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

ABSTRACT

Drawing on the insights from upper echelons theory (UET), we advance understanding of how top management team (TMT) functional background heterogeneity (TMTFBH) influences the 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 the two dimensions of dynamic capabilities, namely, integrating capabilities and innovating capabilities, mediate this relationship, business environment positively moderates the relationship between dynamic 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, highlighting the role of dynamic capabilities and business environment.

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

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

1. Introduction

This study examines how top management team (TMT) functional background heterogeneity (TMTFBH) influences the performance of technology-based small and medium sized enterprises (SMEs). Upper echelons theory (UET) suggests that the properties of TMT matter to organizational performance (Neely et al., 2020; White & Borgholthaus, 2022). In this regard, the literature differentiates between 'generalist' TMT (i.e., TMT members come from various functional backgrounds) and 'specialist' TMT (i.e., TMT members come from same/similar functional backgrounds), and suggests that the 'generalist' TMT presents advantages over 'specialist' TMT. It is argued that a higher degree of TMTFBH can improve the TMT's cognitive structure and allow for integration of diverse ideas, skills, and resources (Heavey & Simsek, 2017) that in turn fosters healthy 'conflicts' between team members, improves team decision-making and consequently firm performance (Roberson et al., 2017). A large number of empirical studies corroborates this view, showing that TMTFBH has a positive effect on firm performance (Buyl et al., 2011; Cui et al., 2019). However, there are also studies reporting either a negative relationship (Simons et al., 1999; Zhang 2007) or no relationship (West Jr. & Schwenk, 1996) between TMTFBH and firm performance.

We suggest that three pitfalls in our understanding may contribute to the inconclusive findings. First, previous studies have examined mainly large firms operating in industries such as information technology, machine tools, and electronic components (Cui et al., 2019; West Jr. & Schwenk, 1996). Certain differences in firm- and industry-specific characteristics between large and small firms mean that the findings of these studies may not apply to technology-based SMEs. Second, extant research has under-theorized the intermediary mechanisms underlying the focal relationship, with the exception of Goll et al. (2001) and Boone & Hendriks (2009) who show that TMTFBH can improve organizational performance by promoting a team's progressive decision-making and decision quality. In this regard, although it is argued that dynamic capabilities, 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), determine the firm's ability to grow output from a limited bundle of resources (Roberson et al., 2017; Teece, 2007), prior research has not considered the way such capabilities influences the relationship between TMTFBH and firm performance. Third, prior research has done little to explore the factors that determine the direction and strength of the relationship between TMTFBH and firm performance. One exception is Buyl et al. (2011), who identify certain CEO

characteristics as moderators of the focal relationship. Although it is well-established that business environment influences firm performance, we know little about how such environment influences the way TMT develops and leverages their dynamic capabilities and how this influences the effects of TMTFBH on firm performance.

This study addresses these gaps by investigating whether and how TMTFBH influences firm performance of technology-based SMEs. It contributes to the literature in two distinct ways. First, we enrich the team diversity literature on the effects of TMTFBH on firm performance by focusing specifically on technology-based SMEs. Compared with their larger counterparts, 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 in the diversity literature to explore how TMTFBH influences the performance of technology-based SMEs.

Second, our study enhances understanding of how TMTFBH influences firm performance by revealing the complex mechanisms underlying the focal relationship and by taking into account the role of both internal and external factors. Specifically, we conceptualize how three key dimensions of dynamic capabilities (internal factors), namely, sensing capabilities, integrating capabilities, and innovating capabilities, mediate the relationship between TMTFBH and firm performance. We also theorize how business environment (external factor) in which the firm operates moderates the effects of those 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 advance prior understanding of the effects of TMTFBH on firm performance of technology-based SMEs and shed light on why previous studies have generated conflicting findings. Our findings also enrich UET by demonstrating the importance of integrating both external and internal factors when evaluating the effect of the properties of TMT on organizational performance.

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. Research backgrounds

2.1. Upper echelons theory, dynamic capabilities, and firm performance

UET predicts that organizational outcomes are a reflection of their executives' knowledge, experience, and expertise (Hambrick & Mason, 1984). Studies based on UET have proliferated in recent years, making it truly a multidisciplinary research paradigm (White & Borgholthaus, 2022). While many studies focus on individual managers, exploring the influence of their demographic or personal attributes on performance (Kiss et al., 2022), recent advances in UET research have extended to the role of the attributes of TMT (White & Borgholthaus, 2022). In this strand of literature, the impact of TMT composition diversity on a firm's performance has become a 'black box'. Previous studies have endeavored to uncover this box and understand what determines the performance outcomes of TMTFBH.

Dynamic capabilities, conceived as 'an organization's ability to achieve new and innovative forms of competitive advantage' (Teece et al., 1997, p.516), are considered crucial for organizations to achieve evolutionary fitness (Zahra et al., 2022). As such, it can be a key determinant of the relationship between TMTFBH and the performance of technology based SMEs. Several researchers provided a typology of this concept. For example, Teece (2007) suggest that sensing, seizing and reconfiguration are three key 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 acquire superior information and sense novel opportunities and threats (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 organization's resources 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 to improve their performance.

Although there is a plethora of studies investing the link between dynamic capabilities and firm performance (Pezeshkan et al., 2016; Colombo et al., 2021); Hernández-Linares et al., 2021), studies seldom explore the role of dynamic capabilities in the relationship between TMTFBH and firm performance. In this study we explore whether these capabilities mediate the relationship between TMTFBH and firm performance.

2.2. TMTFBH and firm performance

Previous research suggests that TMTFBH is a 'mixed blessing' (Williams & O'Reilly, 1998) and can have both positive and negative effects on firm performance. On the one hand, given that the very hallmark of TMTFBH is the diversity of knowledge, skills, cognition, and experience of TMT members across different functional specializations (Bunderson & Sutcliffe, 2002; Narayan et al., 2021), research emphasizing the 'variety' aspect of TMTFBH (Harrison & Klein, 2007) suggests that diversity is beneficial because diverse teams can draw from different pools of information or resources and can evaluate alternative solutions (Bell et al., 2011; Finkelstein & Hambrick, 1996). Furthermore, TMTs often engage in a variety of ambiguous and ill-defined tasks which influences the organization's direction as a whole (Devine, 2002). In this regard, TMTFBH can enable a 'debating society' within the TMT where managers with different types of skills discuss and analyse the task at hand from diverse viewpoints that can help 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 (Harrison & Klein, 2007), positing that TMTFBH may negatively affect firm performance. This is because TMTFBH can cause interpersonal conflicts, communication breakdowns and slower decision making, unification breakdowns, and interpersonal conflict (Greening & Johnson, 1997); (Hambrick & D'Aveni, 1992). Drawing on theories such as 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.

