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Assessing the Impact of Business Model Innovation on Firm Performance: Insights from the China Growth Enterprise Market

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Abstract

This article explores the impact of business model innovation (BMI) on firm performance by analyzing 2,970 annual reports of firms in the China Growth Enterprise Market (GEM) from 2012 to 2017. The dependent variable bmi is constructed using crawler technology to reflect the business model innovation of the research sample. Four financial indicators, i.e. gross profit ratio total assets (GPA), earnings per share (EPS), return on total assets (ROA), and return on equity (ROE), are used to represent firm performance. The results suggest that BMI has a positive impact on a firm's performance in China, and the robustness test confirms the findings. This study provides empirical evidence of the impacts of BMI on firm performance in the China GEM and offers managerial implications for governments, firms, and entrepreneurs.

Keywords: business model, business model innovation, China GEM, firm performance, regression

1. Introduction

1.1 Background

BMI has gained an increasing amount of attention within management research and practice(Foss & Saebi, 2017; Spieth et al., 2014; Trischler & Li-Ying, 2022). Research focusing on BMI are abundant. Yet, there are relatively little empirical evidence connecting BMI to firm performance, especially in the Chinese market. As an important form of innovation, BMI has been widely recognized across various sectors of society. It has become a key focus for both scholars and industry professionals. This study aims to fill the research gap by using crawler technology to collect data and empirically examine the impact of BMI on firm performance in the China Growth Enterprise Market (GEM). Specifically, this study seeks to answer questions such as whether existing BMI can help firms improve their performance and to what extent BMI impacts firm performance.

The GEM market for high-tech small and medium-sized enterprises (SMEs) was launched in China in 2009. However, based on the statistics of annual reports from China GEM firms, few firms adopted BMI before 2012. Growing firms began implementing BMI after 2012, which provides the basis for this article. This article utilized the annual reports of China GEM firms from 2012-2017 and employed crawler technology to construct indicators that reflect a firm's implementation of BMI. The article applies both ordinary least squares (OLS) regression and instrumental variable (IV) regression models for analysis. The empirical findings offer noteworthy insights and provide first-hand answers to the research questions.

Earnings management in listed firms in China commonly involves non-recurrent gains and losses (Chen et al., 2013; Jiang et al., 2022; Shan, 2015). To eliminate their influence, the article subtracted non-recurring gains and losses $EPS2$ from earnings per share, non-recurring gains and losses $ROA2$ from return on total assets, and non-recurring gains and losses $ROE2$ from return on equity. Furthermore, the article incorporated gross profit ratio total assets (GPA) (Novy-Marx, 2013), as an effective indicator for measuring firm profitability. GPA is less susceptible to manipulation than EPS, ROA, and ROE, since it is not influenced by capital structure.

1.2 Contribution

Using crawler technology, the article analyzes annual reports of firms from 2012 to 2017 in the China GEM and establishes a novel way of measuring BMI at the firm level. This article addresses two research questions: does

BMI improve firm performance, and to what extent does it influence performance? First, the article offers a unique method for measuring BMI that differs from existing questionnaires or scales. Second, the article provides empirical evidence of the effectiveness of BMI in improving firm performance in the China GEM. Third, the article quantifies the degree of BMI's effect, demonstrating that BMI significantly improves firm performance. The average effect of undertaking BMI on firms is an increase of approximately ￥0.14, ￥0.02, and ￥0.04 in EPS, ROA, and ROE, respectively. The findings suggest that proactively adopting BMI in response to economic changes can be advantageous for firms.

1.3 Literature

1.3.1 Business Model

The term "business model" has become a common phrase in academic research and management practices. From a firm's perspective, a business model refers to the organizational structures designed to generate commercial value (George & Bock, 2011). Despite the limited analysis and vague understanding of business models (Amit & Zott, 2012), the business model has been widely acknowledged as the transaction network formed by firms and stakeholders, which includes business content, structure, and governance (Amit & Zott, 2012; Demil & Lecocq, 2010). The definition of a business model developed by Amit and Zott (2001) has been broadly accepted in academic research. They suggest that a business model illustrates the content, structure, and governance of transactions designed to create value through the exploitation of business opportunities. A well-designed business model can confer a competitive advantage to a firm.

There are several popular viewpoints on the concept of the business model. Zott and Amit (2007) argue that from the perspective of value creation, a business model refers to the activities that a firm conducts around the entire transaction structure. Johnson et al. (2008) suggest that a business model includes a customer value proposition, key resources, key processes, and a profit formula. Osterwalder and Pigneur (2010) decompose business models into specific elements and propose a widely used 9-element canvas model, consisting of value proposition, customer segments, customer relationships, channels, key resources, key activities, key partners, cost structure, and revenue streams. Teece (2010) defines a business model as a way in which a firm delivers value to customers, entices them to pay for value, and converts those payments to profit. Nenonen and Storbacka (2010) construct a business model as the configuration of 12 interrelated elements covering market, offering, operational, and management viewpoints. Demil and Lecocq (2010) propose that a business model consists of resources and competencies, organizational structure, and value delivery. Amit and Zott (2012) describe a business model as the content, structure, and governance of a system of interconnected and interdependent activities that determine the way a firm does business with its customers, partners, and vendors.

