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TMT functional background heterogeneity and SMEs' performance: The role of dynamic capabilities and business environment

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ABSTRACT

Drawing on the insights from upper echelons theory, we advance understanding of how top management team functional background heterogeneity (TMTFBH) influences firm performance of technology-based small and medium sized enterprises (SMEs). Analysis based on a sample of listed Chinese SMEs shows that TMTFBH has a positive effect on firm performance. While dynamic capabilities, namely, sensing capabilities, integrating capabilities, and innovating capabilities, mediate this relationship, business environment positively moderates the relationship between these capabilities and firm performance. The study provides a more nuanced understanding of the mechanisms and conditions underlying the effects of TMTFBH on the performance of technology-based SMEs, particularly the role of dynamic capabilities and business environment.

Keywords:
TMT functional background heterogeneity, Performance, Dynamic capabilities, Business environment, China

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1. Introduction

It has long been argued that the properties of top management team (TMT) matter to organizational performance (Yuan et al., 2014). Modern organizations compete by relying increasingly on 'generalist' top management teams with diversified functional backgrounds. This is because diversified functional backgrounds can improve the team's cognitive structure and allow for flexible access to and integration of diverse ideas, skills, and resources (Heavey & Simsek, 2017). The different functional backgrounds of team members help form different knowledge bases within the organization. This in turn generates diverse views and perspectives, foster healthy 'conflicts' and improve decision-making and the quality of team performance (Roberson et al., 2017). A large number of empirical studies corroborates this view, showing that the top management team functional background heterogeneity (TMTFBH) has a positive effect on technological innovation performance (Ma & Guo, 2010) and firm performance (Buyl et al., 2011; Cui et al., 2019; Wang et al., 2015).

However, despite wide acceptance, certain real-world practices challenge this view. We take IFLYTEK, a well-known intelligent voice and artificial intelligence company in the Asia Pacific region, as an example. All 18 members of the entrepreneurial team in this company came from technical backgrounds. Today, seven of the nine members of the TMT still come from similar technical background after more than 20 years since its establishment. This 'specialist' TMT makes IFLYTEK a 'unicorn that is not a unicorn' and the company remains competitive in the marketplace. Some empirical findings are congruent with this example. For instance, Wang et al. (2013) and Yao et al. (2015) find that TMTFBH of Chinese listed companies is not conducive to the improvement of corporate performance, and even has a negative effect. Sun et al. (2019) similarly shows that TMTFBH has a negative impact on the performance of start-ups.

We suggest that three pitfalls in our understanding may contribute to the inconclusive findings. First, previous studies on the subject have examined different types of firms such as information technology firms (Cui et al., 2019), resource-based enterprises (Ma & Guo, 2010), and pharmaceuticals (Wang et al., 2015). Heterogeneity in terms of certain firm- and industry-specific characteristics means that different or even conflicting findings regarding the relationship between TMTFBH and firm performance may emerge from these studies. Second, extant research has provided incomplete account of the complex mechanisms through which TMTFBH influences firm performance. It has typically under-theorized the intermediary mechanisms underlying the focal relationship, with the exception of Goll et al. (2001) which shows that TMTFBH can improve organizational performance by promoting a team's progressive decision-making. In this regard, although it is argued that dynamic capabilities determine how firms can sustain their ability to grow output from a

limited bundle of resources (Teece, 2007; Roberson et al., 2017), prior research has not considered the issue of how dynamic capabilities influence the relationship between TMTFBH and firm performance. Third, prior research has done little to explain the conditions under which TMTFBH influences firm performance. Although it is well-established that business environment influences firm performance, we know little about how such environment influences how TMT develops and leverages their capabilities and consequently the effects of TMTFBH on firm performance.

This study addresses these gaps and contributes to the literature in three distinct ways. First, we enrich the literature on the effects of TMTFBH on firm performance by focusing specifically on technology-based SMEs. Technology-based SMEs exhibit certain distinctive characteristics, such as innovativeness orientation, small size, high growth potential and low growth speed (Zhou et al., 2018). These characteristics mean that extant research findings on the role of TMTFBH in firm performance might not apply, to the same extent, to technology-based SMEs. To our best knowledge, this study is among the first to explore how TMTFBH influences the performance of technology-based SMEs. Second, our study extends prior research by revealing the complex mechanisms through which TMTFBH influences firm performance. Specifically, we conceptualize how three key dimensions of dynamic capabilities, namely, sensing capabilities, integrating capabilities, and innovating capabilities, mediate the relationship between TMTFBH and firm performance. We also theorize how business environment in which the firm operates moderates the effects of those dynamic capabilities on firm performance. By conducting a moderated mediating analysis that focuses on the mediating role of dynamic capabilities and the moderating role of business environment, our conceptualizations explain how dynamic capabilities and business environment influence the effects of TMTFBH on firm performance of technology-based SMEs and also helps us explain why previous studies have generated conflicting findings.

Our empirical analysis relies on a sample of Chinese technology-based SMEs over the period of 2013-2016. The results largely support our framework, showing that two of the three dimensions of dynamic capabilities (i.e. integrating capabilities and innovating capabilities) mediate the relationship between TMTFBH and firm performance, whilst a good business environment enhances the effects of dynamic capabilities on firm performance. Although our analysis focuses on Chinese technology-based SMEs, our framework could be adapted to other firms and other emerging markets.

2. Theory and hypotheses development

2.1. Theoretical background

Two opposing viewpoints concerning the relationship between TMTFBH and firm performance exist in the literature. On the one hand, given the very hallmark of TMTFBH is the diversity of knowledge, skills and experience of TMT members across different functional specializations (Bunderson & Sutcliffe, 2002), research

emphasizing the 'diversity' aspect of TMTFBH (Harrison & Klein, 2007) suggests that "diversity is beneficial to performance because diverse teams can draw from different pools of information or resources" (Bell et al., 2011, p.713). For example, a higher level of TMTFBH means that a wide range of different knowledge, skills, and experience of TMT members across different functions can be applied to a task, and this in turn may result in high innovativeness (Yuan et al., 2014) and consequently high performance. Furthermore, TMTs often engage in a variety of ambiguous, ill-defined tasks which influences the organization's direction as a whole (Devine, 2002). In this regard, TMTFBH can help managers make the best decisions for the organization (Bell et al., 2011) by enabling a 'debating society' within the TMT where managers with different types of skills discuss and analyse the task from diverse viewpoints that can stimulate new ideas and find the most effective ways of solving the problem.

