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The Impact of Group Control on the Effectiveness of Enterprise Innovation: An Empirical Study

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Abstract: Innovation has been elevated beyond the traditional forces of production, by the emergence of a new wave of industrial upgrading and the technological revolution, to become a significant force in the advancement of human society. Can an enterprise group, a significant type of industrial organization, improve the effectiveness of enterprise innovation? Here, a quantitative analysis approach was used to systematically analyze the impact of group control on enterprise innovation effectiveness and its transmission path based on the logical framework of the "policy environment-influence effect-influence path". The study found that group control significantly improves the effectiveness of enterprise innovation compared to independently listed enterprises. The impact path showed that group control can reduce financing constraints through internal capital markets. It increases the investment in innovation and thus enhances the effectiveness of enterprise innovation. Meanwhile, internal information exchange is accelerated through the internal knowledge market, improving enterprise innovation's effectiveness. The results of this study were still valid after robustness tests, such as propensity score matching and accounting for lag effects. According to the paper's findings, to enhance financial support for innovation, financial market reform should be intensified. The growth of manufacturing enterprise groups should also be encouraged. Additionally, the ability of businesses to innovate while improving the internal benefits of enterprise groups and their innovation paths should be strengthened.

Keywords: group control; innovation effectiveness; sustainable development; internal capital market; internal knowledge market

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1. Introduction

Group control, innovation efficiency, and sustainable development are strongly correlated, and they collectively form a crucial pillar of enterprise development that is required to achieve sustainable growth [1]. High innovation efficiency supports the enterprise group's technological advancement and rapid product renewal, increases market competitiveness, and supports sustainable development [2]. The enterprise's progress toward sustainable development is then accelerated via group control to increase the effectiveness of corporate innovation [3]. Innovation is a necessary requirement for development advancement. From a macro perspective, improving the effectiveness of innovation can improve the quality of human life, promote economic development, advance social progress, and protect the ecological environment. From a micro perspective, innovation is a competitive advantage for each organization, enabling increased productivity and maximizing the reduction in production costs. It ensures that companies receive the maximum benefit in the market.

Chinese enterprises have invested much more in innovation in recent years because of the active direction of numerous national initiatives. However, the majority of industrial upgrading, transformation, and innovation investment has been focused on low-tech and

low-value-added industries [4]. This means that the overall technological level is still lagging and the innovation effect is not significant. Innovation is an endogenous engine for economic growth, and innovation efficiency represents the speed and quality of creating innovation and accelerating the attainment of sustainable development [5,6]. Investment in innovation is, therefore, a crucial financial choice for enterprises [7].

While China actively encourages innovation capital investment, how to increase enterprise innovations' effectiveness has emerged as a critical issue that must be addressed during China's economic transition [8,9]. According to the strategic management theory, an enterprise's strategic choices are limited by the structure of the enterprise organization [10]. Enterprise groups are a common type of business structure, they are the backbone of the privately listed firms in China's economic transformation and development process [11,12]. In light of this, can group control, a type of corporate structure, increase the effectiveness of enterprise innovation by utilizing "financing constraint relief" and "information advantage"?

This study can assist enterprise groups in making the most of their internal "capital pool" to meet their member enterprises' cash flow needs for innovation. By fully utilizing the information-sharing system, it may also offer technical support for the innovative endeavors of member enterprises. Additionally, it promotes resource sharing and the synergy effect, which can increase the enterprise group's innovation efficiency. It also maximizes social, environmental, and economic benefits to better advance sustainable development by way of product logistic management and production process optimization. Enterprise organizations may also be able to cut back on wasteful spending on resources such as labor, materials, and energy while also lowering carbon emissions and environmental damage.

In summary, this paper focuses on analyzing whether companies under group control can improve innovation efficiency. What are the impact paths of group control affecting the innovation efficiency of companies? How do the two key factors of the internal capital market and internal knowledge market of the corporate group affect innovation efficiency? To address these inquiries, Section 2 of this study presents the research hypotheses through a kind of literature review. In Section 3, the study sample is determined by selecting data from Chinese A-share listed manufacturing enterprises from 2003 to 2017. In Section 4, an empirical study is used to systematically examine the way in which group control affects enterprise innovation efficiency and to investigate potential avenues for manufacturing organizations to improve innovation efficiency. A comparison between this study and those of other researchers is shown in Sections 5 and 6 of this paper is the conclusion.