1.3.2 BMI

The need for BMI has been on the rise from a firm’s perspective in response to the advancements in technology, e.g. blockchain (Wang et al., 2021), big data (Sorescu, 2017), the internet of things (Haaker et al., 2021), artificial intelligence (Ciasullo & Lim, 2022), and central bank digital currencies (Wang & Hausken, 2022). Johnson et al. (2008) argue that competitive pressure is a driving factor for BMI, while Doz and Kosonen (2010) suggest that firms need to innovate in their business when their strategy is disrupted. Baden-Fuller and Haefliger (2013) propose that BMI is a continuous process of trial, error, and readjustment. Another view is that BMI is the result of active innovation within firms. Demil and Lecocq (2010) view BMI as a process where firms reorganize and optimize resources and continue to evolve. Based on four case studies, Dmitriev et al. (2014) suggest that commercial innovation is often accompanied by BMI. Clauss (2017) developed a new scale for BMI systematically.

In sum, existing research on BMI has adopted various viewpoints, e.g. the technology perspective: BMI as driven by technological innovation (Teece, 2010), the strategic perspective: BMI as the unit of analysis for firm strategic management, with the core of BMI being the transformation of the firm's development strategy (Zott et al., 2011), and the customer perspective: BMI as business innovation fueled by changing customer needs, value delivery methods, and enhanced customer value (Casadesus-Masanell & Zhu, 2013). This article is consisting of the perspective of strategic management, i.e. BMI as a strategic movement.

1.3.3 BMI and Firm Performance

Literature on BMI is abundant, but relatively less empirical research explores the impact of BMI on firm performance, particularly in the Chinese market. Foss and Saebi (2017) called for more research on the performance implications of BMI in firms. The foundational work on the relationship between BMI and firm performance is Zott and Amit (2007). They categorized BMI into two types: efficiency-centered and novelty-centered. Efficiency-centered business design aims to reduce costs and improve efficiency, while

novelty-centered business model design aims to create a new business model that provides customers with unparalleled value propositions and experiences. Frankenberger et al. (2013) developed the 41-framework that structures the BMI process. Cucculelli and Bettinelli (2015) based on a sample of 376 small- and medium-sized Italian firms and suggest that a modification of the business model has a positive effect on firms' performance.

Bouncken and Fredrich (2016) found that BMI has a positive impact on return of equity, particularly for firms with more alliance experience. Visnjic et al. (2016) observed that the combination of service BMI and product innovation yields long-term performance advantages despite some short-term performance trade-offs. Tavassoli and Bengtsson (2018) found that BMI is significantly and positively linked to superior product innovation performance. Bashir and Verma (2019) emphasized that BMI is a key predictor of firm performance and strategic flexibility. Guo et al. (2022) demonstrated a positive relationship between BMI and the performance of digital start-ups. While a common perception of the positive outcomes of BMI in the literature, few studies have thoroughly examined its impact on performance, perhaps due to the intricate relationship between BMI and firm performance (Foss & Saebi, 2017). BMI impacts a firm's value proposition, market segments, value chain, and revenue model, but there are numerous factors that can play out differently over time and for different individuals. Bouwman et al. (2019) investigate 321 European SMEs that use social media, big data, and information technology to conduct BMI. They found that more resource allocation to BMI and engagement in strategy implementation practices positively affected overall firm performance. Menter et al. (2020) used cross-industry data from 60 German stock-market-listed corporations. The study shows that BMI has a positive yet lagged effect on firm performance. Guo et al. (2022) explore the impact of BMI on Chinese digital start-ups. They find that value proposition innovation positively affects performance, which is then mediated by value creation and value capture innovation. Snihur and Bocken (2022) analyze the impact of *BMI* on business ecosystems, society, and the planet. Clauss et al. (2022) investigate five SMEs from Austria, Germany and Liechtenstein during COV-19. They point out that BMI positively affects strategic flexibility and could also be incorporated into the firm long-term while also creating new revenue streams.

Potential gaps in existing research are as follows. First, relatively less empirical research investigates the relationship between BMI and firm performance, particularly in the Chinese market. Second, literature commonly used questionnaires and scales, which are vulnerable to human error and subjective judgments. The article applies crawler technology to capture data from annual reports of China's GEM firms and build BMI indicator to avoid interference from subjective factors. Third, prior research mainly focused on certain industries or based on conceptual or case-based analyses, resulting in a lack of cross-industry research. Although some studies empirically analyzed the influence of BMI on firm performance, little quantitative evidence is available to answer the question of to what degree BMI adoption influences business performance. Fourth, traditional financial indicators, e.g. EPS, ROA, and ROE may not trustworthy due to the prevalence of earnings management through non-recurring gains and losses. Therefore, the article applies adjusted EPS, ROA, and ROE, which better reflect firm performance. The article also adopts gross profit ratio total assets (GPA) Novy-Marx (2013), which is accepted as an effective indicator for measuring a firm's profitability. GPA better reflects the profitability of a firm and is unaffected by the capital structure, which is difficult to manipulate compared with EPS, ROA, and ROE.