On the other hand, research emphasizing the 'separation' aspect of TMTFBH focuses on the differences among team members in their lateral position on a continuum (Harrison & Klein, 2007), positing that TMTFBH may negatively affect firm performance. Drawing on the theories of social identity and self-categorization (Hornsey, 2008) and attraction-selection-attrition (Schneider et al., 2010), this stream of research suggests that a higher level of separation (i.e. greater dissimilarity) leads to decreased team performance (Bell et al., 2011) and consequently lower firm performance. For example, the social categorization theory suggests that team members categorize others into subgroups. This can form the basis for an in-out group distinction (Hornsey, 2008), develop an intergroup bias (Bell et al., 2011) and therefore hamper firm performance. Functional diversity may also create difficulties in comprehension and communications between TMT members (Bachrach et al., 2019) that in turn hinders coordination, cohesion, and cooperation between these members (Milliken & Martins, 1996), consequently hampering firm performance.

Given these conflicting views, research has attempted to reconcile the two contradictory theoretical predictions by revealing the conditions under which the TMTFBH-performance relationship can be positive or negative. For example, Yao et al. (2015) suggest that a CEO's structural power, ownership power, and the expert power alleviate the negative effect of TMTFBH on firm performance, whilst a CEO's prestige power positively moderates the relationship between TMTFBH and performance. Similarly, factors such as ownership structure (Cui et al., 2019), competitive uncertainty (Qian et al., 2012), and information exchange and integration (Buyl et al., 2011) have been theorized to moderate the focal relationship. Prior research has also attempted to understand the mechanisms through which TMTFBH influences firm performance. For example, research has identified decision quality (Boone & Hendriks, 2009), strategic ambidexterity (Wang et al., 2015), and managerial cognition and group conflict (Deng et al., 2020) as factors that can mediate the relationship between TMTFBH and firm performance.

To some up, prior conceptualizations have provided conflicting theoretical predictions concerning the relationship between TMTFBH and firm performance.

Moreover, we still know little about whether and how TMTFBH influences performance of technology-based SMEs. Further, although prior research has moved beyond the relationship between TMTFBH and firm performance and explored the mechanisms (moderating and mediating) through which TMTFBH influences firm performance, we have rather limited knowledge about how dynamic capabilities and business environment affect the focal relationship. This study aims to address this lack of understanding.

2.2. Technology-based SMEs and firm performance

Upper echelons theory, introduced by Hambrick & Mason (1984), is a behavioral information processing model. The model predicts that an organization's performance is a reflection of its TMT's knowledge, experience, and expertise (Carpenter et al., 2004). For technology-based SMEs, 'generalist' TMT is better than 'specialist' TMT in promoting firm performance. First, innovativeness is a distinct characteristic of technology-based SMEs and it involves both exploratory and exploitative innovative activities. While decisions about conducting exploratory or exploitative innovation are critically important for organizational survival and growth, managers' previous functional background may bias such decisions (Waller et al., 1995). Certain functional backgrounds may lead a manager to habitually pay more attention to exploration, while other functional backgrounds may lead the manager to focus on exploitation. For example, research indicates that TMT members from R&D or marketing backgrounds tend to pay more attention to exploratory innovation, while those from finance or production backgrounds tend to focus on exploitative innovation (Yuan et al., 2014). The 'generalist' TMT has diversified functional backgrounds, which enable the team to consider both exploration and exploitation options simultaneously.

Second, technology-based SMEs exhibit the characteristics of high growth potential. Yet the realization of the growth potential relies on the existence of different views among TMT members to enable healthy debates about the different methods and routes to achieve the growth goal. The greater the heterogeneity of TMT's functional background, the more likely the TMT of the firm is able to make right decisions about complex and strategically important issues, and consequently achieve the growth goal. Finally, slow growth speed characterizes technology-based SMEs (Zhou et al., 2018). This characteristic means that TMT relies on collaborations between TMT members for problem solving to ensure growth and long-term survival of the firm. While a higher level of heterogeneity of TMT function backgrounds may lead to task conflicts (Pelled et al., 1999), conflicts in backgrounds, expertise and experience may stimulate healthy debates and even collaboration, which could make the future team decision-making process smoother and more effective (Lewis, 2003).

However, TMTFBH might also have a negative impact on performance of technology-based SMEs. First, technology-based industries are characterized with dynamism, uncertainty, and short-windows of opportunities. These characteristics mean that technology-based SMEs must have the ability to adjust important decisions

quickly as market conditions change. However, a higher degree of TMTFBH might result in a lack of strategic consensus (Knight et al., 1999) that slows down decision-making and thus negatively impacts performance. Second, as technology-based industries are fast changing, the TMT members of technology-based SMEs need to exchange information with each other more frequently to ensure that they respond to market changes in a timely manner and do not miss new opportunities. However, TMTFBH may lead to the formation of internal clans, i.e., managers with similar experiences tend to form informal sub-groups. These sub-groups could hinder TMT's 'cross sub-group' information exchanges and collaborations. This in turn will hamper the ability of the firm to respond to market changes and unleash the performance benefits of functional background diversity.

Given these conflicting arguments, we offer the following competing hypotheses:

Hypothesis 1. (a) TMTFBH is positively associated with performance of technology-based SMEs and (b) TMTFBH is negatively associated with performance of technology-based SMEs.

2.3. The mediating role of dynamic capabilities

Dynamic capabilities are defined as a firm's abilities to integrate, build, and reconfigure internal and external competences to respond to rapidly changing environments (Teece et al., 1997). Dynamic capabilities are an important perspective to understand how organizations transform heterogeneous resources into competitive advantage (Teece et al., 1997) and promote firm growth. Several researchers provided a typology of this concept. For example, Teece (2007) suggest that sensing, seizing and reconfiguration are three components of dynamic capabilities. Wang & Ahmed (2007) deconstructed dynamic capabilities as adaptive, absorptive, and innovative capabilities. The special features of technology-based SMEs include 'high risk, high investment, high growth and long cycle'. These '3 highs and 1 long' mean that these firms may experience financing difficulty and low transformation and slow growth (Zhou et al., 2018). In this regard, dynamic capabilities should help technology-based SMEs overcome these inherent challenges, adapt to the constantly changing external environment and maintain their competitive advantage.

Based on prior conceptualizations and the characteristics of technology-based SMEs, we suggest that the dynamic capabilities of technology-based SMEs are mainly comprised of three dimensions, namely, sensing, integrating and innovating capabilities (Teece, 2007; Wang & Ahmed, 2007). Sensing capabilities refer to the ability of an organization to perceive and respond to environmental changes such as opportunities and risks (Teece, 2007). A dynamically capable firm can sense novel opportunities and threats and acquire superior information (Teece et al., 1997; Teece et al., 2016), which assists it to achieve higher growth. Integrating capabilities refer to the ability of an organization to integrate and transform different resources, skills and knowledge into other capabilities and consequently performance outcomes (Fuchs et

al., 2000). These capabilities can be both internal and external. Internal integrating capabilities refer to the capacity to communicate within the organization, coordinate activities effectively, and transform the firm's resources and capabilities into high performance outcomes (Helfat & Campo-Rembado, 2016). External integrating capabilities refer to "a firm's ability to integrate activities, learning, and objectives across firm boundaries by means of effective communication and coordination with partners" (Chen et al., 2017, p. 2584). They support "interactions and relationships with external parties, enabling firms to align their activities and objectives with their partners" (Helfat & Raubitschek, 2018, p. 1396). Finally, innovating capabilities refer to "a firm's ability to develop new products and/or markets, through aligning strategic innovative orientation with innovative behaviors and processes" (Wang & Ahmed, 2007, p.38). Overall, these three dimensions of dynamic capabilities characterize the essential role of technology-based SMEs as technology innovation agents, enabling them "continuously transform knowledge and ideas into new products, processes and systems" (Lerro et al., 2009, p. 11), and therefore improve their performance.

