

Original Paper

The Impact of Enterprise Innovation Level on IPO Underpricing under Registration System - Based on Signaling Theory

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Abstract

Background: Chinese capital market has continued to develop and mature recently. And in December 2021, the Central Economic Work Conference formally proposed the full implementation of the stock issuance registration system. In this context, the phenomenon of IPO underpricing has not been effectively alleviated in the Chinese capital market.

Objective: This paper aims to analyze the impact of listed companies' characteristics and underwriters' underwriting level on high IPO underpricing in the Chinese capital market, find the main reasons for high IPO pricing, and ultimately help enterprises alleviate IPO high underpricing.

Methods: Based on incomplete adjustment theory and signal transmission theory, this paper analyzes the impact of listed companies' innovation level (R&D), governance level (CG), and underwriters' underwriting level on high IPO underpricing in the Chinese capital market through the RE model and robustness test. And all the data are from the CSMAR database and related enterprise annual report search.

Conclusion: Based on the signal transmission theory, this paper empirically finds that the high innovation level of enterprises can replace their active underpricing issuance by transmitting high-quality signals to investors, thus alleviating the phenomenon of high IPO underpricing in China. But the level of corporate governance is difficult to send a signal to investors, and underwriters have no significant impact on IPO underpricing. Therefore, the main reason for the high IPO underpricing in China is the active underpricing of the issuer. And enterprises bear the cost of eliminating information asymmetry through low-price issuance between enterprises and investors.

Keywords

IPO underpricing, enterprise innovation level, corporate governance level, underwriter level, registration system reform, signal transmission theory

1. Introduction

An initial public offering (IPO) is a frequent and important event for both capital markets and enterprises. Companies will formally become public entities and raise funds from the public for business development after the IPO. It also provides investors with an opportunity to share the dividends of corporate growth. However, the IPO price given by the company at the time of IPO is often lower than the market price at the initial stage of listing (commonly used as a reference for the closing price on the first day), which means that investors holding new shares can obtain stable excess returns. This phenomenon is called IPO underpricing (Michelle et al., 2004). Through a large number of studies, it is found that IPO underpricing is widespread in the capital markets of various countries, and the degree of IPO underpricing in emerging capital markets is lower than that in developed capital markets (Chambers & Dimson, 2009). In an incompletely efficient capital market, an IPO may involve three prices: issue price, fair price, and market price. The difference between the fair price and the issue price is called the issue underpricing in the primary market. The excess return brought to investors by the low substantive pricing is regarded as the cost compensation for investors to take risks or acquire additional information (Ritter & Welch, 2002). The difference between the real market price and the fair price is called the secondary market premium, which is the inflated deviation of the new stock market price from its real value caused by the irrational sentiment of noise traders and investors (Amiyatosh & Bhaskaran., 2004; Derrien, 2005). Therefore, IPO underpricing is composed of primary market underpricing and secondary market premium (Ljungqvist, Nanda, & Singh, 2006). In the Chinese capital market, the IPO underpricing phenomenon also exists and is more significant. Taking the Chinese A-share market as an example, the degree of IPO underpricing is mostly above 100 %, which is far greater than the 10%-20% level of western developed capital markets (Li & Xiao, 2022). Therefore, it has also caused many scholars to study and analyze the phenomenon of strong IPO underpricing in the Chinese capital market and the reasons behind it.

In the past, the structure of the Chinese capital market was single, the IPO issuance system has a strong color of administrative intervention, and the overall level of investors is low due to the small proportion of institutional investors. Therefore, the underpricing theory based on the basic assumptions of improving and perfecting the capital market in the western research system cannot effectively explain the IPO underpricing phenomenon in China. For the IPO underpricing phenomenon in the Chinese capital market, scholars have studied more from other factors, such as the issuance system based on administrative intervention in the primary market, the irrational sentiment of investors in the secondary market, and noise trading (Zou, Zhang, & Xu, 2012). However, in recent years, the Chinese capital market has continued to develop and mature. For example, the Beijing Stock Exchange which officially opened in November 2021 has become the last piece of the puzzle to complement the Chinese multi-level capital market. Chinese capital market has formed a multi-level capital market covering the Shanghai and Shenzhen Main Board, the Science and Technology Innovation Board, the Growth Enterprise Market, the Beijing Stock Exchange, and the New Third Board. Then in July 2019, as the

