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Research on Innovation Ecosystem and Industrial Development of Technology Standardization under the Background of Digital Intelligent Manufacturing

Liangtao Zhu

China Jiliang University, Hangzhou, Zhejiang, China

Abstract

His paper takes the equipment manufacturing industry driven by digital intelligent manufacturing as the research object, and takes the policy coordination degree in the technological standardization innovation ecosystem as the entry point as the explanatory variable. At the same time, the relevant financial data of the enterprise is selected as the explained variable, through descriptive statistics and correlation Sexual analysis, regression analysis and other methods have tested the deep connection between the two. Research shows that the technological standardization innovation ecosystem has a positive effect on the development of the intelligent equipment manufacturing industry.

Keywords

Technical specifications; Innovation ecosystem; Smart manufacturing; Policy coordination.

1. Introduction

Technological competition in today's high-tech industry is increasingly fierce, and enterprise competition has gradually evolved from "competition between individual enterprises" to "competition between innovation ecosystems" [1]. China's equipment manufacturing industry has made some achievements in the application of technology standardization innovation ecosystem. According to the Equipment Manufacturing Industry Standardization and Quality Improvement Plan [National Quality Inspection standard Association (2016) No. 396] [2], the National Equipment Manufacturing Industry Standardization Development Plan from 2005 to 2007 [GB/T Industry and Communications Association (2005) No. 7] [3], GB/T 4754 -- 2017 National Economic Industry Classification [4] And the actual situation of standardization management in China to determine the scope of equipment manufacturing standardization work. The equipment manufacturing industry standardization and quality improvement plan is put forward to promote a new generation of information technology, high-end CNC machine tools and robotics, aerospace equipment, Marine engineering equipment and high technology, advanced shipping rail transportation equipment, energy saving and new energy vehicles, electric equipment, agricultural machinery and equipment, new materials, high performance of medical equipment and so on ten big key areas of standardization, Among them only the field of new materials is not in the equipment manufacturing industry eight categories.

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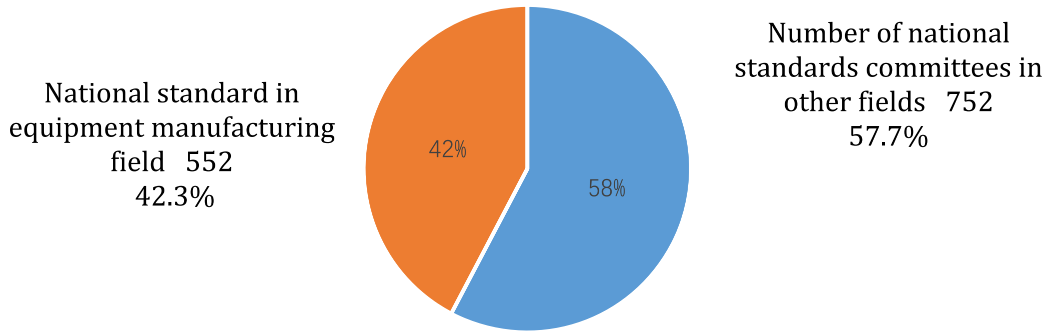

Figure 1. National Professional Standardization Technical Committee of Equipment Manufacturing Industry

With the emergence and continuous development of the innovation ecosystem of technology standardization, its applicable fields are also constantly expanding. At present, many high-tech enterprises in China, such as Huawei, have begun to adopt the technology standardization innovation ecosystem to accelerate their development and gain greater product competitiveness. At the same time, the impact of technological standardization innovation ecosystem on enterprise development has gradually become a topic of keen attention of scholars in this field, and scholars at home and abroad have many research achievements in this direction.