We first argue that TMTFBH has a positive impact on the enhancement of dynamic capabilities. First, TMTFBH has a positive impact on the sensing capabilities of technology-based SMEs. Technology-based SMEs tend to operate in highly turbulent environments in terms of, for example, constantly changing markets, competitors, and technologies (Wilden & Gudergan, 2015). Such environments require that organizations possess strong sensing capabilities, enabling them to constantly search, scan, and explore across both local and distant technologies and markets to identify opportunities (Short et al., 2010). A key determinant of such sensing ability is the capacity to get access to and utilize diverse information (Teece, 2007). TMTFBH means that the TMT has access to diverse information in terms of knowledge, expertise and experience of the TMT members that helps reduce the cognitive bias when using external information to make decisions, and therefore improving SMEs' sensing capabilities. In addition, TMTFBH can offer an approach to access information about the trends of environmental changes more timely (Roberson et al., 2017), strengthening sensing capabilities of technology-based SMEs.

Second, TMTFBH has a positive impact on the integrating capabilities of technology-based SMEs. Internal integrating capabilities reflect an organization's ability of communication and coordination of internal resources (Helfat & Campo-Rembado, 2016). While cognitive conflicts may emerge when functionally diversified TMT members work together as a team (Qian et al., 2012), TMTFBH increases the pool of the TMT's cognitive resources (Ensley et al., 2002), assists in generating diverse ideas and stimulating constructive conflicts (Henneke & Lüthje, 2007) and consequently improve the integrating capabilities of technology-based SMEs. External integrating capabilities reflect a firm's ability to interact and coordinate external parties' resources (Chen et al., 2017). A higher degree of TMTFBH embraces the diversity of resources, and the resulting interconnections, interfaces, and dependencies between different resources, systems and processes not

only facilitate exploitation and exploration of such resources (Cao et al., 2010) but also enhance the firm's integrating capabilities. Besides, functionally diversified TMT members' cross boundary network connections improve the ability of resource exchanges (Reagans & Zuckerman, 2008) which enhances the firm's external integrating capabilities.

Finally, TMTFBH positively affects the innovating capabilities of technology-based SMEs. Heterogeneous functional backgrounds of TMT members provide the team with access to diverse knowledge (Gibson & Vermeulen, 2003). Such access helps improve innovating capabilities of technology-based SMEs by creating unique technological combinations (Kafouros et al., 2012). Diversified knowledge and technological resource base can also reduce core rigidity and path dependence of firms, thus speeding up invention (Quintana-García & Benavides-Velasco, 2008). In addition, as organizational level innovation capabilities are generally embedded in teams or groups (Helfat & Raubitschek, 2018), the existence of diverse perspectives in the TMT provides SMEs with strong ability of creating innovation (Cox & Blake, 1991).

While the above analysis suggests that TMTFBH enhances dynamic capabilities of technology-based SMEs, we further argue that such dynamic capabilities help enhance their performance. First, sensing capabilities have a positive effect on the performance of technology-based SMEs by enabling firms to scan external environment and identify opportunities for innovation, enhancing their performance. Besides, the emergence of new technologies, from mobile devices to social media to virtual, facilitates low cost access to information, knowledge and resources, offering a wider range of opportunities for SMEs to innovate (Redoli et al., 2008). Technology-based SMEs with strong sensing capabilities can capture and exploit such opportunities to promote their growth (Short et al., 2010).

Second, integrating capabilities can help technology-based SMEs to re-coordinate and re-allocate resources and improve performance. Technology-based SMEs suffer from 'liability of smallness' due to their limited multidisciplinary competence base and financial and human resources (Harms & de Weerd-Nederhof, 2020) and, as a result, their innovation processes tend to be informal and less structured (De Toni & Nassimbeni, 2003). Internal integrating capabilities can help these SMEs overcome such challenges, smooth their internal innovative processes, making these processes more efficient and effective, for example, by reducing wrangling among different departments of the firm. External integrating capabilities can help SMEs address their 'liability of smallness' by getting access to more diverse and complementary external resources from partners. In short, integrating capabilities help technology-based SMEs coordinate internal and external diverse resources into their operating routines, enhancing their resource base, sustainable competitive advantage and consequently performance.

Similarly, innovating capabilities can help technology-based SMEs enhance performance. Innovating capabilities enables SMEs to reconstruct their core competencies continuously, develop new ideas and turn them into working prototypes,

and therefore develop new products or processes. The development of new products is considered a fundamental determinant of organizational performance and long-term survival because it helps the firm to differentiate its products and changes what the firm offers to the market (Camisón & Villar-López, 2014). It is particularly important for technology-based SMEs. Because these firms suffer from 'liability of smallness' and resource constraints, they have to rely on innovative products to respond to customer's demand or to capture new markets. Besides, innovating capabilities also reflect the capability of manufacturing products by using appropriate process technology (Yam et al., 2004), which can lower cost and increase profitability. Therefore, innovating capabilities are essential for technology-based SMEs to generate competitive advantage and enhance performance.

To sum up, TMTFBH helps enhance dynamic capabilities of the firm by bringing diversified resources, knowledge, and views. Dynamic capabilities in turn will enable the firm to coordinate the diverse resources and knowledge into the organizational process effectively, and thus extending the competitive advantage of the firm and improving its performance (Roberson et al., 2017). Dynamic capabilities thus act as a bridge, connecting TMTFBH and firm performance. Without dynamic capabilities, it is difficult to materialize the impact of TMTFBH on firm performance.

Hypothesis 2. The relationship between TMTFBH and performance of technology-based SMEs is mediated by (a) sensing capabilities, (b) integrating capabilities and (c) innovating capabilities.

2.4. The moderating role of business environment

In their process of development, technology-based SMEs have to deal with a number of daunting challenges arising from their external environment. Factors, such as legal environment, policy frameworks and competition landscapes, can be collectively referred to as 'business environment' (Wang et al., 2017). Recognizing that business environment has a number of different dimensions, Wang et al. (2017) measure it from eight aspects including open, fair and just policies, administrative intervention and efficient government, legal environment, tax burdens, financial services and financing costs, human resource supply, infrastructure conditions, market environment and intermediary services. Among these factors, legal environment, human resource supply, and market environment and intermediary services are often considered to have the most significant impact on the performance of technology-based SMEs for the liabilities of smallness (Harms & de Weerd-Nederhof, 2020).

