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Technological Innovation and Enterprise Capacity Utilization

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Abstract. China has now entered a stage of high-quality development. Realizing the transformation and upgrading of the manufacturing industry in the new stage is conducive to promoting China's high-quality development process. However, the current problem of insufficient capacity utilization in the manufacturing industry will affect its transformation and upgrading. From the perspective of micro-enterprises based on the data of 1,628 A-share listed companies in China's manufacturing industry, this paper uses a random panel Tobit model to study the impact of technological innovation on enterprise capacity utilization. The research results show that technological innovation promotes the optimization and upgrading of enterprise products, improves the production efficiency of enterprises, and effectively promotes the improvement of enterprise capacity utilization.

Keywords. Technological innovation, capacity utilization

1. Introduction

China's economy has now entered a stage of high-quality development from high-speed development, and building a modernized economic system is the main goal at present. Under the new development pattern, the transformation and upgrading of the manufacturing industry, which is the foundation of the country, is an important link in the construction of a modern economic system. However, problems such as profit loss and rigid industrial organization structure caused by insufficient utilization of manufacturing capacity will hinder its transformation and upgrading. To improve capacity utilization in the manufacturing industry, China has introduced several policies, including eliminating outdated capacity and promoting enterprise mergers and reorganizations. However, the introduction of policies fails to improve the manufacturing capacity utilization to a reasonable level. How to improve the manufacturing capacity utilization substantively has become a difficult problem at present. In fact, in the context of China's gradual reforms, the innovations carried out by micro-subjects and the industrial structure upgrades that may result from them have a positive impact on capacity utilization. At the same time, China's "14th Five-Year Plan" pointed out that it is necessary to adhere to the core position of innovation in the overall situation of China's modernization drive, and to implement the innovation-driven development strategy. Based on the above background, an in-depth study of the relationship between technological innovation and capacity utilization is conducive to exploring ways to

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improve China's manufacturing capacity utilization and enriching the theory of innovation-driven development strategies.

Since China is still in the transition stage from a planned economy to a socialist market economy, Chinese academic circles generally seek ways to resolve the insufficient utilization rate of manufacturing capacity from external factors, such as the intervention of local governments in the investment and production of local enterprises [1], there are few researches on the innovation factors originating from the enterprise. In addition, the direction of the role of innovation remains controversial. Starting from the promotion of market demand, some scholars believe that innovation can effectively improve the capacity utilization rate of enterprises [2]. Other scholars, starting from the bias of technological progress, believe that some China's existing innovation behavior will reduce the capacity utilization rate [3]. To this end, based on the related research on capacity utilization, this paper deeply studies the relationship between technological innovation and capacity utilization, in order to make contributions to related fields.

2. Theoretical Analysis and Research Hypothesis

Technological innovation can be divided into product innovation and process innovation. Product innovation refers to the introduction of new products or services by enterprises in order to meet market demand, while process innovation refers to the development of new elements in the process of production or service operations to produce products or provide services [4]. On the one hand, the entry of new products or services into the market can easily lead to market instability, and the emergence of high-tech, high-value-added products can break the existing competition pattern [5]. Innovation promotes the optimization and upgrading of enterprise products and enhances product market recognition. Through the implementation of product innovation strategies, enterprises are conducive to expanding market demand, and the increase in market demand will significantly improve the capacity utilization rate of enterprises [6]. On the other hand, process innovation brings improvements in production methods and processes for enterprises, which greatly improves the production accuracy and production efficiency of enterprises. Increased precision means higher performance in production and fully guaranteed product quality. The improvement of production efficiency can reduce the loss of materials and the waste of resources such as manpower and equipment in the production process. Enterprises with high production efficiency and high precision can effectively use existing production equipment to meet external production needs without the need for large-scale expansion of production capacity. Based on the above discussion, this paper proposes the following research hypothesis H:

Hypothesis H: Technological innovation is positively correlated with enterprise capacity utilization, and innovation promotes enterprise capacity utilization.

3. Research Design and Model Construction

3.1 Sample selection and data sources

This paper selects Chinese manufacturing A-share listed companies as the research object, and the time span is from 2016 to 2020. In the process of sample selection, ST*, ST, SST company samples were eliminated; Eliminate the samples of companies with

missing financial data and abnormal indicators. After the above adjustment, the data of 1,628 listed companies were finally obtained, with a total sample amount of 8,140. In order to eliminate the influence of inflation factors, producer price index is used to adjust the main business income of listed companies, and GDP deflator is used to adjust other financial data, taking 2010 as the base year. The financial data of listed companies come from WIND database, and the PPI and GDP deflator come from China Statistical Yearbook.

