How market orientation affects open innovation? Exploring the role of information and communication technology capability

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Abstract

Purpose – Based on the organizational learning theory, this study regards market orientation as market-based learning and seeks to advance insight into how proactive and responsive market orientations affect two kinds of open innovation strategies, sourcing and selling. A firm’s information and communication technology (ICT) capability is considered an essential moderator in these relationships.

Design/methodology/approach – This study adopted a quantitative design and used the questionnaire survey method to collect data. The authors finally collected data on samples in China. Multiple regression analysis was used to test the hypotheses.

Findings – The results show that proactive and responsive market orientations act as antecedents of open innovation, showing linear and curvilinear relationships between them. Specifically, responsive market orientation positively affects selling, and proactive market orientation positively affects sourcing. Responsive market orientation has an inverted U-shaped relationship with sourcing, and proactive market orientation has a U-shaped relationship with selling. In addition, ICT capability strengthens the positive effects of market orientation on open innovation and weakens the negative effects.

Originality/value – Drawing on organizational learning theory, this study provides a novel perspective to explain the complex mechanism between market orientation and open innovation. This study also explores the moderating role of ICT capability in this process, which advances research on how to select open innovation strategies under different conditions.

Keywords Proactive market orientation, Responsive market orientation, Sourcing, Selling, ICT capability

1. Introduction

New ventures characterized by high-risk dynamics and initiatives have an important impact on economic development (Bachmann et al., 2021). Studies show that innovation-driven entrepreneurial activities are more likely to succeed (Sempere-Ripoll et al., 2020). However, with the rise of the digital economy and sharing economy, new ventures can no longer afford to depend solely on internal research and development (R&D) innovation processes (Natalicchio et al., 2017). There is a need to break internal boundaries to promote open innovation (Chesbrough, 2003). Open innovation is seen to reduce new ventures’ internal R&D costs (Kutvonen, 2011), accelerate time to provide new products (Helm et al., 2019), increase collaboration between firms and create new revenue streams (Zhu et al., 2019), as well as overcome existing lack of managerial or technical knowledge (Hung and Chou, 2013). Therefore, scholars and practitioners have recently shifted attention from traditional closed internal innovation to open innovation (Naseer et al., 2021). Open innovation refers to
the deliberate use of inflows and outflows of knowledge and expansion of external markets for fostering innovation (Bacon et al., 2019; Chesbrough, 2003). Previous studies mainly explored the outcomes of open innovation, there are few studies focused on the antecedents of open innovation. However, exploring the driving factors of open innovation is of great significance for promoting and encouraging open innovation (Arrigo, 2018; Naseer et al., 2021).

Any innovation activities of enterprises should be aimed at creating value for current and potential customers (Iyer et al., 2019). Based on this consensus, extant research has recognized market orientation as one of the key driving factors of innovation (Cai et al., 2015; Wang and Liu, 2019; Aydin, 2021). However, they mainly focused on closed innovation (Naidoo, 2010), and we still know little about the relationship between market orientation and open innovation. Nonetheless, there is a rising interest in investigating the two areas that have previously been discussed separately. For example, some scholars combined market orientation and open innovation in one research model, such as regarding both of them as independent variables (Rajala et al., 2012), examining the moderating effect of market orientation on the relationship between open innovation and innovation performance (Cheng and Huizingh, 2014) and the mediating role of open innovation between green market orientation and performance (Tjahjadi et al., 2020). Despite such research, studies on the direct effect of market orientation on open innovation are still scarce, relatively ill-understood and even conflicted. For example, some studies showed a positive effect of market orientation on open innovation (Arrigo, 2018; Denktas-Sakar et al., 2015; Tjahjadi et al., 2020), while others found there is no relationship between them (Naqshbandi, 2018). Finding the reasons for the above inconsistent conclusions is helpful for revealing the relationship between market orientation and open innovation.

One possible reason is that scholars differ on the concepts and types of market orientation and open innovation. For example, some studies focused on the whole variable, market orientation (Naqshbandi, 2018; Tjahjadi et al., 2020) and open innovation (Rajala et al., 2012); others focused on the specific types, such as proactive market orientation (Arias-Pérez et al., 2021), market-driven (Arrigo, 2018), outbound or inbound innovation (Naqshbandi, 2018). Our study focuses on proactive and responsive market orientations which have been recognized as the most common in new ventures (Lamore et al., 2013; Narver et al., 2004). And we select sourcing and selling, the two typical kinds of open innovation that could reflect the uniqueness of open innovation activities in new ventures. Sourcing could help new ventures use external sources of knowledge at low or no cost (Dahlander and Gann, 2010) and selling is helpful in obtaining strategic benefits (Kutvonen, 2011). Then we extend the understanding of the relationship between market orientation and open innovation by investigating how proactive and responsive market orientations impact sourcing and selling.

The second reason for the above inconsistent findings is the application of different theories, such as social network theory (Arrigo, 2018), the theory of sustainability and entrepreneurship (Tjahjadi et al., 2020), and even some findings are based on data instead of theory (Naqshbandi, 2018). In seeking to address this research conflict, this study draws on March’s (1991) organizational learning theory to explore how different types of market orientation influence sourcing and selling. Specifically, proactive market orientation promotes new ventures to search for new discoveries and experimentations through explorative learning to find innovative business options, procedures or products (Chou and Yang, 2011), while responsive market orientation enables new ventures to utilize current knowledge, resources and capabilities through exploitative learning to reach a better understanding of existing markets, products or processes (Lamore et al., 2013). We then conduct an in-depth examination of the influence of responsive and proactive market orientations on sourcing and selling based on organizational learning theory.

The third reason for the inconsistent findings may be that this relationship is context-dependent. Market orientation generates benefits because it drives firms to anticipate latent or expressed market demands. This is the premise of conducting open innovation activities and creating value for customers (Narver et al., 2004). However, market orientation alone is
insufficient because firms also need to utilize particular techniques to support the learning process demanded by market orientation (Iyengar et al., 2015). Information and communication technology (ICT) capability is defined as a firm’s ability to strategically use a wide array of technologies in work processes (Parida et al., 2016), reflecting how a firm deploys ICT-based resources to facilitate organizational learning (Adamides and Karacapilidis, 2020). This capability is usually considered a critical factor that helps firms to gather vital market information and coordinate relationships with external actors (Mao et al., 2016). However, how the ICT capability functions in the open innovation context still have not received ample consideration in market orientation literature (Kazakov et al., 2021; Borges et al., 2009). Addressing this noted gap in the theory, a second research question is to explore the moderating effects of ICT capability on the market orientation–open innovation relationship.

Our study offers to answer and unravel several research questions in market orientation and open innovation literature. First, it sheds more light on market orientation as a catalyst for new ventures’ open innovation. Specifically, we focus on more fine-grained market orientation (i.e. proactive and responsive market orientations) and open innovation (i.e. sourcing and selling), illustrating the complex mechanisms by which different types of market orientation affect different open innovation strategies from the perspective of exploitative and explorative learning. Moreover, by looking at both sourcing and selling, this study contributes to the research on new ventures and open innovation, which frequently referred exclusively to inbound open innovation (Cheah and Ho, 2021). Second, this study examines how ICT capability moderates the relationship between market orientation and open innovation in new ventures, extending the research of ICT capability to the field of market orientation and open innovation. Third, this study also offers an empirical test of open innovation that breaks through the impasse presented by much of the current evidence on different types of openness being reliant on limited case studies (Yuan and Li, 2019).