Business environment, including the above three key dimensions, differs substantially across subnational regions within China. For example, with respect to legal environment, although intellectual property (IPR) protection laws are the same for all provinces in China, the enforcement of such laws varies between different regions (Kafouros et al., 2015). The same is true for human resource supply. Talents are unevenly distributed across China's regions because of variations in economic development and opportunities in these regions. The development of market

environment and intermediary services also varies significantly across different regions within China because of the path-dependent nature of institutional evolution, the simultaneous operation of market and state-controlled governance mechanisms (Peck & Zhang, 2013), and location-specific characteristics (Yi et al., 2020).

We contend that business environment positively moderates the effects of dynamic capabilities on the performance of technology-based SMEs. First, while sensing capabilities enables technology-based SMEs to generate, disseminate, and respond to market intelligence about changes in customer tastes and preferences and the trend of technology development (Jaworski & Kohli, 1993), and therefore enhance performance, better developed market environment can further augment this positive effect. For example, intermediary services (e.g., services from local lawyers, accountants, logistics and local industry associations) are integral elements of business environment (Wang et al., 2017). Well-developed intermediary services provide more business knowledge and valuable information that enables technology-based SMEs to not only generate more valuable market intelligence but also better utilize such market intelligence to strengthen the effect of sensing capabilities on performance. Similarly, as better developed business environment provides more high-quality human resources, technology-based SMEs with higher sensing capability are better able to acquire scientific talent and engineers as well as middle level managers, enhancing performance. By contrast, poor business environment will hinder technology-based SMEs' ability to utilize sensing capabilities to enhance performance. In other words, poor business environment may attenuate the positive effect of sensing capabilities on firm performance.

Second, better developed business environment augments the effect of integrating capabilities on the performance of technology-based SMEs. Integrating capabilities may influence technology-based SMEs in two ways, through enhancing the effectiveness of both operating-routines and resource access. Well-developed intermediary services under better business environment provide more business knowledge and valuable information (Wang et al., 2017). Strong internal integrating capabilities enable technology-based SMEs to coordinate such knowledge into its internal routines and operations. Such integration of internal operational knowledge with diverse external knowledge can enhance the effectiveness of the internal operating processes and hence firm performance (Wilhelm et al., 2015). Similarly, better developed business environment may enhance the effect of integrating capabilities on performance by increasing the effectiveness of resource access. Better developed business environment provides functioning markets and rich intermediary resources and services (Wang et al., 2017), allowing firms to get access to various factors and innovation intermediaries. Such environment thus enables firms to use external integrating capabilities and interact with external partners more effectively, enhancing their performance.

Finally, better business environment enhances the positive effect of innovating capabilities on the performance of technology-based SMEs. Innovating capabilities

enable technology-based SMEs to "continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders" (Lerro et al., 2009, p. 11). We contend that the effect of innovating capabilities of technology-based SMEs on their performance will be lower in subnational regions of China with under-developed business environment. Under-developed business environment is often characterized with poor intellectual property rights (IPRs), lower incentives and support for innovations, R&D collaborations, and knowledge-sharing (Alam et al., 2019). Such environment not only hinders the development of innovating capabilities but also limits firms' ability to use innovating capabilities effectively to enhance performance. For example, the regime of appropriability, which governs an innovator's ability to capture the profits generated by an innovation (Teece, 1986), is a key element of business environment. An effective appropriability regime helps firms prevent imitations and enhances the economic returns to their R&D activities, thus enhancing performance (Teece, 1986). Kafouros et al. (2015) suggests that the strength of IPR enforcement differs across China's regions. Although strong innovative capabilities can help firms develop innovation, those firms that operate in regions with poor business environment (e.g., weak enforcement of IPR laws) will not be able to fully reap the returns from their innovations. This is because an ineffective IPR regime is not able to help the firm protect their inventions from imitation by competitors (Teece et al., 1997) which can lead to lower performance. Hence:

Hypothesis 3. Business environment positively moderates the relationship between (a) sensing capabilities and firm performance, (b) integrating capabilities and firm performance, and (c) innovating capabilities and firm performance, such that the positive relationship is stronger when business environment is better.

Figure 1 depicts our research model. The model shows (1) the effect of TMTFBH on the performance of Chinese technology-based SMEs is mediated by dynamic capabilities and (2) business environment positively moderates the relationship between dynamic capabilities and firm performance.

(Insert Figure 1 about here)

3. Methods

3.1. Samples and data collection

We selected Chinese firms that operate in science and technology industries over the period of 2013 and 2016 from the CSMAR database. We adopted the industry classification of the China Securities Regulatory Commission in 2012 and selected SMEs from industries such as information transmission, software, and information technology service industries. While the data on firm performance are obtained from the financial statements of companies in CSMAR, the data on TMT functional backgrounds are extracted from firms' annual reports that are obtained from websites such as Cninfo. The data for business environment are obtained from the report of China's provincial enterprise business environment index which was developed by

Wang et al. (2017). The report provides data on the business environment in 2016, which is consistent with the survey time of this study. The data on dynamic capabilities are based our own calculations from firms' annual reports which are then supplemented by the data from the CSMAR database and Wind. We manually collected data for all other variables. Our initial dataset contains 161 companies. We excluded 60 *ST and ST firms, including those with negative profit margins and incomplete information of senior management team and those without data on R&D investment as well. The final sample contains 101 firms over the period of 2013-2016, creating 303 firm-year observations.

3.2. Measurement

3.2.1. TMTFBH

In keeping with prior research (Barroso-Castro et al., 2022), we calculated the functional diversity of TMT with Blau's heterogeneity index. The Blau index is expressed as $H = 1 - \sum_{i=1}^{n} P_i^2$, where P_i is the proportion of TMT members with functional specialization i. We categorized TMT functional backgrounds as: management and administration, accounting and finance, R&D, marketing and sales, law, human resources, and others. The H value is between 0 and 1. The higher the H value, the greater diversity of TMT functional background will be.

3.2.2. Firm performance of technology-based SMEs

We follow Adner & Helfat (2003) and define firm performance as annual return on assets (ROA). Specifically, it is calculated as net profit after tax / average total assets × 100%. This measurement has been widely adopted and can improve the comparability of the measure across firms that may have different asset, debt, and tax structures. The higher the rate of return on total assets is, the better the overall efficiency of utilizing assets will be.

