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Research paper

Linking business model design and operational performance: The mediating role of supply chain integration

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ABSTRACT

Despite the increasing interest in the role of business model design (BMD) in improving performance, its influence on operational performance remains unexplored, as do the underlying mechanisms of such effects. Drawing on dynamic capability theory, we propose that supply chain integration (SCI), including external integration and internal integration, mediates the relationship between BMD and operational performance. Matched survey data and objective performance data were collected from 131 Chinese manufacturing firms in three waves to test our research model. The key results are that external integration fully mediates the effect of novelty-centered BMD on operational performance, and efficiency-centered BMD directly improves operational performance. Theoretical and practical insights on how BMD and SCI can be leveraged to support operational performance are discussed.

1. Introduction

Business model design (BMD), which refers to how a firm transacts with various stakeholders to create and capture value (Amit & Zott, 2001; Teece, 2010), has been regarded as a critical dynamic capability (Amit & Zott, 2016) for superior firm performance (Foss & Saebi, 2017; Rai & Tang, 2014; Sohl, Vroom, & McCann, 2020). Various researchers have demonstrated the significant connections between BMD and strategic management (Guo, Wang, Su, & Wang, 2020; Morris, Schindehutte, & Allen, 2005; Teece, 2010), technology and innovation management (Calia, Guerrini, & Mourac, 2007; Chesbrough, 2007; Mcdonald & Eisenhardt, 2020), and marketing (Coombes & Nicholson, 2013; Spieth, Schneider, Clauß, & Eichenberg, 2019; Wieland, Hartmann, & Vargo, 2017). Specifically, some industrial marketing scholars have paid more attention to this issue (Coombes & Nicholson, 2013; Mason & Spring, 2011; Storbacka, 2011). For example, Coombes and Nicholson (2013) suggested that there is a significant synergy between BMD and marketing in terms of value creation, delivery and capture, thereby "networked and open business models are an emerging theme within the industrial marketing literature" (p. 658). Recently, researchers have frequently underlined BMD as a means to deliver and profit from the customer value it creates by effectively satisfying customer needs (Bellos, Ferguson, & Toktay, 2017; Cachon, 2018; Liu, Feng, Lin, Wu, & Guo, 2020). Trkman, Budler, and Groznik (2015), for example, proposed that BMD is vital for a supply chain to ensure operational performance, as "the business models used by various tiers in supply chains are critical for delivering value to end-users" (p. 587). However, even though BMD can be a critical factor for achieving operational performance, its impact on operational performance lacks empirical support, and the underlying influence mechanism also remains unclear.

Scholars have widely categorized BMD into novelty-centered BMD (NBMD) and efficiency-centered BMD (EBMD) by its design theme (Zott & Amit, 2008). NBMD refers to designing new ways to transact with stakeholders to create value, while EBMD refers to designing more efficient ways to transact with stakeholders to create value (Zott & Amit, 2010). Although the literature proposes that NBMD and EBMD allow firms to achieve superior performance (Amit & Zott, 2001), the empirical findings on the effects of NBMD and EBMD remain inconclusive. For example, Zott and Amit (2007) suggest that higher levels of EBMD do not increase a firm's stock market value, or even overall firm performance (Pati, Nandakumar, Ghobadian, Ireland, & O'Regan, 2018). Other scholars indicate that the link between BMD and performance may not be universal but rather could be context-specific. For example, some scholars propose that the effect of BMD depends on the firm's capabilities (Foss & Saebi, 2017; Teece, 2018). As the Gartner report indicates, manufacturing firms that use digital technologies to support their business models can unlock new ways of driving business growth

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(Gartner Group, 2014). Thus, it is of great significance and interest to differentiate the influences of NBMD and EBMD on performance.

To address these research gaps, we draw on dynamic capability theory to examine how NBMD and EBMD affect operational performance, as BMD has been labeled a dynamic capability by Amit and Zott (2016). According to dynamic capability theory, the relationship between a firm's dynamic capabilities and firm performance should be indirectly linked through its operational capabilities (Helfat & Peteraf, 2003; Kortmann, Gelhard, Zimmermann, & Piller, 2014). Specifically, dynamic (also called higher-level) capabilities refer to a firm's abilities to build, integrate, and reconfigure its operational (also called zero-level) capabilities (Mishra, Devaraj, & Vaidyanathan, 2013; Teece, Pisano, & Shuen, 1997), while operational capabilities refer to the development, production, and delivery of products and can directly affect performance (Kortmann et al., 2014; Winter, 2003). This indicates that to understand the influencing mechanism of BMD on operational performance, it is necessary to explore the potential mediators related to operational capabilities.

Recently, supply chain integration (SCI) has been widely proposed as a fundamental operational capability related to operational performance (Brusset, 2016; Liu, Ke, Wei, & Hua, 2013). This integration normally involves both external integration, which refers to a firm's operational capability of collaborating with its suppliers and customers (Lai, Wong, & Cheng, 2010; Swink, Narasimhan, & Wang, 2007), and internal integration, which refers to the firm's operational capability of collaboration by all intra-organizational functions (Wong, Boon-Itt, & Wong, 2011). Recently, scholars have realized that this integration may be affected by BMD. Ehret, Kashyap, and Wirtz (2013), for example, indicated that a firm's BMD guides its integration with supply chain partners. Trkman et al. (2015) further proposed that the BMD within a supply chain enables companies to enhance the cross-organizational alignment of various activities and processes, which means BMD can be vital for successful SCI. Despite this, no research has empirically explored how SCI mediates the link between BMD and operational performance.

In the current study, we distinguish the mediating effects of external and internal integration in the link between BMD and operational performance, based on scholarly differentiation between the two types of integration mechanisms for achieving operational performance (Huo, Ye, Zhao, & Shou, 2016; Wong et al., 2011). To test our research model, we collected two waves of matched survey data from 524 top managers (e.g., CEOs and marketing managers) in 131 Chinese manufacturing firms, combining that with their objective performance data collected in a third wave.

This paper makes three main contributions. First, we extend the business model literature by linking BMD and operational performance and differentiating the effects of NBMD and EBMD on operational performance. Second, we theorize two underlying mechanisms (external integration and internal integration) to uncover how BMD affects operational performance. We empirically test and confirm the different influencing mechanisms of NBMD and EBMD on operational performance. The results demonstrate that the link between NBMD and operational performance is fully mediated by external integration, while EBMD directly improves operational performance. Third, we also contribute to the dynamic capability theory that highlights the indirect link between dynamic capabilities and performance through operational capabilities (e.g., Helfat & Peteraf, 2003; Winter, 2003). Our findings unveil important practical insights and approaches for firms endeavoring to achieve superior operational performance through BMD and SCI.