Baron J (2020) analyses policy decisions regarding intellectual property rights (IPR) in a standardized ecosystem. Although there is a large literature that examines the intellectual property policies of standards-setting organizations (SDO), we provide a more rigorous analysis of how the interdependencies between Sdos and between Sdos and various stakeholders shape these IPR policies [5]. Wang Lijun (2020) points out that the interaction between technological innovation and economic growth is mainly negative, but technological innovation still plays a role in promoting economic growth in the medium term. In general, the interaction between standardization and economic growth is mainly positive. The interaction between technological innovation and standardization is mainly positive . HuaLei (2020) on the basis of literature research and field research, combined with analytic hierarchy process (AHP) and expert interview method to construct the micro small and mid-sized enterprise technology innovation ability to promote the standardization of the construction of system, and the weight of each influence factor results within the system comparative analysis, obtained the enterprise technology innovation ability promotion methods . TaoZhongYuan (2020) use of panel data model with variable coefficients, the empirical results show that the technology innovation and standardization on seven sectors synergy degree increase, and the scale of foreign trade and the utilization of foreign capital scale, respectively, only the four types of textile, chemical, pharmaceutical and medical equipment industry and chemical, medical equipment industry synergy degree have a significant role, The effect of government support is not significant .

It can be seen from the existing research results that there are different views on the impact of technological innovation on enterprise development, and there are few studies on the impact of technological standardization innovation ecosystem on enterprise development. This paper innovatively takes the policy coordination degree in the innovation ecosystem of technological standardization as the entry point as the explanatory variable, and selects the relevant financial data of enterprises as the explanatory variable and collects data in the database. On this basis, the regression model between the innovation ecosystem of technology standardization and the development of enterprises in China's equipment manufacturing industry was constructed, and the SPSS mathematical statistics method was used to analyze the relationship between the two. According to the analysis results, corresponding strategies and suggestions are given in order

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to provide reference for the utilization of technology standardization ecosystem in Chinese equipment manufacturing enterprises.

2. Establishment of Technology Standardization Innovation Ecosystem Model

2.1. The Conceptual Model

The conceptual model of technological standardization innovation ecosystem is mainly composed of three parts: technological standardization, innovation ecosystem and government behavior. In this paper, government regulation is used to replace policy coordination degree and a conceptual model of technological standardization innovation ecosystem is established.

At present, under the background of strengthening government service functions, in the development of technology standardization and innovation ecosystem, government behavior is embodied in incentive behavior, normative behavior and long-term behavior, which can be expressed through the government's public policies. In this paper, policy coordination is specifically referred to. In the process of technology standardization, with the continuous development of R&D activities, technical standards activities and industrialization activities, the boundary of the network composed of the relationship between each innovation subject shows dynamic characteristics, and the network effect may be positive or negative. However, the existence of negative network effect makes the individual behavior of some innovation subjects damage the interests of other stakeholders, leading to the withdrawal behavior of some subjects, which damages the scale expansion of the system. The intervention of the government, on the one hand, promotes the accession of new members through incentive policies; On the other hand, the negative network externalities can be restrained by administrative regulations to prevent the withdrawal of system members, thus promoting the expansion of system scale. At the same time, the government's policy is the important drivers of technological standardization (product) diffusion, can promote the standard technology and products such as more quickly by the diffusion source conveyed to accept, as acceptor into across the industry technology, under the network effect and lock-in effect, expanding the boundaries of innovation ecosystem, the system scale expands unceasingly.

2.2. Theoretical Model

From the characteristics and connotation of technological standardization innovation ecosystem, the most basic activities in the process of scientific and technological achievements from research, diffusion, transformation to product production and sales are to meet the effective continuity of supply and demand.

In terms of demand, it is necessary to meet consumers' demand for scientific and technological products, enterprises' demand for science and technology, management methods, scientific and technological talents and funds, universities' demand for talent training, discipline construction and scientific and technological RESEARCH and development, and governments' demand for regional economic and social development. In terms of supply, enterprises provide jobs and scientific and technological products; intermediary institutions provide management consulting, information channel docking, and financial services; universities and scientific research institutions provide scientific and technological talents and scientific and technological R&D achievements; the government provides taxation, support and other relevant industrial development and enterprise development policies and regulations. In order for supply and demand to be effectively sustained and mutually satisfied, it is inevitable that enterprises will be able to provide products to consumers. In order to effectively increase output, enterprises and intermediaries, universities and research institutions, and governments will cooperate. Competition and cooperation between enterprises; The overall

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operation of ecosystem needs effective coordination; Every transaction, cooperation or other business behavior in the operation cycle of the innovation ecosystem inevitably involves the distribution of interests of relevant subjects, which is also the key issue to maintain balance of various innovation subjects and sustainable operation of the innovation ecosystem.