2. Literature Review

2.1. Group Control and Innovation Effectiveness

Most people believe that enterprise groups are made up of numerous independent legal entities with formal or informal organizational structures, based on the material that is currently available [13]. However, the relevant behavior of a firm is more significantly influenced by its organizational structure as an institutional arrangement, with different organizational structures ultimately having diverse effects on firm behavior [14]. As a strategic organizational practice, innovation is a difficult, time-consuming, and risky process [15]. Enterprises controlled by a group are typically better at integrating resources than separately listed enterprises [16]. The mastery of expertise and cutting-edge technology by a group-controlled company allows for the best deployment of R&D resources within the group, maximizing the company's output of innovation and ultimately enhancing the effectiveness of corporate innovation [17,18]. The way in which the group distributes its internal power is crucial to the allocation of its R&D resources and the effectiveness of innovation in the enterprise is increased by its financial power concentration [19]. The centralization of financial power can help enterprise organizations lessen their reliance on outside finance, while the concentration of affairs and people power can hurt corporate innovation [20,21]. Finance firm credit for enterprise groups can also encourage innovation in listed member companies; this is reflected in the surge in patent applications. As a result, the following hypothesis is put forth:

H1: *Group-controlled enterprises are more innovative than individually listed enterprises, other things being equal.*

2.2. The Path of Group Control on Innovation Effectiveness

If the aforementioned enterprise groups' innovation efficiency is noteworthy, it is crucial to consider how they will encourage innovation efficiency [22]. An essential metric for measuring the effectiveness of innovation activities is innovation efficiency. It is proposed that enterprise groups may affect innovation efficiency through two paths: the "internal capital market" and the "internal knowledge market", with reference to previous studies [8,9]. Compared to independent firms, enterprise groups have unique functions [13], i.e., they can directly address the issues of "financing constraints" and "lack of information" that affect a firm's ability to innovate through its internal capital market and knowledge market [16].

2.2.1. Internal Capital Market Impact Path

Regarding the "internal capital market" path, sufficient and consistent support for R&D funding is a key factor for driving innovation in enterprises and ensuring the endurance of innovation activities [23]. In general, enterprises use both internal and external financing to support innovation initiatives. The internal allocation of capital is the primary method of internal financing for a conglomerate [24]. The majority of enterprise innovation efforts require steady and appropriate financial assistance. When an enterprise's internal resources can only support its ongoing operations and it is difficult to consistently fund R&D projects, there will be insufficient internal financing [25,26]. Additionally, bank loans and outside investments account for the majority of the external financing for the R&D funds needed by an enterprise, although it can be challenging to obtain bank loans [27]. Due to the high bar that banks set for business loans, there are several standards for the operation, capitalization, and other aspects of the lending organization [28]. As a result, it is extremely challenging for an enterprise to secure external finance in the form of bank loans, particularly for SMEs that require sizable sums of money for R&D activities [29]. Innovation initiatives involving foreign capital typically entail a lengthy R&D cycle and a significant level of uncertainty surrounding the production of research findings [4]. External investors are also significantly less eager to invest in innovation projects due to the substantial risk involved for investors, in addition to issues with adverse selection and managerial moral hazards [6,30]. Inadequate internal financing and problems in obtaining external financing for businesses result in a huge number of innovative R&D projects that cannot be completed due to a lack of funding.

Enterprise groups can enable financial support for innovation activities among enterprise group members through internal capital markets to address the aforementioned "financing constraint" challenge of enterprise innovation [9]. Innovation is a long-term investment endeavor with a substantial R&D risk. This can prevent external financial channels from opening up, especially when coupled with the unpredictability of project returns. In addition, by taking advantage of the internal capital market to provide adequate funding sources, the enterprise group may effectively address the unpredictability of project returns to reduce innovation risk [31]. The enterprise group is capable of carrying out the distribution of money among its member companies in order to fulfill the internal capital market function [26]. Within the enterprise group, member companies that urgently need money are given short- and long-term loans [32]. Members of the enterprise group also engage in a mutual conduct of guarantees. The internal capital market is founded on the mutual guarantees provided by group members when obtaining funds [33]. Moreover, it is a common phenomenon for the member companies of Chinese conglomerates to mutually guarantee loans. Enterprises might lessen their dependency on external finance by internally guarantying one another and allocating funds [34]. This is helpful to preserve the enterprise group's effective financial allocation and to lower financial waste. In addition, adequate R&D funding can boost organizations' innovation output, which in turn influences their innovation efficiency [35]. Therefore, the enterprise group has a positive

influence on innovation efficiency through the internal capital market path. Considering this, we suggest:

H2: *Group-controlled businesses can increase the effectiveness of their innovation by reducing financing constraints through internal capital markets.*