Prior empirical evidence is in line with these conflicting views, showing that the effect of TMTFBH on firm performance can be positive (Norburn

& Birley, 1988; Li, 2017), negative (Simons et al., 1999) and negligible (West Jr. & Schwenk, 1996). Research has attempted to reconcile the inconclusive findings by revealing the conditions under which the TMTFBH-performance relationship can be positive or negative. For example, 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 progressive decision making (Goll et al., 2001) and decision quality (Boone & Hendriks, 2009) as factors that can mediate the relationship between TMTFBH and firm performance.

To sum up, prior conceptualizations have provided conflicting theoretical predictions and findings concerning the relationship between TMTFBH and firm performance. Moreover, we still know little about whether and how TMTFBH influences the performance of technology-based SMEs. Further, although prior research has 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.

3. Hypotheses

3.1. Technology-based SMEs and firm performance

According to UET, TMTFBH might potentially have a negative impact on the performance of technology-based SMEs. For instance, technology-based industries are characterized with high 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. Besides, 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, according to theories of social identity and self-categorization (Hornsey, 2008), 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 TMTFBH.

Nevertheless, for technology-based SMEs, we argue that a higher degree of TMTFBH may help enhance firm performance. First, innovativeness is a distinct characteristic of technology-based SMEs, and it involves both exploratory and exploitative innovative activities. Decisions about conducting

exploratory or exploitative innovation are critically important for survival and growth of technology-based SMEs. However, top managers' previous functional backgrounds 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, 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 can 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 technology-based SMEs need to develop and market new technologies and products more productively (Li & Zhang, 2007). In such cases, a higher level of TMTFBH helps provide a wider set of knowledge and skills, and enhance problem solving and team decision-making efficiency (Lewis, 2003), consequently promoting firm performance. Accordingly,

Hypothesis 1. TMTFBH is positively associated with the performance of technology-based SMEs.

3.2. The mediating role of dynamic capabilities

In this section, we propose (1) TMTFBH enhances dynamic capabilities of a SME and (2) dynamic capabilities in turn enable the SME to improve its performance (Roberson et al., 2017). Dynamic capabilities thus act as a mediator, through which TMTFBH influences firm performance. Below, we present several arguments supporting both (1) and (2) and consequently the mediating role of dynamic capabilities.

We first argue that TMTFBH has a positive impact on the enhancement of dynamic capabilities. Firstly, 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 TMTs 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). A higher degree of TMTFBH provides the TMT with access to a wide range of information, knowledge, expertise, perspectives and experience (Narayan et al., 2021), which in turn helps reduce the cognitive bias when using external information to make decisions, 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.

Secondly, 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 various internal resources (Helfat & Campo-Rembado, 2016). 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 such 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.

Finally, TMTFBH positively affects the innovating capabilities of technology-based SMEs. A higher degree of TMTFBH provides the TMT with access to diverse knowledge and technologies (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 bases can also reduce core rigidity and path dependence of firms, thus speeding up invention (Quintana-García & Benavides-Velasco, 2008). In addition, as innovative capabilities at organizational level 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. Firstly, sensing capabilities enhance the performance of technology-based SMEs. 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 growth and performance (Short et al., 2010).

Secondly, integrating capabilities can help technology-based SMEs to re-coordinate resources and improve performance. Technology-based SMEs suffer from 'liability of smallness' (i.e., disadvantages associated with small size such as 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 weaknesses, smooth their internal innovative processes, making these processes more efficient and effective, for example, by reducing wrangling among different departments of the firm. On the other hand, external integrating capabilities can also 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 enable 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 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.

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

3.3. 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, including but not limited to, market size, tax and land incentives, logistics costs, labor skills, can be collectively referred to business environment (Zhang et al., 2012). 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 due to their liabilities of smallness (Harms & de Weerd-Nederhof, 2020).

Business environment, including the above three key dimensions, differs substantially across subnational regions within China because of the significant variations in institutional landscape among these regions (Sun et al., 2017). For example, regional innovation system (RIS) which is a key element of business environment differs between different regions of China (Wang et al., 2015). With respect to legal environment, the enforcement of property protection laws varies between different regions of China (Kafouros et al., 2015). 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 well-developed 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). Because service intermediaries are nodes connecting firms, organizations and industries, they could help maintain extensive networks (Zhang & Li, 2010). Well-developed intermediary services enable technology-based SMEs to plug into these networks. By broadening their scope of search and reducing their search cost, technology-based SMEs can not only obtain 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 capabilities are better able to acquire scientific talent and engineers as well as middle level managers, enhancing 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 by enhancing operating-routines and effectiveness of resource access. Well-developed intermediary services under better business environment provide extensive networks connecting various organizations and industries (Zhang & Li, 2010), offering ample knowledge. 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. Well-functioning markets and rich intermediary resources and services (Wang et al., 2017) allow firms to get access to various factors and intermediaries. Such environment 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 constantly develop new products and/or markets (Wang & Ahmed, 2007). We contend that the effect of innovating capabilities on the performance of technology-based SMEs will be higher in subnational regions of China with better-developed business environment. Better developed business environment is often characterized with strong protection of intellectual property rights (IPR), high incentives and support for R&D collaborations and knowledge-sharing (Alam et al., 2019). Such environment not only accelerates the development of innovating capabilities but also augments 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. When firms

operate in regions with better business environment (e.g., strong enforcement of IPR laws), strong innovative capabilities can help SMEs not only develop innovation, but also to fully reap the returns from their innovations. This is because an effective IPR regime could help the firm protect their inventions from imitation by competitors (Teece et al., 1997) which can lead to higher performance. Hence:

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

4. Methods

4.1. Samples and data collection

We selected Chinese firms that operate in high technology industries over the period of 2013 and 2016 from the China Stock Market Accounting Research (CSMAR) database. This database contains financial, investment and innovation information of listed Chinese firms and it has been used in many previous studies (e.g., Liu et al., 2021). 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 CSMAR, the data on TMT functional backgrounds such as age, tenures and education levels of CEOs are extracted from firms' annual reports that are obtained from Cninfo (http://www.cninfo.com.cn), which is the information disclosure website of listed companies designated by China Securities Regulatory Commission. The platform provides information such as company listing announcements, company information, interactions between companies, online voting of shareholders' meetings. 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 Cninfo. We manually collected data for all other variables. Our initial dataset contains 161 companies. We excluded 60 *ST and ST firms, those with negative profit margins and incomplete information of TMT as well as those without data on R&D investment. The final sample contains 101 firms over the period of 2013-2016, creating 303 firm-year observations.