2. Theoretical framework

2.1. Dynamic capability theory

Dynamic capability theory posits that managers need to build their dynamic capabilities in order to gain sustained competitive advantage (Teece, 2007). This theory originates from resource-based theory (RBT), which proposes that a firm's competitive advantage derives from its valuable, rare, inimitable, and nonsubstitutable resources (Chadwick, Super, & Kwon, 2015). However, RBT failed to pursue the questions of how firms develop or acquire new competences and adapt when the environment changes. Dynamic capability theory deals primarily with such questions by arguing that dynamic capabilities enable the firm to "adapt, integrate, and reconfigure internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment" (Teece et al., 1997, p. 515); thus, having such capabilities is the key to achieve and sustain competitive advantage (Winter, 2003). Further, Helfat and Peteraf (2003, p. 999) underlined that "dynamic capabilities do not directly affect output for the firm in which they reside, but indirectly contribute to the output of the firm through an impact on operational capabilities". In other words, operational capabilities mediate the association between dynamic capabilities and firm performance (Kortmann et al., 2014).

Dynamic capability theory is particularly useful for this study. Specifically, previous researchers underlined the dynamic nature of BMD (Ferreira, Proença, Spencer, & Cova, 2013; Willemstein, van der Valk, & Meeus, 2007), where the term "dynamic" represents the firm's capacity to adapt their BMDs in order to achieve congruence with changing environments (Foss & Saebi, 2017). In other words, BMD supports the reconfiguration of resources and processes (Morris et al., 2005) and thus represents the capability of a firm to deal with changing environments (Foss & Saebi, 2017). Hence, Amit and Zott (2016) classify BMD as one type of dynamic capability, which validates applying the insights from dynamic capabilities theory to the study of BMD. According to this theory, we propose that the degree to which a firm translates its BMD into heightened operational performance is mediated by its operational capabilities, such as SCI (Brusset, 2016; Liu et al., 2013).

2.2. BMD and operational performance

BMD elucidates how a firm transacts with various stakeholders and how it creates value for all stakeholders (Amit & Zott, 2001; Teece, 2010). It is often categorized into NBMD and EBMD based on different value creation foundations (Zott & Amit, 2008). Specifically, NBMD refers to designing new ways to transact with stakeholders to create value (Zott & Amit, 2007). These new ways comprise, for example, using novel information technologies and novel platforms, such as the integration of offline and online channels to transact with customers and suppliers (Zott & Amit, 2008). By contrast, EBMD refers to designing more efficient ways to transact with stakeholders to create value (Zott & Amit, 2010). These approaches include streamlining transactions, coordinating activities, and reducing transaction risks (Rai & Tang, 2014). Despite NBMD and EBMD could coexist in any given business model, their design domains are different: NBMD entails activities associated with creating a new market or innovating transactions in existing markets, while EBMD includes activities associated with reducing transaction costs (Zott & Amit, 2008).

Previous studies indicate that BMD can profoundly impact various performance outcomes, including technological innovation (Doganova & Eyquem-Renault, 2009; Hu, 2014), financial performance (Loon & Chik, 2019; Wei, Song, & Wang, 2017; Zott & Amit, 2007), and market performance (Kim & Min, 2015; Visnjic, Wiengarten, & Neely, 2016). Zott and Amit (2007), for example, suggested that BMD can improve financial performance since the focal firm's BMD creates value while not decreasing its bargaining power relative to other BMD stakeholders. Recently, research has frequently underlined BMD as a means to deliver and profit from the customer value it creates by effectively satisfying customer needs (Bellos et al., 2017; Cachon, 2018). In this vein, BMD could significantly influence operational performance. Nevertheless, the influence of BMD on operational performance lacks empirical support, and its influence mechanism also remains unclear.

Despite researchers suggest that both NBMD and EBMD play vital roles in achieving better firm performance (Brettel, Strese, & Flatten, 2012; Pati et al., 2018), their influence pathways are different. For example, Zott and Amit (2007) stated that NBMD enables better firm performance through designing new ways to transact with stakeholders to create entrepreneurial rent (Zott & Amit, 2007). In addition, NBMD increases the switching costs of other stakeholders because they may have no available alternative for conducting transactions with the focal firm (Pati et al., 2018). This also gives rise to entrepreneurial rent and benefits firm performance. Compared to NBMD, EBMD enables better firm performance by improving the transaction efficiency for all stakeholders (Wei et al., 2017). Moreover, EBMD maintains the firm's bargaining power with other stakeholders to appropriate the generated value because of the increased pool of potential stakeholders and better information flow among stakeholders (Zott & Amit, 2007), thereby ensuring firm performance. Due to the different influence pathways of NBMD and EBMD on performance, we distinguish their effects on operational performance in this study.

Dynamic capability theory provides an opportunity to uncover the influences of NBMD and EBMD on operational performance. Following Helfat and Peteraf (2003), we underline that the relationship between a firm's BMD and operational performance should be indirectly linked through its operational capabilities. In other words, to achieve superior operational performance, the BMD should be aligned with operational capabilities rather than the independent effects of the BMD. Therefore, we propose SCI, which has been widely acknowledged as a key operational capability in the literature (Brusset, 2016; Liu et al., 2013), as a link for uncovering details of the relationship between BMD and operational performance.

2.3. BMD, SCI, and operational performance

SCI refers to a firm's operational capabilities to collaboratively manage inter-organization processes with customers and suppliers, and intra-organization processes among internal functions (Flynn, Huo, & Zhao, 2010; Liu et al., 2013). This operational level capability is guided by high-order dynamic capabilities (Teece, 2018), such as the BMD of a firm. For example, Ehret et al. (2013) argued that a firm's BMD is a key factor in the development of SCI. By fostering information sharing and collaboration with customers and suppliers and among various departments within the company, BMD nurtures the development of SCI, including external integration with customers and suppliers and internal integration among departments. These integrations, in turn, enhance the firm's operational performance (Huo et al., 2016; Swink et al., 2007).

Further, prior research has underlined the importance of differentiating the external integration and internal integration mechanisms for achieving operational performance (Huo, Qi, Wang, & Zhao, 2014; Srinivasan & Swink, 2015). External integration refers to a firm's operational capability to collaborate with its customers and suppliers (Lai et al., 2010; Swink et al., 2007). In contrast, internal integration refers to a firm's operational capability to have all of its intra-organizational functions collaborate with each other (Wong et al., 2011). Since firms perform their business activities within and across organizational boundaries, there is a need to distinguish external from internal integration mechanisms in the link between BMD and operational performance. Fig. 1 presents our conceptual model.