first batch of enterprises completed the listing on the science and technology innovation board under the registration system, China officially launched the institutional reform from the audit system to the approval system and then to the registration system. And in December 2021, the Central Economic Work Conference formally proposed the full implementation of the stock issuance registration system. In this context, the phenomenon of IPO underpricing has not been effectively alleviated in the Chinese capital market. Therefore, the inhibition of the issuance system on issuance pricing in the past cannot effectively explain the phenomenon of IPO underpricing in today's capital market. At the same time, Li and Xiao (2022) found that in the composition of IPO underpricing in the Chinese stock market, the contribution of IPO underpricing in the primary market to IPO underpricing is about 80%. Therefore, the current high IPO underpricing in the Chinese capital market is mainly caused by the low pricing of new shares. This low pricing is not caused by government intervention under the registration system, but by the other two entities in the IPO: underwriters and issuers (listed companies).

In summary, to better explore the causes of high IPO underpricing in the Chinese capital market under the registration system. Based on incomplete adjustment theory and signal transmission theory, this paper analyzes the impact of listed companies' characteristics, and underwriters' underwriting level on high IPO underpricing in the Chinese capital market and aims to help enterprises alleviate IPO high underpricing.

2. Related Literature

The IPO underpricing phenomenon, domestic and foreign scholars have already carried out systematic and comprehensive research on it. However, due to the inherent differences between Chinese and Western capital markets, the research directions are also different but form the primary market underpricing explanation and the secondary market premium bubble explanation. The primary market underpricing theory holds that the market is effective, which means that the market price is equal to the fair price, and the IPO underpricing is caused by the low issue price (Ritter & Welch, 2002). The secondary market premium theory holds that the market is invalid, which means that the issue price is equal to the fair price. However, because the market is incompletely efficient, there is speculation and noise trading, which makes the market price deviate from the fair price of new shares, and ultimately shows IPO underpricing. Further scholars have found that IPO underpricing is composed of issuance underpricing and market speculative bubbles (Amiyatosh & Bhaskaran, 2004; Ljungqvist, Nanda, & Singh, 2006).

When analyzing the specific reasons behind IPO underpricing, foreign scholars have formed many theories, such as the "winner's curse" theory that reflects the information gap between investors based on information asymmetry, the signal transmission theory that reflects the information gap between issuers and investors, the information display theory that reflects the information gap between underwriters and investors, and the agency theory that reflects the information gap between issuers and underwriters. Based on bounded rationality, the prospect theory reflects the bounded rationality of the

issuer, the incomplete adjustment theory reflects the bounded rationality of the underwriter, the heterogeneous belief theory reflects the bounded rationality of the investor, and the gaming preference theory is formed (Song, 2022). Signaling theory means that due to information asymmetry between issuers and investors, to send high-quality signals to investors and overcome the “lemon problem”, issuers will send signals to investors by hiring large underwriters or deliberately lowering the issue price at the time of listing to attract the attention of capital markets and consumers (Randolph & Ritter, 1986; Welch, 1989). The incomplete adjustment theory refers to the incomplete rationality of the underwriter which leads to the untimely adjustment of the price of the new shares in the inquiry stage and cannot effectively reflect the new information in the market (Hanley, 1993).

In the study of the causes of IPO underpricing based on the Chinese capital market, scholars have found that IPO underpricing is composed of both primary market underpricing and secondary market premium. However, Li and Xiao (2022) proposed that the contribution rate of primary market underpricing to IPO underpricing was 66% through accurate quantitative calculation from 2009 to 2012. And from 2014 to 2017, the contribution rate of primary market underpricing to IPO underpricing was 79% (Li & Xiao, 2022). The main reason for IPO underpricing in China is the underpricing of primary market issuance, and its explanation proportion is increasing. In the study of the interpretation of underpricing in the primary market, Chinese scholars mainly base on the perspective of the issuance system and propose that the audit system implemented in the Chinese capital market will regulate the pricing of new shares, making the issue price deviate from its true value under administrative intervention. With the reform of the issuance system from the audit system to the approval system, and then to the registration system, the high IPO underpricing will gradually return to normal (Liu & Xiong, 2005; Tian, 2010). However, with the implementation of the registration system, Feng and Zhou (2022) found that the release of dividends from the GEM registration system reform and investors’ speculation on the reform significantly increased the IPO underpricing on the first day of IPO based on 932 companies on the GEM (Feng, Zhou, & Ren, 2022). Therefore, the backward issuing system is not the main cause of high IPO underpricing. Instead, the paper will focus on the other two important subjects in the IPO process, underwriters, and issuers (listed companies). Some scholars also study the impact of underwriters’ reputations on IPO underpricing. Li and Zhao et al. (2022) used the analyst forecast method and found that the underwriters’ reputation had no significant effect on the IPO underpricing rate in the primary market, but had a significant positive effect on the IPO response rate in the secondary market (Li, Zhao, Cao, & Hu, 2022). Therefore, the reputation of an underwriter is also not the main reason for high IPO underpricing. Based on the incomplete adjustment theory and signal transmission theory, this paper proposes that the main reasons for IPO underpricing in the Chinese capital market are as follows. Firstly, the insufficient ability of underwriters leads to an insufficient response of price adjustment to information. Secondly, due to the enterprise’s lack of confidence in the new shares, enterprises tend to set low issue prices to complete the IPO and take the initiative to send high-quality signals to investors. For investors, the most important characteristics of listed companies