2. Hypothesis on the Impact of BMI on Firm Performance

BMI is widely recognized as an important factor contributing to a firm's success (Bucherer et al., 2012). From a comprehensive review of existing literature, BMI may has a positive impact on firm performance in the following ways. First, BMI can enhance a firm's innovation capability by facilitating technology and product innovation, which in turn increases value proposition (Teece, 2010). Moreover, BMI can stimulates innovation across industrial systems, technology, resource integration, and partnerships, resulting in a broad range of positive impacts. Apple, a multinational corporation renowned for its innovative capabilities, is an excellent example of this.

Second, BMI can reduce a firm's costs and improve its operational efficiency. By altering the existing transaction structure and value transfer methods in the industrial ecosystem (Amit & Zott, 2012), firms can better meet the needs of their upstream and downstream partners and customers, leading to reduced internal transaction costs and a competitive edge (Zott & Amit, 2007). For example, Dell Inc. reduced its costs and improved its efficiency by undertaking BMI in various value chains, including raw material procurement, order manufacturing, and telemarketing.

Third, BMI contributes to the creation of new market space and customers. By analyzing and mining potential customer needs, firms can design a new transaction structure and develop a new value proposition to meet the needs of users. This, in turn, can lead to greater customer loyalty and stickiness toward products and services

(Ramdani et al., 2022). E.g. Snapchat successfully acquired a large number of young users in the new mode of "reading and burning" in the competitive social media market. Furthermore, Snapchat is transforming into an e-commerce platform, offering one-stop shopping services to its users.

Fourth, BMI can alter the competitive strategies of industries. Historically, technology has been the primary battleground for firms seeking to gain an edge. However, as the value of BMI receives more attention, firms are investing more effort in fusing BMI with technological innovation, creating a novel path to attain a competitive advantage in the market (Bock et al., 2012). E.g. Qihoo 360, a renowned antivirus software supplier in China, revolutionized the industry's competitive mode by being the first to offer free antivirus services. In addition, BMI contributes a firm's performance by facilitating the utilization of new opportunities and adapting to changes in the business environment (Teece, 2010). Prior research has consistently demonstrated that BMI is positively associated with firm performance (Amit & Zott, 2012; Latifi et al., 2021; White et al., 2022). Therefore, the article proposes the hypothesis: The implementation of BMI results in a favorable effect on a firm's performance.

The hypothesis is generated based on the positive effects of BMI. However, it should be noted that BMI can also pose certain challenges. First, a good BMI may attract imitators, leading to intensified competition for the leading firm. Even if the BMI cannot be replicated due to cost or other reasons, it can still become outdated when competitors adopt more effective BMI, thereby reducing the firm's performance. Second, the adoption of a BMI requires a certain amount of risk-taking and entrepreneurial behavior, which may negatively affect a firm's performance (Hughes & Morgan, 2007). Third, BMI may be a difficult task for a firm, presenting a greater challenge than the technology itself (Aspara et al., 2013). Moreover, even firms with a good BMI may fail due to dramatic changes in the external environment, competition, and turbulence in the markets. It is unrealistic to assume that BMI could uniformly improve the performance of all firms across diverse sectors. This article mainly focuses on the China GEM, which covers a vast range of SMEs in China.

3. Methodology

3.1 Research Sample

The article selects the 2012-2017 China GEM firms as the research sample. 2,970 annual reports among 720 firms from the China GEM are collected and analyzed. The article applies the quantitative analysis of BMI, which has traditionally been a conceptual approach. To achieve this, crawler technology is used to construct a dataset consisting of panel data of six years. The dataset consists of two parts, i.e. variables obtained through crawler technology using annual reports that reflect the implementation of BMI by firms in the China GEM, and other variables obtained from the China Stock Market & Accounting Research Database.

3.2 Research Design

3.2.1 Firm Performance

This article uses financial indicators to represent firm performance, which is consistent with existing literature (Alodat et al., 2022; Delen et al., 2013; Kessler et al., 2020). Three indicators, i.e. earnings per share (EPS), return on total assets (ROA), and return on equity (ROE), are selected. However, given the prevalence of earnings management behavior in domestic listed firms (Chen et al., 2013; Jiang et al., 2022; Shan, 2015), the article also adopts adjusted EPS, ROA, and ROE. In the consideration that Profit is unable to reflect a firm's actual economic gains. The article future applies the gross profit ratio to total assets (GPA) (Novy-Marx, 2013) to measure firm performance to verify the analysis. GPA is calculated as follows and is considered to be an effective indicator by the academic community in measuring a firm's profitability.

$$GPA = \frac{Gross\ Profit}{Total\ Assets} \tag{1}$$

where $Gross\ Profit$ is the purest measure of profit. It is at the top of the income statement and is the least likely to be manipulated. As $Gross\ Profit$ represents the foundation of a firm's operations, it serves as the basis for assessing its profitability. Using $Total\ Assets$ as the denominator has the advantage of being independent of a firm's asset structure. This is consistent with the independence of gross profit from a firm's capital structure.

3.2.2 BMI

The core variable in this article is bmi, which represents a firm's implementation of BMI. This indicator is obtained from 2,970 annual reports of China's GEM firms. Figure 1 illustrates the process to obtain bmi.

