Analysis of the Effect of Business Model Innovation on the Sustainability Performance of Manufacturing Enterprises Based on Fixed Effects Model

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Abstract: Manufacturing is the backbone of China's economy and the driver of economic growth, and the role of sustainable development of manufacturing enterprises for the national economy cannot be ignored. The innovation of business models gives vitality to enterprises and continuously promotes the improvement of their economic and environmental performance. Therefore, exploring the connection between the business model innovation of manufacturing firms and their sustainability performance is of great concern. The research takes panel data of China's listed manufacturing enterprises from 2010 to 2016 as an example to construct regression models and uses content analysis to empirically verify that both novelty-centered and efficiency-centered business model innovation significantly and positively affect the sustainability performance of the listed manufacturing enterprises.

1 INTRODUCTION

In the context of accelerating the transformation of economic development mode, the sustainable development of enterprises has increasingly become a heated topic in the related field of research. At present, the manufacturing industry, which is the pillar industry of China's national economy, is under great pressure to transform and upgrade. Innovation, as the root of the development of the manufacturing industry, has become an essential issue to facilitate its sustainable development. Business model innovation taps new business values for enterprises, reduces transaction costs, improves production efficiency, increases profit income, and promotes the sustainable and healthy development of enterprises. This is why it is of great significance to study business model innovation in manufacturing companies nowadays. Based on the background above, the study sets the research object as A-share listed manufacturing enterprises from 2010 to 2016 and uses this as a sample to study the effect of business model innovation on the sustainable development performance of the listed manufacturing enterprises in China, with a view to exploring effective ways to promote the sustainable development of manufacturing firms.

2 THEORETICAL ANALYSIS AND HYPOTHESIS

Corporate business model innovation energizes the inherent business model through continuous innovation, creating new growth drivers and competitive advantages, thus continuously promoting the expansion of new markets and creating new engines for the increase of corporate operating income and profits. Li Wei (2017) found that efficiency-centered business model innovation significantly and positively affects the market and financial performance of enterprises, while novelty-centered business model innovation positively influences the financial performance in manufacturing SMEs. Given that the concept of sustainable development has received increasing attention in recent years, research on the sustainability performance of enterprises has also emerged. The concept of sustainable development demands that companies focus on both economic and environmental benefits and achieve the integration and coordination of profit growth and environmental protection. Mao Shiying (2011) highlighted the significant role of business model innovation in the development of the green economy. Business model innovation, as a new form of innovation, can greatly

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promote the implementation of green development strategies. Zhou Wenyong et al. (2012) pointed out that the business model innovation of manufacturing enterprises in the low-carbon context can promote the growth of their own profits and the sustainability of their development. The results of the above-mentioned studies show that the continuous innovation of enterprise business models can significantly contribute to the improvement of the financial and environmental performance of enterprises. Based on this, it is inferred that both novelty-centered and efficiency-centered business model innovation can effectively contribute to the sustainable development of enterprises.

Wu Jun et al. (2016) point out that novelty-centered business model innovation promotes business development by creating a new business model that increases people's willingness to pay and improves the user experience, thereby sustaining value creation, improving market reputation, expanding the user base, and creating a sustainable competitive advantage. At the same time, driven by the concept of sustainability, companies create new products and low-carbon services that are beneficial to the environment through the introduction of creative trading and business models, thus promoting their own environmental performance. Based on this, this paper proposes H1: Novelty-centered business model innovation can positively and significantly improve enterprise sustainability performance.

Zott et al. (2007) argue that efficiency-centered business models can promote the improvement of transaction efficiency by reconfiguring the value chain, thus saving more costs for business partners. Wang Xuejun et al. (2016) point out that through efficiency-centered business model innovation, enterprises bring into play their resource allocation and value chain integration capabilities to save scarce decision-making opportunities and operating costs for themselves and their partners, thus promoting their value creation and sustainable development. Based on this, this paper proposes H2: Efficiency-centered business model innovation can positively and significantly improve corporate sustainability performance.

3 DATA AND RESEARCH DESIGN

3.1 Sample and Data Sources

In the study, the 2016 A-share listed companies with the top 500 innovation capabilities are used as the research sample, and the data from 2010 to 2016 of the listed manufacturing companies on the list are studied. The secondary data involved in the study were obtained from Wind and CSMAR. The data of novelty-centered and efficiency-centered business model innovation were coded and quantitatively scored for the content of CSR reports using the content analysis method. In this paper, the sample is screened as follows: (1) Delete ST and *ST enterprises. (2) Delete delisted companies in that year. (3) Remove the samples with a large number of missing important data of observations of relevant variables. Finally, a total of 620 valid samples were obtained. This study utilized Stata for the data processing of the variables.