are their operating capacity and growth potential. The specific characteristics of the company are governance level and innovation level. Strengthening corporate governance is an important part of improving the quality of listed companies. Improving the governance level of listed companies based on modern company theory is an important issue to be solved urgently in the post-epidemic era (Shu, Li, Sun, & Cao, 2022). The high level of innovation will improve corporate performance, send a signal to investors that the company has a good future, and reduce the rate of return required by investors, thereby reducing the cost of corporate financing (Atalay, Anafarta, & Sarvan, 2013; Li, Li, Guo, & Tu, 2022). Therefore, higher levels of innovation and governance can also become important signals and transmit high-quality signals to investors, forming a substitution effect on low-price issuance, thereby alleviating IPO underpricing.

In summary, this paper assumes that the high governance level and innovation level of enterprises can replace the deliberate underpricing of IPOs, which means that enterprises with strong innovation level and governance levels are more reluctant to pass high-quality signals to investors through deliberate underpricing during initial public offerings, so their offering prices will be closer to the fair value of new shares. At the same time, underwriters with stronger underwriting ability are also more able to react to various information in the market to the issue price, which means that the issue price is close to the real value of new shares, thus alleviating IPO underpricing.

3. Data and Methodology

3.1 Sample Selection and Data Source

To examine the IPO underpricing phenomenon in the Chinese capital market more comprehensively, this paper selects the data of all listed companies on the main board of the Shanghai Stock Exchange and Shenzhen Stock Exchange from 2006 to 2022. At the same time, observing the changes in IPO underpricing before and after the reform of the registration system, it is demonstrated that the IPO underpricing in the Chinese capital market is not caused by the issuance system of government intervention. The relevant data of listed companies from 2009 to 2022 are selected for regression analysis. After processing missing values and outliers, 990 samples were obtained, including 592 GEM samples. All the analysis data in this paper are obtained from the CSMAR database and related enterprise annual report searches.

3.2 Variables Description

3.2.1 Dependent Variables

(1) Market-adjusted first-day stock return (MRIPO)

In previous studies, scholars often use the stock return on the first day of listing (RIPO) to reflect and quantify the IPO underpricing. The higher return on the first day of issuance means stronger IPO underpricing. However, RIPO also reflects the volatility of the overall market unrelated to the characteristics of the company and is affected by the overall sentiment of the market. Therefore, this paper chooses to use the market-adjusted first-day stock return (MRIPO) that excludes the overall

market return on the first day of listing. The calculation formula is as follows:

$$\text{MRIPO} = (P_e - P_s)/P_e - (M_e - M_s)/M_e \quad (1)$$

P_e , P_s , M_e , and M_s represent the open and close prices of individual stocks and stock indexes respectively.