2.2.2. Internal Knowledge Market Impact Path

Innovation projects are exploratory endeavors in the context of the "internal knowledge market" strategy. Whoever has the earliest access to R&D trends and related knowledge will also have the earliest opportunity. Generally speaking, enterprises rely primarily on the external knowledge market to receive the knowledge for their innovation operations [36]. However, it is challenging for the external knowledge market to bring meaningful information for enterprise innovation because of the high level of confidentiality and redundancy of R&D knowledge. Regarding the innovation activities of enterprises, R&D knowledge information is related to the innovation output of enterprises [6,37,38]. Once the R&D information is leaked, it will be first accessed by other enterprises. This means not only wasting a lot of human and material resources but also helping other firms to progress. To avoid crises, enterprises keep their R&D information private, making it challenging for them to access the external knowledge market for the information they require for R&D [39]. In addition, it takes too much time and money for enterprises to extract usable information from the R&D data collected from the external knowledge market since it is so cluttered. It might be challenging for an enterprise to gather the pertinent knowledge information needed for R&D activities from external sources because R&D activities require the most up-to-date, cutting-edge information. As a result, the enterprise will encounter "information scarcity" issues when it is engaging in innovation [17].

Enterprise groups can support R&D knowledge sharing for the innovation activities of group members through internal knowledge market functions to address the issue of "information scarcity" faced by enterprises' innovation activities. Enterprise groups can partially make up for the institutional deficiencies in environments with imperfect labor markets and contract performance [30]. This primarily gives other group members the resources they need, and it can lower transaction costs when the enterprise group acts as an internal talent market, an internal product market, etc. [36,40]. The internal knowledge market of an enterprise group's sharing mechanism provides for the deployment of technical talents within the group, in addition to the sharing of technical information [6]. There are two ways that the group's internal knowledge market supports innovative activities. First, it boosts the internal member companies' ability to innovate, so the same R&D investment will result in more innovative products as the "trial and error cost" is reduced [8]. Second, there is a "knowledge spillover" effect in which member companies can benefit from the R&D knowledge of other member companies in the group [41]. Thus, it is proposed that:

H3: *Enterprises under group control can cope with information scarcity through internal knowledge markets and, thus, can improve innovation efficiency.*

Combining the three hypotheses, the specific impact path diagram is shown in Figure 1.

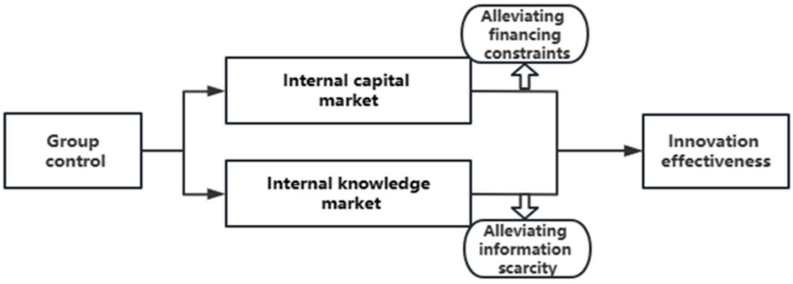

Figure 1. Impact path.

3. Methodology

3.1. Sample Selection and Data Sources

The data collected for this study needed to be representative. We examined Chinese sectors and discovered that, in terms of innovation, China's manufacturing sector is better represented. Chinese manufacturing enterprises with A-share listings were therefore chosen as the study's sample. However, the ultimate sample period was decided to be from 2003 to 2017 due to the availability of data. It was necessary to eliminate ST (special treatment), PT (problematic trading), and businesses with missing data for the key variables to assure the accuracy of the data. Ultimately, 11,915 observations were collected for 1730 enterprises. The data on the enterprise groups were compiled from the annual reports of Chinese enterprises and the CSMAR (China Stock Market and Accounting Research) database. Data on the number of patents granted were compiled from the China Patent Office and the China database. With reference to published literature, a Winsorize tailing of roughly 1% was added to all continuous variables in order to reduce the negative effects of extreme values on the model's accuracy. For these data, we adopted a quantitative analysis method in which the endogeneity test adopts the propensity score matching (PSM) method.

3.2. Definition of Variables

3.2.1. Explained Variables

An enterprise's innovation efficiency determines how many patents it can create with a certain amount of R&D spending; the more patents it can create with the same level of spending, the greater the innovation efficiency of the enterprise [42]. The amount of innovation output that an enterprise produces for every unit of innovation input is known as its innovation efficiency [43]. Innovation output is evaluated by the overall number of yearly patents awarded and by the number of invention patents granted by enterprises, whereas innovation input is measured by the annual R&D expenditure of enterprises [39]. Meanwhile, the innovation efficiency index is constructed based on the ratio of the enterprise's R&D input and the number of patents granted, drawing on the methods of [42–44]. The specific formula is as follows:

$$IE_{i,t} = Ln\left(\frac{Patent_{i,t}}{R\&D_{i,t}}\right) + 1 \quad (1)$$

where R&D is the R&D investment metric and Patent is the number of patents awarded, assessed using the total number of patents granted and invention patents granted. The ratio of innovation efficiency logarithmized is processed by adding 1 because an enterprise's yearly patent grant volume may be zero. Furthermore, samples with zero R&D input are not included in the innovation efficiency calculation because this metric uses R&D input as the denominator.

