

# Equity pledge of controlling shareholders, property right structure and enterprise innovation efficiency: evidence from Chinese firms

Guangqian Ren, Yifan Mo, Li Liu, Minna Zheng & Liying Shen

To cite this article: Guangqian Ren, Yifan Mo, Li Liu, Minna Zheng & Liying Shen (2022) Equity pledge of controlling shareholders, property right structure and enterprise innovation efficiency: evidence from Chinese firms, Economic Research-Ekonomika Istraživanja, 35:1, 6558-6578, DOI: [10.1080/1331677X.2022.2052331](https://doi.org/10.1080/1331677X.2022.2052331)

To link to this article: <https://doi.org/10.1080/1331677X.2022.2052331>



© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 07 Apr 2022.



[Submit your article to this journal](#)



Article views: 1538



[View related articles](#)



[View Crossmark data](#)



Citing articles: 1 [View citing articles](#)

# Equity pledge of controlling shareholders, property right structure and enterprise innovation efficiency: evidence from Chinese firms

Guangqian Ren<sup>a</sup>, Yifan Mo<sup>b</sup>, Li Liu<sup>c</sup>, Minna Zheng<sup>d</sup> and Liying Shen<sup>e</sup>

<sup>a</sup>Business School, Zhengzhou University, Zhengzhou, China; <sup>b</sup>School of Management, Xiamen University, Xiamen, China; <sup>c</sup>School of Management, Henan University of Technology, Zhengzhou, China; <sup>d</sup>School of Economics and Management, Hebei University of Technology, Tianjin, China; <sup>e</sup>Business School, University of International Business and Economics, Beijing, China

## ABSTRACT

The innovation efficiency of an enterprise is subject to the behavior of the innovation subject, while the equity pledge behavior of the controlling shareholder not only brings convenience for innovation investment and financing, but also brings risks which has an impact on the innovation output of the enterprise. In this paper, we investigate how equity pledge of controlling shareholders affect the enterprise innovation efficiency using the data of China's A-share listed companies from 2014 to 2020, and examine the effect of property right structure on the relationship between them from the two dimensions of equity nature and equity concentration. We find that equity pledge of controlling shareholders are significantly negatively related to innovation efficiency, meaning that equity pledge inhibits the innovation behavior of enterprises and reduces the innovation efficiency. We further provide evidence to show that the impediment effect of equity pledge of controlling shareholder on enterprise innovation efficiency is more pronounced in non-state-owned enterprises and decentralized equity enterprises. Moreover, our analysis shows that different equity concentration levels have different effects in the process of equity pledge affecting enterprise innovation efficiency and the effect of concentrated equity enterprises is lower than that of decentralized enterprises.

## ARTICLE HISTORY

Received 12 February 2021  
Accepted 7 March 2022

## KEYWORDS

Equity pledge of controlling shareholders; property right structure; equity nature; equity concentration; innovation efficiency

## JEL

G32; G34; O31

## 1. Introduction

In the period of economic and social transformation, the problems of overcapacity and low efficiency caused by extensive development mode need to be improved by upgrading industrial structure and improving production efficiency. In this process, innovation has become the core driving factor of the long-term competitiveness of a firm and even a country (Zhao et al., 2016). As the main carrier of innovation

**CONTACT** Li Liu  [smile\\_liliu@163.com](mailto:smile_liliu@163.com)

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

activities, enterprises promote the transformation and upgrading of industrial structure by improving their innovation efficiency (Hong et al., 2015). Equity pledge has attracted attention because it can provide funds for innovation investment. In recent years, it has become an increasingly common financing channel for listed companies in China to exchange equity pledge by the controlling shareholder for loans. According to a report issued by China Securities Depository & Clearing Corp, the shares of 2447 listed companies have been pledged by their controlling shareholders in 2019 and private enterprises account for more than half, which 90 companies in the A-share market have pledged more than 50% of total shares outstanding and 33 companies have more than 60%. Although equity pledge provides financing convenience for enterprises' innovative behaviors, it poses a great risk to listed enterprises due to the pledged liquidation of stock prices, which restricts the enterprise's innovation output. If the controlling shareholder fails to release the pledge or pay the deposit in time, they would lose control of the listed enterprise. This increases the uncertainty of the enterprise's internal operations and further affects enterprise innovation efficiency.

Over the past years, although more and more literature have examined various market and company characteristics to innovation (He & Tian, 2013; Aghion et al., 2013; Fang et al., 2014; Cornaggia et al., 2015; Jiang & Yuan, 2018), there is little research on the impact of equity pledge. It is very important to understand the role of equity pledge in stimulating innovation because whether insiders should be allowed to pledge their stocks has aroused heated debate in China and other countries (Pang & Wang, 2020). In this study, we mainly focus on the equity pledge by controlling shareholder rather than other shareholders because the controlling shareholder is the final decision-maker of the enterprises in China. Therefore, their willingness to innovate could directly determines the scale of their investment in innovation projects.

The equity pledge of controlling shareholders have two opposite effects on innovation efficiency. On the one hand, equity pledge not only enables controlling shareholders to cash in 100% of their shares, but also enables them to benefit from any stock price rise in the future. The payment structure of equity pledge is described as a 'call option', because the controlling shareholders would default and abandon their loan obligations when the value of the shares pledged is lower than the loan value (Dou et al., 2019). Therefore, the downward risk of the controlling shareholder has been effectively hedged, but the larger upward potential provides the driving force for the controlling shareholder to undertake more risks and carry out more effective innovative projects.

On the other hand, due to the high uncertainty of innovation, the probability of failure is also relatively high. The failure or inefficient innovation projects may lead to a sharp drop in the stock price. And the default of pledged loan trigger the compulsory sale of shares, which makes the controlling shareholders face the significant risk of losing the control right of the company (Shipman et al., 2017). These risk-taking incentive theories assume that the controlling shareholders do not put the security of their controlling position in the first place when they pledge their shares, but this may be inconsistent with the facts. The large shareholders of listed companies have

significant private control benefits, especially in the case of underdeveloped capital market and more centralized ownership, the private benefits of control are more significant. In order to maintain the control right of their private interests, the controlling shareholders have strong motivation to maintain the stability of stock price during the period of equity pledge and can not tolerate any event that may damage the short-term performance and stock price of the company (Nanda & Nicholas, 2014), so as to reduce the probability of losing the company's control right in case of compulsory sale of shares triggered by margin increase. According to this argument, the controlling shareholders may have a strong incentive to reduce the enterprise's risk exposure by suspending innovation projects if they have a stock pledge, and this incentive would be more obvious when the controlling shareholder have pledged more shares.

On the basis of the above analysis, we examine the impact of controlling shareholders' equity pledge on enterprise innovation efficiency. In addition, considering the characteristics of China's economic transition, there are large differences in the structure of property rights between enterprises, and this difference will also have an impact on the relationship between equity pledges and enterprise innovation efficiency. Although a number of studies on property right structure (Morano & Tajani, 2016; Wang & Yu, 2019), little is known about how property right structure interact to enterprise innovation efficiency in emerging markets, previous studies in this field have ignored the relationship between them (Yi et al., 2013). Because these studies believe that the impact of ownership on innovation is still similar in different regions and industries in a given country (Li & Tellis, 2016). Therefore, we also investigate the relationship between the structure of property rights and enterprise innovation efficiency. Our finding meet the prediction that the relationship between the structure of property rights and enterprise innovation efficiency will be affected by equity pledge.