(2) Relative Price-to-book Ratio (RBP)

Xu, Shi, and Jin (2017) used the relative issue price-to-book ratio (RBP) to measure and reflect the degree of IPO underpricing of stocks, which equals the ratio of the price-to-book ratio at the initial issue of stocks divided by the corresponding overall price-to-book ratio of the industry. This paper uses RBP as a newly explained variable to conduct a robustness test to ensure the stability and reliability of the conclusion. The calculation formula is as follows:

$$\text{RBP} = \text{BP}_{\text{IPO}}/\text{BP}_{\text{Industry}} \quad (2)$$

3.2.2 Core Independent Variables

(1) Enterprise innovation (R & D)

The high level of innovation of enterprises will improve the performance of enterprises, convey the signal of good prospects to investors, reduce the required rate of return of investors, and thus reduce the financing cost of enterprises (Atalay, Anafarta, & Sarvan, 2013; Li, Li, Guo, & Tu, 2022). Therefore, the high level of innovation may have a substitution effect on underpricing. This paper measures the innovation level of enterprises by the ratio of R & D investment in the year before listing divided by the operating income of the year, to reflect the innovation ability of enterprises in the eyes of investors. For the missing data, the order of the two years before listing, the first three years, the year of listing, the year after listing, and the two years after the listing is used to fill the innovation level.

(2) Corporate governance (CG)

Strengthening corporate governance is an important part of improving the quality of listed companies. Improving the governance level of listed companies based on modern company theory is an important issue that needs to be solved urgently in the post-epidemic era (Shu, Li, Sun, & Cao, 2022). Therefore, as a high-quality signal of enterprises, a high governance level may form an alternative effect on underpricing and alleviate IPO underpricing. For the quantification of governance level, based on the definition and division of corporate governance by Zhang (2013), this paper uses principal component analysis to reduce the dimension of several important variables that affect the level of corporate governance and finally merge them into a comprehensive governance level value (Zhang, 2013). The process of principal component analysis is as follows in Table 1.

Table 1. Principal Component Analysis Variable Table of Comprehensive Management Level

Variable	Component	Variable	Component
Largest Private Equity Ratio (%)	1	Number of Independent Directors of Audit Committee	4
Taking charge of chairman and manager concurrently	2	Number of the remuneration and Assessment Committee members	5
Number of Audit Committee Members	3	Number of the Remuneration and Assessment Committee Independent Directors	6

By incorporating the data corresponding to the above variables of the listing companies, the dimension is reduced and merged into a comprehensive value. However, the use of principal component analysis needs to meet certain premises. It mainly analyzes whether the data is suitable for principal component analysis through the KMO test and Bartlett test. The test results are shown in Table 2.

Table 2. KMO Test and Bartlett Test

KMO value		0.734
Bartlett sphericity test	Chi-square	6369.035
	df	15
	P	0.000***

Annotation: ***, **, * represent 1%, 5%, 10% significance level respectively.

According to the results of the KMO test, the value of KMO is 0.734 (> 0.6), indicating that there is a good correlation between the variables that affect the level of corporate governance; the results of Bartlett's sphericity test show that the significant P value is 0.000***, which is significant at the level, and rejects the null hypothesis that there is no correlation between variables. So there is a correlation between variables that affect the level of corporate governance, and the principal component analysis is effective.

Table 3. The Principal Component Analysis Process

Total variance explanation					
Component	Latent root				
	Latent root	Variance	interpretation	Cumulative	variance
		rate (%)		interpretation	rate (%)
1	3.148	52.473		52.473	
2	1.034	17.238		69.711	
3	0.94	15.665		85.376	
4	0.527	8.787		94.164	
5	0.226	3.772		97.936	
6	0.124	2.064		100	
	Factor Load Coefficient Table			Composition matrix table	
	Factor Load Coefficient	Common	degree	Component	
	Principal component 1	(common factor variance)		Component 1	
1	0.148	0.022		0.047	
2	-0.139	0.019		-0.044	
3	0.904	0.817		0.287	
4	0.83	0.689		0.264	
5	0.907	0.822		0.288	
6	0.883	0.779		0.28	

Through the interpretation of the total variance, the contribution rate of the six variables to the governance level is analyzed in Table 3. The higher the variance interpretation rate is, the more important the principal component is, and the higher the weight ratio should also be. The factor load coefficient is further analyzed to analyze the importance of the hidden variables in the principal component, and finally, the component matrix table of the influencing variables is obtained. The model equation of the comprehensive management level of the enterprise is as follows.

$$\text{Enterprise comprehensive management level (CG)} = 0.047 * \text{Component 1} - 0.044 * \text{Component 2} + 0.287 * \text{Component 3} + 0.264 * \text{Component 4} + 0.288 * \text{Component 5} + 0.28 * \text{Component 6} \quad (3)$$

Through the above model, the comprehensive corporate governance level value of each enterprise is calculated by substituting the value of each variable into Excel software.

