

Can Reducing Knowledge Network Sharing Degree Improve Innovation Performance of Specialized and Special New Enterprises? The Role of Financial Constraints

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Abstract

This paper takes the specialized and special new A-share listed companies from 2012 to 2021 as the research samples, and uses the method of combining theoretical and empirical research to explore the impact of knowledge network sharing degree on the innovation performance of specialized and special new enterprises, and analyzes the regulatory effect of financing constraints on this relationship. The empirical results show that reducing the sharing degree of knowledge network of specialized and special new enterprises can significantly improve the innovation performance of enterprises, and financing constraints play a positive regulatory role in this relationship. The heterogeneity test based on the micro characteristics of enterprises shows that in the enterprises with the integration of the chairman and the general manager and the high degree of corporate equity balance, due to the low degree of information asymmetry, reducing the degree of knowledge network sharing has a more significant effect on the improvement of enterprise innovation performance and the regulatory effect of financing constraints. What's more, further research finds that the digital transformation of specialized and special new enterprises can significantly enhance the positive regulatory effect of financing constraints on knowledge network sharing degree and enterprise innovation performance. The research conclusion of this paper is of great significance for the specialized and special new enterprises to strengthen the protection of intellectual property rights, strengthen the "differentiation" competition strategy, and make full use of knowledge resources to create core competitive advantages to achieve sustainable development of enterprises.

Keywords

Knowledge Network Sharing Degree, Innovation Performance of Specialized

1. Introduction

Taking the sharing degree of knowledge elements contained in the classification numbers of invention patents and utility model patents of specialized and special new enterprises among different enterprises as the entry point, this paper attempts to explore the impact of knowledge network sharing degree on the innovation performance of specialized and special new enterprises, and the regulatory effect of financing constraints on this relationship. How to use the embedded effect of knowledge network to make full use of its own knowledge resources has always been an important topic for specialized and special new enterprises. The concept of knowledge network sharing degree is the extension of the concept of knowledge network. Knowledge network sharing degree refers to the sharing degree of knowledge elements among different enterprises. The strength of knowledge sharing among different enterprises is measured by the degree to which the same knowledge element appears in patent applications of different enterprises. The greater the degree of knowledge network sharing of an enterprise, the more fully the potential of its knowledge resources is tapped and utilized, and the smaller the contribution of this knowledge element to the improvement of enterprise innovation performance. The degree of knowledge network sharing of enterprises will also have an important impact on financing constraints and innovation performance.

Strong innovation ability and close relationship with the upstream and downstream of the industrial chain are the significant characteristics of the specialized and special new enterprises. Influenced by the outbreak of the COVID-19 epidemic in recent two years, the speed of economic development slowed down. In this counter trend environment, specialized and special new enterprises closely followed the pace of national strategy, made full use of their own knowledge resources, strengthened information interaction with upstream and downstream enterprises, promoted the transformation and upgrading of traditional business through digital empowerment, constantly improved innovation capabilities, enhanced core competitive advantages, and achieved a sudden rise in the epidemic. On November 23, 2021, [Xu Xiaolan \(2021\)](#), Vice Minister of the Ministry of Industry and Information Technology, said at the policy briefing held by the Office of the National People's Congress of the People's Republic of China, "specialized and special new enterprises are small and medium-sized enterprises with the characteristics of specialization, refinement, characteristics and innovation. They are outstanding among the small and medium-sized enterprises group by building expertise with monographs, supporting strong industries, and winning the market with innovation." It is worth noting that for specialized and special new enterprises, the improvement of innovation ability not only requires en-

terprises to fully tap and utilize existing knowledge resources, but also the diffusion and sharing of knowledge elements among enterprises and in the upstream and downstream industrial chains can inject continuous new impetus into the improvement of enterprise innovation performance, making specialized and special new enterprises an important engine to promote China's economic growth and help China's economy achieve sustainable high quality development.

Generally speaking, the financing constraints faced by enterprises are affected by many internal and external factors, including the development of regional digital economy from a macro perspective (Sheng & Xu, 2021), the political connection between listed companies and the government from a meso perspective (Cui et al., 2022), and the scale of local government debt (Chen & Cui, 2022). From the micro perspective, factors such as the connection of suppliers and customers (Li & He, 2022) and the quality of environmental information disclosure (Ning & Chu, 2022) will affect the financing situation of enterprises. As the leader of small and medium-sized enterprises, the financing constraints faced by specialized and special new enterprises are highly representative. As most of the specialized and special new enterprises are in the growth period and the R&D investment cost is relatively high, if the financing problems faced by them, such as "financing difficulty" and "financing cost", are not effectively solved, the innovation of enterprises will lack sufficient financial support. Moreover, due to the problems of asymmetric internal and external information of enterprises, the diffusion and sharing of knowledge resources among enterprises and the improvement of their own innovation performance will face great resistance.

The research in this paper is also an important expansion of the existing research gap in the economic effects of network embedding. At present, the academic community has studied the economic effects of network embeddedness such as cooperative networks (Zhou & Li, 2022), capital networks (Li et al., 2022), interactive empowerment of social networks and knowledge networks (Xin & Meng, 2021) and dual network embeddedness (Chen & Song, 2022). However, from the perspective of knowledge network embeddedness, the research on the relationship between financing constraints and innovation performance of specialized and special new enterprises is still limited. This paper measures the degree of knowledge network sharing by building a two-mode examination knowledge network, and distinguishes the differences in the degree of knowledge sharing among different enterprises, which is helpful to further reveal the economic effect of network embedding and the "black box" of the mechanism of the impact of financing constraints on enterprise innovation performance.

This paper, taking the A-share listed companies of specialized and special new from 2012 to 2021 as a sample, uses the network analysis software Ucinet and Python crawler method to manually sort out the knowledge elements involved in

the classification number of enterprise invention patents and utility model patent applications, build a two-mode knowledge sharing network for analysis, explore the impact of knowledge network sharing on the innovation performance of specialized and special new enterprises, and analyze the regulatory effect of financing constraints. The empirical results show that reducing the sharing degree of knowledge network can significantly improve the innovation performance of specialized and special new enterprises, and financing constraints play a positive regulatory role on this relationship. In the enterprises where the two positions of chairman and general manager are integrated and the degree of equity balance is high, due to the low degree of information asymmetry, reducing the degree of knowledge network sharing has a more significant role in promoting innovation performance. Further research found that when considering the digital transformation of specialized and special new enterprises, the digital transformation will also significantly enhance the positive regulatory role of financing constraints between knowledge network sharing and innovation performance.

Compared with the existing literature, the contributions of this paper lie in: first, taking knowledge network sharing degree as the starting point, it expands the research on the economic effects of network embedding. The existing literature discusses the economic effects of network embedding, such as knowledge networks (Chen & Song, 2022), cooperation networks (Zhou & Li, 2022), interactive empowerment of social networks and knowledge networks (Xin & Meng, 2021), and the centrality of capital networks (Li et al., 2022). However, few literature studies the network sharing degree of knowledge networks from the perspective of building a two-mode knowledge network. There is no literature to explore the internal mechanism of the impact of network embeddedness on enterprise innovation performance from the perspective of knowledge network sharing degree. The research of this paper finds that reducing the sharing degree of knowledge network can significantly improve the innovation performance of specialized and special new enterprises, and financing constraints play a positive regulatory effect on this relationship, further enriching the relevant research on the economic effects of network embedding. Second, taking the digital transformation of enterprises into consideration will help supplement the relevant research on the digital transformation of specialized and special new enterprises. In further research, this paper examines the microeconomic consequences of digital transformation from the perspective of network embedding, uses Python crawler technology to conduct word frequency statistics on the digital transformation keywords of specialized and special new enterprises, and brings digital transformation factors into the research framework. It is found that the digital transformation of specialized and special new enterprises can significantly enhance the positive regulatory role of financing constraints between knowledge network sharing and enterprise innovation performance. The research conclusion is helpful to understand more deeply the driving role of digital transforma-

tion on the high-quality development of specialized and special new enterprises, and supplement and improve the research related to the digital transformation of specialized and special new enterprises. Third, it has clear and important practical significance. Through the heterogeneity test based on the micro characteristics of enterprises, this paper finds that, in the enterprises where the two positions of chairman and general manager are integrated and the degree of equity balance is high, due to the relatively low degree of information asymmetry, reducing the degree of knowledge network sharing plays a more significant role in improving the innovation performance of specialized and special new enterprises. This conclusion is of great significance for the specialized and special new enterprises to improve corporate governance and enhance corporate governance efficiency.