Different from previous research, this study has three contributions: Firstly, our study contribute to the research on the equity pledge. Equity pledge exists in many markets in the world, including some developed and underdeveloped markets. However, there are few systematic researches on equity pledge, and most of them focus on the impact of equity pledge on shareholder's wealth and short-term financial value (Li et al., 2020). However, these studies ignore the long-term impact of equity pledge on enterprises. Our study have deeply investigated the effect of controlling shareholders' equity pledge on enterprise innovation efficiency, which further expand the research of controlling shareholders' pledge behavior and enterprise innovation efficiency. Our research results not only have great policy significance for improving the equity pledge system in China, but also have important policy significance for many other countries with similar equity structure.

Secondly, our study extend the literature of innovation efficiency. Aghion et al. (2013) find that higher institutional ownership can promote innovation activity because institutional investors focus on long-term commitment, which can reduce managers' short-term career risk. However, these conclusions assume that the occupational safety of managers is determined by the board of directors and affected by the acquisition market, which is a typical feature of decentralized ownership structure.

However, in the market with centralized ownership, controlling shareholders are not challenged by the board of directors or external acquisition market. Some studies have shown that centralized ownership promotes innovation because it reduces the high agency and contracting costs associated with innovation (Hall & Lerner, 2010). However, they ignore the risk that controlling shareholders may lose control of the company, in a case where margin calls on pledged shares trigger a forced sale of shares.

Thirdly, our paper also supplement the literature on property right structure and innovation efficiency. Previous studies have ignored the relationship between property right structure and innovation efficiency, which is difficult to analyze innovation efficiency from the perspective of property rights. We account for the effects of different ownership property in particular, which are seen as key differentiators of success on innovation and entrepreneurial success (Mahmood & Rufin, 2005). Meanwhile, we empirically test the impact of property right structure on the relationship between equity pledge and enterprise innovation efficiency from the perspective of ownership nature and ownership concentration. It's beneficial supplements to the existing literature.

The remainder of this paper is the following. In [Section 2](#), we introduce the theoretical background and discusses our hypotheses development. In [Section 3](#), we describe the empirical design, including the sample selection, definition of variables and model design. In [Section 4](#), we present the descriptive statistics, empirical results and robustness tests. In [Section 5](#), we conclude by discussing conclusions, policy implications and future research directions.

## **2. Theoretical background and hypotheses development**

### ***2.1. Equity pledge and enterprise innovation efficiency***

Pledge is a method of transferring collateral to generate security interest in collateral. Although pledge enables shareholders to obtain low-cost loans without losing control of the company, there are many risks in equity pledge. Financial institutions can sell shares in the open market to recover their dues if the collateral provider defaults, which may lead to a decline in share prices and a fall in market value. If a large part of the shares held by the controlling shareholders are pledged, they will also face the risk of losing the control of the management (Huang & Xue, 2016). With the rapid growth of China's stock pledge transactions, the equity pledge of controlling shareholders may lead to insufficient innovation investment, which should be paid attention to by government regulatory departments, investors and financial management departments.

As a manifestation of capital shortage of controlling shareholders, equity pledge not only bring risks to controlling shareholders, but also bring negative impact on innovation investment of enterprises. The reasons mainly include the following two aspects. On the one hand, equity pledge brings the risk of transfer of control right to the large shareholders, which leads to their negative behavior when they invest in innovation activities. According to Chemmanur et al. (2014), the large shareholders will consider the risk of control transfer after the pledge of their shares when making decisions and deliberately avoid those innovative projects with high uncertainty.

Thus, large shareholders are afraid of losing the control right after the equity pledge, which will lead to risk aversion. In addition, the innovation activities of enterprises have the characteristics of high risk, funds specificity and long investment return period. High risk indicates that the probability of the high failure rate of innovation activities. Once the innovation activities fail, the stock price will fall rapidly and the controlling shareholders will face the risk of losing control. The specificity of funds indicate that innovation activities have high conversion costs. Once the innovation activities fail, the previously invested resources cannot be recovered and the enterprises will also face great losses. The long period of return on investment indicates that the controlling shareholders can't obtain profits in the short term, and the shareholders will tend to improve the short-term performance after the equity pledge, which will reduce the innovation activities of enterprises.

On the other hand, equity pledge also exacerbates the second agency problem. Although China's law stipulates that equity pledge must be disclosed to the public, there is no mandatory disclosure of the amount and use of the pledge funds. If the controlling shareholders use the funds obtained from the equity pledge for the innovation activities of the enterprise, the income obtained from these activities should be shared equally with other minority and medium-sized shareholders, while the risk caused by the equity pledge is mainly borne by the controlling shareholder. The inequality between benefits and risks may cause the controlling shareholder to use the funds obtained from equity pledge for themselves or related enterprises to maximize their own utility, rather than using the funds obtained from equity pledge for enterprise innovation and research activities to enhance their core competitiveness. The self-interest behavior in equity pledge will lead to the major shareholders, especially the controlling shareholders, to encroach on the interests of minority and medium-sized shareholders, which aggravate the second kind of agency problem, induce enterprises decision-making to deviate from the goal of value maximization, and bring negative impact on the innovation activities of enterprises. Therefore, equity pledge of the controlling shareholder will reduce the innovation efficiency of an enterprise. The reduction of enterprise innovation investment will have a lock-in effect on the technology level, which hinders the enterprises to improve the innovation efficiency through technology innovation. Meanwhile, enterprise innovation activities have higher adjustment costs. It may lead to innovation failure or technological backwardness if the innovation input is reduced in the short term, which will slow down the improvement of enterprise innovation efficiency. Based on the above analysis, the first hypothesis is proposed below:

Hypothesis 1: The equity pledge is negatively related to the enterprise innovation efficiency, that is, the equity pledge behavior of the controlling shareholder significantly reduce the innovation efficiency of the enterprise.

## ***2.2. The effect of equity nature in the impact of equity pledge on enterprise innovation efficiency***

In the process of affecting the innovation efficiency of enterprises, equity pledge will be affected by the nature of enterprise equity. In China, the equity nature is mainly

divided into state-owned equity and non-state-owned equity. Due to China's special political and economic system, state-owned holding enterprises account for a large proportion of listed enterprises in China. State-owned enterprises (SOEs) undertake part of social functions, and their business objectives should take into account social interests. Therefore, SOEs have a natural performance disadvantage in the market competition environment (Bruton et al., 2015). As discussed by Belloc (2014), social benefit is an important factor that SOEs need to consider in investment activities, which results in the low efficiency of innovation and research activities of the SOEs. Thus, the difference in the equity nature will lead to differences in the behavior patterns and decision-making methods of controlling shareholders (Sun et al., 2014).