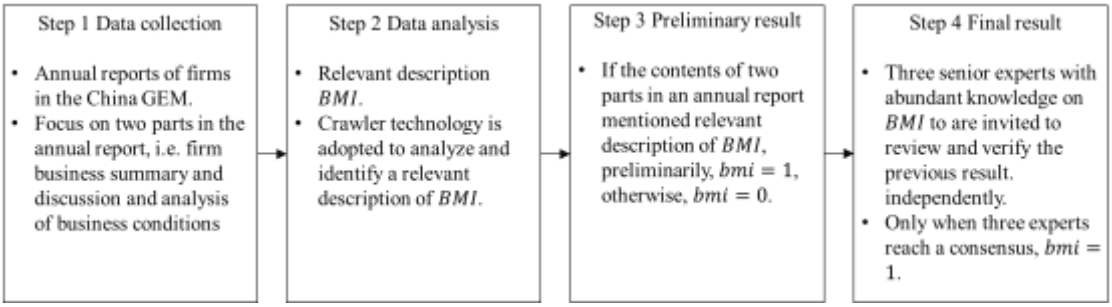

Figure 1. The process of obtaining the variable of bmi

First, 2,970 annual reports of China's GEM firms are collected. The article focuses on two specific parts in the annual reports, i.e. the firm business summary and discussion, and analysis of business conditions. This is because the two parts provide detailed information on the firm's business operations and contain information on BMI.

Secondly, crawler technology is applied to analyze the contents of the two parts in the annual reports to identify whether they include relevant descriptions of BMI. Keywords, e.g. 'Innovative Business Model', 'Business Model Innovation', 'Business Model Upgrading', 'New Business Model', 'Reconstructing Business Model', 'Optimizing Business Model', or 'Business Model Conversion' are selected to analyze the annual reports of sample firms from 2012 to 2017. To identify firms that conduct BMI, the article first screened those with reported "actively promoting the exploration of BMI" in their annual reports. Then, three MBA graduates who work in investment banks and have extensive knowledge of BMI are invited as evaluation experts to verify the preliminary results (Amit & Zott, 2001). We asked the experts whether the firm adopted BMI, and if all three experts answered "yes", $bmi = 1$, otherwise $bmi = 0$. If there is no consensus among the experts, they are asked to read the annual report again, discuss it, and verify it until they reach an agreement. We believe that the narrative of whether the listed firms have carried out BMI in their annual reports is credible, given the rigorous regulatory requirements of the China Securities Regulatory Commission (CSRC).

3.2.3 Control Variables

The article considers the impact of corporate governance and earnings management on a firm's BMI. To quantify the level of corporate governance, two variables, i.e. internal control defects (Def), the chairman, and the general manager of two in one (Two) are included. Furthermore, we also control for other relevant factors such as the nature of property right ($State$), financial leverage ($Level$), firm size ($Asset$), the age of a firm (Age), the share proportion of management ($Mratio$), and the degree of ownership concentration represented by the sum of top three shareholders' proportion ($Cr3$). In total, seven control variables, along with a firm's individual fixed effects (ε_i) and year-fixed effect (ε_t) are included in the analysis. The variables are defined in Table 1.

Table 1. Variable definition

Variable	Definition
bmi	$bmi = 1$ if a firm conducts BMI, otherwise $bmi = 0$. This is based on the information disclosed in the firm's annual report and is further evaluated by the consensus of three experts.
EPS	Earnings per share is calculated as the net profit value of the current period divided by the paid-in capital at the end of the current period.
ROA	The return on total assets is calculated as the net profit divided by the average balance of total assets.
ROE	The return on equity is calculated as the net profit divided by the average balance of equity.
$EPS2$	Adjusted EPS is calculated as (net profit - non-operating income + non-operating expenses) current value divided by the paid-in capital at the end of the current period.
$ROA2$	Adjusted ROA is calculated as (net profit - non-operating income + non-operating expenses) divided by the average balance of total assets.
$ROE2$	Adjusted ROE is calculated as (net profit - non-operating income + non-operating expenses) divided by the average equity.
GPA	GPA is calculated as the gross profit divided by the firm's total assets.
Two	$Two = 1$ if the chairman and general manager in a firm are the same person, otherwise $Two = 0$.
$State$	$State = 1$ if the actual controller of a firm is the government, otherwise $State = 0$.
Def	$Def = 1$ if an internal control defect exists in a firm, otherwise $Def = 0$.
$Lever$	The asset-liability ratio, i.e. total liabilities / total assets.
$Asset$	A firm's total assets are measured in Renminbi and are converted to logarithmic form.
Age	A firm's age is measured in years.
$Mratio$	The share proportion of management is equal to the number of shares held by executives divided by the total number of shares.
$Cr3$	The degree of ownership concentration is equal to the proportion of the top three shareholders in the firm's shares.

3.2.4 The Model

This article applies the following econometric model:

$$Financial_{it} = \alpha + \beta_1 bmi_{it} + \beta_2 Two_{it} + \beta_3 State_{it} + \beta_4 Def_{it} + \beta_5 Lever_{it} + \beta_6 Asset_{it} + \beta_7 Age_{it} + \beta_8 Mratio_{it} + \beta_9 Cr3_{it} + \varepsilon_i + \varepsilon_t \quad (2)$$

where the subscripts i and t denote firm i and year t, respectively. The variable $Financial$ represents a firm's performance, measured using EPS, ROA, and ROE. Additionally, considering the prevalence of earnings management in Chinese listed companies (Chen et al., 2013; Jiang et al., 2022; Shan, 2015), the article conducts a robustness test using adjusted performance metrics, i.e. $EPS2$, $ROA2$, and $ROE2$ that exclude non-recurring gains and losses. Furthermore, GPA is adopted to further verify the result.

