevance and completeness of each of the questionnaire items to maintain conceptual equivalence between the original and translated instruments. Based on the managers' comments and suggestions, we revised a few questionnaire items regarding wording, grammar, and sentences to achieve consistency. We also conducted a pilot study with 30 senior managers to refine the questionnaire and finalize the survey. In addition, to increase our questionnaire context

**Table 1.** Distribution of the sampled firms ($N$ = 265).

| Firm characteristics | *N* | Percentage |
|---|---|---|
| Industry type | | |
| Manufacturing-based firms | 160 | 60% |
| Service-oriented firms | 105 | 40% |
| Ownership type | | |
| State-owned firms | 54 | 20% |
| Private firms | 211 | 80% |
| Firm size (employees) | | |
| 1–100 | 37 | 14% |
| 101–500 | 104 | 39% |
| 501–1000 | 102 | 38% |
| More than 1000 | 22 | 9% |

validity and reliability, those 30 senior managers did not overlap with the above in-depth six senior managers.

Table 1 provides an analysis of the respondents by size-level data. In the emerging China market, many firm ownership structures continue to be held by the central government. Thus, these firms' operational models are very different, as are their innovation activities in such a market. Based on our sample, firm types can be divided into manufacturing-based firms (60%) and service-oriented firms (40%). Our available 265 firms were collected from 160 manufacturing-based firms and 105 service-oriented firms. The use of different types of firms can provide us with a better understanding of how different types of firms balance different dimensions of OI and TICs in their routine innovation activities. Furthermore, firms with a private ownership structure represented 80% of our sample, whereas firms with a state ownership structure represented 20%. Finally, we classified firm size into four broad groups based on the number of employees. Thus, 39% of the firms had 101–500 employees, and 38% had 501–1000 employees.

### *4.2. Measures*

Our measure items are adopted from previous studies. The measurement items are listed in Table 2. All items were measured with a seven-point Likert scale, ranging from (1) strongly disagree to (7) strongly agree. OI was developed from Damanpour and Evan (1984), the OECD (2005), and Camisón and Villar-López (2012). The OI scale assesses a firm's adoption of new methods, procedures, administrative, and external relationships in facilitating their innovation efforts. Nine items are used to assess firms' OI activities and behaviors. We developed the measure of TICs based on Chiesa, Coughlan, and Voss (1998), Yam et al. (2004), and Guan et al.'s (2006) conceptualizations. The researchers emphasize that the TICs are characterized as a multidimensional scale, including ten items for learning capability, six items for R&D capability, seven items for resource operating capability, five items for manufacturing capability, seven items for marketing capability, eight items for organizational capability, and seven items for strategy planning capability (see Appendix A). Furthermore, we adopted Yam et al. (2004) and Guan and Ma's (2003) scale to measure firm performance. We measured firm performance by asking respondents to estimate their firms' sales growth, return on investment, return on assets, and profit level relative to those of their major competitors. In addition, to explain the effects of extraneous variables, we included firm size, industry type and firm

**Table 2.** Operational definition of variables.

| Variable | Definition | Proposed by |
|---|---|---|
| Organizational innovation | Introduction of a new organizational method for business management not only in managerial practices and the workplace but also in building external relations between a company and external agents. | Damanpour and Evan 1984; OECD 2005; Camisón and Villar-López 2012 |
| Technological innovation capabilities | Learning capability is the firm's ability to identify, assimilate, and exploit knowledge from external sources. | Chiesa, Coughlan, and Voss 1998; Yam et al. 2004; Guan et al. 2006 |
| | R&D capability refers to the firm's ability to integrate R&D strategy, project implementation, project portfolio management, and R&D expenditure. | |
| | Resources allocation capability ensures that the firm possesses sufficient capital, professionals and technology during the innovation process. | |
| | Manufacturing capability refers to the firm's ability to transform R&D results into products that meet market needs, agree with the design request and that can be manufactured in batches. | |
| | Marketing capability is the firm's ability to publicize and sell products based on understanding consumer needs, competition situation, costs and benefits, and acceptance of the innovation. | |
| | Strategic planning capability is the firm's ability to identify internal strengths and weaknesses and external opportunities and threats, formulate plans in accordance with corporate vision and missions, and acclimatize plans for implementation. | |
| Firm performance | There are four types of firm performance, including sales performance, innovation performance, sales growth and product performance. | Yam et al. 2004; Guan and Ma 2003 |