In conclusion, the controlling shareholders of SOEs and non-SOEs have significant differences in the decisions of innovation investment after equity pledges. Specifically, there are two main reasons as detailed in the following part. On the one hand, the multi-level principal-agent relationship and the owner vacancy of SOEs lead to the insufficient attention of the controlling shareholders to innovation projects and innovation efficiency. Compared with SOEs, non-SOEs need to continuously improve their innovation efficiency to enhance their core competitiveness due to perfect supervision mechanism and fierce market competition. In this way, these non-SOEs can get long-term development. Using the sample data of China enterprises, Song et al. (2015) find that in the market environment of incomplete competition, 'visible hand' and 'invisible hand' dominate market resources at the same time. Enterprises with political ties are indeed facing less financing constraints than those without political relations, which lead to private enterprises more inclined to adopt the way of technological innovation to increase their competitiveness. Therefore, in the process of controlling shareholders' equity pledge, the demand for innovation investment of SOEs smaller than non-SOEs, which cause greater negative impact on innovation efficiency.

On the other hand, the controlling shareholders of non-SOEs lose their control right because of the stock price falling to the closing line. The risk of control transfer weakens the inhibitory effect of equity pledge on the innovation efficiency of non-SOEs. Compared with non-SOEs, the controlling shareholders of private enterprises are more inclined to use equity pledge to obtain funds. And the transfer risk of control rights brought by equity pledge will also make the controlling shareholders improve the innovation efficiency of enterprises actively in order to enhance the profitability of enterprise. Favara (2012) documents evidence that the controlling shareholders of private enterprises usually worry about the transfer of control right due to the fall of stock price after equity pledge. They often pay more attention to the value of enterprises, so they have strong motivation to improve corporate governance and enhance the efficiency of enterprise innovation. In addition, many non-SOEs in China are usually founded and operated by major shareholders. These major shareholders entrepreneurs deeply hope that their enterprises can develop in the long run. Driven by this kind of emotion, these major shareholder will try their best to create a good environment for the further development of enterprises, rather than just pursue the maximization of personal interests. Therefore, the second hypothesis in this paper is proposed as follows:

Hypothesis 2: Compared with SOEs, the effect of equity pledges on enterprise innovation efficiency is more significant in non-SOEs.

### ***2.3. The effect of equity concentration in the impact of equity pledge on enterprise innovation efficiency***

According to the principal-agent theory, equity concentration is conducive to the controlling shareholders to play a supervisory role on the management and alleviate the first-class principal-agent issues. However, other research indicates that this also increase the second-class principal-agent issues (Belloc, 2012). In the process of equity pledge affecting the innovation efficiency of enterprises, the degree of equity concentration will affect the behavior pattern and decision-making mode of controlling shareholders, which in turn affect the innovation activities of the enterprise. The controlling shareholders have more influence on the business decision-making in the enterprises with high concentration of shares (Gul et al., 2010). As found by Chen and Hu (2007), the increase of the proportion of large shareholders make the cash flow of management rights and equity pledge tend to be consistent and have a more significant role in promoting enterprise innovation activities. The more centralized the equity, the more beneficial it is for enterprises to concentrate high-quality resources and control rights and to improve the efficiency of business decision-making (Nobanee & Abraham, 2017). Therefore, higher equity concentration may enhance the positive effect of equity pledge.

In addition, the risk of control right transfer caused by equity pledge is different due to different equity concentration, which have different impact on the innovation activities of enterprises. The controlling shareholders of concentrated equity enterprises are faced with greater risk of control transfer than the controlling shareholder of decentralized equity enterprises after the equity pledge. Therefore, shareholders with higher shareholding ratio are more motivated to strengthen the management of enterprises to maintain control rights and avoid risks. And the improvement of equity concentration weaken the negative effect of equity pledge on the innovation enterprise efficiency. However, the controlling shareholders in decentralized equity enterprises are faced with relatively less debt paying risks and control rights transferring risk due to the low shareholding ratio. As a result, the controlling shareholders of equity-decentralized enterprises may not have enough motivation to enhance the operating efficiency of enterprises. The controlling shareholders of decentralized equity enterprises usually have relatively low shareholding ratio, so they are faced with less control rights transferring risk. Therefore, they may have an incentive to reduce high-risk innovation investment in order to maintain the stability of the enterprise's stock price. Wang and Li (2007) point out that the pledge behavior of controlling shareholders is regarded as a sign that the company is in financial distress. The equity pledge behavior usually means that the controlling shareholder does not have enough funds to compete for control rights, which will arouse a large number of 'barbarians at the gate'. In this case, the threshold of the control right competition will be further reduced if the shareholding ratio of the controlling shareholders is low, which also affect the stable development of the enterprise. Therefore, the



negative impact of the controlling shareholders' equity pledge on the enterprise innovation efficiency will be exacerbated in decentralized equity enterprises. Therefore, the third hypothesis in this paper is proposed as follows:

Hypothesis 3: Compared with concentrated equity enterprises, the inhibition of equity innovation on enterprise innovation efficiency more significant in decentralized equity enterprises.

### **3. Empirical design**

#### **3.1. Data and sample**

The initial sample of this paper includes Chinese A-share listed companies from 2014 to 2020. The reason why the sample period started in 2014 is that after Measures for stock pledge repurchase transactions and registration and settlement business (Trial Implementation) was issued by China Stock Exchange and China Securities Regulatory Commission in May 2013, the standardized stock pledge mode was started, and the stock pledge showed explosive growth. The final sample is obtained by screening this sample with the following conditions: (1) observations with abnormal data or with missing variables are removed. (2) ST companies are removed. (3) financial, securities and insurance companies are dropped. (4) companies listed in A-share market, B-share market and H-share market at the same time are eliminated. (5) companies whose actual controller is changed are excluded. In addition, all of the continuous variables are winsorized at the level of 1% and 99% to avoid the influence of outliers. Our final sample consists of 4227 firm-year observations for 675 firms from 2014 to 2020. After the above steps, we obtain stock pledge data, ownership information as well as other financial data from China Stock Market & Accounting Research Database (CSMAR) database.

#### **3.2. Definition of variables**

##### **3.2.1. Dependent variable: enterprise innovation efficiency**

Some literatures use innovative R & D investments or outputs to replace innovation activities. However, due to the large difference in the total amount of R & D investment of different scale enterprises, the amount of innovation R & D investments or outputs are not conducive to horizontal comparative analysis (He & Tian, 2013). And Chinese firms only voluntarily disclose their R & D outputs. Therefore, the lack of R & D outputs does not necessarily mean that firms have no innovation activities (Pang & Wang, 2020).

Therefore, we use the ratio of patent application to R & D investment to measure innovation efficiency (Hirshleifer et al., 2013) because of two reasons: on the one hand, not all new inventions are patents, because those that do not meet the requirements in the patent application examination are excluded by government departments. On the other, only 'successful' innovation activities can be granted patents, which means that all products that fail in innovation activities will not be recognized by certification standards. Therefore, patent is an effective means to measure the

innovation ability of an firm, which is closely related to the innovation efficiency of the enterprise, and it is widely used to measure the firm innovation efficiency by scholars in the existing research (Plank & Doblinger, 2018; Lu & Wang, 2018). And innovation efficiency is expressed by  $P/R$  in this paper, where  $P$  is the patent application number of the firm in the current year, and  $R$  is the natural logarithm of the enterprise's R & D investment in that year. For a small number of samples (only 0.1% of the total number of samples) whose absolute R & D investment is 0, we use 1 to replace it.