4. Result

4.1 Descriptive Statistics

4.1.1 Correlation

Table 2 displays the Pearson correlation between bmi and eight control variables. The maximum Pearson correlation coefficient is relatively low at 0.293, which indicates that the correlations among the control variables are within an acceptable range and no multicollinearity issue in the model.

Table 2. Correlation between dependent variable bmi and eight control variables

	bmi	Two	$State$	Def	$Lever$	$Asset$	Age	$Mratio$	$Cr3$
bmi	1								
Two	-0.011	1							
$State$	0.068***	-0.111***	1						
Def	-0.004	-0.011	-0.003	1					
$Lever$	0.040**	0.001	0.020	0.030*	1				
$Asset$	0.112***	-0.120***	0.036**	0.031*	0.293***	1			
Age	0.043**	-0.008	0.015	0.043**	0.069***	0.090***	1		
$Mratio$	-0.025	0.147***	-0.137***	-0.045**	-0.144***	-0.215***	-0.065***	1	
$Cr3$	-0.035*	0.136***	-0.022	-0.066***	-0.109***	-0.168***	-0.114***	0.175***	1

$* p < 0.10, ** p < 0.05, *** p < 0.01$.

4.1.2 Descriptive Statistics Grouped by Industry

Table 3 presents descriptive statistics for BMI across different industries. On average, industries such as Information Transmission, Software and Information Technology Services (I), Leasing and Business Services (L), Wholesale and Retail (F), and Culture, Sports, and Entertainment (R) have a higher mean of bmi. This suggests that these industries may be more inclined to adopt BMI as new technologies continue to develop.

Table 3. Descriptive statistical analysis of bmi grouped by industry

Industry	Variable	Mean	Median	Std	Max	Min	N
A	bmi	0.025	0	0.158	1	0	40
B	bmi	0.000	0	0.000	0	0	24
C	bmi	0.042	0	0.200	1	0	2096
D	bmi	0.000	0	0.000	0	0	9
E	bmi	0.098	0	0.300	1	0	41
F	bmi	0.107	0	0.315	1	0	28
G	bmi	0.118	0	0.332	1	0	17
I	bmi	0.170	0	0.376	1	0	522
L	bmi	0.321	0	0.476	1	0	28
M	bmi	0.055	0	0.229	1	0	55
N	bmi	0.100	0	0.304	1	0	40
O	bmi	0.000	0		0	0	1
Q	bmi	0.375	0	0.500	1	0	16
R	bmi	0.094	0	0.295	1	0	53
Total	bmi	0.072	0	0.258	1	0	2970

Note: According to the CSRC's industry classification, A: agriculture, forestry, animal husbandry, and fishery. B: mining. C: manufacturing. D: electricity, heat, gas, and water production and supply. E: construction. F: wholesale and retail. G: transportation, warehousing, and postal services. I: information transmission, software, and information technology services. L: leasing and business services. M: scientific research and technical services. N: water, environment, and public facilities management industry. O: residential service repair and other services. P : education. Q: health and social work. R: culture, sports, and entertainment.

Notably, the health and social work industry (Q) had a higher mean of bmi. This is primarily because the firm "Dian Diagnostics" mentioned BMI in its annual reports during the observation period. Similarly, the mean of bmi is higher in the environmental and public facilities management industry (N), largely due to the inclusion of BMI information in the annual reports of listed firms such as "Bishuiyuan", "Yongqing Environmental Protection", and "CLP Environmental Protection". Industries such as mining (B), agriculture, forestry, animal husbandry, fisheries (A), scientific research and technology services (M), and others had a lower mean of bmi.

4.1.3 Descriptive Statistics Grouped by bmi

Table 4 provides descriptive statistics for the main variables grouped by bmi. The group with $bmi = 0$ has lower values of EPS, ROA, and ROE compared to the group with $bmi = 1$. For the group $bmi = 0$, the average values of EPS, ROA, and ROE are 0.399, 0.061, and 0.086, respectively, For the group $bmi = 1$, the average values of EPS, ROA, and ROE are 0.537, 0.083, and 0.120, respectively. Therefore, BMI increased EPS, ROA, and ROE by approximately ￥0.14, ￥0.02 and ￥0.04, respectively.

The significant t-test of the mean values between the two groups confirms that firms that undertake BMI have higher values of EPS, ROA, and ROE, as well as $EPS2$, $ROA2$, and $ROE2$, and GPA. The descriptive analysis supports the hypothesis, i.e. on average, firms that undertake BMI exhibit better performance compared to those that do not.