3.2.3. Dynamic capabilities

As discussed above, dynamic capabilities have three key dimensions: sensing, integrating, and innovating capabilities. Since sensing capabilities refer to the ability of firms to perceive and respond to environmental changes such as opportunities and risks (Teece, 2007), we screen information based on computer text mining, and measure the frequency of the word 'risk' and the ratio of the length of 'risk' to the total length of enterprise annual report. The use of these words and paragraphs reflects the sensitivity, insight, and risk awareness of firms to the environment, as well as the importance of risk prevention. As integrating capabilities reflect the ability to transform the resources into other capabilities and performance outcomes (Fuchs et al., 2000), we define it as the turnover rate of total assets, i.e., the ratio between net operating income and average total assets. This measurement captures firms' ability to launch new products through the integration and utilization of resources. Lastly, innovating capabilities refer to the ability of technology-based SMEs "continuously transform knowledge and ideas into

new products, processes and systems" (Lerro et al., 2009, p. 11). While prior studies (cf. Ahuja, 2000; Wen et al., 2021) used the number of patents to measure innovating capabilities, we used the ratio of R&D investment to operating income. This measure has an advantage over patent because not all technologies are patentable and there is a substantial distance between patent application, granting and firm performance outcomes (Yuan et al., 2018).

3.2.4. Business environment

Business environment can be defined as the sum total of all factors that are external to a firm but greatly influence its business operation and performance (Reyes et al., 2021). In this study, we consider business environment of a province where the firm is located. Province is a principal administrative division of China and economic reforms and open-door policy have led to substantial variations in business environment across different provinces of China (Tang & Tang, 2012).

3.2.5. Control variables

First, we include several TMT level control variables. As age reflects knowledge structure and professional experience that TMT members can use to cope with the impact of environmental changes, we control average age of TMT members, which is measured as the total age of the team members divided by the total number of members (based on the calculation year). Next, education helps TMT members develop knowledge and technology related skills and problem-solving skills which in turn help technology-based SMEs develop innovation and improve performance. We therefore include a variable for educational level of TMT which is coded ordinal from low (1= under junior college) to high (5= doctor) and the average value is calculated. Furthermore, as longer tenure of a TMT member is positively associated with a higher level of understanding of the company's management and strategic development and therefore a higher level of firm performance, we include average tenure of TMT members, which is defined as the total tenure of TMT members divided by the total number of members. Tenure is calculated as the measurement year minus the time of entering TMT. Finally, following Buyl et al. (2011), we include team size which is measured as the total number of team members.

Our study also includes several firm level controls which may confound the effect of TMTFBH. First, we include firm size, which is measured by the logarithm of total assets. Second, we include firm age, which is measured by the number of years since the establishment of the company. Third, we control for the effect of human capital, which was measured by the ratio of R&D members to total employees. Forth, we control for the effect of R&D condition which was measured by the proportion of R&D capitalization in R&D investment. Finally, industry and region dummies are included to capture any additional effects of various locational and industrial attributes on performance.

4. Results

Table 1 shows descriptive statistics for all variables. All correlations are fairly low. All variance inflation factors (VIFs) are substantially below the acceptable level of 10, indicating that multicollinearity is not a serious concern. To further eliminate the problem of multicollinearity and enhance the interpretation of interactions, we mean-centered variables before generating those interaction terms.

Regression results are shown in Table 2. First, we look at the effect of TMTFBH on firm performance. Model 5 shows that TMTFBH has a positive and significant effect on firm performance ($\beta = 0.151$, $p < 0.01$). Hypothesis 1(a) is supported. Second, we turn to the mediating effect of dynamic capabilities on the relationship between TMTFBH and firm performance. TMTFBH has significant positive impact on the two dimensions of dynamic capabilities, namely, integrating capabilities (Model 2, $\beta = 0.169$, $p < 0.01$) and innovating capabilities (Model 3, $\beta = 0.157$, $p < 0.01$). The three dimensions of dynamic capabilities have significant positive impact on firm performance (Model 6, $\beta = 0.138$, $p < 0.05$; $\beta = 0.268$, $p < 0.001$; $\beta = 0.123$, $p < 0.05$). However, we note that when the three mediators are added to Model 6, TMTFBH has no significant effect on firm performance ($\beta = 0.074$, $p > 0.05$).

(Insert Table 2 about here)

In addition, we use bootstrap method to further check the mediation effects. The upper and lower bounds of the bootstrap 95% confidence interval of sensing capabilities include 0, indicating that Hypothesis 2(a) is not supported. By contrast, the upper and lower bounds of bootstrap 95% confidence intervals for the mediating effects of integrating capabilities and innovating capabilities do not include 0, suggesting that the effect of TMTFBH on firm performance is mediated by the resource integrating capabilities and innovating capabilities. Hypotheses 2(b) and 2(c) are supported.

Finally, we test the moderating role of business environment in the relationship between the three dimensions of capabilities and firm performance. Model 7 shows that the coefficients for the interactions between the three dimensions of dynamic capabilities and business environment are positive and significant ($\beta = 0.125$, $p < 0.05$; $\beta = 0.159$, $p < 0.01$; $\beta = 0.163$, $p < 0.01$). Further simple slope analysis (Figures, 2, 3 and 4) shows that the three dimensions of dynamic capabilities, namely, sensing capabilities (simple slope=0.277, $p < 0.01$), integrating capabilities (simple slope=0.417, $p < 0.01$) and innovating capabilities (simple slope=0.262, $p < 0.01$), all have a significant positive impact on firm performance under a good business environment (M+1SD). However, when business environment is poor (M-1SD), all three dimensions (simple slope=0.027, $p > 0.05$; simple slope=0.109, $p > 0.05$; simple slope= -0.064, $p > 0.05$) have an insignificant effect on firm performance. Hypotheses 3(a), 3(b) and 3(c) are supported.

(Insert Figures, 2, 3 and 4 about here)

To see more directly the effect of business environment, Figure 5 further shows the changes of the total, direct and indirect effects of TMTFBH on the performance of

technology-based SMEs when integrating capabilities are the mediators (the graph of innovating capabilities is similar). As business environment improves, the indirect and total effects of TMTFBH on firm performance through dynamic capabilities increase. These results indicate that better business environment enables technology-based SMEs to fully harness the heterogeneity of TMT function backgrounds and enhance performance.

(Insert Figure 5 about here）

To show more clearly the conditional indirect effects under the continuous value of the moderator, we follow Preacher *et al.* (2007) and select some points to plot the mediating effects of integrating and innovating capabilities with different levels of business environment (Figures 6 and 7). The straight lines in the graphs represent the moderated mediation effect of TMTFBH on firm performance when different mediators are considered. It is a linear function of the moderating variable. The dotted line represents the corresponding confidence intervals. Figure 6 shows that when the standardized value of business environment is between －0.359 and 1.998, the indirect effect of TMTFBH on performance through resource integrating capabilities is significant. When the standardized value of business environment is between 0.173 and 1.255, the indirect effect of TMTFBH on performance through innovating capabilities is significant. Because the values of business environment have been standardized, it means that technology-based SMEs need to operate in a business environment that is close to the average level (corresponding business environment value is 0) and better, in order to utilize dynamic capabilities fully and realize the value of TMTFBH.