3.2.2. Explanatory Variables

The definition of whether an enterprise is controlled by a group, per the research on the identification of enterprise groups, is that all the listed controlled enterprises making up an enterprise group are taken into account when the actual controller of a listed enterprise controls two or more listed enterprises at the same time in the same year [45]. The listed controlled enterprises are called enterprise group members [46]. The actual and ultimate controller of the enterprise was recognized by the block diagram of the actual controller in the annual report of the listed enterprises, and then the data were manually sorted to determine if the listed enterprise was a member of the same enterprise group.

3.2.3. Control Variables

In order to reduce the influence of enterprise characteristics on the results, the following control variables were also selected with reference to the existing literature [6,25,44,47]: enterprise size (**Size**), gearing ratio (**GR**), return on total assets (**ROA**), capital intensity (**CI**),

cash flow from operating activities ratio (**OCF**), percentage of ownership of the first largest shareholder (**F-share**), and the independent directors' ratio (**IDR**). The specific variables are defined in Table 1.

Table 1. Variable definition table.

Variable Type	Variable Name	Variable Symbol	Variable Description
Explained Variables	Innovation Efficiency	IE	Calculated according to Formula (1), this is the ratio of the number of patents granted in the year to the R&D investment taken logarithmically.
Explanatory Variables	Enterprise Group	Group	Group deducts 1 when two or more listed businesses share an ultimate controller in the same year; otherwise, it deducts 0.
Control Variables	Enterprise Size	Size	Total assets at the end of the period.
	Return on Total Assets	ROA	Net profit/Average total assets.
	Capital Intensity	CI	Net fixed assets at the end of the period/Total assets at the end of the period.
	Cash Flow from Operating Activities Ratio	OCF	Cash flow from operating activities for the period/Total average assets.
	Gearing Ratio	GR	Total liabilities at the end of the period/Total assets at the end of the period.
	Shareholding Ratio of the First Major Shareholder	F-share	Shareholding of the largest shareholder as a percentage of the total shared capital.
	Ratio of Independent Directors	IDR	Number of independent directors as a percentage of the total number of board of directors.
	Annual Fixed Effect	Year	Annual dummy variables.
	Industry Fixed Effect	Industry	Industry dummy variables.

3.3. Model Setting

This paper focuses on the impact of group control on the innovation effectiveness of enterprises. To test Hypothesis 1, it is necessary to put enterprises subject to group control and independently listed enterprises into the regression model as explanatory variables. Then the efficiency of enterprise innovation is put into the regression model as the explained variable. Regression analysis is then performed to determine whether group control can improve the innovation effectiveness of enterprises. Therefore, the model is constructed as follows:

$$IE_{i,t} = \alpha_0 + \alpha_1 Group_{i,t} + \alpha_c Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (2)$$

where *IE* is the explained variable in the model (**2**). Both IE_A (innovation output as a total number of patents granted) and IE_I (innovation output as patents granted for inventions) measure innovation efficiency and act as the explained variables in the specific empirical analysis. Enterprise groups (**Group**) are the explanatory variables; if *Group* = 1 implies that an enterprise group controls the listed enterprise, then *Group* = 0 shows that the listed enterprise is independent. The *Industry* is the industry effect, and *Year* is the year effect as well. Furthermore, it should be emphasized that the number of issued patents (used to construct the explained variables) has no lag in the Chinese CSMAR database. Therefore, unlike the existing studies, no lags are applied to the variables.

To test Hypothesis **2**, the following model was built to demonstrate the existence of an internal capital market for enterprise groups by examining the correlation between the

listed enterprises' innovation effectiveness and the cash flows of other enterprise group members:

$$IE_{i,t} = \beta_0 + \beta_1 OtherOCF_{i,t} + \beta_c Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (3)$$

In model (**3**), *OtherOCF* refers to the average operating cash flows of the other members of the enterprise group. To prove the existence of the internal capital market, one needs only to consider whether the estimated coefficient of *OtherOCF* is significant. If the estimated coefficient of *OtherOCF* is significantly positive, then it proves that the innovation efficiency of the enterprise is influenced by the cash flows of other members within the group, and it also proves that the internal capital market plays a role.