ownership as control variables. The importance of industry type in innovation research has been proposed and may impact innovation outcomes. We use a dummy variable to control for the effect of industry type, manufacturing and service firms. In addition, we controlled the ownership of firms because firm ownership in the emerging China market has been demonstrated to influence innovation behavior. We also use the dummy variable to control for state ownership and private ownership. Finally, we controlled firm size, which was classified into four categories; thus, we create three dummy variables to control firm size.

To assess construct reliability and validity, we employ a confirmatory measurement model. The confirmatory measurement model fits the data acceptably ($\chi^2/df = 2.21$, $p = 0.000$; CFI = 0.98; NNFI = 0.98; NFI = 0.96; SRMR = 0.06; RMSEA = 0.06), and all factors' loadings are statistically significant ($p<0.001$), supporting our estimated model proposed by (Hu and Bentler 1999). To assess the discriminant validity of the constructs, we ran chi-square difference tests for all constructs in pairs to determine whether the constrained model is significantly worse than the freely estimated model (see Appendix A). Furthermore, based on the suggestions of Fornell and Larcker (1981) and Bagozzi and Yi (1988), the composite reliability (CR) and the average variances extracted (AVE) for all the constructs provided further support for composite reliability and discriminant validity, respectively.

## 5. Analyses and results

To test for common method variance (CMV), we employed Harman's one-factor test procedure (Podsakoff and Organ 1986). According to the work of Podsakoff and Organ (1986), if one factor can explain the majority of the variance, then CMV may be present. Accordingly, a principal components factor analysis was conducted for the analysis using all of the variables, and it resulted in a four-factor solution. As a result, the first and largest factor accounted for only 16.74% of the variance. Thus, CMV does not appear to be a concern in our study (Podsakoff and Organ 1986). Furthermore, to examine the multicollinearity concern, we employed variance inflation factor (VIF) values to estimate whether or not the VIF values were all below the threshold of 10, according to the work of Aiken and West (1991). The VIF scores ranged from 2.1 to 3.42 in our model, suggesting that multicollinearity was not a problem.

The descriptive statistics and correlation coefficients, including the means, standard deviations (SD), and correlation matrices for the variables used in this study, are shown in Table 3. The correlation matrix indicates a stable significant correlation between the dependent and independent variables. Although all the variables of TICs in Table 3 were highly correlative, they are not statistically significant.

For the hypotheses tests, we employed SEM with the maximum likelihood estimation method to test all the hypothesized relationships simultaneously. In accordance with Anderson and Gerbing's (1988) method, the outcomes of our analysis show an adequate model based on the fit indices provided in Table 4. Thus, we summarized the path coefficients and their significance in Table 4. The results from the statistical analysis support most (but not all) of the hypotheses developed. In summary, we find support for the hypothesized positive relationships between OI and all constructs of the TICs ($p$<0.001). These results support the predictions of $H1_{a\sim f}$. However, the TICs have a positive effect on firm performance only for R&D capability ($\beta = .02,\ p < 0.05$), marketing capability ($\beta = .35,\ p < 0.001$) and strategic planning capability ($\beta = .44,\ p < 0.001$), which supports our hypotheses. This result supports the partial prediction of $H_{2a}$, $H_{2e}$, and $H_{2f}$.