2. Theoretical background
2.1 Market orientation
Market orientation has been defined as the generation and dissemination of market knowledge and the response to such knowledge within an organization (Narver et al., 2004). Its core process is to access, spread and use market knowledge (Lamore et al., 2013; Aydin, 2021). Therefore, market orientation can significantly affect the degree of openness in new ventures. Market orientation also leads to organizational commitment to provide new products to the market, thus exerting a strong influence on innovation activities in new ventures (Song et al., 2015). Therefore, it is reasonable to postulate market orientation as a driver of open innovation.

Given the concern about the essence of market orientation, it has been a consensus that market orientation can be represented by two separate constructs, responsive and proactive market orientations (Iyer et al., 2019; Wang and Liu, 2019). Responsive market orientation focuses on discovering existing customer needs and solving them (Narver et al., 2004). Its key objectives are to optimize and expand the market share by deepening existing knowledge (Jaeger et al., 2016). Thus, responsive market orientation is aligned with exploitative learning, which emphasizes efficiency and improvement of the existing ways of doing things (March, 1991). Without responsive market orientation, firms are less likely to meet immediate customer needs, thereby endangering current profitability. Thus, responsive market orientation focuses on short-term benefits (Zhang and Duan, 2010).

Proactive market orientation emphasizes discovering the future needs of customers and detecting new market opportunities (Ozdemir et al., 2017). It underscores the willingness for risk-taking on behalf of the new venture, even at the expense of cannibalizing the sales of existing products (Iyer et al., 2019). Proactive market-oriented firms are sufficiently flexible to
develop a variety of promising ideas to create novel customer solutions without being limited
by their existing knowledge, mental models and management practices (Tinoco et al., 2020).
Not surprisingly, proactive market orientation requires an explorative learning mindset to
challenge existing ways of doing things and promote invention (Herhausen, 2016).

2.2 Open innovation
Open innovation between organizations is a critical activity that can enhance the
accessibility and dissemination of knowledge created and used in firms (Naseer et al.,
2021). Until now, previous studies agree with Chesbrough (2003) and regard open innovation
as a paradigm that assumes when firms seek to advance technology, they can employ both
external and internal knowledge and paths to market (Cheng and Huizingh, 2014;
Chesbrough, 2003). A key characteristic of open innovation is the two-way flow of
knowledge (Cassiman and Valentini, 2016). Some scholars classify open innovation into
inbound open innovation and outbound open innovation (Kutvonen, 2011; Lichtenthaler,
2009; Sisodiya et al., 2013; Spithoven et al., 2011), while other scholars find knowledge
exchange can also be pecuniary or nonpecuniary (Dahlander and Gann, 2010). According
to the classification scheme above, scholars are increasingly attaching importance to sourcing
and selling (Dahlander and Gann, 2010; Yuan and Li, 2019). Sourcing refers to firms’ use of
valuable external knowledge at low or no cost (Dahlander and Gann, 2010). Selling refers to
firms’ commercialization of knowledge resources through sales or licensing to other
organizations (Lichtenthaler, 2009).

This study would like to focus on sourcing and selling for two reasons. First, focusing on
selling and sourcing instead of outbound and inbound open innovations could reflect new
ventures’ preference for open innovation more accurately. For example, if we use outbound
open innovation as the variable, it not only includes selling but also the revealing strategy.
In fact, new ventures may only want to enter the market through selling quickly rather than
relying on revealing to build legitimacy slowly. In addition, sourcing reflects inbound open
innovation with nonpecuniary effects, and selling reflects outbound open innovation with
pecuniary results (Dahlander and Gann, 2010). The two occur in sharp contrast. Second,
the two kinds of open innovation are typical in new ventures. As new ventures generally
lack financial resources (Bruton et al., 2018), there is a need to reduce innovation costs by
accessing external knowledge for free (Dahlander and Gann, 2010). Moreover, due to
limited manufacturing and distribution capabilities (Lee et al., 2010), new ventures are less
likely to commercialize everything by themselves (Gentile-Lüdecke et al., 2020). Instead,
they prefer to collaborate with external partners to facilitate and accelerate the
commercialization of their technologies (Usman and Vanhaverbeke, 2017). For example,
through sourcing, Xiaomi Technology [1] successfully developed MIUI by introducing
the public middleware and applications for Android announced by Google Inc. (Yuan and
Li, 2019), without asking for higher pay for intellectual property licenses. Through selling,
Xiaomi has spread internal resources, such as product design style, its trademark “Mi” and
an e-commerce platform, to external firms, realizing the rapid development of multiple
ecological products.

2.3 Market orientation and open innovation
To understand the relationship between market orientation and open innovation, we have
systematically reviewed articles listing “market orientation” and “open innovation” in
the topic field from ISI, Elsevier Science Direct, Emerald, JSTOR EBSCO and Wiley Online
Library. We then select literature that is highly relevant to the relationship between market
orientation and open innovation. After screening out those with little to do with the above
relationship, ten papers were left, details are shown in Table 1.
<table>
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Existing studies have examined the relationship between market orientation and technological innovation (Cai et al., 2015), service innovation (Wang and Liu, 2019), marketing innovation (Naidoo, 2010) and innovation performance (Song et al., 2015). However, how market orientation affects open innovation has been a neglected area of inquiry (see Table 1). Although some scholars combined market orientation and open innovation in one research model, they either put them both as independent variables (Rajala et al., 2012) or examine how market orientation moderates the relationship between open innovation and performance (Cheng and Huizingh, 2014) or explore the mediating (Arias-Perez et al., 2021; Tjahjadi et al., 2020) or the moderating (Morgan et al., 2019) role of open innovation in the relationship between market orientation and performance. Only three papers address the direct relationship between market orientation and open innovation. One paper deduced that market orientation was the driving factor of open innovation through a literature review (Arrigo, 2018), one paper speculated that market orientation can promote open innovation by using a grounded theory approach (Denktas-Sakar et al., 2015), and the other paper found no direct relationship between market orientation and open innovation through one-way analysis of variance (Naqshbandi, 2018). These papers focused on the whole variable of market orientation and open innovation, and the research on the relationship between the two is still relatively superficial. Therefore, in order to deepen the understanding of this relationship, it is urgent to conduct research on the relationship between the specific types of market orientation and open innovation.

2.4 Information and communication technology capability

We posit that ICT capability can improve the efficiency of firms’ business processes (Parida and Ortqvist, 2015), which is critical in allowing them to learn more efficiently and effectively (Cai et al., 2016). ICT capability has attracted a growing number of scholars to examine its role in firms’ competitive advantage. Some scholars view ICT capability as equal to firms’ investment in ICT infrastructure or processes (Mithas et al., 2012; Parida et al., 2016). However, this definition is proposed as problematic and unreliable (Wales et al., 2013). Consistent with our focus on organizational learning theory, we examine a new venture’s utilization of ICT to support its learning processes, not merely its general possession of ICT tools or infrastructure (Iyengar et al., 2015).