### **3.2.2. Independent variable: equity pledge**

According to the relevant provisions of China's administrative measures for information disclosure of listed companies, if the actual controller of a listed company or the shareholders holding more than 5% of the company's shares pledge, it must be announced to investors (Bharath et al., 2013). We use the equity pledge rate to measure the equity pledge behavior, which is the proportion of equity pledge when the controlling shareholders of listed companies have equity pledge behavior in the year. The calculation formula is the ratio of the number of equity pledge of controlling shareholders to the total number of shares held by controlling shareholders at the end of that year.

### **3.2.3. Control variables**

Based on the research of corporate governance theory, we introduce a set of firm-specific control variables which affect the innovation efficiency of enterprises. We control firm characteristics including: firm size, CEO duality (Wang et al., 2019), firm age, proportion of independent directors (Plank & Doblinger, 2018), asset-liability ratio, return on assets and investment opportunity (Rong et al., 2017; Lu & Wang, 2018), proportion of fixed assets (Hc et al., 2021), board size (Augusto et al., 2020). Finally, we introduce industry dummy variable and year dummy variable to control the influence of industry and year on the model.

### **3.2.4. Grouping variable**

Referring to the literature (Jiang et al., 2013), we measure the property right structure from the two angles of equity nature and equity concentration. The ultimate ownership of the company is determined by the nature of the company, SOEs being recorded as 1, and the non-SOEs being recorded as 0. At the same time, we use the shareholding ratio of the largest shareholder to measure the equity concentration. Referring to the practice of listed companies and the classification standards of domestic and foreign scholars, we take 30% as the dividing line. If the largest shareholder of the sample company holds more than or equal to 30%, it is defined as the equity concentrated sample, otherwise it is the equity decentralized sample. The main variables and their definitions are shown in Table 1.

**Table 1.** Definition of variables.

Category	Name	Symbol	Definition
Dependent variable	Enterprise innovation efficiency	<i>P/R</i>	The patent application number of the firm in the current year / the natural logarithm of the enterprise's R & D investment in that year
Independent variable	Equity pledge	<i>Pledge</i>	The number of equity pledge of controlling shareholders / the total number of shares held by controlling shareholders at the end of the year
Control variable	Firm size	<i>Size</i>	Ln (number of employees)
	Asset-liability ratio	<i>Lev</i>	Total debts / total assets
	Return on assets	<i>Roa</i>	Net income / average total assets
	Tobin's Q	<i>Tobin's Q</i>	The market value of the enterprise / total assets of the enterprise in the end of the year
	Firm age	<i>Age</i>	Ln (number of years since establishment)
	Proportion of independent directors	<i>Indep</i>	Number of independent directors / total number of directors
	Proportion of fixed assets	<i>Tang</i>	Fixed assets / total assets at the end of the year
	Board size	<i>Board</i>	Ln (number of directors at the end of the year + 1)
	CEO duality	<i>Duality</i>	Whether the chairman and the general manager are the same person, the assignment is 1 if they are the same person, otherwise it is 0.
	Year	<i>Year</i>	Dummy variable, it is equal to 1 if associated with the corresponding year.
	Industry	<i>Indu</i>	Dummy variable, it is equal to 1 if affiliated at the corresponding two-digit industry
	Grouping variable	Equity nature	<i>Eqnaure</i>
Equity concentration		<i>Top1</i>	If the largest shareholder of the sample company holds more than or equal to 30%, it is defined as the equity concentrated sample, otherwise it is the equity decentralized sample.

Source: The authors.

### 3.3. Model design

To test our three hypotheses, we estimate the following model:

$$P/R_{it} = \alpha_0 + \beta_1 Pledge_{it} + \beta_2 Size_{it} + \beta_3 Lev_{it} + \beta_4 Roa_{it} + \beta_5 Tobin's Q_{it} + \beta_6 Age_{it} + \beta_7 Indep_{it} + \beta_8 Tang_{it} + \beta_9 Board_{it} + \beta_{10} Duality_{it} + \beta_{11} Year_{it} + \beta_{12} Indu_{it} + \varepsilon_{it}$$

where,  $i$  and  $t$  denote serial number and year of listed company, and  $\varepsilon_{it}$  is the random error term. To investigate how equity pledge by controlling shareholder affect innovation efficiency, we use the full sample data to make an empirical analysis of the regression model. On the basis of complete sample data regression, we conduct two sub sample comparative regression analysis to test Hypothesis 2 and Hypothesis 3.

On the one hand, according to the classification criteria of the CSMAR database, we divide all samples into two groups: SOEs and non-SOEs, and then test Hypothesis 2. On the other hand, according to the critical value of equity concentration (30%), we divide all samples into two groups: concentrated equity enterprises and decentralized equity enterprises, and then test Hypothesis 3.

## 4. Empirical results

### 4.1. Descriptive statistics

Table 2 presents the descriptive statistics of all variables. The average of *P/R* is 0.434, the maximum value is 1.635 and the minimum value is 0, which shows that innovation efficiency of Chinese enterprises is not high, and there is a big gap between different enterprises. The maximum value of *Pledge* is 0.958 and the minimum value is 0, which indicates that there are great differences in different enterprises. The mean and other values of the control variables are shown in Table 2.

### 4.2. Correlation analysis

Table 3 provides the results of main variables' Pearson and Spearman correlation coefficients. It can also be seen that the Spearman and the Pearson coefficient of *Pledge* and *P/R* are  $-0.044$  and  $-0.028$  respectively, and both coefficients are significant at the 1% level, suggesting that the existence of controlling shareholder's equity pledge has a negative impact on the enterprises innovation efficiency, which can verify Hypothesis 1. Table 3 also shows that *P/R* is positively correlated with *Size*, *Tobin's Q*, *Indep*, *Board*, *Duality* and *Roa*, but negatively correlated with *Lev* and *Age*.

### 4.3. Regression analysis results

#### 4.3.1. Equity pledge behavior on enterprise innovation efficiency

The impact of equity pledge on enterprise innovation efficiency are shown in Table 4. As shown in Table 4, the *F* value of the regression model is 36.628 and the *Adjusted R-squared* value is 0.199, suggesting that the model has a high fitting degree and good interpretation ability. The regression coefficient of *Pledge* is  $-1.493$  and it is significant at the 5% level, which suggests that a 1% increase of equity pledge leads to

**Table 2.** Descriptive statistics.

Variable	N	Mean	SD	Min	Median	Max
<i>P/R</i>	4227	0.434	0.774	0	-0.042	1.635
<i>Pledge</i>	4227	0.105	0.199	0	0	0.958
<i>Size</i>	4227	1.345	0.059	0.967	1.332	1.468
<i>Lev</i>	4227	0.389	0.189	0.059	0.377	0.836
<i>Roa</i>	4227	0.053	0.040	0.002	0.045	0.195
<i>Tobin's Q</i>	4227	2.02	1.77	0.239	1.521	11.04
<i>Age</i>	4227	1.924	0.928	0	2.079	3.258
<i>Indep</i>	4227	0.376	0.053	0.333	0.357	0.571
<i>Tang</i>	4227	0.203	0.143	0.004	0.175	0.646
<i>Board</i>	4227	0.343	0.144	0.086	0.326	0.732
<i>Duality</i>	4227	0.692	0.462	0	1	1

Source: The authors.