2.3.1. BMD, external integration, and operational performance

External integration reflects the extent of collaboration between a firm and its customers and suppliers (Lai et al., 2010). It is a critical operational capability (Liu et al., 2013) that helps firms manage inter-organizational business processes (Chen, Liu, Wei, & Gu, 2018). Based on dynamic capability theory, this operational capability is influenced by a firm's dynamic capabilities, such as BMD. When firms design their business models, they will integrate and reconfigure resources and processes in their collaboration with customers and suppliers (Trkman et al., 2015), thereby promoting the firms' achievement of external integration. In particular, when designing a novel business model, the firm will deploy resources to establish new transaction methods between firms and customers and suppliers (Zott & Amit, 2007). For example, firms may use novel platforms, such as an integration of their online and offline channels, to transact with their customers and suppliers (Zott & Amit, 2008). By enriching the communication and information sharing between firms and customers and suppliers, NBMD enables firms to build collaborations more easily with customers and suppliers, thereby improving external integration.

EBMD also enables the achievement of external integration. When designing an efficient business model, the firm will deploy resources to offer high transaction efficiency for all transaction participants. For example, by using internet-based technologies such as electronic data interchange (EDI), manufacturing firms are increasingly facilitating connections and collaborations with customers and suppliers to achieve high transaction efficiency (Devaraj, Krajewski, & Wei, 2007). In this vein, EBMD enables firms to improve the level of integration with customers and suppliers. Moreover, the improved transaction efficiency for all stakeholders, a factor emphasized by EBMD, allows the customers and suppliers to benefit more from participating in transaction activities. Hence, firms can more easily form collaborations with customers and suppliers, thereby improving external integration.

Subsequently, external integration relates to higher operational performance. By building the external routines of collecting both demand and supply information, external integration allows firms to effectively coordinate supply and demand to optimize their production plans, thereby improving the production flexibility and delivery performance of the firm (Wong et al., 2011). Moreover, external integration helps firms resolve conflicting objectives with customers and suppliers and further promotes joint efforts in reducing cost and improving product quality (Chen et al., 2018). Finally, the positive link between external integration and operational performance is supported by various studies (Srinivasan & Swink, 2015; Wong et al., 2011). Hence, we hypothesize that external integration benefits from BMD and, subsequently, is related to operational performance.

H1. : NBMD (H1a) and EBMD (H1b) relate positively to external

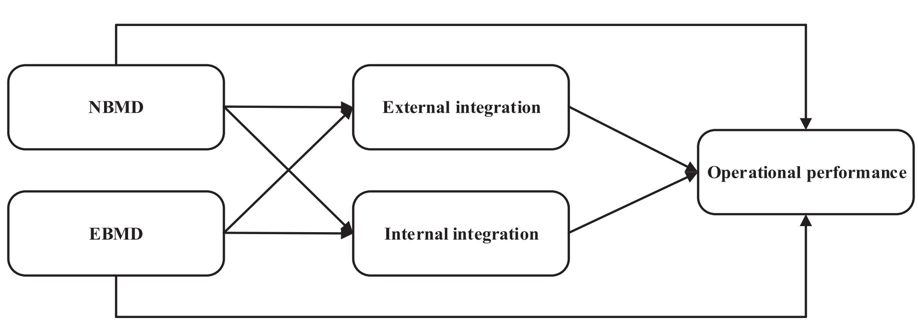

Fig. 1. Conceptual model.

integration. External integration, in turn, relates positively to operational performance (H1c).

2.3.2. BMD, internal integration, and operational performance

Internal integration reflects the extent of collaboration among intra-organizational functions in a firm (Wong et al., 2011). It is also an important operational capability that could break down functional barriers and promote information sharing across functions (Brusset, 2016). According to dynamic capability theory, the level of internal integration is influenced by a firm's dynamic capabilities, such as NBMD and EBMD. Specifically, when designing a novel business model, the firm will optimize the process of cross-functional coordination within itself to support and implement its business model innovations (Foss & Saebi, 2017; Trkman et al., 2015). Trkman et al. (2015), for example, proposed that firms focused on NBMD will structure their internal organizational practices into collaborative processes to provide quick responses to changing customer requirements. In this view, NBMD could facilitate collaboration among departments and contribute to establishing a cross-function integration system. Therefore, higher NBMD will enable companies to develop a higher level of internal integration.

Like NBMD, EBMD also facilitates internal integration. EBMD emphasizes the improvement of transaction efficiency both within and across firm boundaries (Brettel et al., 2012). Internally, this improvement can be derived from the lowered inventory and information asymmetry among departments (Zott & Amit, 2007). Therefore, firms that have adopted EBMD are more likely to exhibit these internally focused behaviors, such as optimizing the physical and information flows among various departments (Wong et al., 2011) to achieve transaction efficiency. This indicates that EBMD can support information sharing and collaboration among internal departments and help to form an integrated system across functions of the firm. Hence, we expect a positive effect of EBMD on internal integration.

Further, the role of internal integration on operational performance has been accentuated by many prior scholars (Huo et al., 2014; Srinivasan & Swink, 2015). These scholars propose that internal integration enables the collaboration of different departments to optimize their product and process designs; such efficiency plays an important role in reducing cost and improving quality (Wong et al., 2011). Moreover, internal integration can also break down functional barriers and enable knowledge sharing across functions; the firms thus can coordinate their production capacity to improve production flexibility, as well as delivery performance (Flynn et al., 2010). Indeed, various studies have empirically supported the significant positive link between internal integration and operational performance (e.g., Huo et al., 2014; Wong et al., 2011). Therefore, we argue that internal integration benefits from BMD and is subsequently correlated with operational performance.

H2. : NBMD (H2a) and EBMD (H2b) relate positively to internal integration. Internal integration, in turn, relates positively to operational performance (H2c).

3. The empirical study

3.1. Sample and data

We collected objective performance data and survey data from firms operating in China's Yangtze River Delta during the period 2016 to 2019. We obtained a list of 1200 firms from a local administrative institution responsible for evaluating economic growth and industry development. These firms were selected because they cover a broad spectrum of industrial activity, including the consumer product, petroleum and chemical, machinery, and electronics industries.