To gain an in-depth understanding of ICT capability, we have reviewed related research and summarized the connotations of the concept. As per our literature review, there are three key aspects of ICT capability, that is, use for internal efficiency, use for collaboration and use for communication (Wales et al., 2013). Use for internal efficiency refers to using ICT tools, such as environmental scanning mechanisms, to develop efficient internal processes and activities that reduce new ventures’ learning costs (Parida et al., 2016). Use for collaboration means establishing and maintaining links with partners, including customers, suppliers and other external actors (Adamides and Karacapilidis, 2020), which may result in improved learning opportunities. As for the communication aspect, ICT capability could help firms communicate both within and outside their boundaries, thus leading to higher learning efficiency (Kmieciak et al., 2012). In general, the three aspects of ICT capability capture the full concept of ICT capability.

ICT capability has attracted increasing scholarly attention because of its key role in the innovation process (Adamides and Karacapilidis, 2020). New ventures actively utilize ICT because these technologies aid them in rivaling bigger-sized businesses (Albar and Hoque, 2019). For example, Mao et al. (2016) argue that through different processes related to gathering vital information about the market and customers and coordinating relationships with external actors, ICT capability can help new ventures to better conduct innovation
activities. However, practical evidence indicates that applying ICT capability to business activities is expensive (Rai et al., 2006). Lu and Ramamurthy (2011) have also presented considerable skepticism regarding the benefits of ICT capability for firms. These controversial findings suggest that how ICT capability works in new ventures deserves more attention, especially in terms of leveraging market orientation to promote open innovation.

3. Research model and hypotheses

3.1 The effects of responsive market orientation on open innovation

To understand the relationship between responsive market orientation and sourcing better, this study considers the marginal benefits and marginal costs associated with rising levels of responsive market orientation. If the marginal costs increase faster than the marginal benefits, the sourcing-related returns derived from responsive market orientation will diminish and become negative. The primary marginal benefits from responsive market orientation are reflected in product improvement supported by new knowledge (Jaeger et al., 2016), while the primary marginal cost in new ventures is a greater expenditure of the limited firm resources, which are consumed in the process of identifying, assimilating and utilizing external knowledge inputs.

At low to moderate levels of responsive market orientation, the benefits are likely to outweigh the costs. First, a low level of responsive market orientation would like to discover and understand customer demands through sourcing (Ozdemir et al., 2017). This is helpful for them to grasp customers’ changing preferences quickly and accurately (Lamore et al., 2013; El Manzani et al., 2022), and expediently improve product offerings (Tinoco et al., 2020). Second, as the level of responsive market orientation increases from low to moderate, the advantages for exploitation accumulate (March, 1991). The mutual positive feedback between experience and competence allows new ventures to further seek knowledge closely related to their existing product domains, thus promoting sourcing (Tsai et al., 2008).

However, at high levels of responsive market orientation, the marginal costs tend to exceed the benefits. With strong responsive market orientation, new ventures become more and more competent in an existing operational domain, and the positive mutual feedback between experience and competence would produce strong path dependency (Tsai et al., 2008). That may lead them into familiarity traps (Jaeger et al., 2016). In this case, the costs of identifying, assimilating and utilizing new knowledge increase, and even exceed the relevant benefits (Atuahene-Gima et al., 2005). Thus, new ventures are reluctant to acquire information and knowledge from outside through sourcing (Wang and Chung, 2013).

Hence, while responsive market orientation provides many benefits, with rising levels also come escalating costs, which are likely to dominate the benefits after a certain point. Therefore,

H1. Responsive market orientation has an inverted U-shaped relationship with sourcing.

We posit that responsive market orientation can positively facilitate selling in two main aspects. First, responsive market orientation aims to meet expressed customer needs (Lamore et al., 2013). This encourages new ventures to carry out exploitative learning and make full use of existing knowledge (Herhausen, 2016). Thus new ventures are eager to consume little cost to get more benefits in the short term, leading to the adoption of selling (Kutvonen, 2011). Second, to establish themselves in the marketplace and survive, responsive market-oriented new ventures need to implement selling, which enables them to exploit their knowledge best and promote their products and technologies well (Tsai et al., 2008). In doing
so, a new venture can occupy a larger market share in the short term (Lichtenthaler, 2010). Thus, we expect the following:

\[ H2. \text{ Responsive market orientation is positively related to selling.} \]

### 3.2 The effects of proactive market orientation on open innovation

Proactive market orientation positively facilitates sourcing for two reasons. First, when a new venture pursues proactive market orientation, it will seek to identify the latent customers’ needs in the market (Atuahene-Gima et al., 2005; Iyer et al., 2019), which requires an explorative learning mindset (March, 1991). That promotes new ventures to acquire deeper insights and ideas for new product development by adopting sourcing (Dahlander and Gann, 2010). Second, with an increasing level of proactive market orientation, a new venture would accumulate a great deal of knowledge about new markets (Iyer et al., 2019), which in turn stimulates the further search for new knowledge. As the old saying goes, the more one knows, the more ignorant one is. Accordingly, a new venture with a strong proactive market orientation would not be exposed to the limitations of the familiar trap discussed earlier but would look further afield for new knowledge. Therefore, we put forward the following hypothesis:

\[ H3. \text{ Proactive market orientation is positively related to sourcing.} \]

From the perspective of explorative learning, we contend that there is a U-shaped relationship between proactive market orientation and selling considering the marginal benefits and marginal costs associated with increasing levels of proactive market orientation. The primary marginal benefit is the improved innovative capability through exploration activities, which secures a new venture’s favorable strategic position (Wang and Liu, 2019). The primary marginal costs are up-front investments in developing product prototypes (Tsai et al., 2008; Usman and Vanhaverbeke, 2017).

At low to moderate levels of proactive market orientation, the costs are likely to outweigh the benefits. Specifically, proactive market orientation focuses on addressing the future needs of customers and requires substantial investments and time to identify, assimilate and utilize new information (Ozdemir et al., 2017). As opposed to responsive market orientation which primarily focuses on “product modification” (Narver et al., 2004; El Manzani et al., 2022), a proactive market orientation may not generate immediate payback in the short term and take longer to accomplish the development of a product prototype (Lamore et al., 2013), which hinders selling.

However, organizational learning literature argues that with the accumulation of explorative learning behaviors, the long-term benefits of proactive market orientation gradually appear and are likely to exceed the costs. With high levels of proactive market orientation, the advantages of exploration accumulate, and the new technology developed by new ventures gradually takes root and mature (Chou and Yang, 2011). That often encourages new ventures to take a selling strategy, in which they aim to introduce new products into the market or achieve brand recognition (Lichtenthaler, 2010), so as to gain market dominance and legitimacy (Kutvonen, 2011). Through selling, new ventures can not only gain access to new product markets but also set an industry standard, which secures the future sales of their products and services (Lichtenthaler, 2009).

Taken together, there is a threshold before proactive market orientation can facilitate the adoption of selling. Before this threshold, selling is hampered by stagnating marginal benefits and increasing marginal costs. Therefore, we hypothesize the following:

\[ H4. \text{ Proactive market orientation has a U-shaped relationship with selling.} \]
3.3 The moderating role of ICT capability between responsive market orientation and open innovation

ICT capability is likely to shape the relationship between responsive market orientation and sourcing by affecting the marginal costs and benefits of increasing levels of responsive market orientation.