The structure of the remainder is as follows: the second part is theoretical developments and hypotheses; the third part is methodology, including data and sample, operationalization of key variables and empirical model; the fourth part is results, including descriptive statistics, hypotheses tests, robustness and endogenous tests; the fifth part is heterogeneity test based on micro characteristics of enterprises; the sixth part is additional analysis, considering the digital transformation of enterprises; The last part is research conclusions and suggestions.

2. Theoretical Developments and Hypotheses

The research on knowledge network in the field of management science originated from the Swedish industry in the 1990s, mainly used to explain the knowledge production and dissemination activities in the scientific development. In the subsequent academic research, scholars have a further understanding of the concept of knowledge network. [Seufert et al. \(1999\)](#) used the term knowledge network to describe people, resources and the relationship between them. In recent years, the embedding of knowledge networks in academia has received more extensive attention, and the understanding of knowledge networks has been deepening. [Xu He et al. \(2022\)](#) believe that knowledge network is the sum of all elements and their interactions formed in the process of knowledge creation, transmission and transfer.

Knowledge network embedding is a theoretical model to effectively analyze the path of knowledge flow, which can be used to study the process of knowledge transfer within enterprises and knowledge diffusion between enterprises. Some scholars explore the role of knowledge network embedding from the perspective of improving the efficiency of knowledge acquisition. The research of [Lu Qicheng et al. \(2020\)](#) shows that the internal connectivity of knowledge networks, which represents the flow of knowledge elements, can have a positive impact on the efficiency of enterprise knowledge acquisition through knowledge creation and knowledge transfer. [Yang Chunbaixue et al. \(2020\)](#) believed that with the improvement of enterprise knowledge network centrality and the increase of the number of knowledge elements directly connected with enterprises, enterprises

can obtain cutting-edge knowledge resources more efficiently with more opportunities, lower costs and faster speed, thus helping to improve enterprise innovation performance. Other scholars studied knowledge network embedding from the perspective of diversity of knowledge resources in the network. Enterprises with higher knowledge network status can more easily obtain novel and heterogeneous resources provided by members in the network, thus improving the richness of knowledge resources in the enterprise's knowledge network (Xu Luyun et al., 2021). At the same time, for enterprises, the central enterprises are more connected, that is, they have more partners and knowledge elements, which will bring more additional information to help enterprises use potential resources, help enterprises improve the diversity of knowledge resources, and effectively seize innovation opportunities (Gulati et al., 2015).

The concept of knowledge network sharing degree is an extension of the concept of knowledge network, and it is also one of the important innovations of this paper. Knowledge network sharing degree refers to the sharing degree of knowledge elements among different enterprises. The strength of knowledge sharing among different enterprises can be measured by the degree of the same knowledge element appearing in patent applications of different enterprises. The greater the degree of knowledge network sharing of an enterprise, the more fully the potential of its knowledge resources is tapped and utilized. Theoretically, the higher the degree of knowledge network sharing among enterprises, that is, the more frequently the same knowledge element is used in different enterprises' patents, the more fully the creative potential of this knowledge element is tapped and utilized. Therefore, its contribution to the improvement of enterprise innovation performance will be smaller. When the enterprise has a high degree of utilization of its own knowledge resources, and the knowledge elements are widely shared among different enterprises, the technical knowledge element has a small supporting role for enterprise innovation, and the creative potential and motivation of the knowledge element are relatively low, which is not conducive to the exclusive patent innovation of the enterprise.

The concept of financing constraint was first put forward by Kaplan and Zingales (1997). It means the difference between internal and external financing costs of enterprises due to market imperfections such as information asymmetry and agency problems, which makes enterprises with potential good performance unable to obtain possible profits due to "lack of money".

In the development process of our socialist market economy, small and medium-sized enterprises play an important role. However, due to the opaque information of small and medium-sized enterprises, the inadequate accounting system, and often the inability to provide adequate guarantees or mortgages, financial institutions are often difficult to effectively overcome the adverse selection problem caused by information asymmetry (Lin & Sun, 2005). Due to the lack of corresponding social trust mechanism and poor information communication with the outside world, small and medium-sized enterprises will have dif-

difficulty in financing. According to the free cash flow theory, when an enterprise faces relatively strict financing constraints, there is less free cash flow in the enterprise. At this time, the agency problem faced by the enterprise is often relatively small, which is conducive to the enterprise making investment decisions in line with its long-term interests, increasing R&D investment, and improving the innovation performance of the enterprise. That is, financing constraints have a positive impact on innovation performance. Empirical studies have found that financing constraints can promote new product development and improve the efficiency of R&D investment (Baker & Nelson, 2005; Zhang, 2021). Therefore, financing constraints have a positive impact on the relationship between knowledge network sharing and innovation performance.

When we explore the financing constraints faced by small and medium-sized enterprises from the perspective of resource limitation, we can understand it from two aspects. On the one hand, compared with domestic listed companies, small and medium-sized enterprises are relatively small in scale and short of funds, and they often cannot provide adequate guarantee or mortgage, and lack of mortgageable assets. The lack of their own resources is an important reason for small and medium-sized enterprises to face financing constraints; On the other hand, the total amount of currency in circulation in society is certain for a certain period, that is, the total amount of loans made by banks and other financial institutions is limited. According to the principle of “investment first”, banks and other financial institutions tend to choose large enterprises with good operating income and guaranteed debt paying ability when choosing loan objects, which further aggravates the financing difficulties faced by small and medium-sized enterprises. The innovation theory believes that the limited resources will lead to the reduction of alternative paths, which will stimulate the creativity of enterprises, help to improve the utilization of existing resources of enterprises and the sharing of knowledge resources among enterprises, alleviate the unfavorable conditions of the lack of resources of small and medium-sized enterprises, and thus help to improve the innovation performance of enterprises.

When exploring the impact of financing constraints on innovation performance, innovation theory holds that when the degree of financing constraints faced by enterprises increases, the funds in enterprises are limited, and the development paths available to enterprises are reduced. On the contrary, it will force enterprises to improve the efficiency of resource utilization and maximize the use of existing knowledge resources, which will help enterprises improve their innovation performance and enhance their core competitiveness. Based on the above analysis, the conceptual framework of this study is listed in **Figure 1**, and this paper proposes the following assumptions:

Hypothesis 1a: Reducing knowledge network sharing degree has a significant role in promoting innovation performance.

Hypothesis 1b: Financing constraints significantly promote innovation per-

formance.

Hypothesis 2: Financing constraints play a positive regulatory role between knowledge network sharing degree and innovation performance.