Next, the path coefficient for the six interaction effects between OI and TICs, namely, OI $\times$ manufacturing capability ($\beta = .06,\ p < 0.05$) and OI $\times$ strategy planning capability ($\beta = .008,\ p < 0.05$), were positive and significant, providing partial support for

**Table 3.** Basic descriptive statistics of the correlation coefficients.

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. OI | 1 | | | | | | | | | |
| 2. Learning capability | .64 | 1 | | | | | | | | |
| 3. R&D capability | .61 | .60 | 1 | | | | | | | |
| 4. Resources allocation capability | .66 | .65 | .69 | 1 | | | | | | |
| 5. Manufacturing capability | .58 | .51 | .68 | .67 | 1 | | | | | |
| 6. Marketing capability | .56 | .64 | .61 | .66 | .66 | 1 | | | | |
| 7. Strategic planning capability | .64 | .65 | .66 | .75 | .68 | .75 | 1 | | | |
| 8. Firm performance | .48 | .50 | .51 | .50 | .47 | .57 | .60 | 1 | | |
| 9. Firm size | .01 | −.05 | .01 | −.02 | .03 | .02 | .06 | .07 | 1 | |
| 10. Firm ownership | .15 | .03 | .12 | .05 | .15 | .01 | .07 | −.02 | −.03 | 1 |
| 11. Industry type | −.09 | −.93 | −.25 | −.09 | −.20 | −.06 | −.08 | .04 | .11 | −.35 |
| Means | 4.78 | 5.10 | 4.84 | 4.74 | 4.84 | 5.20 | 4.97 | 5.00 | | |
| S.D. | 1.12 | 1.07 | 1.30 | 1.23 | 1.32 | 1.10 | 1.18 | 1.20 | | |

**Table 4.** Path coefficients and their significance.

| Hypothesis | Path | Coefficient | Support or not |
|---|---|---|---|
| H1a | OI → Learning capability | 0.82*** | Yes |
| H1b | OI → R&D capability | 0.78*** | Yes |
| H1c | OI → Resource allocation capability | 0.82*** | Yes |
| H1d | O I→ Manufacturing capability | 0.77*** | Yes |
| H1e | OI → Marketing capability | 0.80*** | Yes |
| H1f | OI → Strategic planning capability | 0.84*** | Yes |
| H2a | Learning capability → FP | 0.05 | No |
| H2b | R&D capability → FP | 0.20** | Yes |
| H2c | Resource allocation capability → FP | −0.27 | No |
| H2d | Manufacturing capability → FP | 0.01 | No |
| H2e | Marketing capability → FP | 0.35*** | Yes |
| H2f | Strategic planning capability → FP | 0.44*** | Yes |
| H4a | OI × Learning capability → FP | 0.03 | No |
| H4b | OI × R&D capability → FP | 0.02 | No |
| H4c | OI × Resource allocation capability → FP | 0.03 | No |
| H4d | OI × Manufacturing capability → FP | 0.06* | Yes |
| H4e | OI × Marketing capability → FP | −0.01 | No |
| H4f | OI × Strategic planning capability → FP | 0.08* | Yes |
| H5 | OI → FP | 0.52*** | Yes |

Notes: *$p<0.05$; **$p<0.01$; ***$p<0.001$; goodness-of-fit statistics, $\chi^2/df = 2.21$, CFI = 0.98, NNFI = 0.98, NFI = 0.96, SRMR = 0.06, RMSEA = 0.07.

$H_{4d}$ and $H_{4f}$. Regarding H5, the SEM coefficient for the path from OI to firm performance, OI→FP ($\beta = .52,\ p < 0.001$), was significant. Therefore, OI does have a positive effect on the firm preference, supporting H5.

One major purpose of this study was to explore the potential mediating roles of TICs between OI and firm performance. Thus, to test the mediating effects of the TICs, we utilized the approach of Baron and Kenny (1986). Specifically, we first established direct paths between OI and firm performance. We then added the mediating variables of TICs to the model. According to Baron and Kenny, full mediation occurs only if (a) the direct path from OI to firm performance is insignificant, and (b) the indirect paths through TICs are significant. Partial mediation occurs if (a) the direct path between OI and firm performance is significant, and (b) the indirect paths are significant. If all of these conditions are adequate and the impact of the independent variable becomes non-significant in the presence of the mediator, the effects of the independent variable are considered to be completely mediated by the mediator. However, if all of the conditions are adequate but the impact of the independent variable remains significant in the presence of the mediator, the effects of the independent variable are considered to be partially mediated. In addition, if any of these conditions are not adequate, there is no mediating effect (Baron and Kenny 1986). Furthermore, using SEM approaches for moderating may cause concerns related to the nonlinear functions of latent variables in SEM models, resulting in difficulties in modeling estimation. However, due to methodological advances in SEM, estimating techniques for the inclusion of nonlinear functions are now becoming increasingly available (Li, et al. 1998; Schumacker 2002). The use of SEM has also been recommended as a remedy for this concern. Thus, SEM attenuates this concern by introducing interaction modeling through the application of latent variables.