4.2. Measurement

4.2.1. TMTFBH

We followed Barroso-Castro et al. (2022) and 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.

4.2.2. Firm performance of technology-based SMEs

We followed Adner & Helfat (2003) and defined 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.

4.2.3. 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 firm 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 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 denote a firm's ability to develop new products and/or markets (Wang & Ahmed, 2007). 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).

4.2.4. Business environment

Business environment is the complex integration of various elements such as policies, infrastructure services, corruption, that are influential to a firm's business activities (Jiang et al., 2021). A measure of region-specific business environment considers the fact that dimensions of business environment may vary across regions depending on the development of regional economy and government. This measure, developed by Wang et al. (2017), is a comprehensive composite index that evaluates regional business environment in 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. Twenty-nine indicators are employed to assess these eight dimensions and form a business environment index. The values of the index, according to Wang et al. (2017), range from 3.32 (Qinghai and Xinjiang) to 3.92 (Shanghai). The higher the value of the index, the better the external environment of the region is.

4.2.5. 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. Next, education helps TMT members develop knowledge and technology related skills and problem-solving skills which in turn affect the performance of technology-based SMEs. 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. 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 technical/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.

4.3. Method of analysis

To test Hypothesis 1, we estimate the following model:

$$Firm\ performance_{i,t+1} = \alpha + \beta_1 TMTFBH_{i,t} + \gamma(Controls)_{i,t} + \varepsilon_{i,t} \quad (1)$$

To test Hypothesis 2, we added dynamic capabilities (DC) (including sensing, integrating and innovating capabilities) to model (1), and estimate the following model:

$$Firm\ performance_{i,t+1} = \alpha + \beta_1 TMTFBH_{i,t} + \beta_2 DC_{i,t} + \gamma(Controls)_{i,t} + \varepsilon_{i,t} \quad (2)$$

To test Hypothesis 3, we added the moderator variable - business environment (BE) and its interaction with the mediator variable - DC to model (2), and estimate the following model:

$$Firm\ performance_{i,t+1} = \alpha + \beta_1 TMTFBH_{i,t} + \beta_2 DC_{i,t} + \beta_3 (DC * BE)_{i,t} + \beta_4 BE_{i,t} + \gamma(Controls)_{i,t} + \varepsilon_{i,t} \quad (3)$$

5. 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.

(Insert Table 1 about here)

Regression results are shown in Table 2. First, Model 5 shows that TMTFBH has a positive and significant effect on firm performance (β= 0.154, p< 0.01). Hypothesis 1 is supported. Second, TMTFBH has significant positive impact on the two dimensions of dynamic capabilities, namely, integrating capabilities (Model 2, β=0.163, p<0.01) and innovating capabilities (Model 3, β=0.155, p<0.01). The three dimensions of dynamic capabilities have significant positive impact on firm performance (Model 6, β=0.141, p<0.05; β=0.263, p<0.001; β=0.113, p<0.05). However, we note that when the three mediators are added to Model 6, TMTFBH has no significant effect on firm performance (β=0.080, 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. Hypotheses 2(b) and 2(c) are supported.

Finally, Model 7 shows that the coefficients for the interactions are positive and significant (β=0.117，p＜0.05；β=0.158，p＜0.01；β=0.167，p＜0.01). Further simple slope analysis (Figures, 1, 2 and 3) shows that the three dimensions of dynamic capabilities, namely, sensing capabilities (simple slope=0.266, p＜0.01), integrating capabilities (simple slope=0.424, p＜0.01) and innovating capabilities (simple slope=0.277, 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=0.042, p>0.05; simple slope=0.101, p>0.05; simple slope=–0.099, p>0.05) have an insignificant effect on firm performance. Hypotheses 3(a), 3(b) and 3(c) are supported.

(Insert Figures, 1, 2 and 3 about here)

6. Discussion

6.1 Theoretical implications

First, extant studies investigating the relationship between TMTFBH and firm performance focus on what factors moderate the focal relationship to reconcile the two opposing views about the relationship - TMTFBH may positively or negatively influence firm performance. However, they have not gone a step further to explore the mediation mechanism underlying the focal relationship. Indeed, we know little about how certain internal factors of the firm may mediate the relationship between TMTFBH and firm performance. Goll et al. (2001) and Boone & Hendriks (2009) are exceptions but both rely mainly on the information processing perspective and have considered neither the mediating role of dynamic capabilities nor controlled for their effect in their research designs. Our findings fill this gap and extend research on team diversity by theorizing and showing evidence that integrating and innovating capabilities mediate the relationship between TMTFBH and firm performance. The introduction of dynamic capabilities advances our understanding of the mediating 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 overall effect insignificant. Sensing capabilities are closely associated with the TMT's cognitive and creative ability (Teece, 2007). TMTFBH in technology-based SMEs can bring in the necessary cognitive and creative skills that are complementary and help enhance the firm's sensing capabilities, but it may also create communication barriers, increase misunderstandings (Bachrach et al., 2019), and generate conflicting views on opportunity and threat identification, thereby inhibiting the development of sensing capabilities.