3. Methodology

3.1. Data and Sample

This paper selects specialized and special new enterprises listed on A-share market from 2012 to 2021 as the research sample. Since China's policy on specialized and special new enterprises was first proposed by the Ministry of Industry and Information Technology in the 12th Five Year Plan for the Growth of Small and Medium-sized Enterprises in September 2011, and the CSRC has implemented new industry classification standards since 2012, the sample range starts from 2012. Manually select A-share listed companies as research samples from the list of three batches of specialized and special new enterprises identified and released by the Ministry of Industry and Information Technology in 2019, 2020 and 2021, and conduct the following processing: 1) exclude ST, *ST enterprises; 2) in consideration of the differences in accounting treatment of enterprises, the sample of financial and insurance companies is eliminated; 3) considering the integrity of sample data, samples with default values are eliminated. Finally, we obtained 313 samples of A-share listed specialized and special new companies.

For the 313 sample enterprises listed on A-share market, there are 73 in mechanical equipment industry (23.32%), 41 in chemical industry (13.10%), 35 in pharmaceutical and biological industry (11.18%), 42 in electronic industry (13.42%), and 35 in electric equipment industry (11.18%). These five industries total 226, accounting for 72.20%. It shows that the industry distribution of A-share listed companies that are specialized and special new companies mainly focuses on high-end equipment manufacturing, new materials, new energy and other high-end manufacturing fields.

Empirical data such as knowledge network sharing degree, innovation performance and financing constraints are from CSMAR database and CNRDS database. The data of patent applications and patent classification numbers of listed companies used to calculate knowledge network sharing degree and innovation performance are from the database of China Research Data Service

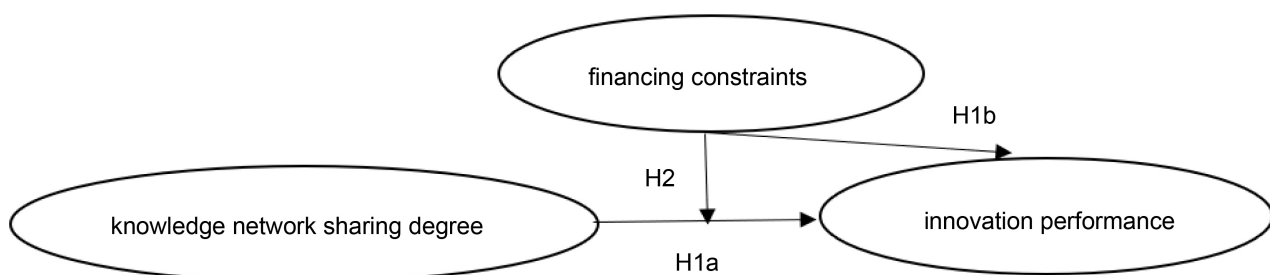


Figure 1. Conceptual framework.

Platform (CNRDS). After manual processing and summary, the data of enterprise knowledge network sharing degree and innovation performance are obtained. Data used to calculate financing constraints and control variables are from CSMAR database. The empirical software includes Stata16.0 and Ucinet6.0. In order to prevent the influence of extreme values, all continuous variables were tailed by 1%. All the standard errors of the regression in this paper are clustered at the company level. A total of 864 sample observations were obtained.

3.2. Operationalization of Key Variables

3.2.1. Innovation Performance

This paper uses the enterprise patent application data in the database of China Research Data Service Platform (CNRDS), with reference to the innovation performance measurement method used by *Yu Yongze and Liu Dayong (2013)*, to measure the innovation ability of enterprises. The calculation formula is as follows (1):

$$\text{Innov} = 0.5 \times \text{Invention} + 0.3 \times \text{Utility} + 0.2 \times \text{Design} \quad (1)$$

3.2.2. Knowledge Network Sharing Degree

The samples of A-share listed specialized and special new companies used in this paper are from different industries. Although the technology categories of each industry are different, the knowledge elements can still be shared among industries and are not unique to enterprises. Therefore, the first three digits of the IPC classification number are used as knowledge elements to build a knowledge network. The greater the degree of knowledge network sharing of an enterprise, the more fully the potential of its knowledge resources is tapped and utilized. Referring to the practice of *Li Yuanyuan et al. (2022)*, the specialized and special new enterprises and knowledge elements are regarded as two types of nodes in the network, and a dual-mode knowledge network is built in the form of two in common, as shown in formula (2). Then the two-mode matrix is transformed into a unimodular matrix in Ucinet through “Data-Affiliations (Row)” based on behavioral standard, that is, the number of times the same knowledge element is shared among different enterprises is measured, and the strength of knowledge sharing between different enterprises is measured. After being symmetrically and binarized, the “Network-Centrality-Degree” operation is performed to calculate the point centrality of each node, thereby building the knowledge network sharing degree of specialized and special new A-share listed companies from 2012 to 2021.

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1j} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2j} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & a_{i3} & \cdots & a_{ij} \end{bmatrix}, \quad i \in (1, +\infty); \quad j \in (1, +\infty) \quad (2)$$

3.2.3. Financing Constraints

Referring to existing research, compared with KZ index, WW index, investment cash flow sensitivity coefficient and other indicators measuring corporate financ-

ing constraints, SA index only uses two variables: size and age when calculating corporate financing constraints, which can better avoid variable endogeneity. The calculated SA index is negative. The smaller the value of this index, the more serious the financing constraints faced by enterprises. The calculation formula is shown in formula (3):

$$SA = -0.737Size + 0.043Size^2 - 0.04Age \quad (3)$$

3.2.4. Control Variables

Referring to existing relevant studies (Gao et al., 2021), this paper controlled variables related to the company's operation, financial status and corporate governance in the process of empirical testing. Previous studies have shown that enterprise size has an important impact on innovation performance, so it is included in the control variable. This paper takes profitability (ROA), growth (Growth) and solvency (Lev) as control variables to comprehensively measure the financial status of enterprises from three dimensions. At the same time, this paper includes the chairman and general manager's dual role integration (DUAL) and equity balance (Top31) used in the heterogeneity test based on the enterprise's micro characteristics into the control variables. In terms of corporate governance, this paper also selects the equity concentration (Top1), the proportion of independent directors (PID) and the nature of property rights (State) as control variables. In addition, the Year and Ind effects of the enterprise are controlled.

See Table 1 for the specific meaning and measurement of each variable.

3.3. Empirical Model

According to previous analysis, in order to verify H1a and H1b, as well as test the relationship between knowledge network sharing degree, financing constraints and innovation performance of specialized and special new enterprises, a benchmark regression model 1 is constructed.

Model 1:

$$\begin{aligned} Innov_{i,t} = & \alpha_0 + \alpha_1 Degree_{i,t} + \alpha_2 SA_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 ROA_{i,t} \\ & + \alpha_5 Growth_{i,t} + \alpha_6 Lev_{i,t} + \alpha_7 Top31_{i,t} + \alpha_8 DUAL_{i,t} \\ & + \alpha_9 PID_{i,t} + \alpha_{10} State_{i,t} + \Sigma IND + \Sigma Year + \varepsilon_{i,t} \end{aligned}$$

In order to verify H2 and test the positive moderating effect of financing constraints between knowledge network sharing degree and innovation performance, a moderating effect model 2 is constructed.

