Key Driving Factors for Technological Innovation in Equipment Manufacturing Enterprises

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Abstract. The equipment manufacturing industry in Heilongjiang faces innovation and capability challenges, limiting its high-quality growth. Using MOA theory and a ridge regression model, this study examines technological innovation drivers among listed companies in the province. Key drivers include R&D investment, human capital, enterprise scale, profit target, R&D personnel, government subsidies, and market competition. These factors jointly propel innovation and industry development.

Keywords: Equipment Manufacturing Enterprises; Technological Innovation; Driving Factors

1 Introduction

Equipment manufacturing is an important pillar of industry in Heilongjiang Province, but it is currently facing challenges such as downsizing and pressure on environmental resources. Addressing these issues is critical to enhancing technological innovation capacity [1]. Domestic and foreign scholars have proposed multiple drivers, but integration into a single model is prone to multiple covariates and reduces model accuracy [2]. For this reason, the ridge regression method was chosen.

2 Theory and Hypotheses

The Motivation-Opportunity-Capability model can be used to reveal the emergence of certain organizational behaviors and is a comprehensive analytical framework for studying technological innovation [3]. This paper combines the model to measure the drivers of firms' technological innovation from these three perspectives.

2.1 Motivation for Enterprise Technological Innovation

Businesses seek to maximize profits [4]. Firms with high profitability are more willing to engage in technological innovation [5]. The following hypothesis is proposed:

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H1a: The profit objectives have a positive impact on technological innovation.

Environmental information disclosure can increase the transparency of companies and help them to obtain external funding for research and development [6]. Based on this, the following hypothesis is proposed:

H1b: Environmental regulation has a positive impact on technological innovation.

Governments can intervene in firms' technological innovation through industrial and fiscal policies [7]. Government subsidies not only supplement firms' R&D funds, but also convey the message that firms are worth investing in [8]. Based on this, the following hypotheses are proposed:

H1c: Government subsidies have a positive impact on technological innovation.

2.2 Enterprise Technological Innovation Opportunities

Industry-university-research collaboration can facilitate technological innovations in enterprises, bridging their innovation gaps. The following hypothesis is proposed:

H2a: Technological progress has a positive impact on technological innovation.

Schumpeter believed that firm size and monopoly degree are closely related to enterprise innovation, and market competition can lower a firm's market position, which is not conducive to enterprise innovation [9]. The following hypothesis is proposed:

H2b: Market competition has a positive impact on technological innovation.

SOEs' limited innovation capacity stems from institutional factors, with their tenure target system lacking innovation incentives and impeding technological progress. Based on this, the following hypotheses are proposed:

H2c: Organizational factors have a positive impact on technological innovation.

In corporate technological innovation, differences in organizational leaders' qualities, abilities and psychological characteristics can directly affect the entire innovation process. Based on this, the following hypothesis is proposed:

H2d: Decision-maker characteristics have a positive impact on enterprise technological innovation.

2.3 Enterprise Technological Innovation Capability

As the time of establishment increases, equipment manufacturers gradually accumulate experience in management and innovation. Such enterprises are larger in size and richer in human capital. The possibility of realizing technological innovation is greater. Based on this, the following hypotheses are proposed:

H3a: Enterprise size has a positive impact on enterprise technological innovation.

H3b: Enterprise age has a positive impact on technological innovation.

H3c: Enterprise profitability has a positive impact on technological innovation.

H3d: Enterprise human capital has a positive impact on technological innovation.

Enterprise R&D investment mainly consists of inputs from research personnel and research funds. Based on this, the following hypotheses are proposed:

H3e: R&D personnel investment has a positive impact on technological innovation.

H3f: R&D fund investment has a positive impact on technological innovation.

3 Research Design

3.1 Indicator Selection

Based on the literature review, this paper selects the three dimensions of motivation, opportunity and capability, and combines the data of CSMAR to analyze the equipment manufacturing enterprises in Heilongjiang Province.

This paper evaluates enterprise technological innovation using innovative output, proxied by main business revenue due to limited new product info in annual reports.

The measurement of variables and proxy indicators are shown in Table 1 below.

Table 1. Description of variables (Data sourced from author's compilation)

Variable type	Variable name	Variable Abbreviations	Specific indexes
Technological Innovation Motivation	Profit Goal	X1	Cost of main business/Revenue of main business
	Environmental Regulation	X2	Whether environmental and sustainable development information is disclosed (1 if not disclosed, otherwise 2)
	Government Subsidy	X3	Total subsidies received by the enterprise
Technological Innovation Opportunity	Technology Push	X4	Full-time equivalent R&D personnel of universities and research institutions
	Market Competition	X5	Sales expenses/Total operating revenue
	Organizational Factors	X6	Enterprise ownership structure (State-owned enterprises = 1, otherwise 2)
	Decision-maker Characteristics	X7	Whether the chairperson and general manager hold separate positions (1 if concurrent, otherwise 2)
Technological Innovation Capability	Enterprise Size	X8	Enterprise total assets at the end of the year
	Enterprise Age	X9	Enterprise establishment time
	Profitability	X10	Net profit during the reporting period/Total assets
	Human Capital	X11	Total number of employees in the enterprise
	Personnel Investment	X12	Number of technical personnel in the enterprise
	Fund Investment	X13	R&D expenses/Revenue of main business

3.2 Ridge Regression Analysis Method

Ridge regression is a biased estimation technique for multivariate data analysis. The ridge trace, the path of regression coefficients on a plane, fluctuates with k. Analyzing this trace reveals the influence of independent variables on the dependent variable.