Second, our study furthers understanding of the mechanisms underlying the relationship between TMTFBH and firm performance by theorizing and showing evidence about how the relationship between the mediator (dynamic capabilities) and firm performance is positively moderated by the business environment in which the firm is embedded. This finding suggests that a better-developed business environment allows firms to use dynamic capabilities more effectively, thus enhancing performance. Furthermore, previous studies have examined factors that moderate the relationship between

TMTFBH and firm performance (Buyl et al., 2011; Cui et al., 2019; Qian et al., 2012) and between dynamic capabilities and firm performance (Colombo et al., 2021); yet they have under-theorized the role of environmental contingencies. Our finding adds to this line of research by showing the moderating role of business environment in the relationship between dynamic capabilities and firm performance. This finding provides a new explanation of the inconsistent findings regarding the relationship between TMTFBH and firm performance in the literature. In short, by integrating mediating and moderating analyses, our study provides a more nuanced understanding of how a firm's internal factors (dynamic capabilities) and external factors (business environment) influence the effects of TMTFBH on the performance of technology-based SMEs, advancing research on the complex mechanisms and conditions underlying the focal relationship.

Finally, our findings extend research on UET. While the UET focuses on the role of individual managers' attributes (Kiss et al., 2022), we extend the theory by paying attention to the attributes of TMTs (White & Borgholthaus, 2022). Furthermore, we move beyond the UET's focus on how managers' attributes influence firm performance; instead, we contribute to this theory by considering how external factors such as business environment affects the relationship between TMT attributes (function heterogeneity) and firm performance. While the impact of TMT composition diversity on firm performance is a well-known 'black box'. Our study helps uncover this box and enhances understanding of what determines the performance outcomes of TMTFBH.

6.2 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 TMT with a higher degree of functional background diversity as this can offer diverse social and cognitive resources that compensate for the 'liability of smallness' and resource weaknesses of technology-based SMEs, thus enhancing their performance. It follows that when building the TMT, these firms 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 the TMT 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 better business environment which will enables them to leverage dynamic capabilities to enhance performance. In addition, local governments in China should also try to improve business environment such as legal environment, human resource supply, and market environment and intermediary services. By doing so, technology-based

SMEs will be better able to leverage their dynamic capabilities to enhance performance.

6.3 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.

References

Adner, R., & Helfat, C. E. (2003). Corporate effects and dynamic managerial capabilities. *Strategic Management Journal*, *24*(10), 1011–1025. https://doi.org/10.1002/smj.331

Ahuja, G. (2000). Collaboration Networks, Structural Holes, and Innovation: A Longitudinal Study. *Administrative Science Quarterly*, *45*(3), 425–455. https://doi.org/10.5465/APBPP.1998.27664401

Alam, A., Uddin, M., & Yazdifar, H. (2019). Institutional determinants of R&D investment: Evidence from emerging markets. *Technological Forecasting and Social Change*, *138*, 34–44. https://doi.org/10.1016/j.techfore.2018.08.007

Bachrach, D. G., Lewis, K., Kim, Y., Patel, P. C., Campion, M. C., & Thatcher, S. M. B. (2019). Transactive memory systems in context: A meta-analytic examination of contextual factors in transactive memory systems development and team performance. *Journal of Applied Psychology*, *104*(3), 464–493. https://doi.org/10.1037/apl0000329

Barroso-Castro, C., Domínguez-CC, M., & Rodríguez-Serrano, M. Á. (2022). SME growth speed: The relationship with board capital. *Journal of Small Business Management*, *60*(2), 480–512. https://doi.org/10.1080/00472778.2020.1717293

Bell, S. T., Villado, A. J., Lukasik, M. A., Belau, L., & Briggs, A. L. (2011). Getting Specific about Demographic Diversity Variable and Team Performance Relationships: A Meta-Analysis. *Journal of Management*, *37*(3), 709–743. https://doi.org/10.1177/0149206310365001

Boone, C., & Hendriks, W. (2009). Top Management Team Diversity and Firm Performance: Moderators of Functional-Background and Locus-of-Control Diversity. *Management Science*, *55*(2), 165–180. https://doi.org/10.1287/mnsc.1080.0899

Bunderson, J. S., & Sutcliffe, K. M. (2002). Comparing Alternative Conceptualizations of Functional Diversity in Management Teams: Process and Performance Effects. *Academy of Management Journal*, *45*(5), 875–893. https://doi.org/10.5465/3069319

Buyl, T., Boone, C., Hendriks, W., & Matthyssens, P. (2011). Top Management Team Functional Diversity and Firm Performance: The Moderating Role of CEO Characteristics. *Journal of Management Studies*, *48*(1), 151–177. https://doi.org/10.1111/j.1467-6486.2010.00932.x

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research*, *67*(1), 2891–2902. https://doi.org/10.1016/j.jbusres.2012.06.004

Cao, Q., Simsek, Z., & Zhang, H. (2010). Modelling the Joint Impact of the CEO and the TMT on Organizational Ambidexterity. *Journal of Management Studies*, *47*(7), 1272–1296. https://doi.org/10.1111/j.1467-6486.2009.00877.x

Chen, T., Qian, L., & Narayanan, V. (2017). Battle on the Wrong Field? Entrant Type, Dominant Designs, and Technology Exit. *Strategic Management Journal*, *38*(13), 2579–2598. https://doi.org/10.1002/smj.2669

Colombo, M. G., Piva, E., Quas, A., & Rossi-Lamastra, C. (2021). Dynamic capabilities and high-tech entrepreneurial ventures' performance in the aftermath of an environmental jolt. *Long Range Planning*, *54*(3), no.102026. https://doi.org/10.1016/j.lrp.2020.102026

Cox, T. H., & Blake, S. (1991). Managing cultural diversity: Implications for organizational competitiveness. *Academy of Management Perspectives*, *5*(3), 45–56. https://doi.org/10.5465/ame.1991.4274465

Cui, Y., Zhang, Y., Guo, J., & Hu, H. (2019). Top management team knowledge heterogeneity, ownership structure and financial performance: Evidence from Chinese IT listed companies. *Technological Forecasting and Social Change*, *140*, 14–21. https://doi.org/10.1016/j.techfore.2018.12.008

De Toni, A., & Nassimbeni, G. (2003). Small and medium district enterprises and the new product development challenge: Evidence from Italian eyewear district. *International Journal of Operations & Production Management*, *23*(6), 678–697. https://doi.org/10.1108/01443570310476672

Devine, D. J. (2002). A Review and Integration of Classification Systems Relevant to Teams in Organizations. *Group Dynamics: Theory Research & Practice*, *6*(4), 291–310. https://doi.org/10.1037/1089-2699.6.4.291

Ensley, M. D., Pearson, A. W., & Amason, A. C. (2002). Understanding the dynamics of new venture top management teams: Cohesion, conflict, and new

venture performance. *Journal of Business Venturing*, *17*, 365–386. https://doi.org/10.1016/S0883-9026(00)00065-3

Finkelstein, S., & Hambrick, D. C. (1996). *Strategic leadership: Top executives and their effects on organizations*. West Publishing Company.