Model 2:

$$\begin{aligned} Innov_{i,t} = & \alpha_0 + \alpha_1 Degree_{i,t} + \alpha_2 SA_{i,t} + \alpha_3 SA_{i,t} \times Degree_{i,t} + \alpha_4 Size_{i,t} \\ & + \alpha_5 ROA_{i,t} + \alpha_6 Growth_{i,t} + \alpha_7 Lev_{i,t} + \alpha_8 Top31_{i,t} + \alpha_9 DUAL_{i,t} \\ & + \alpha_{10} PID_{i,t} + \alpha_{11} State_{i,t} + \Sigma IND + \Sigma Year + \varepsilon_{i,t} \end{aligned}$$

In the above model, the definition and measurement of each variable are detailed in the previous text, and the meaning and measurement of other control

Table 1. Variables description summary.

Name	Symbol	Explanation and measurement	Source
Innovation performance	Innov	Weighted average of invention patent, utility patent and design patent	Yu Yongze et al. (2013)
Knowledge network sharing degree	Degree	The degree centrality of knowledge sharing network	Li Yuanyuan et al. (2022)
Financing constraints	SA	The SA index of financing constraints	Benlu Hai et al. (2022)
Company size	Size	The natural logarithm of total assets	
Company profitability	ROA	The net interest rate of total assets of listed companies	
Corporate growth	Growth	The operating income growth rate of listed companies	
Solvency of the company	Lev	The asset liability ratio of listed companies	
Company equity concentration	Top1	The shareholding ratio of the largest shareholder of listed companies	
Equity balance of the company	Top31	(Shareholding ratio of the top three shareholders—Shareholding ratio of the largest shareholder)/Shareholding ratio of the largest shareholder	Gao Jingzhong et al. (2021)
Whether the chairman and general manager are integrated	DUAL	When the chairman and the general manager are held by one person at the same time, take 1; otherwise, take 0	
Proportion of independent directors	PID	Number of independent directors/Number of directors	
Nature of property right	State	If the enterprise is a state-owned enterprise, take 1; otherwise, take 0	

variables are detailed in **Table 1** above.

4. Results

4.1. Descriptive Statistics

The descriptive statistical results of the main variables in this paper are shown in **Table 2**. The average value of the innovation performance indicators of specialized and special new enterprises is 9.885, the median is 6.5, the minimum value is 0, the maximum value is 61, and the standard deviation is 10.154, indicating

Table 2. Descriptive statistics.

Variables	N	Mean	SD	P50	Min	Max
Innov	864	9.885	10.154	6.500	0.000	61.000
Degree	864	3.936	5.218	0.000	0.000	14.423
SA	864	-3.715	0.200	-3.699	-4.293	-3.234
Size	864	21.122	0.612	21.039	19.871	23.219
ROA	864	0.062	0.065	0.049	-0.110	0.611
Growth	864	0.131	0.997	-0.119	-0.651	8.110
Lev	864	0.255	0.138	0.226	0.044	0.652
Top1	864	33.458	12.992	31.280	10.750	69.280
Top31	864	0.622	0.443	0.499	0.060	2.000
DUAL	864	0.428	0.495	0.000	0.000	1.000
PID	864	0.392	0.072	0.375	0.273	0.600
State	864	0.072	0.258	0.000	0.000	1.000

that the patent innovation of specialized and special new enterprises is relatively good, but there is a large difference between enterprises. The average value of knowledge network sharing degree is 3.936, the maximum value is 14.423, the standard deviation is 5.218, and the median is 0, which indicates that the overall knowledge network sharing degree among specialized and special new enterprises is low. The average value of SA index of financing constraints is -3.715, the median is -3.699, the standard deviation is 0.2, and the median is slightly higher than the average value, indicating that the overall financing constraints faced by specialized and special new enterprises are relatively high and the difference between enterprises is small. The mean and median of other control variables are basically in a reasonable range.

4.2. Hypotheses Tests

In order to verify the relationship between knowledge network sharing degree, financing constraints and innovation performance of specialized and special new enterprises, this paper adopts a progressive regression strategy, and the regression results are shown in **Table 3**. In **Table 3**, the results of column (1) show that the coefficient between knowledge network sharing degree Degree and innovation performance Innov is -0.309 without controlling relevant control variables, and it is significant at the 10% level; the results of column (2) show that, after controlling the relevant control variables, although the coefficient size and the corresponding t value have decreased, the knowledge network sharing degree Degree and innovation performance Innov can be significantly negatively correlated at the level of 5%, that is, reducing the knowledge network sharing degree can significantly promote innovation performance, H1a has been verified. The

Table 3. Main hypotheses testing results.

	(1)	(2)
	Innov	Innov
Degree	-0.309*	-0.474**
	(-1.876)	(-2.524)
SA	-1.809	0.008
	(-0.569)	(0.003)
Size		5.151***
		(3.683)
ROA		-6.019
		(-0.860)
Growth		0.785**
		(2.151)
Lev		6.610
		(1.575)
Top1		0.074
		(1.136)
Top31		1.947
		(0.949)
DUAL		-0.122
		(-0.106)
PID		1.319
		(0.192)
State		-1.085
		(-0.483)
Constant	-2.449	-106.263***
	(-0.224)	(-3.696)
IND	controlled	controlled
Year	controlled	controlled
Observations	519	519
Adjusted R-squared	0.081	0.158

Note: ***represents $p < 0.01$, **represents $p < 0.05$, and *represents $p < 0.1$; the value in brackets is t, and the standard is wrongly clustered at the company level. The same below.

results in **Table 3** show that no matter whether the relevant control variables are controlled or not, the coefficient between financing constraint SA and innovation performance Innov is not significant, and H1b is not valid.

In order to examine the moderating role of financing constraints in the relationship between knowledge network sharing degree and innovation performance

of specialized and special new enterprises, this paper constructs model 2 to verify it. The inspection results are shown in **Table 4**. In **Table 4**, the results of column (1) show that before the centralization of financing constraint variables, the coefficient between knowledge network sharing degree Degree and enterprise

Table 4. Moderating effect testing results.

	Before Centralization	After Centralization
	(1)	(2)
	Innov	Innov
Degree	7.042** (2.262)	-0.252 (-1.211)
SA	-0.341 (-0.110)	-0.341 (-0.110)
SA × Degree	1.964** (2.448)	1.964** (2.448)
Size	5.064*** (3.637)	5.064*** (3.637)
ROA	-6.001 (-0.847)	-6.001 (-0.847)
Growth	0.855** (2.305)	0.855** (2.305)
Lev	7.680* (1.772)	7.680* (1.772)
Top1	0.085 (1.295)	0.085 (1.295)
Top31	2.107 (1.030)	2.107 (1.030)
DUAL	-0.095 (-0.082)	-0.095 (-0.082)
PID	0.958 (0.139)	0.958 (0.139)
State	0.703 (0.500)	0.703 (0.500)
Constant	-110.015*** (-3.897)	-108.746*** (-3.724)
IND	controlled	controlled
Year	controlled	controlled
Observations	519	519
Adjusted R-squared	0.160	0.160

innovation performance Innov is 7.042, which is significant at the 5% level. The coefficient of the cross item between financing constraint SA and knowledge network sharing degree Degree is 1.964, which is significantly positive at the 5% level; the results of column (2) show that after centralizing the financing constraint variables, the coefficient of the cross multiplying term of the sharing degree of the financing constraint SA and the knowledge network sharing degree Degree is 1.964, which can still be significant at the 5% level. Centralization refers to the de-averaging of the SA index of the regulating variable. The purpose of the centralization is to make the coefficient have a more intuitive meaning. It can be seen that whether the regulatory variable financing constraint SA is centralized or not, the financing constraint plays a positive role in regulating the sharing degree of knowledge network and the innovation performance of specialized and special new enterprises. Assume that H2 is verified.