ICT capability can play an important role in decreasing marginal costs. First, ICT use for internal efficiency includes scanning mechanisms, which facilitate access to a larger knowledge base (Parida et al., 2016), hence reducing the cost of identifying unmet and expressed customer needs (Salge et al., 2013). Therefore, with superior ICT capability, a responsive market-oriented new venture is more likely to implement sourcing. Second, ICT use for collaboration also represents an important manner for avoiding the familiar trap of new ventures. Collaborations with customers and other partners guarantee steady inflows of information for new ventures (Wales et al., 2013); continual learning and renewal could ensure new ventures avoid path dependency (Cai et al., 2016). It can increase the ability of new ventures to spot new knowledge, reduce myopia and thus activate sourcing. Third, ICT use for communication enhances inter- and intra-firm information and knowledge exchanges (Zhang et al., 2020). This enables new ventures to become efficient and cost-effective in locating and identifying appropriate external knowledge (Cepeda and Arias-Pérez, 2019). In this case, responsive market orientation is more likely to drive new ventures to adopt sourcing, so as to better understand customers’ needs and tailor their products to those needs (Ozdemir et al., 2017).

ICT capability can also expand the marginal benefits. Through ICT use for internal efficiency, collaboration and communication, new ventures with responsive market orientation are expected to have better knowledge identification and recombination capabilities, thereby contributing to the emergence of more novel and useful ideas (Salge et al., 2013). This is necessary for the design of new products that can better serve customers (Borges et al., 2009). Further, high levels of ICT capability might be more effective at helping new ventures navigate the uncertainties of new product development (Lu and Ramamurthy, 2011). Thus, ICT capability in combination with responsive market orientation will form a unique ability to capture greater value from sourcing, facilitating the implementation of sourcing.

Taken together, ICT capability allows new ventures to identify knowledge more efficiently, assimilate it more easily and utilize it more rapidly (Sheng, 2019), thus increasing the marginal benefits and reducing the marginal costs. Therefore,

\[ H5. \] ICT capability positively moderates the inverted U-shaped relationship between responsive market orientation and sourcing in such a way that increasing ICT capability increases the range and extent of positive effects of responsive market orientation on sourcing and reduces the negative effects.

We posit that the positive effect of responsive market orientation on selling may benefit from higher ICT capability. First, ICT use for internal efficiency contributes to identifying those customer demands that can be transformed into innovation more accurately (Parida and Oräkvist, 2015; Sheng, 2019). If this is the case, new ventures can come up with simple but technically sound innovations within a short span of time (Usman and Vanhaverbeke, 2017), thus promoting the adoption of selling. Second, ICT capability can also drive collaboration with new and diverse partners, which increases the possibilities for new ventures to develop and introduce innovative products in markets (Zhang et al., 2020). Thus, new ventures with superior ICT capability have more opportunities to commercialize their products when they adopt responsive market orientation. Third, ICT use for communication can allow more expedient and efficient communication between new ventures and external partners (Adamides and Karacapilidis, 2020). As a result, the
relationship between responsive market orientation and selling should be more pronounced under the condition of better communication because it enables an effective interactive work process with their partners (Mao et al., 2016). Thus, we hypothesize the following:

\[ H6. \text{ICT capability positively moderates the relationship between responsive market orientation and selling.} \]

3.4 The moderating role of ICT capability between proactive market orientation and open innovation

We argue that ICT capability can strengthen the positive relationship between proactive market orientation and sourcing. First, ICT use for internal efficiency plays an important role in enhancing the understanding of the new market and acknowledgment of the value of new knowledge (Parida et al., 2016). From the perspective of explorative learning, with superior ICT capability, proactive market-oriented new ventures can benefit more from sourcing (Iyer et al., 2019). Second, ICT use for collaboration, such as through an electronic data interchange system, can foster and stabilize the relationship between new ventures and external partners (Cai et al., 2016). Apart from providing new ventures with more reliable external resources (Cai et al., 2016), such relationships involve a higher frequency of interactions among partners, which, in turn, enable the development of collaborative routines and render knowledge exchange more efficient (Zhang et al., 2020). Under these conditions, the proactive market orientation would empower new ventures to engage in sourcing more actively. Third, ICT use for communication can provide two advantages for new ventures, which lead to a more pronounced proactive market orientation–sourcing relationship. For one thing, improved communication means that new ventures can decode external information through improved sense-making functions, so as to gain faster and more informed market insights (Parida et al., 2016). For another thing, due to a better flow of information externally and internally, ICT-driven communication improves the ability of new ventures to coordinate their internal efforts and actions based on the information gained (Cepeda and Arias-Pérez, 2019). Thus, it is hypothesized that

\[ H7. \text{ICT capability positively moderates the relationship between proactive market orientation and sourcing.} \]

ICT capability can be very helpful in altering the relationship between proactive market orientation and selling. ICT capability can serve to reduce marginal costs. First, ICT use for internal efficiency can contribute to lowering the costs of identification and assimilation by creating more effective knowledge accessing, processing and recombination routines within new ventures (Chen and Kamal, 2016; Salge et al., 2013). That improves learning efficiency and speeds up the formation of product prototypes. Thus, proactive market orientation would drive new ventures to execute the selling strategy more rapidly. Second, ICT use for collaboration can provide new ventures with a well-established network of external contacts (Cai et al., 2016), which increases their exposure to selling opportunities. Thus, proactive market-oriented new ventures are more likely to commercialize the technology externally. Third, ICT use for communication can reduce communication barriers between a new venture and its partners (Lu and Ramamurthy, 2011). Then, proactive market-oriented new ventures can achieve greater process efficiency in selling activities (Lu and Ramamurthy, 2011).

ICT capability can also increase marginal benefits. First, ICT capability can provide new ventures with improved reciprocal interaction between new ventures and customers through
the use of internal efficiency, collaboration and communication (Parida and Örtqvist, 2015). Then, proactive market orientation can anticipate customers’ demands in an effective manner, ensuring that cutting-edge, innovative products are technically and commercially viable (Iyer et al., 2019; Wales et al., 2013). In this case, new ventures with proactive market orientation are easier to implement selling. Second, when possessing superior ICT capability, proactive market-oriented new ventures exhibit stronger explorative abilities and thus are able to discover and tap into more available and high-quality selling opportunities (Mao et al., 2016).

Taken together, ICT capability enables new ventures to simultaneously decrease the marginal costs and increase the marginal benefits associated with increasing levels of proactive market orientation. Thus,

\[ H8. \quad \text{ICT capability positively moderates the U-shaped relationship between proactive market orientation and selling in such a way that increasing ICT capability increases the range and extent of positive effects of proactive market orientation on selling and reduces the negative effects.} \]

This study proposes the research model presented in Figure 1.

4. Research methodology

4.1 Data collection

We adopted the survey method to capture the essence of real organizations without sacrificing generality. To test the effect of market orientation on open innovation, and the moderating role of ICT capability, we chose Chinese new ventures as the research samples for two reasons. First, the sharing economy has made open innovation the key to the survival of new ventures (Bacon et al., 2019). Second, the new ventures are appropriate as establishing themselves in the marketplace makes it necessary to implement market orientation to gain a competitive advantage (Narver et al., 2004).