We collected data in three waves. In Wave 1 (from November 2016 to December 2016), we invited the entrepreneurs (i.e., CEO or president) from each firm to participate in an online survey. The informants were assured that all the answers were anonymous and would only be used for research purposes. We asked the entrepreneurs to respond to the questionnaire examining the BMD because they were in charge of the firm's strategic decisions and would be highly familiar with their BMDs. Follow-up phone calls were made three weeks after the invitations for participation were sent. The Wave 1 data collection yielded a sample of 314 firms. In Wave 2 (April 2018), we collected information on SCI from three top managers of each firm, following the same process as in Wave 1. We asked the top executive managers to fill in the questionnaire examining the internal integration, while marketing managers answered the questions regarding customer integration and operations managers answered the questions regarding supplier integration. After merging the responses from 1067 top executive managers, 753 marketing managers, and 802 operations managers, the Wave 2 data collection yielded a sample of 672 firms. We then matched these firms with Wave 1 according to firm names and got a sample of 153 firms. In Wave 3 (March 2019), we obtained objective performance data such as the firm's operating income, number of employees, and cost of goods sold from a collaborating government agency; this agency collects such business data every year. The final sample contains 131 firms after excluding missing data related to the variables in our study, representing a response rate of 10.92%.

Considering nonresponse bias, we applied a *t*-test to compare the differences between firms that completed the matched surveys and firms that did not. These groups showed no significant difference regarding mean scores of the constructs and the underlying items (the largest absolute value of t-value was 1.26) (Kortmann et al., 2014), indicating non-response bias was not serious. We present the sample demographic in Table 1.

3.2. Measures

We developed an English questionnaire by identifying scales for relevant variables and then adapting them to our research setting. Each item in the questionnaire was measured with a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). We then translated the English questionnaire into Chinese and back-translated twice using independent translators from different fields to ensure conceptual equivalence. Further, we invited three scholars with expertise in strategic and supply chain management research to assess our questionnaire design. Finally, we conducted a pilot test with 30 senior managers and revised the questionnaire based on the comments and feedback received. Table 2 presents the study's measures and their validity assessments.

3.2.1. Operational performance

We applied Stochastic Frontier Estimation (SFE) methodology to calculate operational performance because it captures a firm's operational efficiency comprehensively and produces efficient estimates

Table 1
Sample demographic ($N = 131$).

	N	Percentage (%)
Firm age		
≤10	71	54.20
11–15	43	32.82
≥ 16	17	12.98
Firm size		
≤100	50	38.17
101–200	40	30.53
201–300	18	13.74
≥ 301	23	17.56
Industry		
Consumer products	20	15.27
Petroleum and chemical	32	24.43
Machinery	39	29.77
Electronics	31	23.66
Mineral	9	6.87

Table 2
Survey items and confirmatory factor analysis results.

Construct and items	Standardized loading
Novelty-centered business model design (Cronbach's α = 0.85; CR = 0.90; AVE = 0.60)	
1. The BMD offers new combinations of products, services, and information.	0.72
2. The BMD offers new links between stakeholders (such as customers, suppliers, etc.).	0.76
3. The richness (i.e., quality and depth) of some of the links between participants is novel.	0.86
4. In our industry, we are a pioneer with our BMD.	0.82
5. The focal firm has continuously introduced innovations in its BMD.	0.68
6. There are other important aspects of the BMD that make it novel.	0.78
Efficiency-centered business model design (Cronbach's α = 0.86; CR = 0.90; AVE = 0.61)	
1. Transactions are simple from the user's point of view.	0.81
2. The BMD enables a low number of errors in the execution of transactions.	0.85
3. Costs for participants in the BMD are reduced.	0.58
4. The BMD enables participants to make informed decisions.	0.69
5. The BMD enables fast transactions.	0.84
6. The BMD, overall, offers high transaction efficiency.	0.87
Customer integration (Cronbach's α = 0.88; CR = 0.92; AVE = 0.70)	
1. Have a high level of information sharing with major customers about market information.	0.84
2. Share information to major customers through information technologies.	0.89
3. Have a high degree of joint planning and forecasting with major customers to anticipate demand visibility.	0.92
4. Our customers provide information to us in the procurement and production processes.	0.84
5. Our customers are involved in our product development processes.	0.68
Supplier integration (Cronbach's α = 0.92; CR = 0.93; AVE = 0.72)	
1. Share information to our major suppliers through information technologies.	0.81
2. Have a high degree of strategic partnership with suppliers.	0.86
3. Have a high degree of joint planning to obtain rapid response ordering process (inbound) with suppliers.	0.85
4. Our suppliers provide information to us in the production and procurement processes.	0.88
5. Our suppliers are involved in our product development processes.	0.84
Internal integration (Cronbach's α = 0.87; CR = 0.92; AVE = 0.74)	
1. Have a high level of responsiveness within our plant to meet other department's needs.	0.87
2. Have an integrated system across functional areas under plant control.	0.76
3. Within our plant, we emphasize on information flows among purchasing, inventory management, sales, and distribution departments.	0.89
4. Within our plant, we emphasize on physical flows among production, packing, warehousing, and transportation departments.	0.91
Firm innovativeness[a] (Cronbach's α = 0.86; CR = 0.90; AVE = 0.60)	
1. Our company frequently tries out new ideas.	0.81
2. Our company seeks out new ways to do things.	0.85
3. Our company is creative in its methods of operation.	0.83
4. Our company is often the first to market with new products and services.	0.69
5. Innovation in our company is perceived as too risky and is resisted.	0.74
6. Our new product introduction has increased over the last 5 years.	0.72
TMT integration[a] (Cronbach's α = 0.94; CR = 0.95; AVE = 0.68)	
1. When a team member is busy, other team members often volunteer to help her/him out to manage her/his workload.	0.82
2. The fact that the TMT members are flexible about switching responsibilities makes things easier for each them.	0.85
3. The TMT members are willing to help each other with complex jobs and meeting deadlines.	0.82
4. The ideas that our TMT members exchange are of high quality.	0.88
5. The solutions that our TMT members exchange are of high quality.	0.90
6. The dialogue among the TMT members produces a high level of creativity and innovativeness.	0.83
7. The TMT members usually let each other know when their actions affect another team member's work.	0.77
8. The TMT members have a clear understanding of the job problems and needs of other members on the team.	0.79
9. The TMT members usually discuss their expectations of each other.	0.76
Exploitative learning[a] (Cronbach's α = 0.93; CR = 0.94; AVE = 0.66)	
1. We are proficient in transforming technological knowledge into new products.	0.84
2. We regularly match new technologies with ideas for new products.	0.83
3. We quickly recognize the usefulness of new technological knowledge for existing knowledge.	0.82
4. Our employees are capable of sharing their expertise to develop new products.	0.85
5. We regular apply technologies in new products.	0.88
6. We constantly consider how to better exploit technologies.	0.82
7. We easily implement technologies in new products.	0.74
8. It is well known who can best exploit new technologies inside our firm.	0.72

[a] Variables used as instruments for the assumed endogenous variable.

despite random error terms (Li, Shang, & Slaughter, 2010). Following Lam, Yeung, and Cheng (2016), we first constructed a stochastic production function as follows:

$$ln(Operating\ Income)_i = \beta_0 + \beta_1\ ln(Number\ of\ Employees)_i + \beta_2\ ln(Cost\ of\ Goods\ Sold)_i + \varepsilon_i + \eta_i \quad (1)$$

where ε_i represents the stochastic random error term, and η_i is the technical inefficiency of firm i compared to the frontier firm in the sample. The "frontier" of a stochastic production function is formed by the best practice firms in the sample that can achieve the maximum potential output for a given level of inputs (Lam et al., 2016). The range of η_i is 0 to 1. Then the operational performance of firm i was calculated as follows:

$$Operational\ performance = 1 - \widehat{\eta_i} \quad (2)$$

We used Frontier 4.1 software to calculate the operational performance and matched it with the survey data by enterprise name.