4.3. Robustness and Endogenous Test

4.3.1. Tool Variable Method

Because the research in this paper may have an endogenous problem caused by the reverse causality, that is, specialized and special new enterprises with high innovation output tend to be unique to key technologies and knowledge resources rather than sharing knowledge resources. The low degree of knowledge network sharing is not the reason for the better innovation performance of specialized and special new enterprises, but the result. Therefore, this paper intends to adopt the instrumental variable method to alleviate the endogenous problems caused by the reverse causality. With reference to the existing literature, this paper selects the number of categories of international patent classification numbers included in enterprise patent applications, the academic background of enterprise executives, and the weighted average of the two as the tool variable, and uses two-stage least square method for estimation test.

First, the regression analysis of the first stage of the two-stage least squares method is carried out in this paper, and the results are shown in column (1) of **Table 5**. The result of column (1) shows that the coefficient between the tool variable Network and Degree is 0.1155, and there is a significant positive correlation at the 10% level. It can be seen that the correlation between the endogenous variable Degree and the tool variable is high, and the error of using the tool variable method to estimate is small. It is reasonable to take the number of categories of international patent classification numbers contained in enterprise patent applications, the academic background of enterprise executives, and the weighted average of the two as the tool variables. On this basis, the second stage of regression analysis is carried out in this paper, and the regression results are shown in column (2) of **Table 6**. The result of column (2) shows that the coefficient between enterprise innovation performance Innov and knowledge network sharing degree Degree is -3.2820 , and there is a significant negative correlation at the 10% level. The above regression results show that the conclusion that reducing the sharing degree of knowledge network can significantly improve the

Table 5. Instrumental variable method testing results.

	First Stage Regression	Second Stage Regression
	(1)	(2)
	Degree	Innov
Degree	0.1155* (1.6783)	-3.2820* (-1.7392)
Size		6.7396*** (3.3045)
ROA	0.2188 (0.5204)	-5.6387 (-0.6730)
Growth	-0.0067 (-0.2227)	0.1436 (0.2178)
Lev	0.9773*** (3.3783)	6.0736 (0.9898)
Top1	-0.0052 (-1.1028)	0.1626 (1.2267)
Top31	-0.1760 (-1.3020)	3.8838 (1.3081)
DUAL	-0.0476 (-0.5067)	-2.2212 (-1.1153)
PID	-0.0421 (-0.0723)	-13.5576 (-1.0241)
State	-0.2207 (-0.5210)	6.9156 (0.8782)
Constant	21.2499*** (58.2086)	-137.3933*** (-2.9871)
IND	controlled	controlled
Year	controlled	controlled
Observations	510	510

innovation performance of specialized and special new enterprises is still valid after using the tool variable method to deal with the endogenous problems caused by the reverse causality, which further supports the expected hypothesis of this paper.

4.3.2. Hausman Test and Random Effect Model

Although this paper controls some variables that may affect the relationship between knowledge network sharing degree, financing constraints and innovation performance of specialized and special new enterprises, there may still be endogenous problems caused by sample selection errors, that is, samples are not

Table 6. Random effect model testing results.

	(1)	(2)
	Innov	Innov
Degree	-0.3220*	-0.5230***
	(-1.6496)	(-2.7597)
SA	-2.8432	1.5522
	(-0.9340)	(0.5590)
Size		5.4747***
		(3.6730)
ROA		1.0408
		(0.2121)
Growth		0.4126*
		(1.7225)
Lev		3.4890
		(0.8095)
Top1		0.0291
		(0.4070)
Top31		-0.2317
		(-0.1083)
DUAL		-0.7568
		(-0.6853)
PID		-1.0467
		(-0.1674)
State		1.2109
		(0.6884)
Constant	-4.1329	-102.4903***
	(-0.3931)	(-3.3605)
IND	controlled	controlled
Year	controlled	controlled
Observations	519	519
Number of ID	188	188

representative. In the selection of fixed effect model and random effect model, this paper first conducts Hausman test, and the test results show that the original hypothesis could not be rejected. Therefore, this paper chooses random effect model to deal with such endogenous problems, and the regression results are shown in **Table 6**. The results of column (1) in **Table 6** show that, when relevant control variables are not controlled, the coefficient between knowledge network sharing degree Degree and innovation performance Innov is -0.3220, which is

significant at the 10% level; The results of column (2) show that after controlling the relevant control variables, the coefficient between knowledge network sharing degree Degree and innovation performance Innov is -0.5230 , which is significant at the level of 1%. It can be seen that after the random effect test, the conclusion that reducing the degree of knowledge sharing network can significantly improve the innovation performance of specialized and special new enterprises is still valid, regardless of whether the relevant control variables are controlled. At the same time, through the random effect test, it can be inferred that the main conclusions of this paper are also robust for specialized and special new enterprises as a whole, which further deepens the expected assumptions of this paper.

4.3.3. Placebo Test

In order to further enhance the robustness of the test results, verify that reducing the sharing degree of knowledge networks is the main reason for specialized and special new enterprises to improve innovation performance, and confirm that there are no other variables related to the sharing degree of knowledge networks but cannot be observed to affect the innovation performance of enterprises. Refer to the practices of Pan Yue et al. (2017), Xu Nianxing and Li Zhe (2016), the degree centrality of the knowledge network sharing degree in that year was randomly assigned to each specialized and special new A-share listed company, and the knowledge network sharing degree and enterprise innovation performance in random order were regressed 500 times according to model 1. The regression results of Placebo test using the degree of knowledge network sharing as the proxy variable of knowledge network sharing degree are shown in Figure 2 and Table 7.

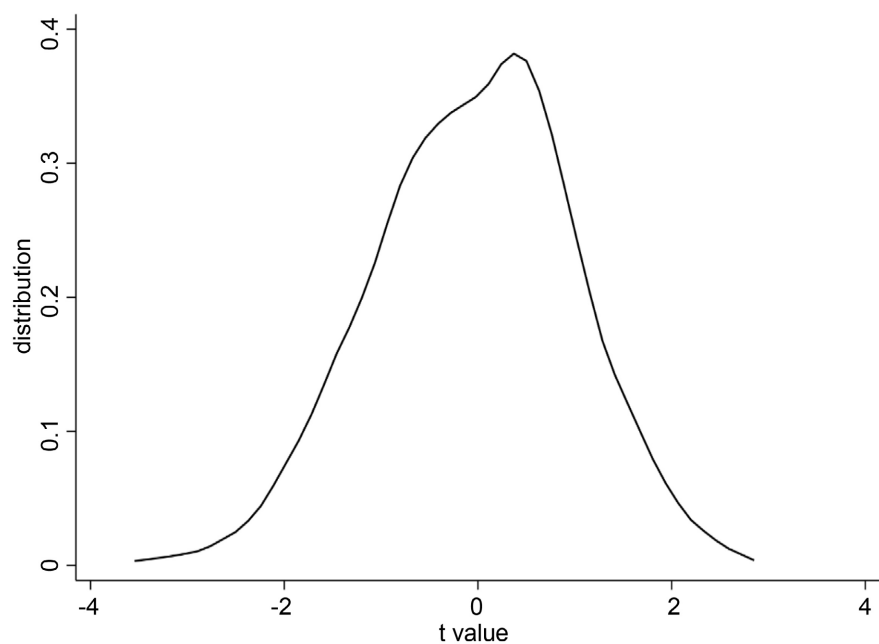


Figure 2. 500 Placebo inspection results.

Table 7. Statistical distribution of dummy effect regression results.