To test Hypothesis **3**, we used a patent spillover effect approach. A model was built to assess whether group innovation efficiency would be affected by the patent output of other member enterprises of the enterprise group. The model was designed as follows:

$$IE_{i,t} = \delta_0 + \delta_1 OtherIO_{i,t} + \delta_c Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (4)$$

In model (**4**), *OtherIO* is the innovation output of enterprise group members other than our enterprise. It is calculated by counting the number of patents at the enterprise group level and using the logarithm. If the estimated coefficient of *OtherIO* is significantly positive, it suggests the existence of an intra-group patent spillover effect, which also verifies the existence of an internal knowledge market.

4. Empirical Results and Analysis

4.1. Descriptive Statistics and Correlation Analysis

The statistics of the model variables, including the sample statistics, means, standard deviations, and comparisons of means between groups, are shown in Table 2. The proportion of group control-belonging enterprises in the sample of all enterprises is approximately 31%, and the mean value of the overall enterprise innovation efficiency (**IE_A**) is approximately 2.13, with a standard deviation of 6.338, showing that the innovation level of individual businesses varies significantly. However, there are some disparities in the substantive innovation efficiency of various enterprises, as can be seen by the mean value of substantive innovation efficiency of enterprises (**IE_I**) being −14.98 and the standard deviation being 1.467.

Table 2. Descriptive statistics of variables.

Variables	Full Sample			Non-Group Control	Group Control	Mean Difference
				N = 8258	N = 3657	
	Sample Size	Mean	Standard Deviation	Mean	Mean	
	(1)	(2)	(3)	(4)	(5)	(6)
IE_A	11,915	−9.14	6.338	−9.294	−8.839	−0.455 ***
IE_I	7540	−14.98	1.467	−15.05	−14.84	−0.204 ***
Group	11,915	0.307	0.461	-	-	-
Size	11,915	21.75	1.146	21.59	22.12	−0.536 ***
ROA	11,915	0.0360	0.0600	0.0400	0.0290	0.011 ***
CI	11,909	0.266	0.147	0.262	0.275	−0.013 ***
OCF	11,915	0.0470	0.0710	0.0480	0.0440	0.003 **
GR	11,915	0.448	0.210	0.424	0.501	−0.076 ***
F-share	11,915	0.360	0.148	0.353	0.376	−0.023 ***
IDR	11,843	0.366	0.0520	0.367	0.361	0.006 ***

Additionally, Table 2 presents the mean different results for both group-controlled and non-group-controlled enterprises. The findings demonstrate that group-controlled enterprises have a significantly higher overall innovation efficiency (IE_A) and a substantial innovation efficiency (IE_I) compared to non-group-controlled enterprises. The preliminary study findings imply that group control may contribute positively to organizations' innovation efficiency; this is a tentative affirmation of the aforementioned research hypothesis. The selection of control variables is also reasonable, as shown by the fact that the variations in the means of the control variables are also more significant (The *p*-value size is treated as an asterisk. When the *p*-value is less than 0.01, three asterisks are marked. When the *p*-value is less than 0.05, two asterisks are marked. When the *p*-value is less than 0.1, one asterisk is marked).

The connection factors for the different variables are displayed in Table 3. Both the substantive innovation efficiency (IE_I) and the overall innovation efficiency (IE_A) have Pearson correlation coefficients that are strongly positive, showing that innovation activities are highly productive and effective. In addition, innovation efficiency (IE_A and IE_I) is also significant at the 1% level for group control (*Group*), which is in line with expectations, and tentatively verifies Hypothesis 1. Additionally, the correlation coefficients among the variables are each less than 0.5, suggesting that there is not any multicollinearity among the variables included in the study.

Table 3. Variable Pearson correlation coefficient matrix.

	IE_A	IE_I	Group	Size	ROA	CI	OCF	GR	F-Share	IDR
IE_A	1.00									
IE_I	0.71 ***	1.00								
Group	0.03 ***	0.06 ***	1.00							
Size	−0.09 ***	−0.21 ***	0.22 ***	1.00						
ROA	−0.11 ***	−0.10 ***	−0.09 ***	0.09 ***	1.00					
CI	0.15 ***	0.02 **	0.04 ***	0.06 ***	−0.18 ***	1.00				
OCF	0.02 **	−0.06 ***	−0.02 **	0.08 ***	0.39 ***	0.16 ***	1.00			
GR	0.18 ***	0.02	0.17 ***	0.30 ***	−0.42 ***	0.20 ***	−0.15 ***	1.00		
F-share	0.05 ***	−0.09 ***	0.07 ***	0.16 ***	0.09 ***	0.05 ***	0.08 ***	−0.01	1.00	
IDR	−0.12 ***	−0.00	−0.05 ***	0.04 ***	−0.01	−0.06 ***	−0.03 ***	−0.05 ***	0.01	1.00