To examine the relationship between market orientation and open innovation deeply, surveys were conducted by distributing questionnaires. We only focused here on new ventures, defined as firms that are not more than 10 years old (Bachmann et al., 2021; Bruton et al., 2018). The survey consists of Chinese new ventures operating in manufacturing, service, IT and emerging industries in Beijing, Changchun, Guangzhou, Tianjin and Shenzhen. We contacted the administrative offices of the zones to obtain lists of these new ventures, randomly selected a total of 600 new ventures, and then sent emails to senior managers or contacts listed on the company web pages. The emails described our research purpose, promised data confidentiality and invited participation. Questionnaires had different titles depending on the company circumstance, and the respondents at each firm were asked to complete the questionnaires. In return, we received 400 surveys that can be used for analysis, with a response rate of 67%.

4.2 Measurement development

Based on an extensive literature review, we chose the appropriate measurement scales to capture market orientation, open innovation and ICT capability. All survey items were widely used in previous studies, which can guarantee the validity of the measures (see Table A1 in Appendix A). As this study was conducted in China, we translated the original English questionnaires and developed a Chinese version based on the Chinese context. Following the translation committee approach (Van de Vijver and Leung, 1997), we first hired a professional translator who was not familiar with our research to translate
the Chinese questionnaire back into English. Second, we carefully compared the translated English version with the original and found no semantic discrepancy. Third, we conducted a pretest by inviting an information system scholar with expertise in marketing and a scholar specializing in strategic management to review and critique items to ensure content validity. Small modifications were made. All study variables were measured using a response format based on a 5-point Likert scale, with “1 = strongly disagree” and “5 = strongly agree”. The measurement scale for market orientation was from Narver et al. (2004), which has been widely used by scholars (Iyer et al., 2019; Ozdemir et al., 2017; Wang and Liu, 2019). The measurement scale for open innovation was from Şisodiya et al. (2013) and Hung and Chou (2013). Following previous studies (Parida and Ortqvist, 2015; Parida et al., 2016), we used the scale from Wales et al. (2013) to measure ICT capability.

Several control variables were used to capture the potential influence of factors on new ventures' open innovation activities. First, we controlled firm age because younger firms tend to be more innovative even when they possess less developed capabilities and resources. To do so, we measured firm age by calculating the log of the number of years since its establishment (Bachmann et al., 2021). Second, firm size was considered important because larger firms might be capable of more expedient innovation than small firms due to their possession of greater resources (Parida et al., 2012). We measured firm size by taking the log of the total number of employees. Third, following previous studies (Naqshbandi and Kaur, 2014), firm ownership is regarded as a variable that can affect the adoption of open innovation, we used firm ownership as a control variable.

4.3 Common-method bias
The data gathered using a single respondent questionnaire might suffer from common-method bias, which may affect our statistical results (Podsakoff and Organ, 1986).
To prevent the negative effects of common-method bias, we performed Harman’s single-factor test (Podsakoff et al., 2003). Our Harman’s single-factor test generated four factors with eigenvalues greater than 1, with the largest capturing only 40.514% of the variance, with no single factor accounting for the majority of the variance in the items (Podsakoff et al., 2003). Hence, common-method bias was not a major concern for the interpretation of the findings.

5. Data analysis and results
5.1 Measurement model
The results verified the reliability and validity of reflective constructs. As shown in Table 2, composite reliability was noted to be above the threshold of 0.90 and Cronbach’s alpha was above 0.90. Thus, the construct reliability and internal consistency were validated. All factor loadings exceeded the recommended value of 0.70 (see Table 2). With respect to the average variance extracted (AVE), all variables were higher than 0.70. This allowed us to conclude that the convergent validity of the construct is acceptable. In addition, Table 3 indicated that the square roots of AVEs for all constructs were found to be greater than the correlations between constructs, confirming discriminant validity.

5.2 Main effects
We conducted multiple regression analyses using SPSS 22 to test our hypotheses. We first took sourcing as the dependent variable (see Table 4). In Model 1, we entered the control variables (firm size, firm age and firm ownership). In Model 2, we added responsive market orientation and proactive market orientation, the result confirms a positive linear relationship between proactive market orientation and sourcing ($\beta = 0.185, p < 0.001$), verifying H3. In Model 3, we added the squared term of responsive market orientation, verifying H1 ($\beta = -1.233, p < 0.001$).

We also took selling as the dependent variable (see Table 5). Model 2’ confirms a significant positive association between responsive market orientation and selling ($\beta = 0.252, p < 0.001$), supporting H2. Model 3’ confirms a U-shaped relationship between proactive market orientation and selling ($\beta = 1.045, p < 0.001$), supporting H4.

5.3 Moderating effects
First, we examined the moderating effect of ICT capability on the relationship between market orientation and sourcing (see Table 4). Model 5 indicates that the interaction term of proactive market orientation and ICT capability was significant ($\beta = 0.325, p < 0.05$), supporting H7. Model 6 shows a significant positive interaction between quadratic responsive market orientation and ICT capability ($\beta = 0.371, p < 0.05$), supporting H5 (see Figure 2). Further, we estimated the $b_1 b_4 - b_2 b_3$ of Model 6, where $b_1 =$ coefficient of responsive market orientation, $b_2 =$ coefficient of responsive market orientation squared, $b_3 =$ coefficient of the interaction term of responsive market orientation and ICT capability and $b_4 =$ coefficient of interaction term of responsive market orientation squared and ICT capability. The result is positive (0.314 in Model 6), confirming that the turning point moves to the right as ICT capability increases (Haans et al., 2016). This further supports H5.

We then examined the moderating effects of ICT capability on the relationship between market orientation and selling (see Table 5). Model 5’ shows that the interaction term of responsive market orientation and ICT capability is not significant ($\beta = -0.181, p > 0.1$), thus indicating no support for H6. Model 6’ shows a significant negative interaction between

How market orientation affects open innovation?
quadratic proactive market orientation and ICT capability ($\beta = -0.338, p < 0.05$), supporting H8 (see Figure 3). Similarly, we also estimated the $b_1b_4 - b_2b_3$ of Model 6'. The result is negative ($-0.441$ in Model 6'), confirming that the turning point moves to the left as ICT capability increases (Haans et al., 2016). This further supports H8.
6. Discussion and conclusion

6.1 Main findings

This study sought to explain whether or not market orientation influences open innovation, why and how? And how does the ICT capability of a new venture affect the market orientation–open innovation relationship? The results support seven of the eight hypotheses and the main findings are as follows:

### Table 4.
The influence of market orientation on sourcing in new ventures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Sourcing</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Control variables</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm age</td>
<td>-0.038</td>
<td>-0.031</td>
<td>-0.050</td>
<td>-0.033</td>
<td>-0.046</td>
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</tr>
<tr>
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<td>0.036</td>
<td>0.047</td>
<td>0.036</td>
<td>0.033</td>
<td>0.037</td>
<td></td>
</tr>
<tr>
<td>Firm ownership</td>
<td>0.064</td>
<td>0.032</td>
<td>0.029</td>
<td>0.023</td>
<td>0.033</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>RMO</td>
<td>0.116*</td>
<td></td>
<td>1.065***</td>
<td>1.050***</td>
<td>1.006***</td>
<td>0.678***</td>
<td></td>
</tr>
<tr>
<td>PMO</td>
<td>0.185***</td>
<td></td>
<td>0.172***</td>
<td>0.264***</td>
<td>0.058</td>
<td>0.071</td>
<td></td>
</tr>
<tr>
<td>RMO²</td>
<td>-1.233***</td>
<td></td>
<td>-1.121***</td>
<td>-1.081***</td>
<td>-0.739***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.076</td>
</tr>
<tr>
<td><strong>Interactive effects</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>RMO*ICT capability</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>0.019</td>
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<tr>
<td>PMO*ICT capability</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.841*</td>
</tr>
<tr>
<td>RMO²*ICT capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.325*</td>
</tr>
<tr>
<td>R²</td>
<td>0.014</td>
<td>0.043</td>
<td>0.155</td>
<td>0.208</td>
<td>0.222</td>
<td>0.233</td>
<td></td>
</tr>
<tr>
<td>ΔR²</td>
<td>0.029</td>
<td>0.112</td>
<td>0.053</td>
<td>0.014</td>
<td>0.011</td>
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<td></td>
</tr>
<tr>
<td>F-value</td>
<td>0.924</td>
<td>2.178***</td>
<td>7.932***</td>
<td>10.208***</td>
<td>9.218***</td>
<td>8.999***</td>
<td></td>
</tr>
</tbody>
</table>

**Note(s):** n = 400 standardized regression coefficients are shown. *p < 0.05, **p < 0.01, ***p < 0.001.

RMO: responsive market orientation. PMO: proactive market orientation

### Table 5.
The influence of market orientation on selling in new ventures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1’</th>
<th>Model 2’</th>
<th>Selling</th>
<th>Model 3’</th>
<th>Model 4’</th>
<th>Model 5’</th>
<th>Model 6’</th>
</tr>
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<tbody>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm age</td>
<td>-0.044</td>
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</tr>
<tr>
<td>Firm size</td>
<td>0.063</td>
<td>0.064</td>
<td>-0.054</td>
<td>-0.043</td>
<td>-0.046</td>
<td>-0.043</td>
<td></td>
</tr>
<tr>
<td>Firm ownership</td>
<td>0.041</td>
<td>0.038</td>
<td>0.060</td>
<td>0.072</td>
<td>0.072</td>
<td>0.069</td>
<td></td>
</tr>
<tr>
<td>RMO</td>
<td>0.252***</td>
<td>0.244***</td>
<td>0.107*</td>
<td>0.250*</td>
<td>0.226*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMO</td>
<td>-0.006</td>
<td>-1.377***</td>
<td>-1.106***</td>
<td>-1.089***</td>
<td>-0.739***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMO²</td>
<td>1.045***</td>
<td>0.985***</td>
<td>0.964***</td>
<td>0.614***</td>
<td></td>
<td></td>
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<tr>
<td>ICT capability</td>
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<td>0.376</td>
<td>0.263</td>
<td>0.700***</td>
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<td></td>
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<tr>
<td><strong>Interactive effects</strong></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMO*ICT capability</td>
<td></td>
<td></td>
<td>-0.181</td>
<td>-0.157</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMO*ICT capability</td>
<td></td>
<td></td>
<td>0.006</td>
<td>1.124**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMO²*ICT capability</td>
<td></td>
<td></td>
<td>-0.338*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.012</td>
<td>0.073</td>
<td>0.158</td>
<td>0.274</td>
<td>0.279</td>
<td>0.288</td>
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</tr>
<tr>
<td>ΔR²</td>
<td>0.061</td>
<td>0.085</td>
<td>0.116</td>
<td>0.006</td>
<td>0.009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-value</td>
<td>0.773</td>
<td>3.872***</td>
<td>8.148***</td>
<td>14.699***</td>
<td>12.502***</td>
<td>12.036***</td>
<td></td>
</tr>
</tbody>
</table>

**Note(s):** n = 400 standardized regression coefficients are shown. *p < 0.05, **p < 0.01, ***p < 0.001.

RMO: responsive market orientation. PMO: proactive market orientation
First, in line with prior studies, responsive market orientation positively promotes selling, and proactive market orientation positively promotes sourcing, too. The findings fill the gap in the research on the antecedents of open innovation research and prove that market orientation is indeed a key driving factor of open innovation (Tjahjadi et al., 2020; Arias-Pérez et al., 2021). That is, a firm’s goal of creating value for current and potential customers can effectively guide its open innovation practices.

Second, while earlier research has generally believed that the market orientation–open innovation relationship is positive and linear (Arrigo, 2018; Denktas-Sakar et al., 2015), our more fine-grained focus on market orientation and open innovation suggests that this relationship is more complex. Results show that there is an inverted U-shaped relationship between responsive market orientation and sourcing. This reinforces the notion that “focusing too much on immediate profits can lead firms into familiar traps” (Jaeger et al., 2016). In addition, the finding concerning the U-shaped relationship between proactive market orientation and selling challenges prior evidence for this relationship. We show that there is a crucial threshold level below which proactive market orientation may prevent new ventures from conducting selling. Beyond this level, proactive market orientation may actively drive new ventures to implement the selling strategy.

Third, the ICT capability strengthens the linear positive relationship between proactive market orientation and sourcing. This finding is consistent with the claim that ICT capability
enables an improved efficiency of a firm’s business processes and an enhanced understanding of the market (Adamides and Karacapilidis, 2020). The combination of a strong ICT capability and proactive market orientation allows information flows efficiently within and across organizational boundaries, thus facilitating sourcing.

We also observe that ICT capability moderates the inverted U-shaped relationship between responsive market orientation and sourcing in such a way that increasing ICT capability strengthens the positive effects, increasing the maximum potential, delaying the turning point and diminishing the negative effects of excessive responsive market orientation (see Figure 2). By driving a new venture to flexibly and meaningfully aggregate and transfer information, ICT capability can help generate new “cognitive maps” and respond to market changes (Iyengar et al., 2015), thus acting as an enabler of the sourcing strategy. As a result, with higher levels of ICT capability, new ventures can leverage stronger responsive market orientation to facilitate sourcing and better meet the expressed customer needs.

ICT capability also moderates the U-shaped relationship between proactive market orientation and selling. As shown in Figure 3, as the level of ICT capability increases, the shape of the U-shaped curve is flatter, the turning point is shifted to the left and the overall level of selling is higher. Put differently, the higher the ICT capability, the faster the new ventures can get through the early stage of “spending more than revenue” demanded by proactive market orientation. That would facilitate the quicker adoption of the selling strategy. These findings not only suggest that the process of market orientation affecting open innovation is contextualized but also indicate that ICT capability is necessary for effective engagement in open innovation practices in new ventures. This idea confirms previous studies that ICT capability can be combined with strategic orientation to improve the firm performance (Wales et al., 2013). We now extend their findings by linking ICT capability to market orientation, which, in turn, facilitates new ventures’ open innovation activities.

Moreover, we hypothesized that ICT capability positively moderates the relationship between responsive market orientation and selling but do not find support for this conjecture. One rationale for this unexpected finding may be explained by the mean value of the composite score of the selling variable, which was 3.053 on the 5-point Likert scale. The mean score indicated that the respondents were working in an organization that was already facing a medium to a high degree of selling. In such situations, the relationship between responsive market orientation and selling may be insensitive to situational variables. A second rationale that might explain this unexpected finding is rooted in the “too-much-of-a-good-thing effect”. For example, in situations where the ICT capability is too high, wider environmental scanning and access to more information may lead to information overload and limit new ventures’ ability to take timely actions (Lu and Ramamurthy, 2011), such as immediately meeting existing market needs. In the face of fleeting opportunities, an overreliance on technology and formal analysis based on data and reports may paralyze new ventures’ ability to pay attention to the outside market and take quick moves to capture the market opportunities. As stated above, the level of ICT capability was on the higher side in our sample (the mean score is 3.134), new ventures are more likely to face “too-much-of-a-good-thing” situations where responsive market-orientated new ventures may be inhibited from the selling strategy. Future research needs to explore and theorize whether and how ICT capability may play a curvilinear moderating role in the relationship between responsive market orientation and selling.