	N	Mean	P5	P25	P50	P75	P95	SD
coefficient	500	0.0003	-0.1207	-0.0577	-0.0024	0.0542	0.1349	0.0776
t value	500	-0.0361	-1.6748	-0.7749	-0.0307	0.6915	1.724	1.0337

From the results in **Figure 2** and **Table 7**, the proportion of significantly positive and significantly negative coefficients in the results is relatively small, which means that the virtual processing effect of the knowledge network sharing degree constructed in this paper does not exist, indicating that the improvement of innovation performance of specialized and special new enterprises is really caused by the reduction of knowledge network sharing degree, and there is no impact of missing important variables. This test result proves once again that the main conclusions of this paper have good robustness.

4.3.4. Change the Measurement Method of Innovation Performance

From the perspective of industry distribution, the sample specialized and special new enterprises used in this paper are mainly concentrated in high-end equipment manufacturing, new materials, new energy and other high-end manufacturing fields. Influenced by industry characteristics, enterprise life cycle, enterprise development strategy and other factors, different enterprises pay different attention to invention patents, utility model patents and design patents, and the focus on patent applications is also different. Drawing on the research ideas of **Zhang Yong'an and Guan Yongjuan (2021)**, the sum of the company's invention patents, utility model patents and design patents (Innov2) is used to measure the innovation performance of enterprises, and benchmark regression and moderating effect tests are conducted. The regression results are shown in **Table 8** and **Table 9**. It can be seen from the results in **Table 8** that after changing the innovation performance measurement method, the coefficient between knowledge network sharing degree (Degree) and innovation performance (Innov2) is -1.261 under the control of relevant control variables, which is significant at the level of 5%, that is, reducing knowledge network sharing degree has a significant role in promoting innovation performance; the coefficient between financing constraints (SA) and innovation performance (Innov2) is not significant, that is, financing constraints have no direct impact on innovation performance. It can be seen from the results in **Table 9** that after changing the measurement method of innovation performance, no matter whether the financing constraint variables are centralized or not, the coefficients of the cross multiplying items between the financing constraint (SA) and the knowledge network sharing degree (Degree) are significantly positive, that is, the positive moderating effect of the financing constraint (SA) is still significant. The regression results still support the original hypothesis, and the main conclusions of this paper are robust.

4.3.5. Other Robustness Tests

In order to further enhance the robustness of the research conclusions, and

Table 8. Benchmark regression testing results of changing innovation performance measurement method.

	(1)	(2)
	Innov2	Innov2
Degree	-0.799*	-1.261**
	(-1.751)	(-2.310)
SA	-5.954	-1.067
	(-0.715)	(-0.131)
Size		13.930***
		(3.713)
ROA		-13.490
		(-0.766)
Growth		1.935**
		(2.082)
Lev		16.394
		(1.561)
Top1		0.191
		(1.112)
Top31		5.549
		(0.993)
DUAL		-0.822
		(-0.271)
PID		2.300
		(0.133)
State		-2.918
		(-0.485)
Constant	-11.025	-291.040***
	(-0.385)	(-3.738)
IND	controlled	controlled
Year	controlled	controlled
Observations	519	519
Adjusted R-squared	0.094	0.174

confirm that reducing the sharing degree of knowledge networks can significantly improve the innovation performance of specialized and special new enterprises and the positive moderating effect of financing constraints, this paper also conducts the following robustness tests: 1) The core explanatory variable

Table 9. Moderating effect testing results of changing innovation performance measurement method.

	Before Centralization	After Centralization
	(1)	(2)
	Innov2	Innov2
Degree	19.138** (2.257)	-0.657 (-1.054)
SA	-2.016 (-0.246)	-2.016 (-0.246)
SA × Degree	5.329** (2.459)	5.329** (2.459)
Size	13.695*** (3.666)	13.695*** (3.666)
ROA	-13.442 (-0.754)	-13.442 (-0.754)
Growth	2.127** (2.252)	2.127** (2.252)
Lev	19.297* (1.790)	19.297* (1.790)
Top1	0.221 (1.279)	0.221 (1.279)
Top31	5.983 (1.073)	5.983 (1.073)
DUAL	-0.749 (-0.246)	-0.749 (-0.246)
PID	1.321 (0.076)	1.321 (0.076)
State	1.935 (0.495)	1.935 (0.495)
Constant	-301.220*** (-3.944)	-293.732*** (-3.777)
IND	controlled	controlled
Year	controlled	controlled
Observations	519	519
Adjusted R-squared	0.177	0.177

lags behind by one period. Considering that the impact of knowledge network sharing degree on enterprise innovation performance may have a time lag, the core explanatory variable, knowledge network sharing degree, is regarded to test the robustness of the conclusion by lagging one period (L. Degree). 2) Median regression. In this paper, the median (Degree_m) of the knowledge network sharing degree of the same industry in the same year is used for regression to mitigate the impact of external environmental factors such as industry and year on the regression results, and again verify the robustness of the conclusions. The benchmark regression results in the above empirical tests are listed in columns (1) to (2) of **Table 10**, and the moderating effect results are listed in columns (1)

Table 10. Benchmark regression testing results of other robustness tests.

	Lag Core Variable	Median Regression
	(1)	(2)
	Innov	Innov
L.Degree	-0.384** (-1.993)	
Degree_m		-0.313* (-1.847)
Size	5.027*** (3.596)	4.896*** (3.595)
ROA	-0.326 (-0.025)	-5.655 (-0.795)
Growth	1.087 (1.375)	0.895** (2.391)
Lev	8.592 (1.515)	6.435 (1.489)
Top1	0.134* (1.713)	0.066 (1.000)
Top31	2.875 (1.270)	1.816 (0.873)
DUAL	-1.123 (-0.858)	0.240 (0.217)
PID	6.760 (0.934)	4.006 (0.592)
State	-4.575* (-1.717)	-2.390 (-0.705)
Constant	-108.020*** (-3.779)	-102.902*** (-3.500)
IND	controlled	controlled
Year	controlled	controlled
Observations	321	321
Adjusted R-squared	0.197	0.148

Table 11. Moderating effect testing results of other robustness tests.

	Lag Core Variable	Median Regression
	(1)	(2)
	Innov	Innov
L.Degree	6.624*	
	(1.678)	
Degree_m		0.077
		(0.372)
SA	-0.647	-0.037
	(-0.172)	(-0.012)
SA × L.Degree	1.822*	
	(1.807)	
SA × Degree_m		0.126**
		(2.592)
Size	4.963***	5.150***
	(3.566)	(3.688)
ROA	-2.033	-6.024
	(-0.155)	(-0.860)
Growth	1.145	0.787**
	(1.419)	(2.156)
Lev	9.594	6.681
	(1.625)	(1.593)
Top1	0.147*	0.075
	(1.830)	(1.149)
Top31	3.065	1.961
	(1.343)	(0.956)
DUAL	-1.061	-0.126
	(-0.802)	(-0.109)
PID	5.848	1.240
	(0.832)	(0.180)
State	-2.693	-0.949
	(-1.328)	(-0.439)
Constant	-112.150***	-107.411***
	(-3.466)	(-3.630)
IND	controlled	controlled
Year	controlled	controlled
Observations	321	321
Adjusted R-squared	0.196	0.158

to (2) of **Table 11**. It can be seen from the empirical results that in each robustness test, the variables of knowledge network sharing degree (Degree and Degree_m) are significantly negatively correlated with the innovation performance of enterprises, and the positive moderating effect of financing constraints (SA) is still significant. The main research conclusions of this paper are still successful, with good robustness.