Fuchs, P. H., Mifflin, K. E., Miller, D., & Whitney, J. O. (2000). Strategic Integration: Competing in the Age of Capabilities. *California Management Review*, *42*(3), 118–147. https://doi.org/10.2307/41166045

Gibson, C., & Vermeulen, F. (2003). A Healthy Divide: Subgroups as a Stimulus for Team Learning Behavior. *Administrative Science Quarterly*, *48*(2), 202–239. https://doi.org/10.2307/3556657

Goll, I., Sambharya, R. B., & Tucci, L. A. (2001). Top management team composition, corporate ideology, and firm performance. *Management International Review*, *41*(2), 109–129. https://doi.org/10.1177/017084069501600504

Greening, D. W., & Johnson, R. A. (1997). Managing industrial and environmental crises: The role of heterogeneous top management teams. *Business & Society*, *36*(4), 334–361. https://doi.org/10.1177/000765039703600402

Hambrick, D. C., & D'Aveni, R. A. (1992). Top Team Deterioration as Part of the Downward Spiral of Large Corporate Bankruptcies. *Management Science*, *38*(10), 1445–1466. https://doi.org/10.1287/mnsc.38.10.1445

Hambrick, D. C., & Mason, P. A. (1984). Upper Echelons: The Organization as a Reflection of Its Top Managers. *Academy of Management Review*, *9*(2), 193–206. https://doi.org/10.5465/AMBPP.1982.4976402

Harms, R., & de Weerd-Nederhof, P. (2020). Building high tech small firms to become – News from the High Technology Small Firms conference, University Twente, 27–28 May 2019. *Technovation*, *90–91*, no.102103. https://doi.org/10.1016/j.technovation.2019.102103

Harrison, D. A., & Klein, K. J. (2007). What's the Difference? Diversity Constructs as Separation, Variety, or Disparity in Organizations. *Academy of Management Review*, *32*(4), 1199–1228. https://doi.org/10.5465/AMR.2007.26586096

Heavey, C., & Simsek, Z. (2017). Distributed Cognition in Top Management Teams and Organizational Ambidexterity: The Influence of Transactive Memory Systems. *Journal of Management*, *43*(3), 919–945. https://doi.org/10.1177/0149206314545652

Helfat, C. E., & Campo-Rembado, M. A. (2016). Integrative Capabilities, Vertical Integration, and Innovation Over Successive Technology Lifecycles. *Organization Science*, *27*(2), 249–264. https://doi.org/10.1287/orsc.2015.1045

Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy*, *47*(8), 1391–1399. https://doi.org/10.1016/j.respol.2018.01.019

Henneke, D., & Lüthje, C. (2007). Interdisciplinary Heterogeneity as a Catalyst for Product Innovativeness of Entrepreneurial Teams. *Creativity and Innovation Management*, *16*(2), 121–132. https://doi.org/10.1111/j.1467-8691.2007.00426.x

Hernández-Linares, R., Kellermanns, F. W., & López-Fernández, M. C. (2021). Dynamic capabilities and SME performance: The moderating effect of

market orientation. *Journal of Small Business Management*, *59*(1), 162–195. https://doi.org/10.1111/jsbm.12474

Hornsey, M. J. (2008). Social Identity Theory and Self-categorization Theory: A Historical Review. *Social and Personality Psychology Compass*, *2*(1), 204–222. https://doi.org/10.1111/j.1751-9004.2007.00066.x

Jaworski, B. J., & Kohli, A. K. (1993). Market Orientation: Antecedents and Consequences. *Journal of Marketing*, *57*(3), 53–70. https://doi.org/10.2307/1251854

Jiang, M., Gao, Y., Jin, M., & Liu, S. (2021). Sustainable development of the business environment in smart cities: A hierarchical framework. *Kybernetes*, *50*(5), 1426–1448. https://doi.org/10.1108/K-03-2020-0148

Kafouros, M. I., Buckley, P. J., & Clegg, J. (2012). The effects of global knowledge reservoirs on the productivity of multinational enterprises: The role of international depth and breadth. *Research Policy*, *41*(5), 848–861. https://doi.org/10.1016/j.respol.2012.02.007

Kafouros, M., Wang, C., Piperopoulos, P., & Zhang, M. (2015). Academic collaborations and firm innovation performance in China: The role of region-specific institutions. *Research Policy*, *44*, 803–817. https://doi.org/10.1016/j.respol.2014.11.002

Kiss, A. N., Cortes, A. F., & Herrmann, P. (2022). CEO proactiveness, innovation, and firm performance. *The Leadership Quarterly*, *33*(3), 101545. https://doi.org/10.1016/j.leaqua.2021.101545

Knight, D., Pearce, C. L., Smith, K. G., Olian, J. D., Sims, H. P., Smith, K. A., & Flood, P. (1999). Top management team diversity, group process, and strategic consensus. *Strategic Management Journal*, *20*(5), 445–465. https://doi.org/10.1002/(SICI)1097-0266(199905)20:53.0.CO;2-V

Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology*, *88*(4), 587–604. https://doi.org/10.1037/0021-9010.88.4.587

Li, H., & Zhang, Y. (2007). The role of managers' political networking and functional experience in new venture performance: Evidence from China's transition economy. *Strategic Management Journal*, *28*(8), 791–804. https://doi.org/10.1002/smj.605

Li, P.-Y. (2017). The impact of the top management teams' knowledge and experience on strategic decisions and performance. *Journal of Management & Organization*, *23*(4), 504–523. https://doi.org/10.1017/jmo.2016.24

Liu, Y., Dong, J., Ying, Y., & Jiao, H. (2021). Status and digital innovation: A middle-status conformity perspective. *Technological Forecasting and Social Change*, *168*, no.120781. https://doi.org/10.1016/j.techfore.2021.120781