3.2.2. BMD

The measurement items for NBMD and EBMD were adapted from Brettel et al. (2012) and Zott and Amit (2007). Although the first scales of NBMD and EBMD were focused on entrepreneurial firms (Zott & Amit, 2007), recent studies have extended the context to established firms and the manufacturing industry (Brettel et al., 2012; Chen, Liu, & Chen, 2020; Pati et al., 2018; Wei et al., 2017). Specifically, NBMD was assessed based on the novelty of their BMDs, which included six items regarding activities, such as continuously introducing innovations in their BMDs. We also used six items to assess EBMD relative to the transaction efficiency of their BMDs, such as enabling fast transactions and reducing transaction costs for all participants.

3.2.3. SCI

We measured SCI using scales from Wong et al. (2011). The scale of external integration evaluates customer and supplier integration. The five customer integration items reflect the extent of collaboration between firms and their customers. The five supplier integration items capture the joint collaboration between firms and their suppliers. Internal integration is evaluated by four items to find the extent to which intra-organizational functions work together to meet customer requirements.

3.2.4. Control variables

We controlled for the firm's age and size, environmental munificence, environmental dynamism, and industry, all of which might influence SCI and operational performance (Wong et al., 2011). Firm age was the operating years since a firm was established to 2016. Firm size was the logged total number of employees in 2016. To control for environmental munificence and environmental dynamism, we regressed the industry's annual sales over a 5-year period and measured environmental munificence by the coefficient and environmental dynamism by the standard error (Boyd, 1995). Finally, four dummy variables were used to control for the industry: consumer products, petroleum and chemical, machinery, and electronics, with the mineral industry as the baseline group.

4. Analysis and results

4.1. Reliability and validity

We used several approaches to examine the construct reliability and validity. First, as shown in Table 2, each scale has a value of Cronbach's α and composite reliability (CR) exceeding the threshold of 0.70 (Lance, Butts, & Michels, 2006), which indicates good reliability. Second, the confirmatory factor analysis (CFA) results indicate that the measurement model fits the data satisfactorily ($\chi^2/df = 440.92\ /\ 289 = 1.53$, CFI

Table 3
Descriptive statistics and correlations.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Operational performance	–																
2. NBMD	0.05	***0.77***															
3. EBMD	0.15	0.66	***0.78***														
4. Customer integration	0.19	0.07	−0.05	***0.84***													
5. Supplier integration	0.24	0.24	0.13	0.43	***0.85***												
6. Internal integration	0.12	0.12	0.01	0.36	0.32	***0.86***											
7. Firm age	−0.12	−0.18	−0.24	−0.08	−0.20	0.05	–										
8. Firm size	0.25	−0.13	−0.07	0.07	−0.01	0.13	0.29	–									
9. Consumer products	−0.01	0.02	0.08	−0.13	0.01	−0.02	−0.09	0.11	–								
10. Petroleum and chemical	0.13	0.04	0.06	0.07	−0.01	0.12	0.11	−0.11	−0.24	–							
11. Machinery	−0.21	−0.01	0.01	−0.10	−0.15	−0.14	0.02	0.00	−0.28	−0.37	–						
12. Electronics	−0.02	−0.03	−0.09	0.03	0.07	−0.00	0.04	0.01	−0.24	−0.32	−0.36	–					
13. Munificence	0.07	0.07	0.13	0.08	0.10	0.09	0.15	0.13	−0.08	0.17	−0.47	0.51	–				
14. Dynamism	−0.09	0.01	−0.03	0.10	0.04	0.02	0.02	−0.15	−0.02	0.34	−0.20	−0.14	−0.16	–			
15. Firm innovativeness[a]	0.11	0.70	0.63	0.09	0.22	0.16	−0.22	−0.12	0.08	−0.02	0.08	−0.08	−0.01	0.00	***0.77***		
16. TMT integration[a]	0.11	0.68	0.61	−0.01	0.10	0.09	−0.14	−0.05	0.07	0.03	0.08	−0.15	−0.01	−0.13	0.69	***0.82***	
17. Exploitative learning[a]	0.04	0.30	0.20	0.44	0.36	0.62	−0.09	−0.00	−0.10	0.07	−0.11	0.06	0.08	0.06	0.33	0.16	***0.81***
M	0.65	4.04	4.24	4.03	4.09	4.08	2.29	4.96	0.15	0.24	0.30	0.24	1.10	1.02	4.27	4.31	4.09
SD	0.19	0.55	0.44	0.45	0.50	0.49	0.53	0.83	0.36	0.43	0.46	0.43	0.07	0.01	0.49	0.48	0.48

Notes: The diagonal elements (i.e., italic values) are the square roots of AVEs.
Absolute values of the correlations above 0.18 indicate statistical significance at $p < 0.05$ (two-tailed tests).
[a] Variables used as instruments for the assumed endogenous variable.

= 0.95, IFI = 0.95, NNFI = 0.95, RMSEA = 0.06, SRMR = 0.06), indicating good convergent validity. Third, the results demonstrate good discriminant validity since all values of the average variances extracted (AVE) exceed the threshold of 0.50 (see Table 2), and their square roots are higher than the correlations with other constructs (Fornell & Larcker, 1981) (see Table 3).

4.2. Common method variance

To alleviate potential concerns about common method bias, we applied procedural remedies in the research design phase, and we conducted statistical analysis after data collection. Specifically, we collected measures for different variables from different sources (i.e., CEO, marketing managers, operations managers) at two time periods (Chang, Van Witteloostuijn, & Eden, 2010) and combined that data with the objective performance data. Further, we placed the conceptually adjacent constructs in varying sections to reduce the respondents' consistency motivation during self-reporting (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). After data collection, we evaluated the potential impacts of common method bias by conducting Harman's single-factor test (Lindell & Whitney, 2001). The first factor accounts for only 15.80% of the total variance, which indicates that common method bias is unlikely to be significant.