**Table 5.** The mediating role of TICs ($H_{3a\sim f}$).

| Mediator | Relationship | Coefficient | Support or not |
|---|---|---|---|
| Learning capability | OI→firm performance | 0.02 | No |
| R&D capability | OI→firm performance | 0.03 | No |
| Resource allocation capability | OI→firm performance | 0.21* | Yes |
| Manufacturing capability | OI→firm performance | 0.35* | Yes |
| Marketing capability | OI→firm performance | −0.02 | No |
| Strategic planning capability | OI→firm performance | 0.81* | Yes |

Notes: *$p$<0.05; **$p$<0.01; ***$p$<0.001; goodness-of-fit statistics, $\chi^2$/df = 2.08, CFI = 0.98, NNFI = 0.97, NFI = 0.95, IFI = 0.98, SRMR = 0.06, RMSEA = 0.08.

To examine the mediating effect of TICs, we also used bootstrapping techniques to test the statistical significance of path coefficients. Bootstrapping is a statistical resampling method that estimates the parameters of a model and their standard errors strictly from the sample. Table 5 summarizes the results of the bootstrapping technique procedure. We tested the significance of H3a~f using bootstrapping ($N$ = 1,000). We multiplied the direct paths that made up the indirect path evaluation for 1000 bootstrapping samples, and a bias-corrected confidence interval of 95% was established for mediation (TICs). First, as expected, there was statistically significant support for the relationship between OI and firm performance, as shown in Table 4. Second, there was positively significant support for indirect effects of OI on resource allocation capability ($\beta = .21,\ p < 0.05$), manufacturing capability ($\beta = .35,\ p < 0.05$), and strategic planning capability ($\beta = .81,\ p < 0.001$) via TICs, as shown in Table 5. The results indicated that of seven proposed relationships, only three (resource allocation capability, manufacturing capability, and strategic planning capability) had a statistically significant effect on the measurement. Thus, our hypothesis H3a~f was partially supported. Hence, the bootstrapping procedure supported our model's TICs as partial mediators between OI and firm performance.

## 6. Discussion

Drawing on the literature on OI and TICs, this study aims to examine the role that OI plays in facilitating and stimulating technological innovation. Our findings indicate that OI facilitates the development of TICs, which in turn promote firm performance. In addition, the results indicate that OI plays a moderating role between TICs and firm performance. Our results confirm that the beneficial effects of TICs on firm performances are strengthened for firms with well-developed OI.

In addition, although TICs have been considered a key factor in innovation efforts in the emerging market, a considerable body of research still emphasizes specific types of innovation activities, such as product and process innovation (see Camisón and Villar-López 2014; Evangelista and Vezzani 2010; Camisón and Villar-López 2014). Our study seeks to expand the previous innovation research by including seven types of technological innovation activities: learning, R&D, resource allocation, manufacturing, marketing, organizational, and strategy planning capabilities. Our study differs from earlier technological innovation studies in that the influences of multidimensional levels on innovation activities are considered.

Consistent with previous studies (e.g., Azar and Ciabuschi 2017; Cheng and Yang 2017; Carboni and Russu 2018; Camisón and Villar-López 2014), we found a positive association between OI and TICs. However, our results showed that TICs only partially explained the relationship between OI and firm performance. This is perhaps why our study linked multidimensional characteristics of TICs with firm performance – the significant dispersal of the effects of TICs on performance in our sample. In the same manner, our results showed that OI partially explained the relationship between TICs and firm performance. One possible explanation for this inconsistent finding concerns the sample of our study and the role of TICs. Our study applied the full sample to estimate the moderating effects of OI. Note that different types of firms may have significant differences in technological innovation activities. It may be that this significant difference eliminated the partial moderating effect found in our study. Furthermore, we also report evidence that TICs only partially mediate the relationship between OI and firm performance. One possible explanation is that while the focal firms require OI to bring new methods, capabilities, and skills to a firm's business practices and workplace organization to improve their technologically based innovation activities, the OI may not have an equivalent contribution to the supportive TIC context. Consequently, the effects of OI on TICs may reduce some of the failure constructs that may not be adequate for explaining technological innovation activities.