Table 4. Descriptive statistical analysis of variables grouped by bmi

Sample	Statistics	EPS	ROA	ROE	$EPS2$	$ROA2$	$ROE2$	GPA	$Lever$	$Asset$	Age
$bmi = 1$	$mean$	0.537	0.083	0.120	0.476	0.072	0.105	0.213	0.310	9.329	15.373
	$median$	0.436	0.069	0.103	0.404	0.057	0.087	0.172	0.285	9.311	14.814
	sd	0.447	0.065	0.089	0.436	0.066	0.089	0.156	0.171	0.443	4.494
	max	3.443	0.384	0.572	3.474	0.400	0.547	1.453	0.839	10.659	29.667
	min	-1.109	-0.174	-0.189	-1.160	-0.184	-0.199	0.025	0.028	8.422	6.125
	N	213	213	213	213	213	213	213	213	213	213
$bmi = 0$	$mean$	0.399	0.061	0.086	0.345	0.054	0.072	0.162	0.284	9.176	14.663
	$median$	0.337	0.058	0.085	0.290	0.051	0.073	0.148	0.258	9.129	14.172
	sd	0.463	0.060	0.104	0.454	0.059	0.107	0.089	0.164	0.339	4.263
	max	4.578	0.373	0.664	4.571	0.338	0.645	0.802	1.037	10.691	40.769
	min	-4.558	-0.725	-2.114	-4.545	-0.401	-2.090	-0.150	0.011	8.235	5.472
	N	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757
All	$mean$	0.409	0.062	0.088	0.354	0.056	0.075	0.166	0.286	9.187	14.714
	$median$	0.343	0.059	0.086	0.295	0.052	0.075	0.150	0.260	9.140	14.192
	sd	0.463	0.060	0.104	0.454	0.060	0.106	0.096	0.165	0.350	4.283
	max	4.578	0.384	0.664	4.571	0.400	0.645	1.453	1.037	10.691	40.769
	min	-4.558	-0.725	-2.114	-4.545	-0.401	-2.090	-0.150	0.011	8.235	5.472
	N	2970	2970	2970	2970	2970	2970	2970	2970	2970	2970
$Mean\ Difference$		0.138***	0.022***	0.035***	0.131***	0.018***	0.032***	0.051***	0.026**	0.152***	0.710**

Mean Difference is the difference between the sample of $bmi = 1$ and $bmi = 0$, $* p < 0.10$,$** p < 0.05$,$*** p < 0.01$.

4.2 Analyzing the Model

4.2.1 Estimating the Model and Illustrating the Result

The ordinary least squares (OLS) regression is applied to test the hypotheses. Table 5 shows the result. EPS, ROA, and ROE are the dependent variables in regressions 1-3, respectively. In all three regressions, bmi are significantly positive at a 1% significance level. The empirical evidence indicates that BMI has a significant positive impact on firm performance. Regarding the control variables, Two is positively associated with firm performance, but only in regression 1, its coefficient is significant at a 10% level. Notably, the coefficients of Def are significantly negative in regressions 1-3, indicating that internal control defects have a substantial negative impact on firm performance. The regression coefficients of $Lever$ and Age are also negatively in the three regressions, whereas the regression coefficient of $Asset$ is significant positive in the three regressions. $State$, $Mratio$, and Cr3 have no statistically significant impacts on firm performance.

Table 5. OLS regression results with EPS, ROA and ROE as the dependent variables

Variables	(1) EPS	(2) ROA	(3) ROE
bmi	0.091***	0.013***	0.023***
	(0.032)	(0.004)	(0.009)
Two	0.047*	0.004	0.007

	(0.025)	(0.003)	(0.007)
$State$	-0.102	0.020	0.002
	(0.222)	(0.029)	(0.059)
Def	-0.049*	-0.008**	-0.013*
	(0.027)	(0.003)	(0.007)
$Lever$	-0.096	-0.044***	-0.040*
	(0.082)	(0.011)	(0.022)
$Asset$	0.251***	0.031***	0.059***
	(0.030)	(0.004)	(0.008)
Age	-0.073***	-0.008***	-0.011***
	(0.007)	(0.001)	(0.002)
$Mratio$	-0.021	-0.000	-0.009
	(0.093)	(0.012)	(0.025)
$Cr3$	0.100	0.005	0.024
	(0.156)	(0.020)	(0.042)
$cons$	-2.046***	-0.248***	-0.531***
	(0.446)	(0.058)	(0.119)
Ind	Yes	Yes	Yes
$Year$	Yes	Yes	Yes
N	2970	2970	2970
$Adj.R2$	0.515	0.517	0.304

Standard errors in parentheses, $* p < 0.10, ** p < 0.05, *** p < 0.01$.

4.2.2 Robustness Test Using $EPS2$, $ROA2$ $ROE2$ and GPA

To test the robustness of the results, a robustness test is employed using $EPS2$, $ROA2$, $ROE2$, and GPA. Considering that earnings management using non-recurrent gains and losses is prevalent among listed firms in China (Chen et al., 2013; Jiang et al., 2022; Shan, 2015). Therefore, the article eliminates the impact of earnings management by using adjusted indicators to measure firm performance, i.e. $EPS2$, $ROA2$, and $ROE2$. Additionally, the article uses GPA as an alternative measure of profitability instead of net profit. Table 6 presents the result of the robustness test. The result has not changed substantially, indicating that our finding is robust.