4.3. Hypothesis testing

To test our hypotheses, we applied the methodology described by Zhao & J. G. L., & Chen, Q., 2010, which has been applied to analyze mediation in a multitude of studies (Davidson, Nepomuceno, & Laroche, 2019; Luo, Wang, Raithel, & Zheng, 2014). Compared with Baron and Kenny's criteria, this methodology can establish mediation while not requiring the direct effect to be significant. Baron and Kenny's analysis includes three tests as follows:

$$M = i_1 + aX + e_1 \tag{3}$$

$$Y = i_2 + c'X + e_2 \tag{4}$$

$$Y = i_3 + cX + bM + e_3 \tag{5}$$

Zhao & J. G. L., & Chen, Q., 2010 methodology replaces the Baron-Kenny steps with only one test: a bootstrap test of the indirect effect (a × b). If the 95% confidence interval of bootstrap results for indirect effects excludes 0, the indirect effect is significant; thus, mediation can be established (Preacher & Hayes, 2004; Preacher & Hayes, 2008). This approach has proven to be rigorous and powerful in estimating models depicting mediating conditions (Zhao & J. G. L., & Chen, Q., 2010). In accordance with this, we perform the bootstrap test in SPSS using Preacher and Hayes (2008) that investigates multiple mediators to analyze our proposed model. The result of bootstrap testing is shown in Fig. 2. Table 4 then presents the bootstrap results when including control variables.

H1a and H1b predicted that NBMD and EBMD relate positively to external integration. Table 4's results for Model 1 and Model 2 show that NBMD exerts a significant positive effect on external integration ($\beta = 0.26$, $p = 0.02$), while EBMD has no significant influence on external integration ($\beta = -0.16$, $p = 0.17$). Therefore, H1a is supported, but H1b is not supported. Further, the results in Table 4 for Model 3 also show that external integration relates positively to operational performance

Table 4
Results of bootstrap test.

	External integration	Internal integration	Operational performance
	Model 1	Model 2	Model 3
Firm age	−0.18**	0.01	−0.02
Firm size	0.11	0.15	0.06***
Consumer products	−0.31**	−0.12	−0.05*
Petroleum and chemical	−0.29*	−0.02	0.00
Machinery	−0.34**	−0.22	−0.08***
Electronics	−0.28	−0.14	−0.03
Munificence	0.14	0.03	−0.03
Dynamism	0.10	−0.02	−0.04**
NBMD	0.26**	0.21*	−0.02
EBMD	−0.16	−0.12	0.05**
External integration			0.04**
Internal integration			−0.01
***R*-square**	0.15	0.08	0.27

Notes: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. All tests are two-tailed. $N = 131$.

Table 5
95% confidence interval of bootstrap results for indirect effects.

Impact path	LLCI	ULCI
NBMD→External integration→Operational performance	0.0007	0.0270
NBMD→Internal integration→Operational performance	−0.0108	0.0068
EBMD→External integration→Operational performance	−0.0201	0.0024
EBMD→Internal integration→Operational performance	−0.0051	0.0083

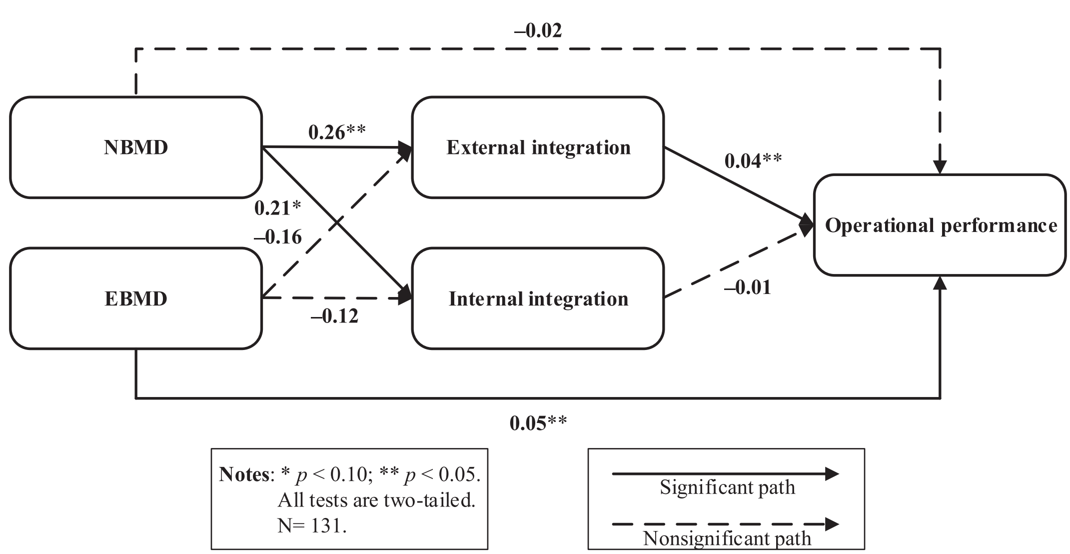

Fig. 2. Results of bootstrap test.

($\beta = 0.04$, $p = 0.02$), so H1c is supported.

H2a and H2b proposed that both NBMD and EBMD are positively related to internal integration. As the results in Table 4 for Models 1 and 2 show, NBMD exerts positive and significant effects on internal integration ($\beta = 0.21$, $p = 0.06$), while EBMD has no significant influence on internal integration ($\beta = -0.12$, $p = 0.30$). Thus, H2a is supported, but H2b is not supported. Moreover, Table 4's results for Model 3 shows that the influence of internal integration on operational performance is not significant ($\beta = -0.01$, $p = 0.73$), so H2c is not supported.

4.4. Mediation analysis

Based on the criteria for mediating effects introduced by Zhao & J. G. L., & Chen, Q., 2010, our results in Table 4 for Model 3 and in Table 5 indicate that the link between NBMD and operational performance is fully mediated by external integration. We also see that EBMD directly improves operational performance.

4.5. Endogeneity

To address the potential endogeneity bias between the independent variables (NBMD and EBMD) and mediating variables (external integration and internal integration), as well as mediating variables and dependent variable (operational performance), we first added eight control variables to alleviate the problem of missing variables. Second, we used multi-stage data to alleviate the reverse causality problem. Finally, we used two-stage least squares (2SLS) estimation procedure with instrumental variables (e.g., Liu, Wei, Ke, Wei, & Hua, 2016).