**Table 3.** Correlation matrix of variables.

Variable	P/R	Pledge	Size	Lev	Tobin'Q	Age	Indep	Tang	Duality	Roa	Board
P/R	1										
Pledge	-0.044***	1									
Size	0.339***	-0.097***	1								
Lev	-0.229***	-0.042***	-0.427***	1							
Tobin'Q	0.114***	0.047***	0.415*	-0.330***	1						
Age	-0.134***	-0.142***	-0.379***	0.243**	-0.044***	1					
Indep	0.041*	0.013	0.174*	-0.011	0.040***	-0.032***	1				
Tang	-0.036	-0.042*	0.229**	0.096**	-0.106**	0.136***	-0.046***	1			
Duality	0.055***	-0.076**	0.008***	0.150***	-0.064***	0.253***	-0.117***	0.076***	1		
Roa	0.012***	0.028*	0.003	-0.411***	0.273***	-0.257***	0.009	-0.099***	-0.097***	1	
Board	0.078***	-0.076**	0.092**	0.160***	-0.117***	0.172***	-0.575***	0.143***	0.177***	-0.052***	1

Note: \*\*\*, \*\*, and \* indicate significant at the level of 1%, 5% and 10% respectively.  
Source: The authors.

**Table 4.** Regression result of equity pledge on enterprise innovation efficiency.

Variable	Coefficient	t
<i>Pledge</i>	-1.493**	-2.014
<i>Sise</i>	5.015**	2.035
<i>Lev</i>	-6.246***	-9.647
<i>Roa</i>	21.231***	15.386
<i>Tobin's Q</i>	0.533***	2.811
<i>Age</i>	-0.839**	-2.168
<i>Indep</i>	10.045*	1.897
<i>Tang</i>	-2.385	-0.660
<i>Board</i>	3.236***	8.950
<i>Duality</i>	0.032**	2.290
Constant	-15.546***	-11.659
<i>Year</i>		Yes
<i>Indu</i>		Yes
<i>Observations</i>		4227
<i>R-squared</i>		0.205
<i>Adjusted R-squared</i>		0.199
<i>F</i>		36.628***

Note: \*\*\*, \*\* and \* indicate significant at the level of 1%, 5% and 10% respectively.

Source: The authors.

an reduce of 1.493 in innovation efficiency and shows that there is a significant negative correlation between equity pledge and enterprise innovation efficiency. Thus, it is consistent with our prediction in Hypothesis 1. This finding is consistent with the view of Chan et al. (2018) believe that the equity pledge should not show any relationship with corporate decision-making when shareholders are not worried about losing control of the company. Consistent with the existing literature, we also find that larger companies, or companies with more return on assets and more market value, have more innovation output which is consistent with the findings in He and Tian (2013) and Aghion et al. (2013).

#### 4.3.2. Equity pledge on enterprise innovation efficiency in different equity nature

Table 5 shows the results of equity pledge on enterprise innovation efficiency in different equity nature. The regression coefficient of *Pledge* is -3.188 and it is significant at the 1% level in non-SOEs sub samples, the regression coefficient of *Pledge* is -0.361 and it is not significant in SOEs sub samples. It's indicates that the state-owned attribute of equity has a stronger inhibitory effect on the innovation efficiency of enterprises. Due to the existence of multi-level principal-agent relationship, the owner's vacancy and the management's position security consideration. Moreover, the imperfect incentive and restraint mechanism of SOEs, their management tends to be more stable business model and is not willing to invest in some long-term R & D activities, which is not conducive to the improvement of enterprise innovation efficiency. Non-SOEs generally do not have the resource advantages of SOEs, and their operating performance and competitiveness are mainly derived from their own operating conditions. Therefore, non-SOEs need to maintain a certain level of innovation efficiency to enhance their profitability and competitiveness. It can also be seen from the regression results that the equity pledge has a less inhibitory effect on the innovation efficiency of non-SOEs, mainly because non-SOEs has a strong demand for innovation efficiency. Therefore, it is consistent with our prediction in Hypothesis 2.

**Table 5.** Subsample grouping regression results with different nature of equity.

Variable	Non-SOEs		SOEs	
	Coefficient	t	Coefficient	t
<i>Pledge</i>	-3.188***	-3.213	-0.361	-1.599
<i>Sise</i>	6.372**	2.156	3.927*	1.802
<i>Lev</i>	-6.632***	-7.757	-5.956***	-9.470
<i>Roa</i>	23.246***	16.077	20.600***	16.235
<i>Tobin's Q</i>	1.003**	2.026	1.408***	3.162
<i>Age</i>	-0.333*	-1.809	-0.511**	-2.296
<i>Indep</i>	22.150***	9.087	2.798**	2.449
<i>Tang</i>	-3.296	-1.347	-1.026	-1.416
<i>Board</i>	3.370***	4.214	2.036***	5.459
<i>Duality</i>	0.014*	1.724	0.098*	1.855
Constant	-18.856***	-6.659	-9.047***	-6.385
<i>Year</i>		Yes		Yes
<i>Indu</i>		Yes		Yes
<i>Observations</i>		1422		2805
<i>R-squared</i>		0.286		0.173
<i>Adjusted R-squared</i>		0.271		0.165
<i>F</i>		18.669***		22.583***

Note: \*\*\*, \*\* and \* indicate significant at the level of 1%, 5% and 10% respectively.

Source: The authors.

**Table 6.** Regression results of grouping different subsamples of equity concentration.

Variable	Concentrated equity enterprises		Decentralized equity enterprises	
	Coefficient	t	Coefficient	t
<i>Pledge</i>	-0.375	-1.012	-2.314***	-2.729
<i>Sise</i>	5.2269**	2.302	4.116**	2.234
<i>Lev</i>	-6.359***	-13.918	-6.109***	-14.049
<i>Roa</i>	25.925***	13.721	16.486***	8.269
<i>Tobin's Q</i>	0.569***	3.970	0.502***	4.049
<i>Age</i>	-0.661***	-7.564	-0.946***	-10.339
<i>Indep</i>	3.143***	3.697	3.978**	2.477
<i>Tang</i>	-3.556***	-6.096	-0.793	-1.309
<i>Board</i>	2.898***	5.768	2.931***	5.670
<i>Duality</i>	0.163	1.052	0.268*	1.796
Constant	-14.951***	-8.143	-11.869***	-6.264
<i>Year</i>		Yes		Yes
<i>Indu</i>		Yes		Yes
<i>Observations</i>		2288		1939
<i>R-squared</i>		0.229		0.195
<i>Adjusted R-squared</i>		0.221		0.183
<i>F</i>		25.293***		15.897***

Note: \*\*\*, \*\* and \* indicate significant at the level of 1%, 5% and 10% respectively.

Source: The authors.

### 4.3.3. Equity pledge behavior on enterprise innovation efficiency in different equity concentration degrees

Table 6 reports the regression results of equity pledge on enterprise innovation efficiency in different equity concentration degrees. It can be seen that the regression coefficient of *Pledge* is -0.375 and it is not significant in concentrated equity enterprises, the regression coefficient of *Pledge* is -2.314 and it is significant at the 5% level in decentralized equity enterprises respectively. It's suggests that the equity concentration has a negative effect on the relationship between the equity pledge and the enterprise innovation efficiency, and this inhibition effect is more significant in the decentralized equity subsamples.