Regression 3 shows a positive and statistically significant relationship between bmi and firm performance ($\beta = 0.083, p < 0.01$). Similarly, regressions 5 and 6 obtain consistent results where bmi is positively associated with firm performance at a 5% significance level. In addition, the regression coefficient of bmi is significantly positive at a 10% level of significance ($\beta = 0.008, p < 0.1$) in regression 7. These results indicate that the positive impact of BMI on firm performance remains robust after controlling for earnings management. The results are consistent in Table 5 for the control variables. Specifically, in regressions 4 and 7, the regression coefficient for Two is significantly positive at a 5% significance level with $\beta = 0.05$ ($p < 0.05$) and $\beta = 0.008$ ($p < 0.05$), respectively. Moreover, the findings for Def, $Lever$, and $Asset$ are similar in Table 5. Notably, in regression 7, the regression coefficient of $Cr3$ is significantly positive at a 1% significance level, indicating that the degree of ownership concentration has a positive impact on firm performance.

Table 6. OLS regression results with $EPS2, ROA2, ROE2$ and GPA as the dependent variables

Variables	(4) $EPS2$	(5) $ROA2$	(6) $ROE2$	(7) GPA
bmi	0.083***	0.009**	0.021**	0.008*
	(0.031)	(0.004)	(0.009)	(0.005)
Two	0.050**	0.002	0.004	0.008**
	(0.025)	(0.003)	(0.007)	(0.004)
$State$	-0.139	0.018	-0.007	0.011
	(0.215)	(0.027)	(0.060)	(0.033)
Def	-0.061**	-0.008**	-0.017**	-0.008**
	(0.026)	(0.003)	(0.007)	(0.004)
$Lever$	-0.138*	-0.033***	-0.059***	0.023*
	(0.080)	(0.010)	(0.022)	(0.012)
$Asset$	0.234***	0.023***	0.055***	-0.001
	(0.029)	(0.004)	(0.008)	(0.004)
Age	-0.053***	-0.009***	-0.011***	-0.003***
	(0.007)	(0.001)	(0.002)	(0.001)
$Mratio$	-0.005	0.002	0.001	-0.020
	(0.090)	(0.011)	(0.025)	(0.014)
$Cr3$	0.136	-0.022	0.010	0.095***
	(0.151)	(0.019)	(0.042)	(0.023)

$cons$	-2.190***	-0.143***	-0.486***	0.121*
	(0.433)	(0.055)	(0.121)	(0.066)
Ind	Yes	Yes	Yes	Yes
$Year$	Yes	Yes	Yes	Yes
N	2970	2970	2970	2970
$Adj.R2$	0.523	0.564	0.325	0.738

Standard errors in parentheses, $* p < 0.10, ** p < 0.05, *** p < 0.01$.

4.2.3 Exploring the Potential Endogenous Issue

To explore the potential endogeneity issue between BMI and firm performance, i.e. it is not easy to disentangle whether firms with better performance engage in BMI or whether BMI leads to better performance. To mitigate this concern, the article chooses an exogenous variable, i.e. city development level ($City$), as an instrumental variable and conducts an instrumental variable (IV) regression. The rationale behind using $City$ as an instrumental variable is twofold. First, city development is exogenous to firms, meaning that it is not influenced by firm performance or BMI. Second, the Pearson correlation coefficient between $City$ and bmi is 0.14 with a 1% level of significance. Therefore, it is feasible to apply $City$ in the IV regression analysis.

The result of the IV regression is presented in Table 7. As expected, the finding that BMI has a positive impact on firm performance still holds. In regressions 9-11, the coefficient of bmi is positive at the 1% significance level (except for regression 8, where the significance level is 5%). The IV regression again verifies the hypothesis. The regression coefficients of the control variables are generally consistent with Table 5 and Table 6. Notably, in addition to $Cr3$, $Mratio$ is also positively related to firm performance at a 1% significance level (except for regression 11, where the significance level is 5%). This suggests that the share proportion of management is beneficial for firm performance to some extent.

Table 7. IV regression result with EPS, ROA, ROE and GPA as the dependent variables

Variables	(8) EPS	(9) ROA	(10) ROE	(11) GPA
bmi	1.069**	0.219***	0.348***	0.516***
	(0.424)	(0.065)	(0.107)	(0.143)
Two	0.045**	0.003	0.006	-0.001
	(0.019)	(0.003)	(0.005)	(0.006)
$State$	0.004	-0.016	-0.024	-0.063**
	(0.082)	(0.013)	(0.021)	(0.028)
Def	-0.109***	-0.013***	-0.024***	-0.003
	(0.032)	(0.005)	(0.008)	(0.011)
$Lever$	-0.489***	-0.115***	-0.084**	-0.083***
	(0.089)	(0.013)	(0.033)	(0.018)
$Asset$	0.181***	0.010	0.023	-0.037**
	(0.050)	(0.008)	(0.015)	(0.014)
Age	-0.007***	-0.001***	-0.001***	-0.0004
	(0.002)	(0.0003)	(0.001)	(0.001)
$Mratio$	0.285***	0.038***	0.058***	0.033**
	(0.0507)	(0.007)	(0.011)	(0.014)
$Cr3$	0.510***	0.051***	0.082***	0.043*
	(0.083)	(0.012)	(0.020)	(0.024)
$cons$	-1.565***	-0.060	-0.209	0.460***
	(0.467)	(0.0718)	(0.141)	(0.143)
Ind	Yes	Yes	Yes	Yes
$Year$	Yes	Yes	Yes	Yes
N	2970	2970	2970	2970
$Adj.R2$	0.506	0.498	0.301	0.712

The instrumental variable is $City$, which is an indicator variable representing a city's level of development. Specifically, $City = 1$ if a firm is in Beijing, Shanghai, Guangzhou, Shenzhen, or Hangzhou, otherwise, $City = 0$. Standard errors in parentheses, $* p < 0.10, ** p < 0.05, *** p < 0.01$.