Milliken, F. J., & Martins, L. L. (1996). Searching for Common Threads: Understanding the Multiple Effects of Diversity in Organizational Groups. *Academy of Management Review*, *21*(2), 402–433. https://doi.org/10.5465/AMR.1996.9605060217

Narayan, S., Sidhu, J. S., & Volberda, H. W. (2021). From Attention to Action: The Influence of Cognitive and Ideological Diversity in Top Management Teams on Business Model Innovation. *Journal of Management Studies*, *58*(8), 2082–2110. https://doi.org/10.1111/joms.12668

Neely, B. H., Lovelace, J. B., Cowen, A. P., & Hiller, N. J. (2020). Metacritiques of Upper Echelons Theory: Verdicts and Recommendations for Future Research. *Journal of Management*, *46*(6), 1029–1062. https://doi.org/10.1177/0149206320908640

Norburn, D., & Birley, S. (1988). The top management team and corporate performance. *Strategic Management Journal*, *9*(3), 225–237. https://doi.org/10.1002/smj.4250090303

Pavlou, P. A., & El Sawy, O. A. (2011). Understanding the Elusive Black Box of Dynamic Capabilities. *Decision Sciences*, *42*(1), 239–273. https://doi.org/10.1111/j.1540-5915.2010.00287.x

Peck, J., & Zhang, J. (2013). A variety of capitalism … with Chinese characteristics? *Journal of Economic Geography*, *13*(3), 357–396. https://doi.org/10.1093/jeg/lbs058

Pezeshkan, A., Fainshmidt, S., Nair, A., Lance Frazier, M., & Markowski, E. (2016). An empirical assessment of the dynamic capabilities–performance relationship. *Journal of Business Research*, *69*(8), 2950–2956. https://doi.org/10.1016/j.jbusres.2015.10.152

Qian, C., Cao, Q., & Takeuchi, R. (2012). Top management team functional diversity and organizational innovation in China: The moderating effects of environment. *Strategic Management Journal*, *34*(1), 110–120. https://doi.org/10.1002/smj.1993

Quintana-García, C., & Benavides-Velasco, C. A. (2008). Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy*, *37*(3), 492–507. https://doi.org/10.1016/j.respol.2007.12.002

Redoli, J., Mompó, R., García-Díez, J., & López-Coronado, M. (2008). A model for the assessment and development of Internet-based information and communication services in small and medium enterprises. *Technovation*, *28*(7), 424–435. https://doi.org/10.1016/j.technovation.2008.02.008

Roberson, Q., Holmes, O., & Perry, J. L. (2017). Transforming Research on Diversity and Firm Performance: A Dynamic Capabilities Perspective. *Academy of Management Annals*, *11*(1), 189–216. https://doi.org/10.5465/annals.2014.0019

Schneider, B., Goldstiein, H. W., & Smith, D. B. (2010). The ASA framework: An update. *Personnel Psychology*, *48*(4), 747–773. https://doi.org/10.1111/j.1744-6570.1995.tb01780.x

Short, J. C., Ketchen, D. J., Shook, C. L., & Ireland, R. D. (2010). The Concept of "Opportunity" in Entrepreneurship Research: Past Accomplishments and Future Challenges. *Journal of Management*, *36*(1), 40–65. https://doi.org/10.1177/0149206309342746

Simons, T., Pelled, L. H., & Smith, K. A. (1999). Making Use of Difference: Diversity, Debate, and Decision Comprehensiveness in Top Management Teams. *Academy of Management Journal*, *42*(6), 662–673. https://doi.org/10.5465/256987

Sun, F., Hong, J., Ma, X., & Wang, C. (2017). Subnational institutions and open innovation: Evidence from China. *Management Decision*, *55*(9), 1942–1955. https://doi.org/10.1108/MD-11-2016-0781

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*,

285–305. https://doi.org/10.1016/0048-7333(86)90027-2

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G. P., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, *18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:73.0.CO;2-Z

Teece, D., Peteraf, M., & Leih, S. (2016). Dynamic Capabilities and Organizational Agility: Risk, Uncertainty, and Strategy in the Innovation Economy. *California Management Review*, *58*(4), 13–35. https://doi.org/10.1525/cmr.2016.58.4.13

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., & S'Jegers, R. (2006). Entrepreneurial Team Development in Academic Spinouts: An Examination of Team Heterogeneity. *Entrepreneurship Theory & Practice*, *30*(2), 249–271. https://doi.org/10.1111/j.1540-6520.2006.00120.x

Waller, M. J., Huber, G. P., & Glick, W. H. (1995). Functional Background as A Determinant of Executives' Selective Perception. *Academy of Management Journal*, *38*(4), 943–974. https://doi.org/10.5465/256616

Wang, C. L., & Ahmed, P. K. (2007). Dynamic Capabilities: A Review and Research Agenda. *International Journal of Management Reviews*, *9*(1), 31–51. https://doi.org/10.1111/j.1468-2370.2007.00201.x

Wang, X., Fan, G., & Ma, G. (2017). *2017 Report of China's provincial business environment index*. Social Sciences Academic Press.

Wang, Y., Sutherland, D., Ning, L., & Pan, X. (2015). The evolving nature of China's regional innovation systems: Insights from an exploration-exploitation approach. *Technological Forecasting and Social Change*, *100*, 140–152. https://doi.org/10.1016/j.techfore.2015.07.010

Wen, J., Qualls, W. J., & Zeng, D. (2021). To explore or exploit: The influence of inter-firm R&D network diversity and structural holes on innovation outcomes. *Technovation*, *100*, no.102178. https://doi.org/10.1016/j.technovation.2020.102178

West Jr., C. T., & Schwenk, C. R. (1996). Top management team strategic consensus, demographic homogeneity and firm performance: A report of resounding nonfindings. *Strategic Management Journal*, *17*(7), 571–576. https://doi.org/10.1002/(SICI)1097-0266(199607)17:7<571::AID-SMJ817>3.0.CO;2-C

White, J. V., & Borgholthaus, C. J. (2022). Who's in charge here? A bibliometric analysis of upper echelons research. *Journal of Business Research*, *139*, 1012–1025. https://doi.org/10.1016/j.jbusres.2021.10.028