2.3. Hypothesized

H1: The innovation ecosystem of technology standardization plays a positive role in promoting the development of intelligent equipment manufacturing industry.

3. Empirical Analysis of Intelligent Equipment Manufacturing Industry

3.1. The Data Source

In this paper, 120 listed intelligent equipment manufacturing companies were selected from the Choice database to collect the data published in 2019. In the data sorting, the companies with outliers or vacancy values were removed, and the relevant index data of 100 companies were finally obtained with 100 sample observation values.

3.2. Define Variables

Financial indicators such as return on Total assets (ROA) are the ratio of the revenue realized by an enterprise in a certain period to its total assets during that period. It is the core index reflecting the comprehensive utilization effect of enterprise assets, and also an important index to measure the profitability of enterprises. It is a comprehensive reflection of a company's short-term historical performance, but as an accounting profit indicator, it is also susceptible to the influence of managers and earnings management. As the company's market value performance can supplement this aspect and reflect the company's long-term performance and future cash flow income, generally speaking, the academic community commonly used to measure the performance of listed companies include corporate performance and market value performance. In this paper, data is not classified in the selection of data samples. In order to ensure the accuracy of the results, the comprehensive evaluation index of enterprise performance is adopted as the explanatory variable. The acquisition process of enterprise performance comprehensive evaluation indicators is as follows:

In order to calculate the comprehensive evaluation indicators of enterprise performance, relevant performance indicators of enterprises are selected as the basic model, as shown in Table 1. At the beginning of sampling, data were not classified according to region and company attributes, so the explanatory variable selected was comprehensive evaluation of enterprise performance. However, it is difficult to deal with the data, so the principal component analysis method is used to reduce the dimension of the data and build a comprehensive evaluation model of enterprise performance.

Principal component analysis (PCA) has been widely used as a data processing method with simple principle and obvious effect. In this paper, 13 kinds of evaluation index data of each company are collected as the initial data input, and a commercial software is used to complete the data dimension reduction work. The characteristic vectors obtained are shown in Table 2.

It can be seen from the cumulative contribution rate in the table that the cumulative contribution rate of the fourth feature root is 86.184%. It is judged that the first four feature roots can fully represent the initial data and fully contain the information contained in the initial data. The corresponding cumulative contribution rates of the four characteristic roots were 29.089%, 50.460%, 69.258% and 86.184%, respectively, and the respective contribution rates were 29.089%, 21.371%, 18.798% and 16.926.

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Table 1. Corporate performance indicators

The index type	The index name	The index code	Expression
profitability	Return on equity	X_1	Net profit/average net assets
	Return on assets	X_2	Profit before tax/average assets
	Net interest rate on assets	X_3	Net profit/average assets
	Gross profit margin on sales	X_4	(Operating income - operating cost)/operating income
	Net profit margin on sales	X_5	Net profit/sales revenue
Debt paying ability	Quick ratio	X_6	Quick assets/current liabilities
	Current ratio	X_7	Current assets/current liabilities
	Asset-liability ratio	X_8	Liabilities/Assets
Operation ability	Shareholder equity turnover	X_9	Sales revenue/average shareholders' equity
	Total asset turnover	X_{10}	Sales revenue/average assets
Ability to grow	Growth rate of operating income	X_{11}	Growth in operating income/base period operating income
	Growth rate of assets	X_{12}	Growth of assets/base assets
	Net profit growth rate	X_{13}	Net profit growth/base period net profit

After principal component analysis and data processing, the mathematical model is constructed by referring to the practice of Chen Suqin (2018). The following model is constructed in this paper to calculate the comprehensive evaluation of enterprise performance:

$$Y = 0.33253Y_1 + 0.21783Y_2 + 0.14115Y_3 + 0.0924Y_4 \quad (1)$$

Among them, Y is the comprehensive evaluation of enterprise performance, Y_1 , Y_2 , Y_3 , Y_4 is the selected four principal components. The comprehensive evaluation of enterprise performance can be obtained by inputting data into the model.