4.2. Baseline Regression Analysis

To confirm that group control had a favorable impact on enterprises' innovation efficiency, the baseline model was first regressed using least squares with stepwise controls for Year fixed effects and *Industry* fixed effects. The regression estimation results are displayed in Table 4. Columns (1) and (2) present the regression results when the enterprise's overall innovation efficiency (IE_A) is taken into account. It is clear from these two columns that, when Year fixed effects and *Industry* fixed effects are not taken into account, the estimated coefficient of the group control variable (*Group*) is 0.329 and positive at the 5% level. After the inclusion of the control Year fixed effects and *Industry* fixed effects, the regression coefficients for the Group variable are still considered positive. It can be seen that the regression coefficient of the Group variable is significantly positive at the 1% level with or without controlling for Year fixed effects and *Industry* fixed effects in columns (3) and (4), which demonstrates that group control significantly boosts the substantive innovation efficiency of enterprises (IE_I), supporting Hypothesis 1 of the study.

Table 4. Baseline regression estimation results.

	IE_A		IE_I	
	(1)	**(2)**	**(3)**	**(4)**
Group	0.329 **	0.217 **	0.363 ***	0.332 ***
	(2.531)	(2.497)	(9.241)	(9.052)
Size	−0.998 ***	−0.206 ***	−0.349 ***	−0.245 ***
	(−17.263)	(−4.605)	(−19.004)	(−12.903)
ROA	−2.000 *	−5.023 ***	−1.121 ***	−3.013 ***
	(−1.714)	(−5.882)	(−2.920)	(−7.884)
CI	4.351 ***	−0.098	0.064	−0.558 ***
	(10.204)	(−0.303)	(0.460)	(−3.941)
OCF	4.476 ***	−0.398	−0.174	−0.267
	(4.930)	(−0.627)	(−0.580)	(−0.928)
GR	6.239 ***	1.643 ***	0.666 ***	0.348 ***
	(19.785)	(6.700)	(6.264)	(3.276)
F-share	3.051 ***	−1.353 ***	−0.538 ***	−0.491 ***
	(7.693)	(−5.093)	(−4.383)	(−4.256)
IDR	−11.417 ***	1.619 **	0.290	0.533 *
	(−10.762)	(2.311)	(0.945)	(1.893)
_cons	11.416 ***	3.985 ***	−7.641 ***	−9.777 ***
	(9.193)	(4.043)	(−19.436)	(−20.668)
Year	No	Yes	No	Yes
Industry	No	Yes	No	Yes
N	11,837	11,837	7503	7503
R2	0.088	0.619	0.074	0.207

4.3. Impact Path Regression Analysis

The outcomes of the benchmark regressions demonstrate that enterprises operating under group control have much higher levels of innovation efficiency. We then looked into how internal capital markets and internal knowledge markets within enterprises determine how effectively they innovate. We tested Hypotheses 2 and 3. Table 5 displays the test results for regression for model (3). The estimated *OtherOCF* coefficient is considerably positive at the 1% level, according to the regression results in columns (1) and (2). This indicates that group members' cash flow has a favorable effect on an enterprise's ability to innovate. It also reveals that the internal capital market has an impact on how effectively businesses innovate. The regression results are consistent with Hypothesis 2, which verifies the existence of the internal capital market and its contribution to enterprises' innovation effectiveness.

Table 5. Internal capital market and internal knowledge market impact paths.

	IE_A	**IE_I**	**IE_A**	**IE_I**
	(1)	**(2)**	**(3)**	**(4)**
OtherOCF	−0.042 ***	−0.042 ***		
	(−4.531)	(−4.483)		
OtherIO			0.019 ***	0.047 ***
			(2.647)	(4.715)
Size	−0.235 ***	−0.216 ***	−0.231 ***	−0.216 ***
	(−14.090)	(−11.337)	(−13.722)	(−11.509)
ROA	−2.658 ***	−3.375 ***	−2.591 ***	−3.261 ***
	(−7.296)	(−8.647)	(−7.004)	(−8.265)

Table 5. *Cont.*

	IE_A	IE_I	IE_A	IE_I
	(1)	**(2)**	**(3)**	**(4)**
CI	−0.705 ***	−0.572 ***	−0.617 ***	−0.498 ***
	(−5.129)	(−3.984)	(−4.532)	(−3.520)
OCF	0.138	−0.237	0.116	−0.245
	(0.510)	(−0.804)	(0.430)	(−0.837)
GR	0.508 ***	0.343 ***	0.485 ***	0.308 ***
	(5.150)	(3.176)	(4.741)	(2.805)
F-share	−0.397 ***	−0.410 ***	−0.429 ***	−0.456 ***
	(−3.632)	(−3.509)	(−3.980)	(−3.950)
IDR	1.102 ***	0.308	1.161 ***	0.397
	(4.093)	(1.068)	(4.354)	(1.394)
_cons	−7.763 ***	−10.185 ***	−8.654 ***	−8.552 ***
	(−17.321)	(−20.973)	(−19.401)	(−16.926)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	7935	7355	8072	7475
R2	0.159	0.201	0.157	0.198