5. Heterogeneity Tests

In the basic regression test, this paper verifies the influence of knowledge network sharing degree and financing constraints on the innovation performance of specialized and special new enterprises as well as the moderating role of financing constraints in this relationship. From the micro perspective of corporate governance, the improvement of innovation performance by reducing knowledge network sharing degree may be affected by information asymmetry, and the impact may be different among enterprises with different degrees of information asymmetry. Therefore, this paper uses whether the chairman and general manager of the board of directors in the control variables are in one position (DUAL) and the level of the company's equity balance (Top31) to build an information asymmetry difference situation to test this mechanism.

5.1. Whether the Chairman and General Manager Are Integrated

Among the control variables selected in this paper, whether the chairman and general manager of the board of directors are dual roles (DUAL) is a control variable related to corporate governance. This variable is a dummy variable. When the chairman and the general manager are both appointed by one person, 1 is taken; otherwise, 0 is taken. The sample is divided into two sample groups based on whether the chairman and general manager are two in one or non two in one. The benchmark regression and moderating effect test are conducted in groups to verify the impact of knowledge network sharing degree on the innovation performance of specialized and special new enterprises and the difference between the moderating effect of financing constraints and whether the chairman and general manager are the sample group with one person serving as the chairman and general manager. The inspection results are listed in **Table 12** and **Table 13**. It can be seen from the results in **Table 12** that in the sample group of two posts in one, namely column (1), the coefficient between knowledge network sharing degree (Degree) and enterprise innovation performance (Innov) is -1.267 , which is significant at the level of 1%; however, in the non dual employment sample group, that is, column (2), the coefficient between the degree of knowledge network sharing (Degree) and the innovation performance of enterprises (Innov) is -0.457 , but it is only significant at the level of 5%. That is, in the sample group of "two in one", the relationship between the degree of knowledge network sharing and the innovation performance of enterprises is more significant. It can be seen from the results in **Table 13** that in the sample group of

Table 12. Benchmark regression testing results of whether the chairman and general manager of the board of directors are two in one.

	(1)	(2)
	Dual Employment	Non Dual Employment
	Innov	Innov
Degree	-1.267*** (-3.121)	-0.457** (-2.546)
Size	4.678** (2.553)	5.577*** (2.774)
ROA	-0.447 (-0.033)	-3.741 (-0.476)
Growth	1.333** (2.387)	-0.109 (-0.177)
Lev	13.435** (2.305)	2.819 (0.516)
Top1	0.129 (1.270)	0.052 (0.636)
Top31	4.430 (1.247)	0.579 (0.240)
o.DUAL	-	-
PID	-8.852 (-0.867)	8.442 (0.953)
State		-0.698 (-0.338)
Constant	-83.563** (-2.149)	-115.311*** (-2.792)
IND	controlled	controlled
Year	controlled	controlled
Observations	246	273
Adjusted R-squared	0.140	0.169

posts in one, namely column (1), the coefficient of the cross multiplying term between financing constraint (SA) and knowledge network sharing degree (Degree) is 5.565, and it is significant at the 5% level; in the non two in one sample group, namely column (2), the coefficient of the cross multiplying term between financing constraints (SA) and knowledge network sharing degree (Degree) is 1.669, but it is only significant at the 10% level. That is, in the two in one sample group, the positive moderating effect of financing constraint SA is more significant. The above analysis shows that the integration of the two positions of

Table 13. Moderating effect testing results of whether the chairman and general manager of the board of directors are two in one.

	(1)	(2)
	Dual Employment	Non Dual Employment
	Innov	Innov
Degree	19.040** (2.160)	5.987* (1.833)
SA	-2.417 (-0.582)	2.733 (0.538)
SA × Degree	5.565** (2.322)	1.669* (1.970)
Size	4.580** (2.302)	5.422*** (2.690)
ROA	0.268 (0.021)	-3.557 (-0.459)
Growth	1.357** (2.376)	-0.043 (-0.071)
Lev	12.997** (2.210)	4.102 (0.719)
Top1	0.132 (1.318)	0.066 (0.810)
Top31	4.545 (1.309)	0.620 (0.261)
o.DUAL	-	-
PID	-8.885 (-0.857)	9.006 (1.037)
State		0.975 (0.623)
Constant	-95.878*** (-2.745)	-106.469** (-2.251)
IND	controlled	controlled
Year	controlled	controlled
Observations	246	273
Adjusted R-squared	0.136	0.170

chairman and general manager in corporate governance can reduce the degree of information asymmetry, so that reducing knowledge network sharing degree can improve innovation performance and the positive moderating effect of financing constraints is more significant.

5.2. The Level of Equity Balance of the Company

Among the control variables selected in this paper, another important control variable related to corporate governance is the level of the company's equity balance (Top31). The equity balance of the company is measured by "(shareholding ratio of the top three shareholders—shareholding ratio of the largest shareholder)/shareholding ratio of the largest shareholder". This paper divided the samples into low equity balance sample group and high equity balance sample group based on the median of the equity balance degree of specialized and special new enterprises, and conducts benchmark regression and moderating effect test in groups. The test results are shown in **Table 14** and **Table 15**. It can be

Table 14. Benchmark regression testing results of company's equity balance.

	(1)	(2)
	Low Equity Balance	High Equity Balance
	Innov	Innov
Degree	-0.386 (-1.552)	-0.612*** (-2.735)
Size	3.262* (1.841)	6.718*** (2.923)
ROA	0.169 (0.018)	-6.503 (-0.699)
Growth	0.913 (1.568)	0.655 (1.227)
Lev	11.464 (1.624)	3.532 (0.605)
Top1	0.067 (0.588)	0.111 (0.870)
Top31	-3.503 (-0.323)	2.918 (1.136)
DUAL	-1.332 (-0.837)	0.921 (0.572)
PID	-3.652 (-0.453)	3.641 (0.325)
State	-4.110 (-1.091)	3.968** (2.067)
Constant	-65.662 (-1.577)	-138.716*** (-2.961)
IND	controlled	controlled
Year	controlled	controlled
Observations	256	263
Adjusted R-squared	0.166	0.130

Table 15. Moderating effect testing results of company's equity balance.

	(1)	(2)
	Low Equity Balance	High Equity Balance
	Innov	Innov
Degree	9.795** (2.045)	2.425 (0.790)
SA	2.732 (0.593)	-2.080 (-0.485)
SA × Degree	0.804 (1.011)	2.643** (2.104)
Size	3.191* (1.770)	6.574*** (2.798)
ROA	2.592 (0.253)	-6.504 (-0.689)
Growth	1.035* (1.747)	0.698 (1.321)
Lev	13.956* (1.831)	3.450 (0.572)
Top1	0.057 (0.494)	0.104 (0.812)
Top31	-4.767 (-0.465)	2.745 (1.019)
DUAL	-1.456 (-0.882)	1.027 (0.652)
PID	-3.541 (-0.433)	3.212 (0.289)
State	-0.362 (-0.159)	3.924** (2.007)
Constant	-59.107 (-1.624)	-144.424*** (-3.031)
IND	controlled	controlled
Year	controlled	controlled
Observations	256	263
Adjusted R-squared	0.173	0.125

seen from the results in **Table 14** that in the sample group of low equity balance, namely column (1), the coefficient between knowledge network sharing degree (Degree) and enterprise innovation performance (Innov) is -0.386, but it is not significant; in the sample group with high equity balance, namely column (2),

the coefficient between knowledge network sharing degree (Degree) and enterprise innovation performance (Innov) is -0.612 , which is significant at the level of 1%. That is, in the sample group with high equity balance, the relationship between knowledge network sharing degree Degree and enterprise innovation performance Innov is more significant. It can be seen from the results in **Table 15** that in the sample group with low equity balance, that is, column (1), the coefficient of the multiplication term between financing constraint (SA) and knowledge network sharing degree (Degree) is 0.804 , but it is not significant; However, in the sample group of high equity balance, namely column (2), the coefficient of the cross product between financing constraint (SA) and knowledge network sharing degree (Degree) is 2.643 , and it is significant at the 5% level. That is, in the sample group with high equity balance, the positive moderating effect of financing constraints is more significant. The above analysis shows that the situation of high equity balance in corporate governance can reduce the degree of information asymmetry, so that reducing the degree of knowledge network sharing can improve innovation performance and the positive moderating role of financing constraints is more significant.