(3) Underwriter level (Underwriter)

According to the incomplete adjustment theory, due to the incomplete rationality of the underwriter, the underwriter's underwriting ability is insufficient and the price adjustment of the new shares in the inquiry stage is not timely. Also, the new information in the market cannot be effectively reflected

(Hanley, 1993). This may be an important reason for the low pricing and high IPO underpricing in the Chinese capital market. Based on the existing literature, the underwriter's underwriting level is measured by the underwriter's business volume (Song, 2022; Qiu, 2010). This paper ranks the underwriters according to the total underwriting market share of each underwriter from 2010 to 2020 and selects the top 20 as the underwriters with high underwriting levels. If the underwriter of the enterprise's IPO cooperation is one of them, the value is assigned to 1, otherwise assigned to 0.

3.2.2 Control Variables

(1) Investor sentiment (TP & CR)

Secondary market premium is also an important part of IPO underpricing, many studies have shown that investor sentiment and speculative behavior is the decisive factor in the secondary market premium (Ritter & Welch, 2002; Dorn, 2009). This paper measures and reflects the change in investor sentiment, reflecting the degree of preference for new shares, by using the total winning rate (TP) of new share issuance and the turnover rate (CR) of individual shares on the first day of listing (Han & Wu, 2007).

(2) Registration Reform (Regist)

Liu and Xiong (2005), Tian (2021), and other scholars propose that administrative intervention inhibits the pricing of new shares, which means that the issuance system is an important factor in the phenomenon of IPO underpricing, and proposed that with the implementation of the registration system, Chinese capital market IPO underpricing phenomenon will be eased (Liu & Xiong, 2005; Tian, 2010). But through empirical analysis, Feng and Zhou (2022) found that the registration system reform exacerbated the degree of IPO underpricing (Feng, Zhou, & Ren, 2022). To demonstrate that the Chinese IPO underpricing phenomenon is not caused by the issuance system, this paper set the registration system reform as a dummy variable into the control variables for analysis. Due to the formal implementation of the registration system reform on the GEM on June 12, 2020, this paper regards the enterprises listed on the GEM after June 12, 2020, as listed on the registration system with an assignment of 1, otherwise assigned to 0.

(3) Other variables

There are many factors affecting IPO underpricing. To improve the interpretation of the regression model and improve the reliability and accuracy of the model conclusions, according to the existing research literature, this paper selects the proportion of the largest shareholder of the enterprise (TopShare), the total asset size of the enterprise (Size), the return on total assets (ROA), the issue price-earnings ratio (PE), the issue price-to-book ratio (PB), the leverage level of the enterprise (Lev), the total year of establishment of the enterprise (Estbdt) and other variables as control variables. The return on equity (ROE) is selected as an alternative to the ROA variable in the robustness test. At the same time, the year of listing (Year) is used as a dummy variable to control the time heterogeneity of IPO underpricing of different enterprises. At the same time, the industry is divided into five categories: finance, public utilities, real estate, industrial and commercial, and the introduction of five virtual to control the industry heterogeneity of different enterprises at the time of IPO. The details of the main variables are described in Table 4.

Table 4. Variables Description

	Variable	Meaning	Measure
Dependent variables	MRIPO	First Day Return of New Shares Excluding Market Volatility	The first day yield of listed stocks - The market yield on the same day
	RPB	Relative price-to-book ratio	Market-to-book ratio of listed enterprises / Corresponding industry price-to-book ratio on the same day
	R&D	Innovation level	R & D expenditure 1 year before listing / Operating income of the listing year
Independent variables	CG	Company governance level	Principal component analysis
	Underwriter	Underwriter level	The top 20 underwriters in the market share are assigned 1; otherwise assigned 0
	TP	Total Plot	TP = total issue volume / number of applying for purchasing
Control variables	CR	Turnover rate of listed shares	The frequency of stock turnover on the first day of listing. CR = First day trading volume / Number of tradable shares
	Underwriter	Underwriter level	The top 20 underwriters in the market share are assigned 1; otherwise assigned 0
	Regist	Listing under registration	Listed enterprises under the registration system are 1 ; otherwise assigned 0
	PE	First day price earnings ratio	First-day closing price / after-tax profit per share
	PB	First Day Price to Net Ratio	Price per share / net asset per share
	Size	Size of enterprise	ln(Total assets 1 year before listing)
	ROA	Return on total assets	Net profit / total assets (1 year before listing)
	ROE	Return on total equity	Net profit / total equity (1 year before listing)
	Lev	Corporate Leverage L	Total liabilities / total assets(1 year before listing)
	Estbdt	Total Year of Establishment at Listing	Year of listing - Year of establishment
TopShare	Proportion of the largest shareholder	Number of shares held by the largest shareholder / total share capital	
Year	Year of listing	Year of listing	
Industry	Industry	--	