4 Empirical Results and Analysis

4.1 Variable Screening and K Value Selection

After analysis, variables X2, X4, X6, X7, X9 and X10 were excluded. The final ridge plot is shown in Figure 1.

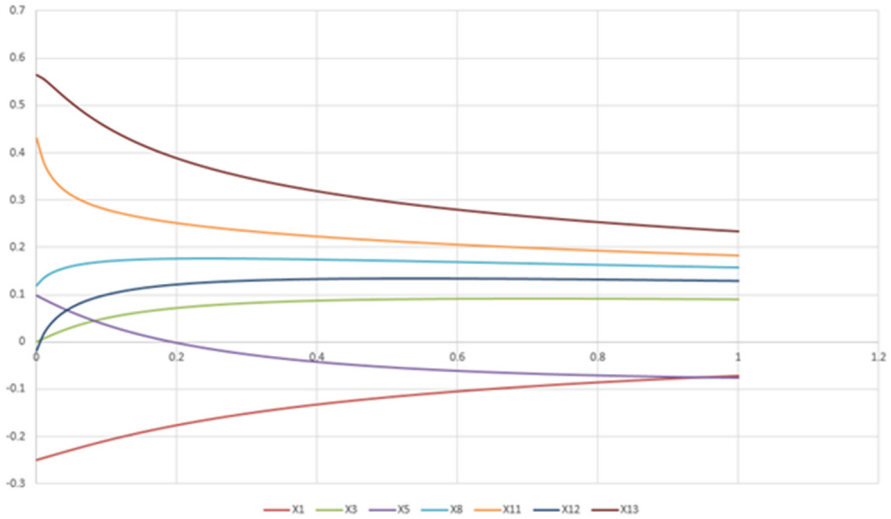

Fig. 1. Ridge trace (Data sourced from author's compilation)

From Figure 1, it can be observed that when k is 0.3, the ridge traces of all independent variables tend to stabilize, and the coefficients no longer change in sign, therefore, k is chosen to be 0.3.

4.2 Regression Results

After determining the best k value to be 0.3, the variables that have been screened are subjected to ridge estimation. The output results of the ridge regression are shown in Table 2.

Table 2. Ridge regression (Data sourced from author's compilation)

Mult R	0.9419
RSquare	0.8872

	Adj RSqu			0.8721	
	SE			0.3577	
		ANOVA table			
	df	SS	MS	F value	Sig F
Regress	7.000	52.347	7.478	58.454	0.000
Residual	52.000	6.653	0.128		
	B	SE(B)	Beta	B/SE(B)	
ZX1	-0.1507	0.0364	-0.1507	-4.1351	
ZX3	0.0828	0.0364	0.0828	2.2698	
ZX5	-0.0259	0.0377	-0.0259	-0.6880	
ZX8	0.1753	0.0373	0.1753	4.6986	
ZX11	0.2343	0.0242	0.2343	9.6464	
ZX12	0.1301	0.0337	0.1301	3.8545	
ZX13	0.3469	0.0354	0.3469	9.7920	
Constant	0.0000	0.0461	0.0000	0.0000	

4.3 Result Analysis

After screening, the importance of factors influencing technological innovation in equipment manufacturing enterprises is ranked as follows: capital investment>human capital>enterprise scale>profit target>personnel investment>government subsidies>market competition. Therefore, H1b, H2a, H2c, H2d, H3b, and H3c were not validated, while H1a, H1c, H3a, H3d, H3e, and H3f were all validated. Among them, investment in R&D is the most critical and significantly outweighs the other factors.

5 Conclusion and Recommendations

The conclusions of this paper are as follows: 1) R&D capital investment is the most critical driver of technological innovation of enterprises. 2) Market competition has a negative effect on technological innovation of equipment manufacturing enterprises in Heilongjiang Province. 3) R&D funding, human capital, enterprise scale, profit target and R&D personnel investment have a significant effect on technological innovation, while government subsidies and market competition have a lesser effect. 4) Motivation and ability promote technological innovation, while the effect of opportunity is not significant. Based on this, the following recommendations are made:

1)Enterprises should boost their economic strength and expand scale.

2)The government should guide the market economy, establish a fair competition environment, and regulate market competition.

3)Enhance industry-academia collaboration, encouraging universities and research institutions to participate in enterprise technological innovation.

4)Strongly support SMEs to prevent monopolies and foster a competitive market.

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