The estimated coefficients of *OtherIO* regression are significantly positive at the 1% level for both enterprise overall innovation efficiency (IE_A) and enterprise substantive innovation efficiency (IE_I), as shown in columns (3) and (4) of Table 5, demonstrating that the output of member enterprises' patents will increase the output of patents at the enterprise group level. The enterprise group's patent output spillover effect is also shown, confirming the idea that the enterprise group will influence innovation activities via the internal knowledge market. The regression results support Hypothesis 3.

4.4. Robustness Test and Endogeneity Problem Treatment

4.4.1. Using the Propensity Score Matching Method

The discrepancies between group-controlled and non-group-controlled enterprises were removed using the propensity score matching (PSM) radius matching approach to lessen the impact of sample selection bias. The PSM estimation results are displayed in Table 6. The equilibrium of the matched samples is first tested using the common support assumption. The t-test findings for all the control variables do not refute the initial hypothesis, as can be seen from the outcomes of the Panel A equilibrium test in Table 6, following propensity score matching. This indicates that the differences in the characteristics of group-controlled and non-group-controlled enterprises have been eliminated to a greater extent. While this is going on, Table 6 Panel B presents the findings of the PSM estimation. It is clear from this that the estimated coefficients for the enterprise groups (*Group*) are still significantly positive at the 1% level, demonstrating that the study's conclusions have not changed significantly and indicating the robustness of the study's conclusions.

Table 6. Using propensity score matching method.

Panel A: Equilibrium Test						
		Treatment Group	**Control Group**	**Deviation**	**T-Value**	***p*-Value**
Size	Unmatched	22.285	21.647	55.8	23.08	0.000
	Matched	21.916	21.882	3.0	0.92	0.358
ROA	Unmatched	0.03085	0.04529	−25.8	−10.32	0.000
	Matched	0.03842	0.04	−2.8	−0.77	0.441
CI	Unmatched	0.2632	0.2442	13.5	5.46	0.000
	Matched	0.25402	0.25847	−3.1	−0.84	0.402
OCF	Unmatched	0.04242	0.0463	−5.8	−2.28	0.023
	Matched	0.04434	0.04605	−2.6	−0.70	0.487
GR	Unmatched	0.48838	0.39173	48.0	19.07	0.000
	Matched	0.43914	0.43314	3.0	0.84	0.400
F-share	Unmatched	0.37148	0.34304	20.0	7.88	0.000
	Matched	0.35354	0.34779	4.0	1.10	0.270
IDR	Unmatched	0.36359	0.37259	−17.7	−6.84	0.000
	Matched	0.36632	0.36293	6.7	1.88	0.061
Panel B: PSM Estimation Results						
		IE_A		**IE_I**		
		(1)		**(2)**		
Group		0.152 ***		0.348 ***		
		(3.670)		(7.888)		
Controls		Yes		Yes		
Year		Yes		Yes		
Industry		Yes		Yes		
_cons		−8.457 ***		−7.816 ***		
		(−8.144)		(−11.404)		
N		3799		3799		
R2		0.170		0.216		

4.4.2. Considering the Lag of Patent Output

There is a delay in innovation output and efficiency since it takes time for an enterprise's patents to be finally issued and filed. Additionally, since patents entail trade secrets, enterprises may postpone patent applications and maintain the secrecy of patent-related information. The benchmark model's variables are therefore lagged at orders 1, 2, and 3, and the effects of group control on the lagged innovation efficiency (IE_A) and (IE_I) are examined independently. The test findings are displayed in Table 7. After taking into account the lag in patent output, the regression results demonstrate that the predicted coefficients of the enterprise's overall innovation efficiency (IE_A) and enterprise substantive innovation (IE_I) regressions are both significantly positive. This proves that their conclusions remain robust.

Table 7. The lag of patent output.