3.2 Variable Definition

(1) Novelty-centered and efficiency-centered business model innovation. According to the study of Zott et al. (2007), the forms of business model innovation were divided into two categories: efficiency-based innovation and novelty-based innovation. And with reference to the study of Mallin et al. (2012), the content analysis method was used to code and quantitatively assign values to the content of the social responsibility reports of the studied manufacturing companies from 2010 to 2016. The method of assigning scores is as follows: 0 points for the part lacking relevant textual descriptions; 1 point for the part involving relevant textual descriptions; 2 points for the part involving in-depth descriptions or quantification; the final score is the average of the scores.

(2) Sustainability performance of enterprises. Referring to the study of Ilias (2018), corporate sustainability performance was divided into two dimensions: financial and environmental performance. And with reference to the study of Xie Xuemei et al. (2021), the financial performance and environmental performance of enterprises are measured by the total asset return and the environmental score of social responsibility of listed companies, respectively. Finally, referring to the research method of Xi Longsheng et al. (2022), the entropy weighting method is used to calculate the

combined score of the two dimensions, and the final score is used to measure corporate sustainability performance. The data of the two indicators are first normalized in Python, and then the combined score is calculated based on the weights.

(3) Control variables. Firm size (Size), the gearing ratio (Lev), years on the market (ListAge), and growth rate of operating income (Growth) were used as control variables. In addition, dummy variables are also set to control for yearly and individual effects.

Table 1: Variable Definition.

Variable	Definitions	Sources
Novelty	①A novel transaction method is adopted ②The new business model brings new partners to the company ③Provides a new way of combining information, services, and products ④The company adopts a novel way to motivate its partners ⑤ The company continuously improves the business model	Corporate Social Responsibility Report
Efficiency	① Reduces marketing, transaction, or communication costs for its partners ②The flow of products, services, and information in the transaction process is transparent ③Enterprises can know a lot of information about products, services, and partners ④Enterprises exchange and share information with partners in the transaction process ⑤New business models make transactions more efficient	
Score	Entropy weighted sum of Roa and CSR rating environmental score	Hexun, Wind
Size	ln(total assets)	Wind
Lev	ln(current year- listed year+1)	
ListAge	Total liabilities/total assets at period end	
Growth	Operating income for the year / Operating income for the previous year - 1	

3.3 Model Construction

To test hypotheses H1 and H2, the study constructs the following empirical models.

$$Score_{it} = \alpha_0 + \alpha_1 Novelty_{it} + \alpha_2 Size_{it} + \alpha_3 ListAge_{it} + \alpha_4 Lev_{it} + \alpha_5 Growth_{it} + \sum Year + \varepsilon_{it} \quad (1)$$

$$Score_{it} = \alpha_0 + \alpha_1 Efficiency_{it} + \alpha_2 Size_{it} + \alpha_3 ListAge_{it} + \alpha_4 Lev_{it} + \alpha_5 Growth_{it} + \sum Year + \varepsilon_{it} \quad (2)$$

4 DATA RESULTS AND ANALYSIS

4.1 Descriptive Statistics

Table 2 shows the results of descriptive statistics of the indicators in the study. According to Table 2, the mean value of novelty-centered business model innovation is 0.371, while the mean value of efficiency-centered business model innovation is 0.407. In comparison, the degree of novelty-centered business model innovation is lower than that of efficiency-centered business model innovation. This

reflects that the sample companies are more concerned with the improvement of their overall efficiency than with the degree of novelty of their business models. The very large value of 0.960 and the very small value of 0.0435 for the sustainability performance of manufacturing firms show a large extreme difference, indicating that there are significant differences in sustainability performance among firms

Table 2: Descriptive Statistics.

Variable	N	Max	Min	Mean	Sd
Novelty	620	1.400	0	0.371	0.260
Efficiency	620	1.400	0	0.407	0.298
Score	620	0.960	0.0435	0.404	0.153
Size	620	26.06	20.39	23.27	1.116
ListAge	620	3.219	0	2.531	0.495
Lev	620	0.821	0.0341	0.488	0.174
Growth	620	6.817	-0.487	0.170	0.382

4.2 Regression Results

In this paper, fixed effects regressions were conducted on the sample according to the empirical model. The regression results are shown respectively in Table 3 and Table 4.

Table 3: Regression Results of Novelty-centered Business Model Innovation and Sustainability Performance of the Listed Manufacturing enterprises.