Table 2. Principal component analysis feature dimension scale

Indicators	The feature vectors			
	λ1	λ2	λ3	λ4
Characteristics of the root	4.323	2.832	1.835	1.201
Cumulative contribution rate (%)	33.253	55.036	69.151	78.393
Return on equity	0.908	0.124	0.249	-0.132
Return on assets	0.908	0.239	0.206	0.005
Net interest rate on assets	0.902	0.2	0.211	-0.048
Gross profit margin on sales	0.581	0.342	-0.691	-0.138
Net profit margin on sales	-0.581	-0.342	0.691	0.138
Quick ratio	-0.414	0.755	0.356	-0.113
Current ratio	-0.425	0.76	0.328	-0.108
Asset-liability ratio	0.195	-0.733	-0.003	-0.468
Shareholder equity turnover	0.301	0.653	0.063	0.473
Total asset turnover	0.367	-0.253	0.613	-0.257
Growth rate of operating income	0.404	-0.388	0.178	0.541
Growth rate of assets	0.536	0.104	0.29	-0.234
Net profit growth rate	0.345	-0.384	0.047	0.512

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In this paper, the interpretation of the variable for policy coordination degree, coordination can be understood as the government at a higher level in order to promote the implementation of cross-sectoral policy goals and, beyond the borders of the existing policy areas beyond the range of a single functional departments, between different departments and integrate the behavior of the policy, the policy coordination degree is one of the embodiment of the depth and breadth. The policy synergy index selected in this paper can be calculated by the policy synergy model as follows:

$$Z_i = \sum_{j=1}^{n} PZ_j \times PM_j \times PC_j \quad (2)$$

In the formula, Z is the policy coordination degree in the technology standardization innovation ecosystem, n represents N departments, J represents the number of policies, PZ policy subject coordination score, PM policy objectives coordination score, PC policy measures coordination score.

In order to make the following empirical analysis more rigorous, this paper chooses the company size, profit margin of main business and asset-liability ratio as control variables. Table 3 lists the names, codes, and explanations of each variable.

Table 3. Variables summary

Variable types	Indicator name and code	Define the indicators
Explained variable	Enterprise Performance Comprehensive Score (Y)	Calculated by principal component analysis
Explanatory variables	Policy synergy (Z_1)	Calculated by policy synergy model
Control variables	Total Asset Turnover (Z_4)	Net sales revenue/total average assets
	Year-on-year growth rate of Net profit (Z_5)	Year-on-year growth rate of net profit = (net profit of this year - net profit of the same period last year)/net profit of the same period last year
	Asset-liability ratio (Z_6)	Total ending liabilities/Total ending assets x 100%

3.3. Regression Model Construction

According to the regression analysis principle and combined with explanatory variables, explained variables and control variables selected in this paper, the regression analysis model is established as follows:

$$Y = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 \quad (3)$$

In the above model, Y refers to the comprehensive evaluation of enterprise performance as the explained variable, Z_1 as the explanatory variable, $Z_2 - Z_4$ is the control variable, namely, the total asset turnover rate, asset-liability ratio and year-on-year growth rate of net profit selected in this paper. $\alpha_1 - \alpha_4$ is the coefficient corresponding to the variable, α_0 for the constant.

3.4. The Data Analysis

3.4.1. Descriptive Statistics

Descriptive statistical analysis is necessary to better understand the data distribution of R&D investment and performance score of the selected sample companies. After the above factor analysis, four principal components and enterprise performance comprehensive score were obtained. Descriptive statistical analysis was conducted by combining the indicators for measuring R&D investment and the control variables selected in this paper. Table 4 shows the results of the descriptive statistical analysis.

Table 4. Descriptive statistical analysis

indicators	N	Minimum	The maximum	The mean	The standard deviation
Comprehensive evaluation of enterprise performance	100	2.73	17.29	7.8414	2.72354
Policy synergy	100	1.17	34.01	10.0226	5.45664
Total asset turnover	100	8.05	205.88	40.1886	24.77602
Asset-liability ratio	100	0.02	4.84	0.7858	0.56621
Year-on-year growth rate of net profit	100	-1555.77	672.78	-17.5835	265.8072
Valid N (list state)	100				

It can be seen from Table 4 that the effective state of the data is 100, in which the maximum value, minimum value and standard deviation of the enterprise comprehensive performance score are 17.29, 2.73 and 2.72354. Therefore, it can be seen that there are certain differences between the samples selected in this paper in the enterprise comprehensive performance score, which is of great research value. The minimum value, maximum value and standard deviation of policy coordination degree are 1.17, 34.01 and 5.45 respectively, indicating that different enterprises have certain differences in policy coordination degree and different implementation degrees of relevant policies. The descriptive statistical analysis of the year-on-year growth rate of net profit shows that the operating conditions of various enterprises are different, and some enterprises are in the state of loss. The other two figures were relatively stable.