6.2 Theoretical implications
In an economically burgeoning country with a rapidly expanding sharing economy, open innovation represents an important strategy for new ventures to respond in an uncertain...
environment (Chesbrough, 2003). This study sought to determine the key factors that drive new ventures’ open innovation. By revealing the salience of different types of market orientation, this study supplements previously insufficient analyses of the value of market orientation in the open innovation paradigm. By focusing on sourcing and selling, this study echoes prior open innovation studies that call for an examination of the dual characteristics of open innovation (Cassiman and Valentini, 2016). In addition, this paper also introduces ICT capability as a moderator. Although ICT capability often appears in supply chain literature, few studies combine it with market orientation and open innovation. This paper provides new evidence for the importance of ICT capability in new ventures by demonstrating its moderating role in the market orientation–open innovation relationship.

Our study makes four major contributions to open innovation literature. First, as new ventures increasingly rely on cooperation to support and drive innovation practices, scholars are calling for intensive research in an effort to understand the role of open innovation in entrepreneurial activities (Hung and Chou, 2013; Kutvonen, 2011; Parida et al., 2012). Thus, our empirical investigation of the contingency of different types of open innovation and their concept enriches this field. Previous studies treat open innovation as an aggregate variable in a holistic view, which leads to our lack of understanding of how new ventures can better implement open innovation. Although some scholars distinguish open innovation into outbound and inbound open innovations according to the direction of knowledge flow (Cassiman and Valentini, 2016; Kutvonen, 2011), these two categories are still very general and cannot accurately describe the specific situation of open innovation activities of new ventures. Our study enriches this classification by introducing the categories of pecuniary or nonpecuniary effects (Dahlander and Gann, 2010). Following in-depth analyses, we identified sourcing and selling as the two main kinds of open innovation in Chinese new ventures. This kind of classification can more accurately reflect some specific strategic preferences of new ventures than simply focusing on inbound and outbound open innovations. This classification can fill a gap in open innovation research in the entrepreneurial field, which is highlighted by Dahlander and Gann (2010). This research lays a foundation for more in-depth and systematic research on open innovation activities of new ventures in the future.

Second, previous studies put more effort into the outcomes of open innovation, but we still know little about the antecedents of open innovation. Even if some scholars find that market orientation is a key antecedent of open innovation (Arrigo, 2018), the in-depth disclosure of the relationship between market orientation and open innovation is still insufficient, and further research is still needed. The present study is unique in the sense that our research model incorporates two related, yet distinct forms of market orientation, namely responsive and proactive market orientations. The distinction between these two forms of market orientation enables the capture of ambidexterity (El Manzani et al., 2022), highlighted in the literature for coping with increasing environmental turbulence (Tan and Liu, 2014). Thus, this study examined different influencing mechanisms of responsive and proactive market orientations affecting two kinds of open innovation, sourcing and selling, in terms of organizational learning (March, 1991). That brings greater theoretical clarity to the existing literature. Earlier studies highlighted that firms’ market orientation can influence open innovation, but they generally suggest that the more, the better (Arrigo, 2018; Denktas-Sakar et al., 2015). Building on the idea that market orientation is not universally beneficial (Narver et al., 2004; Jaeger et al., 2016), we offer a more nuanced perspective by explicitly acknowledging that the relationship between market orientation and open innovation can be represented as curvilinear, such as an inverted U-shaped relationship between responsive market orientation and sourcing, and a U-shaped relationship between proactive market
orientation and selling. These findings enrich the understanding of the relationship between market orientation and open innovation by revealing the complicated influencing mechanism.

Third, this study further responds to debates regarding the relationship between market orientation and open innovation by investigating the moderating role of ICT capability in new ventures. Existing studies have suggested the examination of the moderating effects of internal and external factors in the relationship between market orientation and innovation (Cai et al., 2015; Wang and Liu, 2019). In fact, open innovation execution activities are determined to be very sensitive to context, leading scholars to call for additional assessments of open innovation implementation in new ventures with different contingent factors (Hung and Chou, 2013; Lichtenthaler, 2009; Zhu et al., 2017). ICT capability has been recognized as an important factor recently that could affect knowledge transfer between new ventures and other firms under conditions of sharing economy (Iyengar et al., 2015). Yet little is known about how ICT capability acts as a moderator in the open innovation context. That’s because most empirical results report the direct and indirect influences of ICT on firm-level innovation outcomes (Adamides and Karacapilidis, 2020; Wei et al., 2022). Our result shows that ICT capability could moderate the market orientation–open innovation relationship. On the one hand, these discoveries are responses to Donaldson (2006), who suggests that it is better to consider a more complex causal relationship between independent and dependent variables based on the contingency theory. On the other hand, these findings extend the understanding of the influences of the ICT capability in the implementation process of open innovation activities. Although previous studies have inferred that market orientation is the key factor that drives open innovation (Arrigo, 2018), we argue that this result should be under certain boundary conditions. The present research found that only with the support of ICT capability can market orientation positively promote open innovation.

Fourth, the results confirm the important role of ICT capability as an enabler of organizational learning. Previous studies have called for more research on how ICT capability facilitates the learning process (Iyengar et al., 2015). This study responds to this call and finds that a firm’s ICT capability is more than an organizational capability limited to a narrow purpose. When ICT capability is combined with proactive and responsive market orientations, it can enhance the effects of market orientation by influencing the learning process within new ventures. We believe that our study will encourage future research to focus more on the role of ICT capability as an enabler of organizational learning processes in order to gain a deeper and richer appreciation of how it works within firms.

6.3 Managerial implications

Our study offers several strategic implications for managers. First, our results demonstrate that proactive market orientation is a key antecedent of open innovation. Proactive market orientation can directly foster sourcing but has a U-shaped relationship with selling within new ventures. Therefore, to improve the levels and outcomes of open innovation activities, a new venture needs to develop a strong proactive market orientation. For example, at the initial growth stage, Xiaomi exhibited a strong proactive market orientation, indicating that Xiaomi is capable of explorative market learning and novel knowledge acquisition regarding customer demands. Thus, Xiaomi can predict future market trends accurately and develop MIUI through sourcing. Further, high levels of proactive market orientation also pushed Xiaomi to sell its new ideas or concepts around Xiaomi phone. However, lower levels of proactive market orientation may hinder selling, because it can make the new ventures neglect to seize and pay attention to the current market. Therefore, managers or
entrepreneurs could establish and cultivate the appropriate conditions for proactive market orientation through explorative market learning. Specifically, managers or entrepreneurs in new ventures must spend their time and money on improving proactive market orientation as well as training employees to engage in explorative market learning to gain more potential market demand knowledge. In this way, new ventures can maximize the benefits of selling and sourcing from a proactive market orientation.