3.2 Capacity utilization measurement

So far, the mainstream methods of capacity utilization measurement include peak method [7], function method [8-9], data envelope method [10-11], etc. The peak method is based on the peak output, but the peak output cannot confirm whether the production capacity is fully utilized. The function method needs to set specific function form, but the production behavior of Chinese enterprises is easily disturbed by external factors, so it is difficult to set the function. Compared with the above methods, the advantage of data envelope method (DEA) is that it does not need to set the production or cost functions of enterprises, and it does not need input-output prices and other difficult data to obtain, so it is more suitable for this study. Therefore, this paper chooses DEA to measure the capacity utilization rate.

It is assumed that input factors include fixed input F, variable input V and technology level $TECH$. Under the data envelopment method (DEA) measurement method, the production capacity can be expressed as $Y(F)$, while the actual output is constrained by variable input and technology level and expressed as $Y(F,V,TECH)$. Since technical level $(TECH)$ is difficult to measure directly, technical efficiency $TE(0 \le TE \le 1)$ is used instead, and actual output is further expressed as $TE*Y(F,V)$. Technical efficiency can be interpreted as the output shortage caused by relatively backward technology in the production process. By comparing the actual output with the production capacity, the capacity utilization ratio (CU) can be obtained, and the formula is as follows:

$$CU = Y(F,V,TECH)/ Y(F) = TE*Y(F,V)/ Y(F) = TE*EU \quad (1)$$

Where, $EU = Y(F,V)/ Y(F)$ is the utilization rate of equipment, reflecting the utilization efficiency of production equipment under variable input constraints. The effective output function $Y(F,V)$ and $Y(F)$ are calculated by DEA method. In the calculation process, fixed assets, labor input and raw materials are selected as input variables, and operating income as output variables. Net fixed assets at the end of the year, the annual average number of employees, the cash flow statement of "purchase of goods, the payment of services", main business income. The model is output oriented BBC model, and the calculation software is MAXDEA8.21.

3.3 Empirical test model design

In order to verify the hypothesis proposed above, this paper constructed the following model to test the impact of technological innovation on enterprise capacity utilization:

$$CU_{i,t} = \beta_0 + \beta_1 RD_{i,t} + \beta_2 Demand_{i,t} + \beta_3 Capital_{i,t} + \beta_4 Share_{i,t} + \beta_5 Turnover_{i,t} + \beta_6 Lev_{i,t} + \varepsilon_{i,t} \quad (2)$$

$CU_{i,t}$ represents the capacity utilization rate of i company (enterprise) in t year; $RD_{i,t}$ represents the innovation level of the enterprise; $Demand_{i,t}$ represents the external market demand faced by the enterprise; $Capital_{i,t}$ represents the capital intensity of the

enterprise; $Share_{i,t}$ represents the ownership concentration of the enterprise; $Turnover_{i,t}$ represents the total asset turnover of the enterprise; $Lev_{i,t}$ represents the asset-liability ratio of the enterprise; ε_i is the error term. Variable definitions and measurement methods are shown in Table 1.

Table 1. Variable Definition and Measurement

Variable Attributes	Variable Code	Variable Meaning	Variable Measuring
Explained Variable	CU	Capacity Utilization	DEA
Explanatory Variable	RD	Technological Innovation	Expenditure of R&D activities, take logarithm
Control Variables	Demand	Market Demand	Growth rate of operating income
	Capital	Capital Concentration	Fixed Assets/Total Assets
	Share	Ownership Concentration	Shareholding ratio of the largest shareholder
	Turnover	Total Asset Turnover	Operating Income/Total Assets
	Lev	Debt Asset Ratio	Total Liabilities/Total Assets

(1) Explained variable. The explained variable is enterprise capacity utilization rate, which is calculated by data Envelopment Method (DEA).

(2) Core explanatory variable. The core explanatory variable is technological innovation level, which is measured logarithmically by the expenditure of R&D activities.

(3) Control variables. Market environment and other enterprise factors also affect enterprise capacity utilization, so some control variables need to be added to improve the explanatory degree of the empirical model. In this paper, market demand, capital intensity, equity concentration, total asset turnover and asset-liability ratio are selected as control variables, and the growth rate of operating income, proportion of fixed assets to total assets, proportion of the largest shareholder, ratio of operating income to total assets and proportion of total liabilities to total assets are respectively used to measure.

4. Empirical results and analysis

Considering that the value of capacity utilization rate is between 0 and 1, which has an obvious truncation property, this paper adopts the random effect panel Tobit model (column 1) to empirically test the relationship between technological innovation and capacity utilization rate. To ensure the robustness of the regression results, the results were compared using a random-effects model (column 2), a fixed-effects model (column 3), and a mixed-effects model (column 4). In Table 2, the regression results of models 1-4 all show that the regression coefficient of R&D investment on capacity utilization is significant at the 1% confidence level, indicating that enterprises increase R&D investment and promote innovation and development to promote capacity utilization. Hypothesis 1 is established. The reason is that, on the one hand, R&D innovation promotes the optimization and upgrading of enterprise products, effectively increasing the technical content, and added value of products. The company thus has the potential for market expansion. The increase in market demand means that companies can greatly digest production capacity, and the utilization rate of production capacity is thus improved. On the other hand, R&D and innovation activities are the fundamental source of improving the technological level of enterprises. R&D innovation brings

improvements in the production methods and processes of enterprises, which is conducive to improving the production efficiency of enterprises and promoting the utilization rate of enterprises' production capacity.