3.4.2. Correlation Analysis

In order to ensure the accuracy of the analysis results, it is necessary to conduct correlation analysis on the collected sample data before regression analysis. This paper chooses to conduct correlation analysis on the data and preliminarily judge the correlation of the selected index data through Pearson correlation and significance (bilateral) two indicators.

As can be seen from Table 5, the correlation coefficient between policy synergy degree and enterprise performance comprehensive score is 0.304, and its significance data is 0.002<0.01, proving that there is a significant positive correlation between the two, proving that the original hypothesis H1 should be accepted. Pearson coefficients of total asset turnover, year-on-year growth rate of net profit and comprehensive performance score were 0.034 and 0.325 respectively, and significance data of 0.000 and 0.001 were all less than 0.01, that is, there was a significant positive correlation at 0.01 level. The results show that there is a significant positive correlation between total asset turnover and net profit growth process and enterprise performance comprehensive score.

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Table 5. Correlation analysis

indicators	The correlation	Comprehensive evaluation of enterprise performance	Policy synergy	Total asset turnover	Asset-liability ratio	Year-on-year growth rate of net profit
Comprehensive evaluation of enterprise performance	Pearson	1	.304**	.548**	-0.001	.325**
	Significant		0.002	0	0.989	0.001
Policy synergy	Pearson	.304**	1	-0.142	-0.089	-0.037
	Significant	0.002		0.16	0.379	0.717
Total asset turnover	Pearson	.548**	-0.142	1	-0.115	0.059
	Significant	0.000	0.16		0.255	0.558
Asset-liability ratio	Pearson	-0.001	-0.089	-0.115	1	0.142
	Significant	0.989	0.379	0.255		0.16
Year-on-year growth rate of net profit	Pearson	.325**	-0.037	0.059	0.142	1
	Significant	0.001	0.717	0.558	0.16	

*. Significant correlation at the level of 0.05 (bilateral); **. Significant correlation at 0.01 level (bilateral) : a. List N=100

3.4.3. Regression Analysis

After descriptive analysis and correlation analysis, to make the study more accurate, we now conduct regression analysis on the collected samples. Table 6 shows the regression analysis results of enterprise performance of policy synergy degree.

Table 6. Regression coefficient table

The coefficient of a				
Model	The coefficient of	The standard deviation	T value	P values
Constant	3.009	0.636	4.728	0
Policy synergy	0.202	0.035	5.767	0.000
Total asset turnover	0.065	0.008	8.431	0.000
Asset-liability ratio	0.293	0.34	0.862	0.391
Year-on-year growth rate of net profit	0.003	0.001	4.232	0.000
a.Dependent variable: enterprise performance comprehensive score				
R^2=0.654				

It can be seen from Table 6 that R2 is 0.654, which proves the validity of regression analysis results. The corresponding P value of policy synergy degree is 0.000<0.01, and the corresponding coefficient is 0.202>0, indicating that there is a significant positive correlation between policy synergy degree and enterprise performance comprehensive score. It can be

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seen from the data in the table that there is also a significant positive correlation between total asset turnover and year-on-year growth rate of net profit and enterprise performance comprehensive score, which is consistent with existing research results. The relationship between asset-liability ratio and enterprise comprehensive performance score is not significant, which needs further analysis.

4. Conclusion

Based on the conceptual model and theoretical model of technological standardization innovation ecosystem, this paper deeply studies the relationship between technological standardization innovation ecosystem and the development of intelligent equipment manufacturing industry from the perspective of policy synergy. Through a series of analysis, it is concluded that the innovation ecosystem of technology standardization plays a positive role in promoting the development of intelligent equipment manufacturing industry.

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