5. Discussion

The article demonstrates the positive impact of business model innovation (BMI) on firm performance. The finding is consistent with previous research (Anwar, 2018; Bouncken & Fredrich, 2016; Tavassoli & Bengtsson, 2018; Trimi & Berbegal-Mirabent, 2012; Trischler & Li-Ying, 2022), which mainly relied on questionnaires, scales, or theoretical analysis. The article introduces a new approach to measure the implementation of BMI in a firm via craw technology. The article provides empirical evidence of the effectiveness of BMI on firm

performance. A large sample comprises 720 firms from the China GEM is explored. The result provides insights on whether *BMI* impact firm performance and to what extent *BMI* impacts firm performance.

BMI is particularly beneficial for firms in high-tech sectors that struggle to commercialize new technologies and products without an appropriate business model. By integrating various resources, technologies, and supply chain partners, *BMI* enhances a firm's innovation capabilities and reduces internal transaction costs, improving its operational effectiveness and competitiveness (Amit & Zott, 2012; Tavassoli & Bengtsson, 2018). Moreover, *BMI* can create new markets and change the competitive landscape, directly and indirectly contributing to improved firm performance. However, *BMI* development faces challenges. First, it is unevenly developed among different types of firms, with state-owned firms showing less willingness and ability to undertake *BMI*. Second, some firms blindly follow trends without a deeper understanding of *BMI*, leading to homogenization and failures in the market. Third, the integration of technology innovation and *BMI* is not yet sufficient, with many firms relying on imitation or low-price competition rather than developing novel and effective business models. In conclusion, *BMI* is essential for firms to maintain innovativeness, enhance their competitiveness, and achieve superior performance. Despite some challenges, *BMI* remains a important factor in driving innovation and growth in the business world.

6. Implication

First, new technologies such as blockchain, big data, and artificial intelligence offer businesses a range of opportunities that can be harnessed through *BMI*. However, firms need to be mindful of maintaining a balance between their core business and *BMI* to avoid any adverse impact on their operations and survival. Careful consideration of their unique conditions and operational characteristics, along with integration with upstream and downstream industries, and the enhancement of technological and product innovation, enable firms to implement *BMI* effectively. This can result in the restructuring of transactions, cost savings, and operational efficiency, ultimately leading to improved competitiveness in the marketplace. Second, it is beneficial for governments and regulators to encourage the integration of *BMI* and technological innovation. An effective *BMI* can combine product, technology, and service innovation, while also bringing together various industrial system stakeholders to promote industrial upgrading and transform competitive modes. Third, it is advantageous to establish a *BMI* intellectual property protection system for society. This would provide legal protection to firms engaged in *BMI*, enabling them to better compete in the market.

7. Conclusion

This article aims to investigate the impact of *BMI* on the firm performance focusing on the China Growth Enterprise Market (GEM). To achieve this objective, a unique dataset is constructed based on 2,970 annual reports of firms from the China GEM. Crawler technology is applied to determine whether a firm's implementation of *BMI*. The judgments are verified by three experts. The article uses OLS regression and IV regression for empirical analysis. The results show that *BMI* has a positive effect on firm performance, and the findings are robust. On average, implementing BMI leads to an increase of approximately ￥0.14, ￥0.02, and ￥0.04 in EPS, ROA, and ROE, respectively. These findings have managerial implications for firms regarding *BMI* strategies.

This article has limitations that suggest avenues for future research. First, to expand the scope of this article, future research may consider collecting and analyzing a more extensive dataset that includes internationally listed firms, as our current sample is limited to China's GEM firms. While the sample provides a good representation of high-tech SMEs, the difficulty of obtaining information on non-listed firms restricts the analysis to listed firms only. Analyzing a broader dataset may provide further insights into the relationship between *BMI* and firm performance. Second, the analysis relies on a binary variable indicating whether a firm has conducted *BMI* during the observation period or not, which has limitations. Future studies can collect more detailed and quantifiable information on *BMI*, e.g. the degree of *BMI*. Third, existing innovation experience in conducting *BMI* is relevant to firm performance. Future research may explore additional indicators from prior experience to better verify the analysis.

The *BMI* concept incorporates diverse elements that can stem from both macroeconomic factors that are influenced by the competitive environment and endogenous factors such as organizational resources, leadership initiatives, learning processes, and other factors that impact the entity's performance. Establishing an appropriate code system to encompass all these elements is critical in achieving a solid ontological foundation for the *BMI* concept. Future research can delve into the mechanisms underlying *BMI* and how *BMI* impacts firm performance. For instance, how *BMI* impacts a firm's value proposition, market segments, value chain, and revenue model, and explore the differences in these impacts. Moreover, future research can examine the effects

of BMI in specific industries or certain types of firms, which may require conducting extensive field surveys and case studies. Another aspect to consider in future research is the duration of BMI implementation, as well as the interaction between time and individual enterprise characteristics.

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