Second, our results reveal the interesting findings that responsive market orientation could positively influence selling but have an inverted U-shaped relationship with sourcing. On the one hand, responsive market orientation pushes a new venture to sell technology or internal ideas to occupy a larger market share. We take Xiaomi as an example again, as the firm matures, it begins to put more effort into meeting the existing market demands. Therefore, by licensing its trademark “Mi” to partners, Xiaomi jointly produce lamps, sweeper robots, TV, speakers, water purifier and other products to occupy the market (Yuan and Li, 2019). On the other hand, responsive market orientation drives a new venture to continuously access a wide range of information and identify market demands through sourcing. However, excessive responsive market orientation can decrease sourcing. This means managers or entrepreneurs in new ventures should be extremely cautious when developing responsive market orientation. In any case, entrepreneurs or managers should develop a modest level of responsive market orientation according to their strategic aims. If new ventures only want to sell technology or knowledge to get a larger market share and immediate profits, it can be achieved by increasing responsive market orientation. However, if new ventures want to have a long-term development goal and need to obtain the key information and knowledge to build a resource base, over-enhancing responsive market orientation will play an inhibiting role.

Third, our results indicate that market orientation requires the support of ICT capability to remove possible barriers in the process of promoting open innovation. For example, due to the “familiar trap”, the learning costs associated with high levels of responsive market orientation increase. While ICT capability enables decreased learning costs and increased learning benefits, thus magnifying the positive effects of responsive market orientation on sourcing. Therefore, substantial returns on ICT capability can eliminate any doubts about the strategic value of ICT investment and adoption (Mithas et al., 2012), and managers should develop the ICT capability of firms. Specifically, in order to cultivate a strong ICT capability, managers should commit to investing in ICT infrastructure, employee ICT skills training and ICT applications. Managers should also make full use of ICT tools such as the Internet of Things, so as to improve communication and collaboration with their partners. Moreover, managers should actively engage in understanding how ICT capability can enhance learning processes and outcomes, and even consider how to develop ICT-based organizational learning mechanisms (Iyengar. et al., 2015). With lower learning costs, more learning opportunities and more efficient learning processes, new ventures can also benefit more from market orientation.

6.4 Limitations and future research
Despite this study’s strengths, it is not free from limitations. First, this paper only focuses on two types of open innovation, selling and sourcing. Thus, other types of open innovation, such as revealing and acquiring, could be considered in future studies. Thus, we call for further research to extend our findings by exploring other types of open innovation and comparing the differences between different types of open innovation. This also raises new questions. Under what circumstances would a firm adopt a certain type of open innovation? What factors might account for differing choices?
Second, although we have found a curvilinear relationship between responsive market orientation and sourcing, we have not found the exact tipping point, that is, what is the highest level of responsive market orientation that promotes sourcing most in new ventures? Finding this threshold and comparing it in different industries can lead to more meaningful conclusions and provide more precise advice on how to effectively conduct open innovation activities for new ventures.

Third, although our research found that responsive market orientation had a positive role in promoting selling, the result did not support our hypothesis when considering the moderating role of ICT capability in the above relationship, which is worth pondering. How does responsive market orientation impact the implementation of selling when the level of ICT capability is high in new ventures? Whether this means that the roles played by ICT capability and responsive market orientation are inconsistent or there is a substitution effect between the two? This question is worthy of further research.

Note
1. Beijing Xiaomi Technology is a mobile Internet supplier which in 2019 became the youngest company in the list of the world’s top 500 companies published by Fortune.

References


Appendix

<table>
<thead>
<tr>
<th>Items (1 = strongly disagree; 5 = strongly agree)</th>
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</thead>
<tbody>
<tr>
<td><strong>Responsive market orientation</strong></td>
</tr>
<tr>
<td>Our company constantly monitors our level of commitment and orientation to serving customers' needs</td>
</tr>
<tr>
<td>Our company freely communicates information about our successful and unsuccessful customer experiences across all business functions</td>
</tr>
<tr>
<td>Our company's strategy for competitive advantage is based on our understanding of customers' needs</td>
</tr>
<tr>
<td>Our company measures customer satisfaction systematically and frequently</td>
</tr>
<tr>
<td>Our company is more customer-focused than our competitors</td>
</tr>
<tr>
<td>Our company believes this business exists primarily to serve customers</td>
</tr>
<tr>
<td>Data on customer satisfaction are disseminated at all levels in this business unit on a regular basis</td>
</tr>
<tr>
<td><strong>Proactive market orientation</strong></td>
</tr>
<tr>
<td>Our company helps our customers anticipate developments in their markets</td>
</tr>
<tr>
<td>Our company continuously tries to discover additional needs of our customers of which they are unaware</td>
</tr>
<tr>
<td>Our company incorporates solutions to unarticulated customers' needs in our new products and services</td>
</tr>
<tr>
<td>Our company brainstorms on how customers use our products and services</td>
</tr>
<tr>
<td>Our company innovates even at the risk of making our own products obsolete</td>
</tr>
<tr>
<td>Our company searches for opportunities in areas where customers have a difficult time expressing their needs</td>
</tr>
<tr>
<td>Our company works closely with lead users who try to recognize customers' needs months or even years before the majority of the market may recognize them</td>
</tr>
<tr>
<td>Our company extrapolates key trends to gain insight into what users in a current market will need in the future</td>
</tr>
<tr>
<td><strong>Selling</strong></td>
</tr>
<tr>
<td>Our company makes it a formal practice to sell technical knowledge and intellectual property on the market</td>
</tr>
<tr>
<td>Our company has specialized units (e.g. guardians and promoters) to commercialize knowledge assets (e.g. sales, cross-licensing of patents and corporate derivatives)</td>
</tr>
<tr>
<td>Our company welcomes others to purchase and use our technical knowledge or intellectual property rights</td>
</tr>
<tr>
<td><strong>Sourcing</strong></td>
</tr>
<tr>
<td>Our company constantly scans the external environment for technology, information, ideas, knowledge, and other inputs that can be used directly</td>
</tr>
<tr>
<td>Our company actively seeks external sources (e.g. research teams, universities, suppliers, customers, competitors, etc.) willing to provide knowledge and technology for free when developing new products</td>
</tr>
<tr>
<td>Our company believes that it is good to use external sources (e.g. research groups, universities, suppliers, customers, competitors, etc.) to complement our own R&amp;D</td>
</tr>
<tr>
<td>Our company pays close attention to the external environment dynamics, introduces the knowledge and technology disclosed by external organizations, and combines with our own R&amp;D</td>
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Table A1. Survey items (continued)
Items (1 = strongly disagree; 5 = strongly agree)

**ICT capability**
- Our company uses ICT to access information (e.g. market, customer)
- Our company uses ICT to enable strategic planning
- Our company uses ICT to enable cost savings
- Our company uses ICT to enable competence/skills development for employees
- Our company uses ICT to maintain collaboration with existing business partners
- Our company uses ICT to establish business collaborations with new partners
- Our company uses ICT to enable work flexibility (e.g. work outside the office)
- Our company uses ICT to handle communication within the firm (e.g. intranet)
- Our company uses ICT to handle external communication with the firm’s stakeholders (e.g. extranet)
- Our company uses ICT to promote marketing activities

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<tr>
<th>How market orientation affects open innovation?</th>
<th>Table A1.</th>
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