It is important to note the OI of firms was the primary driver of TICs as they engaged in innovation efforts. In addition to linking OI dimensions to TICs, our study is the first to examine an antecedent and moderator of OI. Consistent with previous studies (Camisón and Villar-López 2014; Evangelista and Vezzani 2010), OI plays an antecedent role for TICs. In this study, we took a different an approach and suggested that the relationships between TICs and firm performance were partially moderated by OI. Thus, our theoretical framework may also help us gain insights into the OI-TICs-firm performance relationships. Overall, our findings suggest that researchers and managers need to revisit the OI-TICs-firm performance relationship for their innovation goals. This would ensure that examining other theoretical perspectives may help us gain a better understanding of this important relationship in emerging markets.

## 7. Limitations and future research

There are certain limitations to this study, which consequently suggest potential future research directions. First, the firm-level data survey in this study was employed in a single emerging market setting (i.e., China). As such, the findings are not easily generalizable to other contexts. Further research into the mediating roles of TICs in innovation development processes in other emerging market settings may be fruitful (e.g., India, Taiwan, and Turkey). Second, the research methodology used in this study involved SEM manipulations of innovation efforts. The validity of the current findings would be enhanced by further testing of the proposed model using OLS regression manipulations of innovation activities. Third, perceptual firm-level performance measures and TICs appear to be highly correlated with objective measures. In our initial study, the ranges of correlation coefficients are between 0.48 and 0.70. Nevertheless, these correlation results indicate that perceptual measures are merely a partial representation of objective performance measures. Moreover, the data are gathered from the self-administered perspective of key informants.

Although senior managers can be considered well-informed respondents with respect to their innovation development, the study cannot control for the common method variance problem. Thus, future research may fruitfully address this issue in more detail and use multiple respondents (i.e., senior managers, project managers, and marketing managers from each firm) as survey participants.

## 8. Theoretical implications

We contribute to the innovation management research by highlighting key capabilities and their roles and relationships among OI, TICs, and firm performance. In this study, we posited that OI is a key antecedent factor enabling the involvement of TICs in innovative processes, and OI also plays a moderator role in catalyzing the relationships between TICs and firm performance. Theoretically, we make several specific contributions to the innovation theory of emerging markets. First, by examining the antecedent role that OI plays in developing TICs, this study contributes to the innovation theory of firms by suggesting that OI enables individual firms to establish innovation action through leveraging their TICs for the attainment of superior performance goals. Second, this study is one of the few attempts to examine OI as a contingency. Previous research focuses mainly on antecedents of OI (Camisón and Villar-López 2014). However, this study did not explore the contingency role of OI, which may be activated to systematically influence the innovation development process. Our findings suggest that the contingency role of OI determines the extent to which individual firms are enhanced and become more crucially linked to TICs and performance. Finally, we enrich innovation management theory by integrating several major constructs into the theory introduced within a unifying framework. Our examination of OI as both an antecedent and a moderator uncovers the comprehensive role that OI plays in the process of innovation effort building. As a moderator, OI delineates the conditions under which TICs can be better utilized to obtain superior performance outcomes. Although prior research has acknowledged the direct effect of TICs on firm performance (Azar and Ciabuschi 2017; Ballot et al. 2015), there is little systematic understanding of the processes that underlie how TICs can be better utilized and leveraged by individual firms. Our study obtains evidence that OI constitutes an important contextual factor in the innovative process of TIC utilization. Developing OI while developing and expanding TICs is therefore critical to superior performance.