Table 2. Empirical Regression Results

	(1)	(2)	(3)	(4)
RD	0.025***	0.027***	0.037***	0.033***
	(14.01)	(15.60)	(28.05)	(25.53)
Demand	0.001***	0.002***	0.002***	0.002***
	(4.25)	(5.00)	(4.31)	(3.51)
Capital	-0.307***	-0.299***	-0.328***	-0.165***
	(-18.57)	(-18.69)	(-24.14)	(-12.79)
Share	0.011	0.025	0.030***	0.060***
	(0.60)	(1.42)	(2.59)	(4.89)
Turnover	0.313***	0.268***	0.219***	0.242***
	(50.18)	(48.54)	(48.01)	(54.21)
Lev	-0.014	-0.009	0.062***	0.043***
	(-1.22)	(-0.79)	(6.56)	(4.40)
_cons	0.127***	0.128***	0.055***	0.028**
	(7.40)	(7.76)	(4.74)	(2.48)
Year FE	NO	NO	YES	NO
Industry FE	NO	NO	YES	NO
R^2		0.3598	0.4668	0.3755
σ_u	0.136***			
	(51.63)			
σ_e	0.081***			
	(111.60)			
Wald	3655.93***	3531.26***		
N	8140	8140	8140	8140

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. The following article is the same.

The regression results of the control variables are consistent with the actual social development. The regression coefficient of market demand (Demand) on enterprise capacity utilization rate is positive at the 1% confidence level in the four models, indicating that the increase in market demand is conducive to promoting the improvement of enterprise capacity utilization rate. In models 1-4, capital intensity (Capital) is negatively correlated with capacity utilization at the 1% confidence level. If the capital intensity of enterprises continues to be at a high level, it means that R&D innovation activities will face the dilemma of lack of scientific research funds, and the reduction of innovation activities is not conducive to improving enterprise performance. The ownership concentration (Share) is positively correlated with the capacity utilization rate in Model 3-4 at the 1% confidence level, indicating that increasing the ownership concentration promotes the improvement of the enterprise capacity utilization rate. The increase in equity concentration enables controlling shareholders to have higher control over strategic decision-making, which in turn can reduce the resistance to advancing R&D projects. The relationship between total asset turnover (Turnover) and capacity utilization is also relatively robust, and is positively correlated at the 1% confidence level in all four models. The total asset turnover ratio reflects the overall operating efficiency of the enterprise. High operating efficiency means that the enterprise has strong project planning and implementation capabilities, which can aid with R&D activities. In models 3-4, the regression coefficient of the asset-liability ratio (Lev) to capacity utilization is significantly positive at the 1% confidence level. R&D and innovation activities last for a long time. In the process of project operation, it is necessary to continuously provide

financial support and appropriately increase the asset-liability ratio to ensure the steady progress of R&D and innovation activities.

5.Conclusions

From the perspective of micro-enterprises, based on the data of 1,628 A-share listed companies in China's manufacturing industry, using the random panel Tobit model, this paper studies the impact of technological innovation on enterprise capacity utilization and the regulatory effect of the institutional environment. The main research conclusions of the article are: technological innovation activities promote the optimization and upgrading of enterprise products, improve the production efficiency of enterprises, and effectively promote the improvement of enterprise capacity utilization. Based on the research findings, the following policy recommendations are put forward:

First, to promote R&D and innovation of enterprises and improve the overall technical level of the manufacturing industry. The current structural overcapacity problem in China's manufacturing industry is mainly caused by insufficient R&D innovation and backward technological level. Government departments can stimulate the willingness of manufacturing enterprises to innovate by implementing industrial policies that are inclined to the manufacturing industry, such as relaxing the conditions for the identification of manufacturing enterprises as high-tech enterprises. Enterprises receive tax incentives for R&D and innovation, increase investment in R&D and innovation, and further drive the increase in capacity utilization.

Second, build a basic technology sharing platform and promote enterprise cooperation and exchanges. At present, China does not have a basic technology reserve and sharing platform in the strict sense. Government departments should undertake the research and development of basic technology and establish a reserve of basic technology for China. At the same time, the technology reserve should be shared with public enterprises, so that all kinds of innovation entities can benefit from it, and pave the way for various industries in the early stage of innovation and development. In addition, government departments should also promote the exchange, study and cooperation of R&D and innovation activities among enterprises, and conduct technical interaction with the industry as a unit. Backward enterprises learn from advanced enterprises, and enterprises at the same level cooperate to overcome technical difficulties.

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