Wilden, R., & Gudergan, S. P. (2015). The impact of dynamic capabilities on operational marketing and technological capabilities: Investigating the role of environmental turbulence. *Journal of the Academy of Marketing Science*, *43*(2), 181–199. https://doi.org/10.1007/s11747-014-0380-y

Wilhelm, H., Schlömer, M., & Maurer, I. (2015). How Dynamic Capabilities Affect the Effectiveness and Efficiency of Operating Routines under High and Low Levels of Environmental Dynamism. *British Journal of Management*, *26*(2), 327–345. https://doi.org/10.1111/1467-8551.12085

Williams, K. Y., & O'Reilly, C. A. I. (1998). Demography and Diversity in Organizations: A Review of 40 Years of Research. *Research in Organizational Behavior*, *20*(3), 77–140. https://doi.org/10.1177/030639689803900313

Yam, R. C. M., Guan, J. C., Pun, K. F., & Tang, E. P. Y. (2004). An audit of technological innovation capabilities in chinese firms: Some empirical findings in Beijing, China. *Research Policy*, *33*(8), 1123–1140. https://doi.org/10.1016/j.respol.2004.05.004

Yi, J., Hong, J., Hsu, W. chung, & Wang, C. (2020). Reprint of "The role of state ownership and institutions in the innovation performance of emerging market enterprises: Evidence from China." *Technovation*, *94–95*, no.102095. https://doi.org/10.1016/j.technovation.2019.102095

Yuan, C., Li, Y., Vlas, C. O., & Peng, M. W. (2018). Dynamic capabilities, subnational environment, and university technology transfer. *Strategic Organization*, *16*(1), 35–60. https://doi.org/10.1177/1476127016667969

Yuan, X., Guo, Z., & Fang, E. (Er). (2014). An examination of how and when the top management team matters for firm innovativeness: The effects of TMT functional backgrounds. *Innovation: Management, Policy & Practice*, *16*(3), 323–342. https://doi.org/10.1080/14479338.2014.11081991

Zahra, S. A., Petricevic, O., & Luo, Y. (2022). Toward an action-based view of dynamic capabilities for international business. *Journal of International Business Studies*, *53*(4), 583–600. https://doi.org/10.1057/s41267-021-00487-2

Zhang, A., Huang, G. Q., & Liu, X. (2012). Impacts of business environment changes on global manufacturing in the Chinese Greater Pearl River Delta: A supply chain perspective. *Applied Economics*, *44*(34), 4505–4514. https://doi.org/10.1080/00036846.2011.591737

Zhang, P. (2007). Top management team heterogeneity and firm performance: An empirical research on Chinese listed companies. *Frontiers of Business Research in China*, *1*(1), 123–134. https://doi.org/10.1007/s11782-007-0008-x

Zhang, Y., & Li, H. (2010). Innovation Search of New Ventures in a Technology Cluster: The Role of Ties with Service Intermediaries. *Strategic Management Journal*, *31*(1), 88–109. https://doi.org/10.1002/smj.806

Zhou, G., Li, Y., & Zhou, J. (2018). SEMs, technology management and innovation economy development. *Management World*, *11*, 188–189. https://doi.org/10.3969/j.issn.1002-5502.2018.11.023

Table 1

Descriptive statistics and correlations.

	M	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1. FP	0.08	0.06	0.001	0.464	–												
2. TMTFBH	0.50	0.14	0.165	0.844	0.149**	–											
3. Sensing	0.16	0.03	0.104	0.223	0.151**	0.076	–										

4. Integrating	0.51	0.24	0.117	1.436	0.256**	0.179**	0.023	–										
5. Innovating	0.12	0.09	0.007	0.482	0.112	0.188**	0.084	-0.191**	–									
6. BE	3.71	0.11	3.44	3.92	0.187**	-0.015	-0.055	0.021	-0.019	–								
7. TMT age	46.12	3.31	35.56	55.14	-0.240**	-0.028	0.010	-0.095	-0.070	-0.086	–							
8. TMT tenure	4.10	1.78	0.083	11.52	-0.013	0.057	0.233**	-0.042	0.182**	0.077	0.134*	–						
9. TMT education	3.39	0.37	2.167	4.444	-0.076	0.040	-0.180**	0.046	-0.006	0.003	0.150**	-0.008	–					
10. TMT size	9.31	2.95	4.00	20.00	-0.026	0.042	-0.127*	0.078	0.104	0.020	0.126*	-0.146*	-0.019	–				
11. Firm size	9.35	0.34	8.25	10.43	0.079	0.061	-0.152**	-0.042	-0.091	0.165**	0.039	-0.051	0.200**	0.215*	–			
12. Firm age	14.51	4.22	5.00	28.00	-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	0.36	0.20	0.013	0.931	0.091	0.118*	-0.086	0.034	0.395**	0.056	0.054	0.159*	0.168*	0.082	0.063	-0.019	–	
14. R&D	0.13	0.20	0.00	0.944	-0.115*	0.049	-0.133*	-0.088	0.204**	-0.101	0.060	0.090	0.207**	0.042	0.076	0.023	0.191**	

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	-0.127*	-0.070	-0.181**	-0.165**	-0.126*	-0.137*
TMT tenure	0.233***	-0.039	0.149**	0.011	0.006	-0.034	-0.056
TMT education	-0.132*	0.073	-0.044	-0.031	-0.027	-0.023	-0.027
TMT size	-0.064	0.101	0.117*	-0.029	-0.037	-0.068	-0.066
Firm size	-0.099	-0.088	-0.119*	0.106	0.100	0.151*	0.115
Firm age	0.027	0.061	-0.151**	-0.122*	-0.145*	-0.148*	-0.132*
Human capital	-0.073	0.016	0.336***	0.142*	0.128*	0.096	0.117
R&D	-0.108	-0.096	0.130*	0.122*	-0.125*	-0.099	-0.093
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	0.163**	0.155**		0.154**	0.080	0.089
Sensing						0.141*	0.154**
Integrating						0.263***	0.263***
Innovating						0.113*	0.089
BE							0.185**
Sensing*BE							0.117*
Integrating*BE							0.158**
Innovating*BE							0.167**
Adjusted R^2	0.094	0.045	0.242	0.089	0.110	0.186	0.247
F	3.412***	2.097*	8.434***	3.473***	3.862**	5.315***	5.947***