This is because the large shareholders in the enterprises with high degree of equity concentration have more discourse power on the operation and decision-making of enterprises after they have mastered more shares, which can influence or even determine the decision-making and operation of enterprises. Therefore, the preference of large shareholders, especially the controlling shareholders, may affect or even become the decision-making of enterprises. In the process of equity pledge, large shareholders may achieve stock price stability and market value management through mergers and acquisitions or publicity of innovation events to reduce the risk of control right transfer, which can improve the profitability of enterprises to a certain extent and weaken the negative impact of equity pledge on the enterprise innovation efficiency. However, the large shareholders' influence on the enterprise is relatively weak in the equity decentralized enterprise because they hold only few shares. Therefore, they lack the incentive to carry out innovation activities and investment and even empty the listed companies, which leads to the inhibition effect of equity pledge on the enterprise innovation efficiency is relatively large in decentralized equity enterprises. Therefore, it is consistent with our prediction in Hypothesis 3.

#### 4.4. Robustness test

We change the measurement method of the enterprise innovation efficiency (Wang & Zou, 2018) to test the reliability and robustness of the above research results. We apply Data Envelopment Analysis (DEA) (Zou et al., 2021) to calculate enterprise innovation efficiency. There is  $n$  DMUs, each  $DMU_j$  ( $j = 1, \dots, n$ ) has  $m$  inputs  $x_{ij}$  ( $i = 1, \dots, m$ ) and  $s$  outputs  $y_{rj}$  ( $r = 1, \dots, s$ ). In this study, we have 4227 firms, one of firm have three inputs (R & D investment amount, proportion of R & D personnel and fixed assets) and two outputs (patent application number and R & D expenditure capitalization). For the firms under evaluation, its relative efficiency can be measured by CCR model:

$$\begin{aligned} & \min \theta_0 \\ & \text{s.t. } \sum_{j=1}^n \lambda_j x_{ij} \leq \theta_0 x_{i0}, i = 1, \dots, m \\ & \sum_{j=1}^n \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \\ & \lambda_j \geq 0, j = 1, \dots, n \end{aligned}$$

where  $\theta_0$  is CCR-efficient of each DMU. And we use relative efficiency to express the enterprise innovation efficiency, the summary statistics are shown in Table 7. It can be seen that the average enterprise innovation efficiency from 2014 to 2020 is 0.298, 0.300, 0.303, 0.315, 0.303, and 0.289, respectively. The result indicates that the enterprise innovation efficiency in Chinese enterprises is not high.

Then, we run the above regression model again. From the results in Table 8, it can be seen that the variable coefficient and significance of regression results are consistent with the research conclusion of this paper, suggesting that the relationship



**Table 7.** Summary statistics of enterprise innovation efficiency from 2014 to 2020.

Year	Mean	Max	Min	Std.
2014	0.298	1	0.107	0.138
2015	0.300	1	0.115	0.144
2016	0.303	1	0.114	0.146
2017	0.315	1	0.109	0.157
2018	0.303	1	0.114	0.147
2019	0.289	1	0.098	0.147
2020	0.275	1	0.091	0.139

Source: The authors.

**Table 8.** Robustness test results.

Variable	Full Sample	Non-SOEs	SOEs	Concentrated equity enterprises	Decentralized equity enterprises
Pledge	-1.227** (-2.015)	-4.328*** (-3253)	-0.356 (-1.305)	-0.525 (-1.013)	-3.307*** (-2.923)
Size	6.718*** (2.926)	6.240*** (3.368)	2.257* (1.831)	5.039** (2.124)	5.080*** (3.183)
Lev	-5.004*** (-7.301)	-7.221*** (-6.101)	-4.121** (-2.234)	-6.729*** (-11.035)	-5.527*** (-7.146)
Roa	17.240*** (11.523)	8.239*** (14.021)	18.113** (2.252)	19.338*** (11.261)	16.970*** (10.024)
Tobin's Q	0.572** (2.052)	15.110** (2.083)	1.334** (2.358)	0.536*** (3.025)	0.529** (2.101)
Age	-0.936** (-2.135)	-0.534** (-2.015)	-0.428* (-1.853)	-0.867*** (-6.362)	-1.685** (-2.290)
Indep	8.206* (1.789)	18.535** (2.404)	6.017** (2.330)	3.231** (2.030)	5.338* (1.861)
Tang	-2.923 (-0.275)	-2.838 (-1.235)	-1.719 (-1.420)	-3.062*** (-7.134)	-0.252* (-1.850)
Board	5.352*** (4.553)	2.782** (2.268)	3.753** (2.115)	3.779*** (5.825)	3.391*** (4.972)
Duality	0.137* (1.820)	0.231** (2.114)	0.087* (1.801)	0.367 (1.229)	0.185 (1.067)
Constant	-16.235*** (-11.021)	-15.357*** (-9.328)	-10.253*** (-8.157)	-16.393*** (-10.260)	-11.031*** (-7.008)
Year	Yes	Yes	Yes	Yes	Yes
Indu	Yes	Yes	Yes	Yes	Yes
R-squared	0.230	0.212	0.178	0.226	0.182
Adjusted R-squared	0.214	0.198	0.166	0.201	0.167
F	34.662*** (11.073)	27.273*** (9.079)	21.057*** (7.002)	27.935*** (9.580)	20.397*** (9.008)

Note: \*\*\*, \*\* and \* indicate significant at the level of 1%, 5% and 10% respectively.

Source: The authors.

between the equity pledge, enterprise property rights and enterprise innovation efficiency is still robust.

Second, we change the sample used in the model and use the sample data from 2015 to 2017 to recalculate the above model to ensure the robustness of our results. This is because China Stock Exchange officially opened equity pledge in 2014 and issued documents to strictly restrict equity pledge in 2018, 2015-2017 is a period of significant increase in equity pledge of Chinese listed companies. Table 9 presents the results in the shorter sample. The regression coefficient of *Pledge* is larger than the conclusion drawn above, the significance does not change. These results indicate that the research conclusion of this paper is not affected by the selection of sample interval.

**Table 9.** Robustness test results.

Variable	Full Sample	Non-SOEs	SOEs	Concentrated equity enterprises	Decentralized equity enterprises
<i>Pledge</i>	-1.526** (-2.134)	-5.259*** (-3.772)	-0.463 (-1.331)	-0.758 (-1.124)	-3.119*** (-2.837)
<i>Sise</i>	6.039*** (2.768)	6.886*** (3.243)	2.997* (1.786)	6.829** (2.336)	5.273* (1.862)
<i>Lev</i>	-4.785*** (-8.159)	-7.081*** (-6.517)	-4.283** (-2.357)	-5.186*** (-12.027)	-5.007** (-2.312)
<i>Roa</i>	19.751*** (13.116)	7.995*** (15.036)	17.285** (2.346)	20.624*** (14.378)	18.296*** (9.112)
<i>Tobin's Q</i>	0.572* (1.775)	17.676** (2.120)	1.382** (2.250)	0.771*** (3.296)	0.669** (2.210)
<i>Age</i>	-0.728** (-2.012)	-0.412** (-2.251)	-0.467* (-1.779)	-0.963*** (-6.447)	-1.115** (-2.007)
<i>Indep</i>	8.159* (1.714)	20.675** (2.342)	5.759** (2.253)	3.872** (2.258)	3.775* (1.861)
<i>Tang</i>	-3.056 (-0.437)	-3.527 (-1.010)	-1.975 (-1.358)	-3.788*** (-6.783)	-0.346* (-1.728)
<i>Board</i>	5.829** (2.336)	2.976** (2.457)	3.016** (2.426)	3.007*** (6.021)	2.896*** (4.882)
<i>Duality</i>	0.115* (1.892)	0.126** (2.015)	0.071* (1.857)	0.280 (1.125)	0.205 (1.534)
Constant	-18.397*** (-10.321)	-15.291*** (-9.273)	-9.328*** (-7.224)	-17.339*** (-9.276)	-15.628*** (-6.775)
<i>Year</i>	Yes	Yes	Yes	Yes	Yes
<i>Indu</i>	Yes	Yes	Yes	Yes	Yes
<i>R-squared</i>	0.221	0.206	0.166	0.243	0.179
<i>Adjusted R-squared</i>	0.198	0.187	0.152	0.229	0.166
<i>F</i>	40.195*** (10.337)	25.296*** (9.674)	20.168*** (7.157)	26.186*** (8.286)	19.375*** (9.163)