## 9. Managerial implications

The findings of this study suggest that managers need to pay more attention to how engaging in OI and TICs simultaneously can contribute to firm performance. OI can help firms access new knowledge, skills, and capabilities to enhance their non-technological innovation capability, whereas TICs can offer firms technologically based innovation capability; both capabilities lead to firm performance. Managers thus should realize that OI and TICs cannot be viewed as a separate activity from innovation processes, and they should consider the logic of complementarity accordingly by connecting the innovation processes. Managers are encouraged to engage in considering the potential benefits of not only implementing OI but also strengthening their TICs in their operation processes. Indeed, as mentioned above, complete sets of technological and non-

technological innovation resources that facilitate progress through all stages of the innovation process may often require that firms pursue both OI and TICs simultaneously.

Furthermore, from the firm innovative perspective, individual firms that desire to advance their innovation efforts would benefit from examining how to best utilize their OI and TICs to achieve superior performance. With regard to the results, managers in firms can achieve high levels of efficiency when they implement OI and TICs jointly. Individual firms can enhance their OI to advance their performance through the effects of OI on TIC development. That is, the level of OI determines whether an individual firm can strengthen the benefits of TICs for their performance. Furthermore, this knowledge can provide policymakers an important clue for improving the design of their innovation policies to promote innovation in manufacturing firms, especially when the coexistence of OI and TICs is demonstrated in emerging Chinese markets. In this sense, this study reveals that the design of a good innovation policy to promote performance that deals separately with OI and TICs does not seem appropriate.

From the OI perspective, since OI is conducive to synergistic relationships and has a direct effect on TICs and combinations, the development of new and external knowledge, technologies, and resources should be facilitated. In addition, since the positive effect of TICs on performance outcomes is contingent on the OI of the firms, the effective utilization and development of technologically based innovation capability and coaching techniques to improve firms' OI capability would be recommended. However, this should be exercised with caution and accompanied by appropriate capabilities, especially in emerging Chinese markets, where TICs are often overemphasized to the neglect of OI concinnity. Managers and decision makers should therefore be careful to ensure that OI and TICs are in harmony rather than substituting for each other to promote firm performance.

## 10. Conclusion

Our results provide a detailed understanding of the roles of OI and TICs and their important contributions to firm performance. Drawing on OI theory, this study examines the roles that OI plays in the development and utilization of TICs in innovation efforts. Our findings confirm the antecedent and moderating roles of OI in establishing and utilizing TICs, which in turn influence firm performance. This study therefore contributes to the literature by uncovering the mechanism that underlies the relationship between OI and firm performance. It also adds to our understanding of the boundary condition under which TICs are linked to superior performance in emerging markets.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This work was supported by the Guangdong Academy of Education [Project: GDJY-2015-C-b010]; Guangdong Social Science Planning Project [GD17XGL15]; Natural Science Research Projects of Guangdong University of Petrochemical Technology, China [2017RC16], and Educational and Teaching Reform Projects of Guangdong University of Petrochemical Technology, China [JY201842].

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## Appendix A. Scales and items/Results of confirmatory factor analysis