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

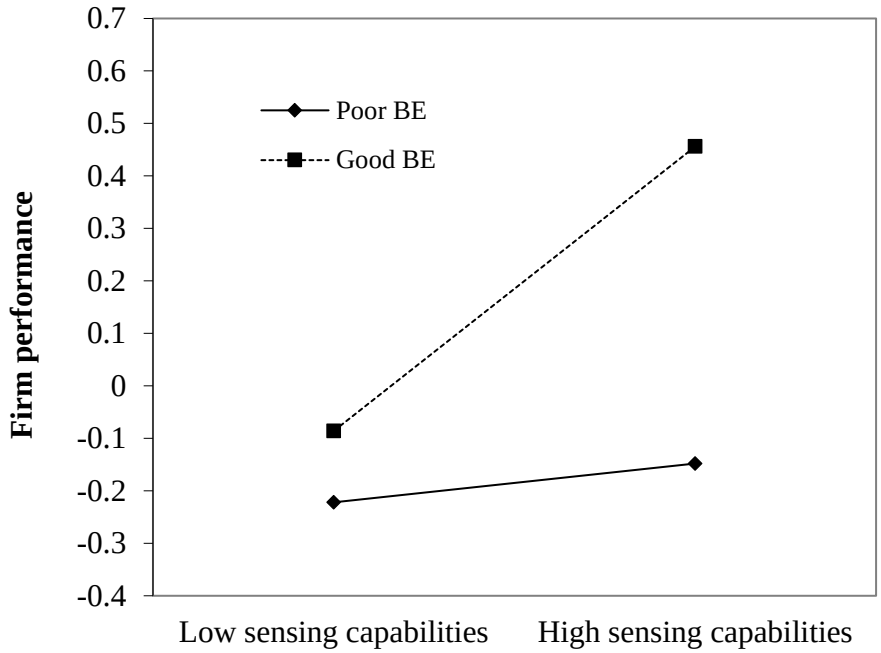

Fig. 1. The moderating role of business environment in the relationship between sensing capabilities and firm performance.

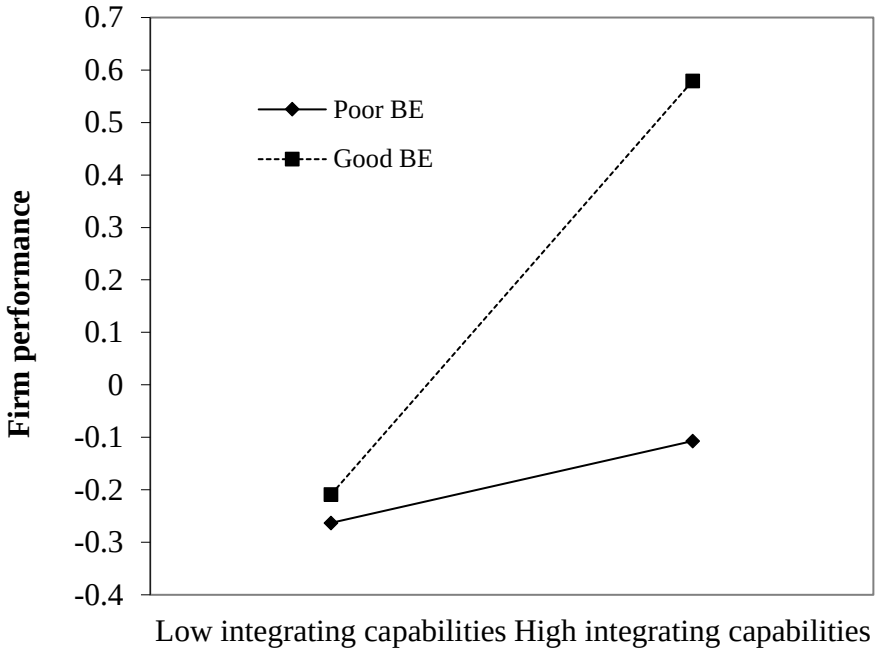

Fig. 2. The moderating role of business environment in the relationship between integrating capabilities and firm performance.

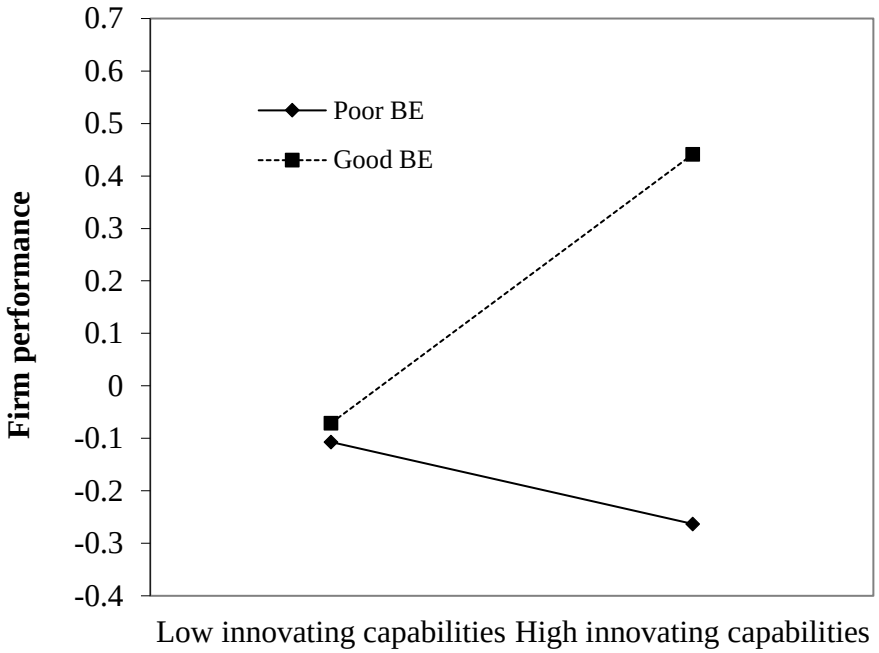

Fig. 3. The moderating role of business environment in the relationship between innovating capabilities and firm performance.