Note: \*\*\*, \*\* and \* indicate significant at the level of 1%, 5% and 10% respectively.

Source: The authors.

## 5. Conclusions and implications

### 5.1. Conclusions

The main findings of this study include the following: (1) Equity pledge of controlling shareholder is significantly negatively related to enterprise innovation efficiency. The negative relationship is robust in different variable definitions and samples. The results support prior literature which examines how share pledging affects the firm performance, shareholder wealth, and firm risk (Chen & Hu, 2007; Dou et al., 2019; Li et al., 2019). (2) We provide evidence to document that the impediment effect of equity pledge by controlling shareholder on enterprise innovation efficiency is more pronounced in non-SOEs compared with SOEs, suggesting that enterprise property rights can affect the relationship between equity pledge and enterprise innovation efficiency. (3) Compared with concentrated equity enterprises, the effect of equity pledge on enterprise innovation efficiency is more pronounced in decentralized equity enterprises, which shows that different equity concentration levels have different effects in the process of equity pledge affecting enterprise innovation efficiency and the effect of concentrated equity enterprises is lower than that of decentralized equity enterprises.

We draw these conclusions based on the data of Chinese companies. Considering the characteristics of Chinese listed companies, we infer that these conclusions are applicable to other markets/countries with concentrated equity, such as Japan and Germany.

## 5.2. Policy implications

Based on above results, we put forward some suggestion as following: (1) The government should broad the financing channels of listed enterprises and develop multi-level capital markets. Equity pledge brings control rights transferring risk to the controlling shareholder, which in turn may inhibit the enterprise's investment in high-risk innovation projects. Therefore, the government should promote the improvement of China's capital market from the policy level and strengthen the supervision of equity pledges. (2) The above tests show that the government should strengthen the information disclosure mechanism of equity pledge to standardize the equity pledge behavior of controlling shareholders. The operating specifications and legal basis of equity pledge should be refined to mitigate the risk of equity pledge and give full play to its advantages. It can reduce the risk caused by information asymmetry and achieve the purpose of regulating the shareholder's equity pledge behavior. (3) The government needs to further deepen the mixed ownership reform of SOEs and improve the incentive and restraint mechanism of SOEs. The controlling shareholders of SOEs are encouraged to carry out innovative activities through the reform of mixed ownership.

## 5.3. Future research directions

Our research has potential limitations that provide directions for future. Firstly, we can further explore the transmission path of equity pledge affecting enterprise innovation, which is great significance for transformation and upgrading of enterprises. Secondly, the vast majority of listed companies have not explained the projects and specific purposes of capital investment, which makes it impossible to explore the impact of equity pledge on enterprise innovation according to the specific purposes of equity pledge, which is a problem to be studied in the future. Thirdly, according to the use objects of equity financing funds, it is an important topic for future research to explore the impact of equity pledge on enterprise innovation.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This study is supported by Philosophy and Social Science Planning Project of Henan Province (2020BJJ056), Excellent Youth Scientific Research Team Cultivation Plan of Humanities and Social Sciences of Zhengzhou University (2020-QNTD-01), General Project of Humanities and Social Science Research in Colleges and Universities in Henan Province (2021-ZZJH-366), High Level Talent Fund Project of Henan University of Technology (2021SBS32), General Research Project of Humanities and Social Sciences of the Ministry of Education (21YJA630005).

## References

Aghion, P., Reenen, J. V., & Zingales, L. (2013). Innovation and institutional ownership. *American Economic Review*, 103(1), 277–304. <https://doi.org/10.1257/aer.103.1.277>

- Augusto, M., Rui, P., & Reis, P. (2020). Firms' performance and board size: A simultaneous approach in the European and American contexts. *Applied Economics Letters*, 27(13), 1039–1043. <https://doi.org/10.1080/13504851.2019.1659487>
- Belloc, F. (2012). Corporate governance and innovation: A Survey. *Journal of Economic Surveys*, 26(5), 835–864. <https://doi.org/10.1111/j.1467-6419.2011.00681.x>
- Belloc, F. (2014). Innovation in state-owned enterprises: Reconsidering the conventional wisdom. *Journal of Economic Issues*, 48(3), 821–848. <https://doi.org/10.2753/JEI0021-3624480311>
- Bharath, S. T., Jayaraman, S., & Nagar, V. (2013). Exit as governance: An empirical analysis. *The Journal of Finance*, 68(6), 2515–2547. <https://doi.org/10.1111/jofi.12073>
- Bruton, G. D., Peng, M. W., Ahlstrom, D., Stan, C., & Xu, K. (2015). State-owned enterprises around the world as hybrid organizations. *Academy of Management Perspectives*, 29(1), 92–114. <https://doi.org/10.5465/amp.2013.0069>
- Chan, K., Chen, H. K., Hu, S. Y., & Liu, Y. J. (2018). Share pledges and margin call pressure. *Journal of Corporate Finance*, 52, 96–117. <https://doi.org/10.1016/j.jcorpfin.2018.08.003>
- Chemmanur, T. J., Loutskina, E., & Tian, X. (2014). Corporate Venture Capital, Value Creation, and Innovation. *Review of Financial Studies*, 27(8), 2434–2473. <https://doi.org/10.1093/rfs/hhu033>
- Chen, Y., & Hu, S. Y. (2007). The controlling shareholder's personal leverage and firm performance. *Applied Economics*, 39(8), 1059–1075. <https://doi.org/10.1080/00036840500462004>
- Cornaggia, J., Mao, Y. F., Tian, X., & Wolfe, B. (2015). Does banking competition affect innovation? *Journal of Financial Economics*, 115(1), 189–209. <https://doi.org/10.1016/j.jfineco.2014.09.001>
- Dou, Y., Masulis, R., & Zein, J. (2019). Shareholder Wealth Consequences of Insider Pledging of Company Stock as Collateral for Personal Loans. *Review of Financial Studies*, Forthcoming.
- Fang, V. W., Tian, X., & Tice, S. (2014). Does stock liquidity enhance or impede firm innovation? *The Journal of Finance*, 69(5), 2085–2125. <https://doi.org/10.1111/jofi.12187>
- Favara, G. (2012). Agency Problems and Endogenous Investment Fluctuations. *Review of Financial Studies*, 25(7), 2301–2342. <https://doi.org/10.1093/rfs/hhs009>
- Gul, F. A., Kim, J., & Qiu, A. A. (2010). Ownership Concentration, Foreign Shareholding, Audit Quality, and Stock Price Synchronicity: Evidence from China. *Journal of Financial Economics*, 95(3), 425–442. <https://doi.org/10.1016/j.jfineco.2009.11.005>
- Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. *Handbook of the Economics of Innovation*, 1, 609–639.
- Hc, A., Ju, R., & Yjk, C. (2021). Fixed asset revaluation and external financing during the financial crisis: Evidence from Korea. *Pacific-Basin Finance Journal*, 67, 101517.
- He, J. J., & Tian, X. (2013). The dark side of analyst coverage: The case of innovation. *Journal of Financial Economics*, 109(3), 856–878. <https://doi.org/10.1016/j.jfineco.2013.04.001>
- Hirshleifer, D., Hsu, P., & Li, D. (2013). Innovative efficiency and stock returns. *Journal of Financial Economics*, 107(3), 632–654. <https://doi.org/10.1016/j.jfineco.2012.09.011>
- Hong, J., Wang, C., & Kafourous, M. (2015). The role of the state in explaining the internationalization of emerging market enterprises. *British Journal of Management*, 26(1), 45–62.
- Huang, Z., & Xue, Q. (2016). Re-examination of the effect of ownership structure on financial reporting: Evidence from share pledges in China. *China Journal of Accounting Research*, 9(2), 137–152. <https://doi.org/10.1016/j.cjar.2015.11.001>
- Jiang, L., Waller, D. S., & Cai, S. (2013). Does ownership type matter for innovation? Evidence from China. *Journal of Business Research*, 66(12), 2473–2478. <https://doi.org/10.1016/j.jbusres.2013.05.037>
- Jiang, X., & Yuan, Q. (2018). Institutional investors' corporate site visits and corporate innovation. *Journal of Corporate Finance*, 48, 148–541. <https://doi.org/10.1016/j.jcorpfin.2017.09.019>
- Li, M., Liu, C., & Scott, T. (2019). Share pledges and firm value. *Pacific-Basin Finance Journal*, 55, 192–205. <https://doi.org/10.1016/j.pacfin.2019.04.001>