（Insert Figures 6 and 7 about here）

5. Discussion

5.1 Theoretical implications

First, extant studies investigating the relationship between TMTFBH and performance focus mainly on what factors moderate the focal relationship. For example, Buyl et al. (2011) show that three sets of CEO characteristics (functional background, status as founder, and shared experience with the other TMT members) moderate the relationship between TMT functional diversity and firm performance. However, they have not gone a step further to explore the mediation mechanism underlying the relationship. Indeed, very limited effort in the literature has been devoted to understanding of what mediates the relationship between TMTFBH and performance. One of the exceptions is Deng et al. (2020) which explored how manager cognition and team conflict mediate the relationship between TMTFBH and enterprise performance. However, the study neither considers the mediating role of dynamic capabilities nor controls for their effect. Our study fills these gaps and extends prior research by theorizing and showing evidence that the effect of TMTFBH on the performance of technology-based SMEs is mediated by dynamic capabilities of the firm. Specifically, we show that two dimensions of dynamic

capabilities, namely, integrating and innovating capabilities, fully mediate the relationship between TMTFBH and firm performance. The introduction of dynamic capabilities enriches the research of upper echelon theory and advances understanding of the mechanisms through which TMTFBH influences performance of technology-based SMEs. Although we focus on technology-based SMEs in China, our approach can also be applied to other types of firms in other countries.

Note that the positive impact of TMTFBH on sensing capabilities is not significant (β =0.089, p>0.05), indicating that sensing capabilities do not mediate the effect of TMTFBH on firm performance. One possible explanation is that the impact of TMTFBH on sensing capabilities is double-edged - promoting and restraining effects coexist, making the effect insignificant. Sensing capabilities are developed from two sources. One is TMT's cognitive and creative ability, while the other is organizational processes, such as research and development activities (Teece, 2007). The diversified functional backgrounds of TMT in technology-based SMEs can bring in the necessary cognitive and creative skills that are complementary and help enhance the firm's sensing capabilities. However, TMTFBH may also create communication barriers, increase misunderstanding, and generate conflicting views on opportunity identification and threat identification, inhibiting the development of sensing capabilities. Research on Chinese firms supports this latter view, indicating that a higher degree of TMTFBH will increase team conflicts (Deng et al., 2020) that in turn may have a negative effect on the development of sensing capabilities.

Second, our study furthers understanding of the mediating mechanisms underlying the relationship between TMTFBH and firm performance by theorizing how the relationship between the mediator (dynamic capabilities) and firm performance is moderated by the business environment in which the firm is embedded. Better-developed business environment is of particular importance for technology-based SMEs because they are small and have limited ability to deal with environmental uncertainties. In line with this view, we find that there is a boundary condition for dynamic capabilities to increase firm performance. Specifically, business environment positively moderates the relationships between the three dimensions of dynamic capabilities and firm performance. This finding suggests that a better-developed business environment allows firms to use dynamic capabilities more effectively, enhancing performance.

Previous studies have examined how environmental dynamics influence the effects of dynamic capabilities on technological capabilities (Wilden & Gudergan, 2015). Our study extends this stream of conceptualizations by highlighting the role of business environment in the relationship between dynamic capabilities and firm performance of technology-based SMEs. Our focus on the moderating role of business environment responds to the calls of previous studies (e.g., Wilden et al., 2013) that research should investigate the internal and external factors that may promote or hinder firms' dynamic capabilities. To sum up, by integrating mediating and moderating analyses, our study provides a more nuanced understanding of how

dynamic capabilities and business environment affect the relationship between TMTFBH and firm performance and advances research on the complex mechanisms and conditions underlying the relationship.

5.2 Practical implications

First, our study shows that TMTFBH improves the performance of technology-based SMEs. According to this finding, technology-based SMEs should form a 'generalist' TMT. This is because a higher degree of TMTFBH can offer diverse social and cognitive resources that compensate for the 'liability of smallness' and resource weaknesses of technology-based SMEs and this in turn will help enhance their performance. It follows that when building the top management team, technology-based SMEs should intentionally choose managers with diverse functional backgrounds.

Second, our study shows that dynamic capabilities mediate the relationship between TMTFBH and firm performance. According to this finding, TMTFBH may not lead to high performance without the bridging role of dynamic capabilities. Therefore, technology-based SMEs should pay attention to not only the formation of top management teams with diversified functional backgrounds but also the development of dynamic capabilities in order for TMTFBH to function enhancing performance.

Finally, our study shows that better-developed business environment enhances the effect of dynamic capabilities on the performance of technology-based SMEs. According to this finding, technology-based SMEs should operate in regions with good business environment which will enables them to better leverage dynamic capabilities to enhance performance. In addition, local governments in China should also try to improve business environment by, for example, developing preferential policies to encourage the development of SMEs, strengthening enforcement of IPR laws, protecting consumers, and establishing platforms for information exchanges. By doing so, technology-based SMEs will be better able to leverage their dynamic capabilities to enhance performance.

5.3 Limitations and future research

First, we conducted a moderated mediating analysis that focuses on the mediating role of dynamic capabilities and the moderating role of business environment. While both dynamic capabilities and business environment help reveal the mechanisms through which TMTFBH influences firm performance, data limitations do not allow us to explore the role of other potential mediators and moderators. Investigating mediators and contingencies other than those examined in this study would also be a productive avenue for future research. Second, our sample consists of technology-based SMEs that are listed in the Chinese stock market. Given the differences in certain firm characteristics particularly corporate governance and TMT parameters between listed and non-listed companies, our findings may not apply,

to the same extent, to non-listed companies. Future research can use our framework to examine the hypothesized relationships for non-listed firms. Finally, we tested our hypotheses using a sample of technology-based SMEs in China. SMEs in China differ from their counterparts in other emerging countries and developed countries. Although our framework can be used for research in any other setting, our findings may not be applied to other types of firms and firms in other countries. Future research can examine technology-based SMEs in emerging countries that differ significantly from China.

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Table 1

Descriptive statistics and correlations.

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. FP	0.08	0.06	–												
2. TMTFBH	0.50	0.14	0.149**	–											
3. Sensing	0.16	0.03	0.151**	0.076	–										
4. Integrating	0.51	0.24	0.258**	0.183**	0.028	–									
5. Innovating	0.12	0.09	0.112	0.188**	0.084	−0.193**	–								
6. BE	3.71	0.11	0.187**	−0.015	−0.055	0.022	−0.019	–							
7. TMT age	46.12	3.31	−0.240**	−0.028	0.010	−0.097	−0.070	−0.086	–						
8. TMT tenure	4.10	1.78	−0.013	0.057	0.233**	−0.043	0.182*	0.077	0.134*	–					
9. TMT education	3.39	0.37	−0.076	0.040	−0.180**	0.045	−0.006	0.003	0.150**	−0.008	–				
10. TMT size	9.31	2.95	−0.026	0.042	−0.127*	0.081	0.104	0.020	0.126*	−0.146*	−0.019	–			
11. Firm size	9.35	0.34	0.079	0.061	−0.152**	−0.039	−0.091	0.165**	0.039	−0.051	0.200**	0.215*	–		
12. Firm age	14.51	4.22	−0.193**	0.128*	0.043	0.039	−0.164**	−0.046	0.314**	0.119*	0.129*	−0.054	0.090	–	
13. Human capital	0.32	0.23	0.097	0.141*	−0.076	0.002	0.310**	0.062	0.017	0.129*	0.114*	−0.053	0.074	−0.009	–
14. R&D	0.13	0.20	−0.115*	0.049	−0.133*	−0.087	0.204**	−0.101	0.060	0.090	0.207**	0.042	0.076	0.023	0.297**

Notes: N=303; *p<0.05, **p<0.01; FP denotes firm performance; BE denotes business environment.