| Construct and items | Standardized loading | CR | AVE |
|---|---|---|---|
| **OI** | | 0.94 | 0.62 |
| 1. Use of databases of best practices, lessons and other knowledge | 0.73 | | |
| 2. Implementation of practices for employee development and better worker retention | 0.88 | | |
| 3. Use of quality management systems | 0.76 | | |
| 4. Decentralization in decision-making | 0.78 | | |
| 5. Use of inter-functional working groups | 0.81 | | |
| 6. Flexible job responsibilities | 0.81 | | |
| 7. Collaboration with customers | 0.74 | | |
| 8. Use of methods for integration with suppliers | 0.86 | | |
| 9. Outsourcing of business activities | 0.69 | | |
| **TICs** | | | |
| **Learning Capability** | | 0.93 | 0.56 |
| 1. Your company encourages work teams to identify opportunities for improvement. | 0.81 | | |
| 2. Your company incorporates accessed knowledge into its daily activities. | 0.81 | | |
| 3. Your company understands its core capabilities and matches them with market needs. | 0.76 | | |
| 4. Your company passes lessons learned across boundaries and time. | 0.85 | | |
| 5. Your company promotes a learning culture and invests in learning. | 0.82 | | |
| 6. Your company has frequent interactions with headquarters to acquire new knowledge. | 0.59 | | |
| 7. Your company's employees regularly visit other branches. | 0.60 | | |
| 8. Your company collects industry information through informal means, such as lunch with friends in the industry. | 0.76 | | |
| 9. Your company periodically organizes meeting with customers or third parties to acquire new knowledge. | 0.70 | | |
| 10. Your employees regularly approach third parties, such as consultants, to acquire new knowledge. | 0.71 | | |
| **R&D Capability** | | 0.92 | 0.65 |
| 1. Different departments are involved in concept development and screening new products. | 0.87 | | |
| 2. Your company has high quality, rapid feedback from manufacturing to design and engineering. | 0.88 | | |
| 3. Your company has good mechanisms for transferring technology from research to product development. | 0.80 | | |
| 4. Your company incorporates a great deal of market and customer feedback into the technological innovation process. | 0.73 | | |
| 5. Your company has a high percentage of R&D personnel in its total employment. | 0.79 | | |
| 6. Your company regularly considers the consequence of changing market demands in terms of new products. | 0.77 | | |
| **Resource Allocation Capability** | | 0.94 | 0.71 |
| 1. Your company attaches importance to human resources. | 0.84 | | |
| 2. Your company programs human resources in phases. | 0.83 | | |
| 3. Your company selects key personnel in each functional department for the innovation process. | 0.85 | | |
| 4. Your company provides steady capital supplements for innovation activity. | 0.90 | | |
| 5. Your company can fully use external technologies. | 0.83 | | |
| 6. Your employees record and store newly acquired knowledge for future reference. | 0.88 | | |
| 7. Your employees record and store newly acquired knowledge for future reference. | 0.74 | | |

(*Continued*)

(Continued).

| Construct and items | Standardized loading | CR | AVE |
|---|---|---|---|
| **Manufacturing Capability** | | 0.89 | 0.61 |
| 1. Your company's manufacturing department has the ability to transform R&D output into production. | 0.86 | | |
| 2. Your company effectively applies advanced manufacturing methods. | 0.76 | | |
| 3. Your company has capable manufacturing personnel. | 0.84 | | |
| 4. Your company exerts great effort to continuously improve its manufacturing system. | 0.79 | | |
| 5. Your company has a high degree of manufacturing cost advantage. | 0.64 | | |
| **Marketing Capability** | | 0.92 | 0.64 |
| 1. Your company has close relationship management with major customers. | 0.81 | | |
| 2. Your company has good knowledge of different market segments. | 0.85 | | |
| 3. Your company has a highly efficient salesforce. | 0.80 | | |
| 4. Your company provides excellent after-sale services. | 0.77 | | |
| 5. Your company effectively maintains its brand image and corporate image. | 0.84 | | |
| 6. New opportunities to serve your clients are quickly understood. | 0.83 | | |
| 7. Your company quickly analyzes and interprets changing market demands. | 0.67 | | |
| **Strategy Planning Capability** | | 0.93 | 0.67 |
| 1. Your company has a high capability in identifying internal strengths and weaknesses. | 0.81 | | |
| 2. Your company has high capability in identifying external opportunities and threats. | 0.82 | | |
| 3. Your company has clear goals. | 0.83 | | |
| 4. Your company has a clear plan—a road map of new products and process with measurable milestones. | 0.85 | | |
| 5. Your company is highly adapted and responsive to the external environment. | 0.85 | | |
| 6. Your company periodically meets to discuss the consequences of market trends and new product development. | 0.88 | | |
| 7. Your company constantly considers how to better exploit knowledge. | 0.65 | | |
| **Firm Performance** | | **0.94** | **0.79** |
| 1. The company's annual sales growth rate during the past three years. | 0.86 | | |
| 2. Number of commercialized new products growth of all products in the company per year during the past three years. | 0.89 | | |
| 3. Innovation performance growth. | 0.96 | | |
| 4. Product performance growth. | 0.84 | | |