Before the 2SLS tests between independent variables (NBMD and EBMD) and mediating variables (external integration and internal integration) were conducted, we searched from the measured variables in the questionnaire and identified firm innovativeness as the instrumental variable of NBMD. This is valid because firm innovativeness is suggested to significantly relate to NBMD (Su, Zhang, & Ma, 2019) but not significantly relate to external integration and internal integration (Salonen & Jaakkola, 2015). Firm innovativeness refers to a firm's willingness and abilities to change (Calantone, Cavusgil, & Zhao, 2002). It is measured using scales from Calantone et al. (2002). Similarly, we identified top management team (TMT) integration as the instrumental variable of EBMD (Frankenberger & Sauer, 2019). TMT integration refers to the extent of member exchange and collaboration within the TMT (Carmeli & Schaubroeck, 2006). We measured this variable using scales from Carmeli and Schaubroeck (2006).

Then, in the first stage, NBMD and EBMD were regressed separately on their instrumental variables and control variables. Table 6's results for Model 1 show that the R^2 of the firm innovativeness and control variables to NBMD regression is 0.51, significantly higher than that of control variables to NBMD regression ($\Delta R^2 = 0.45$, ΔF-value $= 109.65$, $p = 0.00$), indicating firm innovativeness is a valid instrumental variable for NBMD in this study. Similarly, Table 6's results for Model 2 show that the R^2 of the TMT integration and control variables to EBMD regression is 0.45, significantly higher than that of control variables to EBMD regression ($\Delta R^2 = 0.31$, ΔF-value $= 67.76$, $p = 0.00$), indicating TMT integration is a valid instrumental variable for EBMD in this study.

Furthermore, we replaced the values of NBMD and EBMD with the predicted values in the second stage. Table 6's results for Model 3 and Model 4 show that the predicted value of NBMD has positive and significant effects on external integration ($\beta = 0.29$, $p = 0.02$) and internal integration ($\beta = 0.27$, $p = 0.03$), but the impacts of the predicted value of EBMD on external integration ($\beta = -0.14$, $p = 0.33$) and internal integration ($\beta = -0.09$, $p = 0.54$) are insignificant. These findings are consistent with our results. Finally, we adopted the Durbin-Wu-Hausman post-estimation for endogeneity after 2SLS tests (Liu et al., 2016). The results show that the impacts of the error term of NBMD ($\beta = 0.14$, $p = 0.15$) and EBMD ($\beta = -0.15$, $p = 0.11$) on external integration, as well as the impacts of the error term of NBMD ($\beta = 0.06$, $p = 0.53$) and EBMD ($\beta = -0.15$, $p = 0.13$) on internal integration are insignificant, indicating endogeneity issues are unlikely to affect our results significantly.

Further, to conduct the 2SLS testing between mediating variables (external integration and internal integration) and the dependent variable (operational performance), we first identified the firm age and NBMD as the instrumental variables of external integration because they were significantly related to external integration but not significantly related to operational performance (see Table 3). We also identified exploitative learning as the instrumental variable of internal integration because it is suggested to be significantly related to internal integration (Zhu, Krikke, & Caniels, 2018) but not to operational performance (Chung, Yang, & Huang, 2015). Exploitative learning refers to learning gained through the refinement and extension of existing routines (Lichtenthaler, 2009). It was measured using scales from Lichtenthaler (2009). Table 7's results for Model 1 show that the R^2 of the instrumental variables and control variables to external integration regression is 0.13, significantly higher than that of control variables to external integration regression ($\Delta R^2 = 0.06$, ΔF-value $= 4.10$, $p = 0.02$), indicating firm age and NBMD are valid instrumental variables for external

Table 6
2SLS model testing for endogeneity between BMD and SCI.

	NBMD	EBMD	External integration	Internal integration
	Model 1 (OLS)	Model 2 (OLS)	Model 3 (2SLS)	Model 4 (2SLS)
Firm age	−0.02	−0.19**	−0.18*	0.04
Firm size	−0.05	−0.01	0.13	0.17*
Consumer products	−0.09	0.09	−0.31**	−0.13
Petroleum and chemical	−0.07	0.05	−0.28	−0.02
Machinery	−0.11	0.14	−0.35**	−0.24
Electronics	−0.10	−0.03	−0.28	−0.14
Munificence	0.09	0.26***	0.13	0.00
Dynamism	−0.00	0.11	0.09	−0.02
Firm innovativeness[a]	0.70***			
TMT integration[a]		0.58***		
NBMD			0.29**	0.27**
EBMD			−0.14	−0.09
***R*-square**	0.51	0.45	0.15	0.10

Notes: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. All tests are two-tailed. N = 131.
[a] Variables used as instruments for the assumed endogenous variable.

Table 7
2SLS model testing for endogeneity between SCI and operational performance.

	External integration	Internal integration	Operational performance
	Model 1 (OLS)	Model 2 (OLS)	Model 3 (2SLS)
Firm age*	−0.16*	0.08	
Firm size	0.11	0.11	0.25***
Consumer products	−0.33**	0.01	−0.04
Petroleum and chemical	−0.30*	0.05	0.15
Machinery	−0.38**	−0.09	−0.22
Electronics	−0.28	−0.06	−0.05
Munificence	0.11	−0.01	−0.18
Dynamism	0.09	−0.05	−0.24**
NBMD[a]	0.17**		
Exploitative learning[a]		0.63***	
External integration			0.28**
Internal integration			−0.06
***R*-square**	0.13	0.43	0.21

Notes: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. All tests are two-tailed. N = 131.
[a] Variables used as instruments for the assumed endogenous variable.

integration in this study. Similarly, Table 7's results for Model 2 show that the R^2 of the exploitative learning and control variables to internal integration regression is 0.43, significantly higher than that of control variables to internal integration regression ($\Delta R^2 = 0.37$, ΔF-value = 79.04, $p = 0.00$), indicating exploitative learning is a valid instrumental variable for internal integration in this study.

As we present in Table 7 for Model 3, the predicted value of external integration has a positive and significant effect on operational performance ($\beta = 0.28$, $p = 0.03$), but the relationship between the predicted value of internal integration and operational performance ($\beta = -0.06$, $p = 0.52$) is insignificant, which is consistent with our results. Finally, the results of Durbin-Wu-Hausman test show that the impacts of the error term of NBMD ($\beta = 0.10$, $p = 0.45$) and EBMD ($\beta = 0.03$, $p = 0.17$) on operational performance are insignificant. Therefore, our results are robust, and endogeneity issues are unlikely to affect the results significantly.