6. Additional Analysis

With the rapid development of digital economy, the digital transformation of enterprises has gradually become a general trend. As the “leader” of small and medium-sized enterprises, specialized and special new enterprises often take the lead in digital transformation. In this paper, the digital characteristics of enterprises are included in the control variables for empirical regression, and further explore the impact of knowledge network sharing degree on the innovation performance of specialized and special new enterprises in the context of enterprise digital transformation, as well as the moderating role of financing constraints in this relationship. Download the 2012-2021 enterprise annual report of the specialized and special new A-share listed company from wanchao.com, use the python crawler method, learn from [Wang Shouhai's \(2022\)](#) measurement method of enterprise digital transformation, and carry out word frequency statistics on the keywords related to enterprise digital transformation such as “digital technology”, “data visualization”, “digital intelligence” and “Internet of things” appearing in the annual report, as a proxy variable of enterprise digital transformation (DT). When the frequency of digital transformation keywords in the enterprise annual report is higher than the median, it is recorded as 1, indicating that the enterprise’s digital transformation is relatively high; Otherwise, it is recorded as 0, indicating that the enterprise’s digital transformation is relatively low.

Adding the enterprise digital transformation characteristics (DT) indicators to the control variables for benchmark regression and moderating effect to test again. The regression results are shown in **Table 16** and **Table 17**. The results in **Table 16** show that, after adding the digital transformation (DT) as control

Table 16. Benchmark regression testing results of further study.

	(1)	(2)
	Model 1	Model 1
	Innov	Innov
Degree	-0.459** (-2.486)	-0.578*** (-3.176)
SA	-4.090 (-1.371)	-2.574 (-0.876)
DT	6.035*** (5.217)	5.375*** (4.953)
Size		5.074*** (3.715)
ROA		-0.804 (-0.119)
Growth		0.599 (1.623)
Lev		4.479 (1.140)
Top1		0.077 (1.203)
Top31		1.801 (0.931)
DUAL		0.163 (0.153)
PID		-0.191 (-0.028)
State		-1.671 (-0.590)
Constant	-9.342 (-0.894)	-112.935*** (-4.088)
IND	controlled	controlled
Year	controlled	controlled
Observations	513	513
Adjusted R-squared	0.167	0.226

variable into the benchmark regression, the coefficient between the degree of knowledge network sharing degree (Degree) and the innovation performance of specialized and special new enterprises (Innov) is -0.578, which is significant at the level of 1%, that is, reducing the degree of knowledge network sharing can

Table 17. Moderating effect testing results of further study.

	Before Centralization	After Centralization
	(1)	(2)
	Innov	Innov
Degree	10.943*** (3.755)	-0.249 (-1.457)
SA	-3.213 (-1.093)	-3.213 (-1.093)
SA × Degree	3.013*** (3.965)	3.013*** (3.965)
DT	5.609*** (5.102)	5.609*** (5.102)
Size	4.912*** (3.628)	4.912*** (3.628)
ROA	-0.571 (-0.083)	-0.571 (-0.083)
Growth	0.699* (1.856)	0.699* (1.856)
Lev	6.099 (1.515)	6.099 (1.515)
Top1	0.094 (1.474)	0.094 (1.474)
Top31	2.023 (1.059)	2.023 (1.059)
DUAL	0.220 (0.208)	0.220 (0.208)
PID	-0.812 (-0.119)	-0.812 (-0.119)
State	1.075 (0.777)	1.075 (0.777)
Constant	-118.348*** (-4.374)	-106.416*** (-3.713)
IND	controlled	controlled
Year	controlled	controlled
Observations	513	513
Adjusted R-squared	0.234	0.234

still significantly improve the innovation performance of enterprises, and the main conclusions of this paper are still stable; **Table 17** shows that in the moderating effect, after adding the digital transformation (DT) as control variable and centralizing the financing constraint variable (SA), the coefficient of the cross term between the financing constraint (SA) and the knowledge network sharing degree (Degree) is 3.013, and can be significant at the 1% level. It can be seen that when considering the digital transformation factors of specialized and special new enterprises, the positive moderating role of financing constraints (SA) between knowledge network sharing degree (Degree) and enterprise innovation performance (Innov) is significantly enhanced, that is, the digital transformation of specialized and special new enterprises is conducive to the positive moderating role of financing constraints.

7. Research Conclusions and Suggestions

This paper takes the A-share listed specialized and special new companies from 2012 to 2021 as the research sample, and systematically explores the impact of knowledge network sharing degree on the innovation performance of specialized and special new enterprises, as well as the moderating effect of financing constraints on this relationship. The results show that: 1) Reducing the sharing degree of knowledge network can significantly improve the innovation performance of specialized and special new enterprises. 2) Financing constraints play a positive role in the relationship between knowledge network sharing degree and enterprise innovation performance. These two main conclusions are still valid after a series of robustness tests. 3) Through the heterogeneity test based on the micro characteristics of enterprises, it is found that in the enterprises with the integration of chairman and general manager and high degree of corporate equity balance, due to the relatively low degree of information asymmetry, reducing the degree of knowledge network sharing plays a more significant role in improving the innovation performance of specialized and special new enterprises and in the positive regulation of financing constraints. 4) Further research finds that when considering the digital transformation of specialized and special new enterprises, the digital transformation of enterprises can significantly enhance the positive moderate role of financing constraints between knowledge network sharing degree and enterprise innovation performance.

The above research conclusions have the following policy implications: First, specialized and special new enterprises should strengthen the protection of intellectual property rights, adhere to the “differentiation” competition strategy, and build their own core competitive advantages. Because reducing the sharing degree of knowledge network can significantly improve the innovation performance of specialized and special new enterprises, when formulating development strategies, on the one hand, specialized and special new enterprises should pay attention to their own intellectual property protection, on the other hand, they should also firmly adhere to the “differentiated” road choice, create core

competitive advantages through the research and development of new technologies and the possession of scarce knowledge resources, so as to achieve sustainable development of enterprises. Second, the specialized and special new enterprises can improve the corporate governance and improve the efficiency of corporate governance in their daily operation and management. In corporate governance, the integration of the two roles of chairman and general manager and the high degree of checks and balances of corporate equity can make the impact of knowledge network sharing on enterprise innovation performance more significant. Therefore, in terms of corporate governance, the specialized and special new enterprises can effectively improve corporate governance by combining the two roles of chairman and general manager to moderately improve the degree of checks and balances between the company's equity. Third, accelerating the digital transformation of enterprises is an urgent task for specialized and special new enterprises. The research conclusion of this paper confirms that the digital transformation of specialized and special new enterprises has enhanced the positive moderating effect on financing constraints. With the rapid development of the digital economy, following the development trend of the times, accelerating the digital transformation of enterprises has important strategic significance for the long-term development of specialized and special new enterprises.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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