Table 2

Regression results.

	Sensing	Integrating	Innovating	Firm performance			
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
TMT age	0.018	−0.129*	−0.073	−0.181**	−0.165**	−0.124*	−0.136*
TMT tenure	0.226***	−0.038	0.183**	0.022	0.016	−0.027	−0.049
TMT education	−0.137*	0.073	−0.020	−0.019	−0.016	−0.015	−0.018
TMT size	−0.074	0.104	0.161**	−0.007	−0.017	−0.054	−0.048
Firm size	−0.098	−0.085	−0.121*	0.101	0.095	0.147*	0.109
Firm age	0.030	0.060	−0.166**	−0.126*	−0.148*	−0.148*	−0.131*
Human capital	−0.062	0.001	0.247***	0.142*	0.124*	0.102	0.131*
R&D	−0.100	−0.094	0.103	−0.142*	−0.142*	−0.116*	−0.116*
Industry	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Region	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
TMTFBH	0.089	0.169**	0.157**		0.151**	0.074	0.082
Sensing						0.138*	0.152*
Integrating						0.268***	0.268***
Innovating						0.123*	0.099
BE							0.187**
Sensing*BE							0.125*
Integrating*BE							0.159**
Innovating*BE							0.163**
Adjusted R^2	0.093	0.046	0.196	0.089	0.109	0.188	0.228
F	3.372***	2.122*	6.649***	3.466***	3.829**	5.368***	5.705***

Notes: N=303; *p<0.05, **p<0.01, *** p<0.001; standardized regression coefficients (β s) are reported; BE denotes business environment; n.s. denotes not significant.

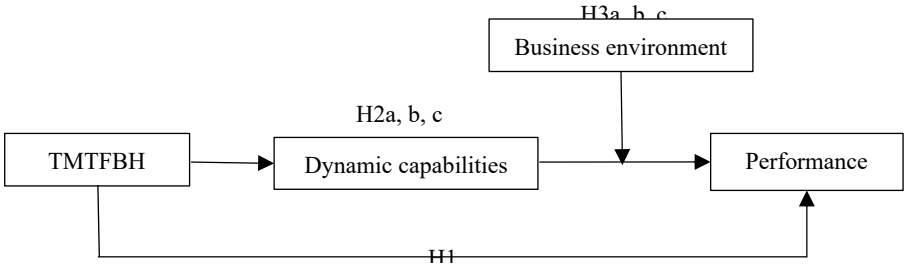

Fig. 1. Research model.

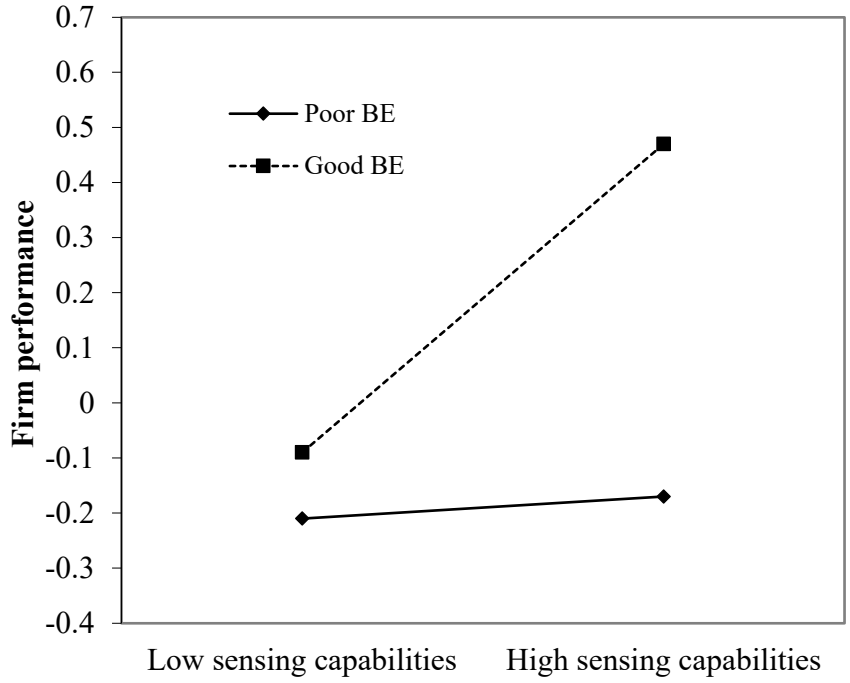

Fig. 2. The moderating role of business environment in the relationship between sensing capabilities and firm performance.

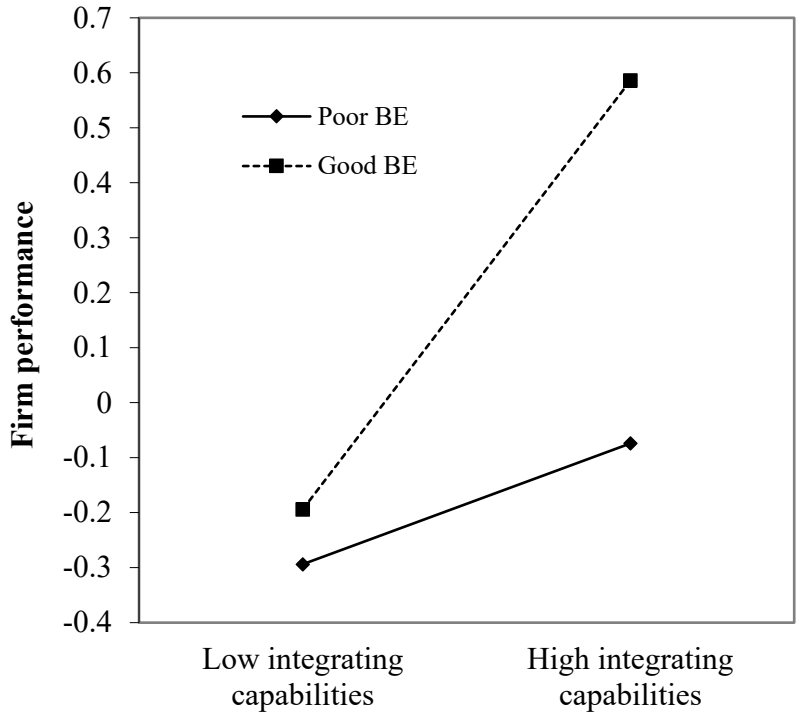

Fig. 3. The moderating role of business environment in the relationship between integrating capabilities and firm performance.