5. Discussion

Despite the calls for research on the underlying mechanisms to investigate how BMD impacts performance (Foss & Saebi, 2017; Zott, Amit, & Massa, 2011), our knowledge of this question remains limited. We begin to fill this gap by incorporating dynamic capability theory to investigate how a firm's external integration and internal integration mediate BMD's effect on operational performance. The findings, based on data from 131 manufacturing firms in China, show that EBMD directly improves operational performance, while NBMD indirectly improves operational performance. These results confirm the need to distinguish the impact of different types of BMDs on performance, which was highlighted earlier by Zott and Amit (2008). They argued that "innovation and efficiency reflect fundamental alternatives for entrepreneurs to create value under uncertainty" (p. 183).

A possible explanation for these findings is that we centered on operational performance, representing a firm's efficiency in transforming various inputs into outputs. EBMD emphasizes optimizing existing transactions between firms and stakeholders, which can directly reduce costs and increase revenue, thereby improving operational performance. In contrast, NBMD requires firms to invest in new transaction methods between firms and stakeholders, which increases costs and operational risk, and makes the result riskier than results from EBMD (Yu, Zhang, & Liu, 2019). Therefore, NBMD requires support from supply chain partners, such as integration with customers and suppliers, to reduce the cost and operational risk, thereby ensuring optimal operational performance. Our findings confirm this view, namely, external integration fully mediates the link between NBMD and operational performance.

We also obtain an unexpected finding: internal integration does not improve operational performance. This result is consistent with various findings in prior studies that question the efficacy of internal integration in operational performance (e.g., Koufteros, Vonderembse, & Jayaram, 2005). A possible explanation is that the information firms collect from customers and suppliers (e.g., through external integration) determines whether the effect of internal integration on operational performance can be established (Zhao, Huo, Selen, & Yeung, 2011). Our further analysis results confirmed that internal integration was significantly related to external integration ($\beta = 0.38$, $p = 0.000$). This explanation may also partially explain why our findings do not support the indirect influence of NBMD on operational performance through internal integration.

5.1. Theoretical implications

This study makes three primary theoretical contributions. First, we contribute to the understanding of the BMD–performance relationship by linking BMD and operational performance and differentiating the effects of NBMD and EBMD on operational performance. Specifically, previous research on BMD–performance relationship has largely focused on conventional performance measures such as technological innovation (Doganova & Eyquem-Renault, 2009; Hu, 2014), financial performance (Kastalli & Van Looy, 2013; Loon & Chik, 2019;Wei et al., 2017 ; Zott & Amit, 2007), and market performance (Kim & Min, 2015; Visnjic et al., 2016), while ignoring more comprehensive measurement of a firm's overall operating efficiency. Comprehensive measures are preferable because operating efficiency could better measure a firm's relative performance compared to other firms in its industry (Lam et al., 2016). In this study, we adopt the SFE methodology to capture a firm's efficiency in transforming various inputs into outputs. In that regard, we extend the business model literature by investigating the effect of BMD on the firm's overall operating efficiency. Through differentiating the effects of NBMD and EBMD on operational performance, our empirical results indicate that their relationships can be direct or indirect, depending on the specific type of BMD. These findings also contribute to unpacking the relationship between BMD and performance.

Second, we contribute to the question of how BMD influences performance (Foss & Saebi, 2017; Zott et al., 2011). The impact of BMD on performance is a complex phenomenon (Foss & Saebi, 2017), so to unpack their relationship, it is necessary to study the intermediate factors that explain how BMD matters. Our review of the business model literature revealed only one study—Anwar (2018)—that explicitly addressed the intermediate factors. Anwar's article highlights competitive advantage as an intervening factor between BMD and financial performance, and we extend this stream of research by demonstrating two intermediate mechanisms with external integration and internal integration to link BMD and operational performance. Our empirical findings suggest that external integration closes the gap between NBMD and operational performance, while EBMD directly improves operational performance. The different influence pathways of NBMD and EBMD on operational performance help resolve the inconsistent findings of the BMD–performance relationship in prior research (Wei et al., 2017; Zott & Amit, 2007).

Third, our empirical results also contribute to the dynamic capability theory (e.g., Helfat & Peteraf, 2003; Winter, 2003). Specifically, our empirical findings reveal that an operational capability, i.e., external integration, plays as the intermediate factor between a dynamic capability, i.e., NBMD, and operational performance. This indirect effect and the difference between dynamic capabilities and operational capabilities were underlined earlier by Helfat and Peteraf (2003). They suggested that operational capabilities mediate the association between dynamic capabilities and firm performance.

5.2. Managerial implications

A firm's strategic managers, particularly CEOs, are often responsible for making strategic decisions (e.g., designing business models), and their decisions may determine the future development of the firm. This paper helps strategic managers gain a richer understanding of their choices on BMDs. Specifically, China's manufacturing industry has long been cost-oriented (Duanmu, Bu, & Pittman, 2018). This industrial environment allows many Chinese manufacturing firms to achieve competitive advantages by fostering transaction efficiency in their BMDs. However, with fast-changing markets and technological progress, manufacturing firms are urged to develop new BMDs to help them gain an advantage over their competition (Wei et al., 2017). Our research provides strategic managers with initial empirical evidence that EBMD enhances operational performance directly, and also that NBMD fosters operational performance through external integration. Therefore, we encourage strategic managers to use innovation in their BMDs, and our results underline the importance of collaboration with other managers. For example, strategic managers could empower supply chain managers to develop integration with customers and suppliers to support the implementation of NBMD, thereby decreasing risks in business model innovations and ensuring firm returns.

Further, a firm's supply chain managers are often responsible for the implementation of its strategic decisions. In this study, they are not only in charge of implementing the BMD of the enterprise, but also of enhancing operational performance. Our results suggest that to simultaneously support the implementation of NBMD and increase operational performance, supply chain managers need to invest in external integration with customers and suppliers. For example, they could consider collaboration with customers and suppliers in terms of information sharing and joint planning, which can nurture the external integration to link NBMD and operational performance.

5.3. Limitations and future research

Four limitations of this research suggest future work. First, our samples are limited to manufacturing firms, and their number is somewhat small. Future research that enlarges the sample size and compares differences between industries might provide a richer finding. Second, our results are limited to the context of China, which differs from most other countries in economic, cultural, and institutional mechanisms. Further research should be conducted in other countries to compare with our findings. Third, we emphasize the mediating effects of external integration and internal integration between BMD and operational performance. It may be fruitful to consider other mechanisms related to operational capabilities, such as innovative ambidexterity (Kortmann et al., 2014). Further research could also benefit from considering boundary conditions for these relationships. For example, future studies can assess how the effects of external integration and internal integration differ between entrepreneurial firms and mature firms. Finally, our research measured external integration based on its two dimensions of customer and supplier integration, as many prior research efforts have done. Future research may distinguish between these two types of external integration to gain more insightful understanding.

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