- Li, Y., & Tellis, G. J. (2016). Is China uniform? Intra-country differences in the takeoff of new products. *Technovation*, 47(1), 1–13. <https://doi.org/10.1016/j.technovation.2015.08.002>
- Li, W., Zhou, J., Yan, Z., & Zhang, H. (2020). Controlling shareholder share pledging and firm cash dividends. *Emerging Markets Review*, 42, 100671. <https://doi.org/10.1016/j.ememar.2019.100671>
- Lu, J., & Wang, W. (2018). Managerial conservatism, board independence and corporate innovation. *Journal of Corporate Finance*, 48, 1–16. <https://doi.org/10.1016/j.jcorpfin.2017.10.016>
- Mahmood, I. P., & Rufin, C. (2005). Government's dilemma: The institutional framework for imitation and innovation. *Academy of Management Review*, 30(2), 338–360. <https://doi.org/10.5465/amr.2005.16387891>
- Morano, P., & Tajani, F. (2016). Bare ownership of residential properties: Insights on two segments of the Italian market. *International Journal of Housing Markets and Analysis*, 9(3), 376–399. <https://doi.org/10.1108/IJHMA-07-2015-0037>
- Nanda, R., & Nicholas, T. (2014). Did bank distress stifle innovation during the great depression? *Journal of Financial Economics*, 114(2), 273–292. <https://doi.org/10.1016/j.jfineco.2014.07.006>
- Nobanee, H., & Abraham, J. (2017). The impact of free cash flow, equity concentration and agency costs on firm's profitability. *Investment Management and Financial Innovations*, 14(2), 19–26. [https://doi.org/10.21511/imfi.14\(2\).2017.02](https://doi.org/10.21511/imfi.14(2).2017.02)
- Pang, C., & Wang, Y. (2020). Stock pledge, risk of losing control and corporate innovation. *Journal of Corporate Finance*, 60, 101534. <https://doi.org/10.1016/j.jcorpfin.2019.101534>
- Plank, J., & Doblinger, C. (2018). The firm-level innovation impact of public R&D funding: Evidence from the German renewable energy sector. *Energy Policy*, 113, 430–438. <https://doi.org/10.1016/j.enpol.2017.11.031>
- Rong, Z., Wu, X., & Boeing, P. (2017). The effect of institutional ownership on firm innovation: Evidence from Chinese listed firms. *Research Policy*, 46(9), 1533–1551. <https://doi.org/10.1016/j.respol.2017.05.013>
- Shipman, J. E., Swanquist, Q. T., & Whited, R. L. (2017). Propensity score matching in accounting research. *The Accounting Review*, 92(1), 213–244. <https://doi.org/10.2308/accr-51449>
- Song, M., Ai, H., & Li, X. (2015). Political connections, financing constraints, and the optimization of innovation efficiency among China's private enterprises. *Technological Forecasting and Social Change*, 92, 290–299. <https://doi.org/10.1016/j.techfore.2014.10.003>
- Sun, X., Li, J., Wu, G., Qian, Y., & Tian, Y. (2014). Construction of collaborative innovation mechanism of knowledge alliance between Chinese state-owned enterprises and organizations. *Transnational Corporations Review*, 6(4), 317–343. <https://doi.org/10.5148/tncr.2014.6401>
- Wang, Z., & H, Li. (2007). Financial distress prediction of Chinese listed companies: A rough set methodology. *Chinese Management Studies*, 1(2), 93–110. <https://doi.org/10.1108/17506140710758008>
- Wang, J. W., & Yu, W. W. (2019). Insider ownership and analyst forecast properties. *Journal of Accounting, Auditing & Finance*, 34(1), 125–150. <https://doi.org/10.1177/0148558X17691669>
- Wang, X., & Zou, H. (2018). Study on the effect of wind power industry policy types on the innovation performance of different ownership enterprises: Evidence from China. *Energy Policy*, 122, 241–252. <https://doi.org/10.1016/j.enpol.2018.07.050>
- Wang, X., Zou, H., Zheng, Y., & Jiang, Z. (2019). How will different types of industry policies and their mixes affect the innovation performance of wind power enterprises? Based on dual perspectives of regional innovation environment and enterprise ownership. *Journal of Environmental Management*, 251, 109586. <https://doi.org/10.1016/j.jenvman.2019.109586>
- Yi, J., Wang, C., & Kafourous, M. (2013). The effects of innovative capabilities on exporting: Do institutional forces matter? *International Business Review*, 22(2), 392–406. <https://doi.org/10.1016/j.ibusrev.2012.05.006>

- Zhao, Z. Y., Chang, R. D., & Chen, Y. L. (2016). What hinder the further development of wind power in China?-a socio-technical barrier study. *Energy Policy*, 88, 465–476. <https://doi.org/10.1016/j.enpol.2015.11.004>
- Zou, Y. G., He, Y. M., Lin, W. L., & Fang, S. (2021). China's regional public safety efficiency: A data envelopment analysis approach. *The Annals of Regional Science*, 66(2), 409–438. <https://doi.org/10.1007/s00168-020-01025-y>