	IO_I			**IE_I**		
	T-1	**T-2**	**T-3**	**T-1**	**T-2**	**T-3**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Group	0.094 **	0.081 **	0.071 *	0.289 ***	0.245 ***	0.225 ***
	(2.558)	(2.087)	(1.715)	(7.508)	(5.977)	(5.131)
Size	−0.219 ***	−0.213 ***	−0.210 ***	−0.208 ***	−0.188 ***	−0.172 ***
	(−12.143)	(−10.767)	(−9.866)	(−10.005)	(−8.171)	(−6.844)
ROA	−3.247 ***	−2.877 ***	−3.119 ***	−3.861 ***	−3.692 ***	−3.887 ***
	(−8.366)	(−6.806)	(−7.493)	(−9.266)	(−8.078)	(−8.399)

Table 7. *Cont.*

	IO_I			IE_I		
	T-1	**T-2**	**T-3**	**T-1**	**T-2**	**T-3**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
CI	−0.648 ***	−0.680 ***	−0.852 ***	−0.595 ***	−0.541 ***	−0.616 ***
	(−4.513)	(−4.373)	(−5.153)	(−3.914)	(−3.297)	(−3.401)
OCF	−0.152	−0.318	−0.078	−0.337	−0.251	−0.152
	(−0.550)	(−1.096)	(−0.249)	(−1.110)	(−0.786)	(−0.445)
GR	0.263 **	0.225 **	0.136	0.109	0.082	−0.105
	(2.553)	(2.038)	(1.098)	(0.946)	(0.638)	(−0.713)
F-share	−0.421 ***	−0.457 ***	−0.398 ***	−0.456 ***	−0.492 ***	−0.445 ***
	(−3.666)	(−3.683)	(−2.884)	(−3.692)	(−3.705)	(−3.011)
IDR	1.231 ***	1.131 ***	1.252 ***	0.409	0.403	0.461
	(4.015)	(3.333)	(3.388)	(1.300)	(1.134)	(1.160)
_cons	−7.752 ***	−7.453 ***	−7.000 ***	−8.371 ***	−11.132 ***	−8.271 ***
	(−16.196)	(−14.213)	(−14.472)	(−15.421)	(−17.856)	(−15.000)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
N	7011	6024	5081	6557	5679	4798
R2	0.168	0.174	0.184	0.220	0.225	0.239

5. Discussion

Group control may considerably boost how well enterprises innovate. According to the results of the path test, group control can boost the effectiveness of innovation by lowering funding restrictions through its internal capital market and by accelerating internal information interchange through its internal knowledge market. Even after robustness tests that took into account lagged effects and propensity score matching, the study's conclusions remain valid.

Regarding Hypothesis 2, the findings are generally compatible with the findings of [17] who employed digital finance to remove the financing restrictions which can give enterprises access to more money and increase the effectiveness of their innovation. In addition, we discovered that group control can increase funding for company innovation by reducing internal capital market financing limits. As a result, it encourages the firm's innovation to be more effective. Contrast this with the proposal of [17] for the use of digital finance to increase innovation efficiency, which is also a component of the internal capital market. Regarding internal knowledge markets, [36] examined the technological knowledge spillover effect among enterprise groups and discovered that the parent enterprise's stock of technological information improved the innovation output of its subsidiaries. This is fairly consistent with what we discovered in Hypothesis 3, which is that the internal knowledge market promotes R&D knowledge sharing in the innovation activities for group members' internal innovation efforts. Because the internal knowledge market promotes R&D knowledge sharing, which also belongs to internal information exchange, its promotion of internal information exchange will further improve the innovation effectiveness of enterprises.

In addition, we demonstrated that, in regard to Hypothesis 1, company groups can boost innovation effectiveness, i.e., group-controlled companies are more inventive than separately listed companies, other things being equal. Similar arguments were made that company groups can promote innovation efficiency in another study [23]. Additionally, they suggested internal labor markets. In order to counteract the rigidity and inefficiency of external labor markets, they contend that labor markets can reallocate available scientific talent to the most suitable jobs, which can encourage innovation among enterprise group affiliates. Although this variable was not considered in our study, the enterprise group still has control over the area in which it falls.

6. Conclusions

In our study, we found that group control can improve the efficiency of innovation by allowing for the pooling of resources, the optimization of processes, and the improvement of management effectiveness, thus contributing, to a certain extent, to the sustainability of a company. Moreover, the results of this study have both practical and theoretical contributions. In terms of theory, this study chose more influencing elements for the effectiveness of company innovation, such as primarily financial restrictions, the knowledge market, and the level of financial market development, which offers a fundamental framework for future relevant research. It also supplemented the study of the elements influencing the high efficiency of independent innovation from the viewpoint of the internal management of firms, further enhancing the study of the factors influencing innovation effectiveness. In terms of practicality, the results of this study not only assist enterprise groups to make full use of their internal "capital pool" to provide cash flow support for member enterprises' innovation activities but to make full use of their knowledge-sharing mechanism to do so. This improves enterprise groups' profitability and sustainability by assisting them in maintaining a leading position in market rivalry. However, because the data are limited to the manufacturing industry it is not complete. Therefore, in future research, we hope to expand the sample to provide innovative ideas for all industries.

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