Variable	Score
Novelty	0.062**
	(2.24)
Size	0.029
	(1.34)
ListAge	0.046
	(1.26)
Lev	-0.070
	(-0.87)
Growth	0.018
	(1.57)
Constant	-0.343
	(-0.72)
R-squared	0.283
F	18.97
Number of Company	91
Company FE	YES
Year FE	YES
Observations	620

*** p<0.01, ** p<0.05, * p<0.1

According to Table 3, The R-square of model (1) is above 28%, and F-value is 18.97, which is significant at the significance level of p<0.001, indicating that the model is meaningful. The regression results show that the regression coefficient between novelty-centered business model innovation and sustainability performance of manufacturing enterprises is 0.062 with a p-value significant at a 5% level of significance, indicating that there is a significant positive effect of novelty-centered business model innovation on the sustainability performance of the listed manufacturing enterprises and H1 is verified.

Table 4: Regression Results of Efficiency-centered Business Model Innovation and Sustainability Performance of the listed Manufacturing enterprises.

Variable	Score
Efficiency	0.067***
	(2.64)
Size	0.033
	(1.53)
ListAge	0.045
	(1.16)
Lev	-0.102
	(-1.24)
Growth	0.022*
	(1.79)
Constant	-0.417
	(-0.90)
R-squared	0.284
F	17.95
Number of Company	91
Company FE	YES
Year FE	YES
Observations	620

*** p<0.01, ** p<0.05, * p<0.1

According to Table 4, the R-square of model (2) is above 28%, and the F-value is 17.95, which is significant at the 1% level of significance, indicating that the model has a good fit and the ability to explain the variables. From the regression results, the regression coefficient between efficiency-centered business model innovation and the sustainability performance of manufacturing enterprises is 0.067, with a p-value significant at a 1% level of significance, indicating that there is a significant positive effect of efficiency-centered business model

innovation on the sustainability performance of the listed manufacturing enterprises. Thus, H2 can be verified.

4.3 Robustness Test

For the purpose of verifying the robustness of the findings above, the study draws on the research approach of Chen Qiangyuan (2020), and the variables are winsorized on the 1% quantile. The conclusions are drawn in line with the previous paper, which shows that the conclusions are reliable.

Table 5: Robustness Test.

Variable	Score	Score
Novelty	0.057**	
	(2.05)	
Efficiency		0.066***
		(2.66)
Size	0.025	0.027
	(1.19)	(1.34)
ListAge	0.052	0.049
	(1.18)	(1.06)
Lev	-0.056	-0.085
	(-0.71)	(-1.06)
Growth	0.020	0.028
	(0.78)	(1.05)
Constant	-0.266	-0.307
	(-0.58)	(-0.70)
R-squared	0.286	0.288
F	18.47	17.61
Number of Company	91	91
Company FE	YES	YES
Year FE	YES	YES
Observations	620	620

*** p<0.01, ** p<0.05, * p<0.1

5 CONCLUSIONS

5.1 Research Conclusion

The study classifies the types of business model innovation into two forms and discusses the impact of novelty-centered as well as efficiency-centered business model innovation on the sustainability performance of manufacturing enterprises, respectively. Based on the 2010-2016 Shanghai and Shenzhen A-share data, the findings of this paper conclude that both novelty-centered and efficiency-centered business model innovations significantly and positively affect the sustainability performance of manufacturing firms and the continuous innovation of business models can significantly contribute to the continuous improvement of the sustainability performance of manufacturing firms. Manufacturing enterprises should actively carry out both types of business model innovation to expand markets, reduce supply chain costs, create long-term competitive advantages, empower the transformation and development of enterprises, and promote their own sustainable development.

5.2 Suggestions

For the government, it should pay great attention to the importance of enterprise business model innovation, strengthen relevant institutional construction, write the goal of promoting the development of business model innovation into the policy platform, create a broad development space for the optimization of enterprise transaction model and business model with an inclusive and prudent attitude, provide excellent business environment for enterprises, and escort manufacturing enterprises to achieve innovation and improve the sustainability of development from a macro perspective.

For manufacturing enterprises in China, they need to make reasonable use of the government's macro policies while continuously exploring business models that are suitable for their sustainable development. Enterprises should eliminate the either/or thinking and take into account the efficiency and innovation of business models. They should actively improve their trading methods, introduce environmentally friendly products and green services, integrate the concept of environmental sustainability into innovation, make energy-saving and low-carbon development an important goal of their business operations, reduce material consumption and save costs through creative improvements in their trading models, and achieve coordinated development of their economic, social and environmental performance.

5.3 Limitation

Although this study uses a scientific approach to the analysis, there may still be some methodological and empirical limitations. The study has the following shortcomings: First, the article uses content analysis as one of the main data collection methods, and the content analysis method itself has a certain subjective nature. Secondly, the research sample size of this article is relatively small and only the enterprises in the list of top 500 listed companies in the manufacturing industry are selected. The subsequent research can expand the sample to improve the

general applicability of the conclusions. Finally, the data collection may be biased to a certain extent due to the differences in the disclosure level of social responsibility reports of different enterprises.

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