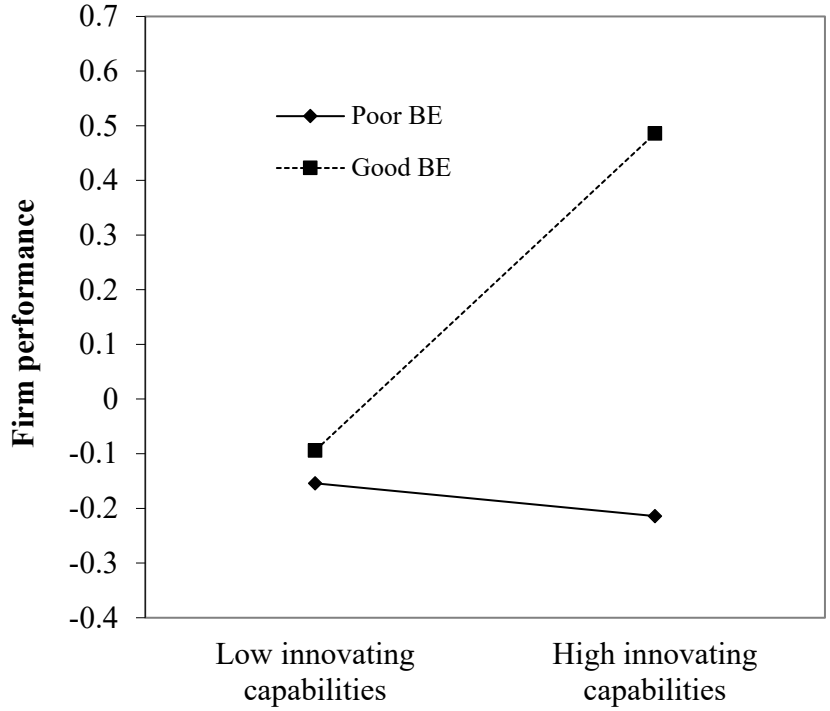

Fig. 4. The moderating role of business environment in the relationship between innovating capabilities and firm performance.

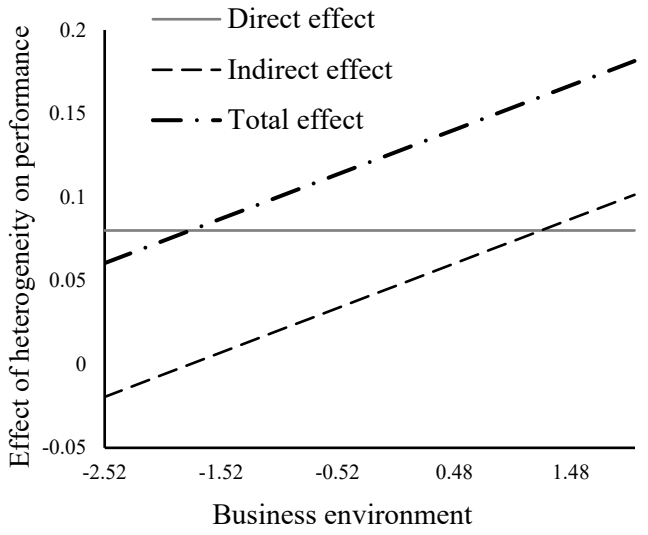

Fig. 5. Effects of TMTFBH on performance (integrating capabilities as mediator).

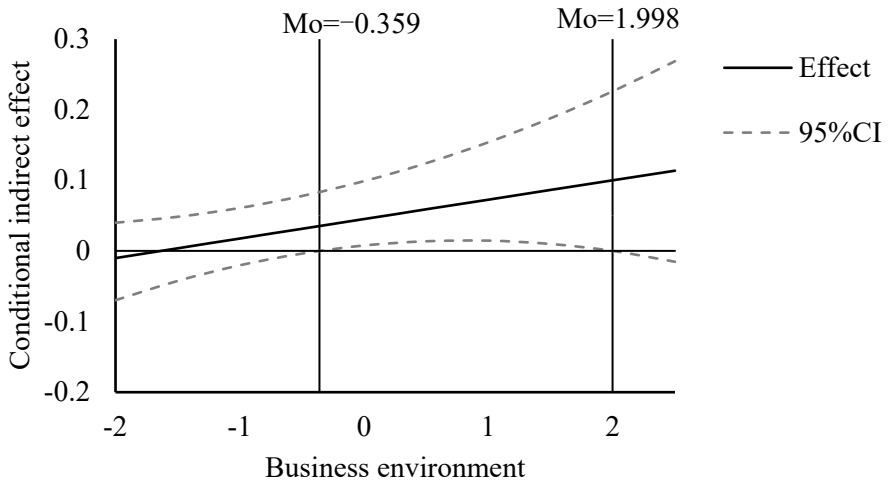

Fig. 6. Conditional indirect effects of TMTFBH on firm performance (integrating capabilities as mediator).

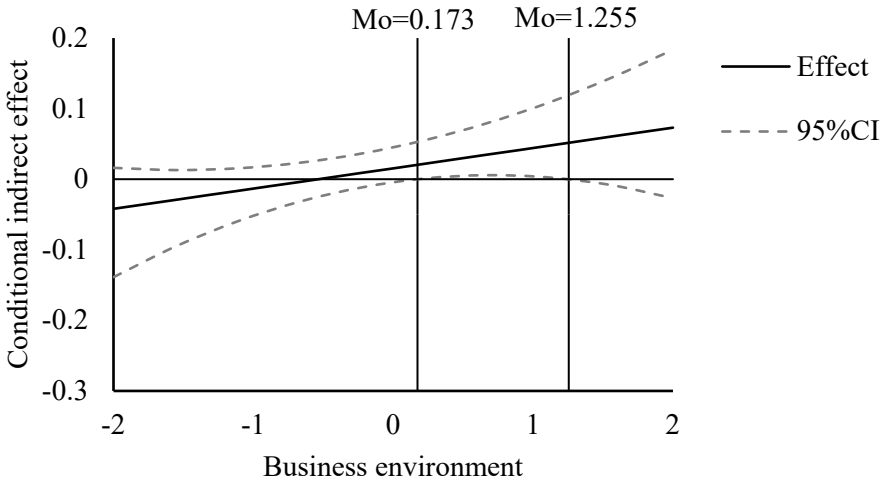

Fig. 7. Conditional indirect effects of TMTFBH on firm performance (innovating capabilities as mediator)