3.3 Model Construction

To test the impact of investor sentiment, registration system reform, corporate innovation, corporate governance, and the underwriting level of IPO underwriters on IPO underpricing, this paper constructs the following regression model:

$$\text{MRIPO} = \beta_0 + \beta_1 * \text{R\&D} + \beta_2 * \text{CG} + \beta_3 \text{Underwrite} + \alpha \sum \text{Controls} + \tau_i + \pi_t + \varepsilon_{it} \quad (4)$$

Where $\sum \text{Controls}$ is the relevant control variables; τ_i is the fixed effect for industry; π_t is the year fixed effect; ε_{it} is a random error term. The robustness test model is obtained by replacing the explained variables and some control variables:

$$\text{RBP} = \beta_0 + \beta_1 * \text{R\&D} + \beta_2 * \text{CG} + \beta_3 \text{Underwrite} + \alpha \sum \text{Controls} + \tau_i + \pi_t + \varepsilon_{it} \quad (5)$$

4. Empirical Analysis

4.1 Descriptive Statistics

Table 5. Descriptive Statistical

Variable	Sample size	Mean	Variance	Coefficient of variation
MRIPO	990	0.651	0.894	1.452656084
RPB	990	2.471	4.593	0.867316593
R&D	990	0.054	0.002	0.91555595
CG	990	3.432	0.629	0.231035067
Underwriter	990	0.71	0.206	0.639267664
PE	990	47.88	1531.806	0.817430661
TP	990	0.581	5.297	3.964540468
CR	990	0.321	0.126	1.105458362
Regist	990	0.21	0.166	1.939952787
Size	990	20.541	1.083	0.050668023
ROA	990	0.074	0.004	0.827991453
ROE	990	0.123	0.008	0.744220024
Lev	990	0.394	0.03	0.440967673
Estbdt	990	13.482	32.363	0.421965598
TopShare	990	0.353	0.018	0.383233119

By observing Table 5, the core explanatory variables corporate governance level (CR) and underwriter level (Underwriter), it is found that the coefficient of variation of the sample corporate governance level is only 0.231, which means that the fluctuation degree of the corporate governance level of each enterprise is much smaller than the explanatory variable. At the same time, the sample mean of the underwriter level is 0.71, and the variance is only 0.206, indicating that underwriters cooperating with

sample enterprises are mainly concentrated in the top 20. Therefore, according to the mathematical principle of regression, this paper predicts that the contribution rate of corporate governance level and underwriter level to the change of new share yield is not statistically significant.

4.2 Data Test Analysis

Testing and diagnosing data before regression is an important means to ensure the validity and reliability of regression analysis results. In this paper, the correlation test, multicollinearity test, stability test, and cointegration test are carried out on the obtained variable data and model, and the variable data that do not pass the test are processed to ensure the validity and reliability of the regression. The test results are as follows.

4.2.1 Correlation Test of Variables

Table 6. Analysis of Relationship

	PE	PB	Regist	CG	R&D	CR	Estbdt	TopShare	Size	ROA	Underwr iter	Lev	T P
PE	1												
PB	0.775***	1											
Regist	0.345***	0.197***	1										
CG	-0.06*	-0.014	-0.131***	1									
R&D	0.168***	0.192***	-0.025	-0.029	1								
CR	0.531***	0.548***	0.393***	-0.019	-0.003	1							
Estbdt	-0.069**	-0.219***	0.203***	-0.078**	-0.024	-0.207***	1						
TopShare	-0.024	-0.01	-0.068**	0.138***	-0.194***	0.006	-0.044	1					
Size	-0.126***	-0.229***	0.04	0.094***	-0.287***	-0.153***	0.114***	0.189***	1				
ROA	0.0723**	0.3***	-0.098***	-0.024	0.093***	0.033	-0.115***	0.049	-0.221***	1			
Underwriter	0.006	0.01	0.007	-0.008	0.034	0.016	-0.042	-0.022	0.044	0.03	1		
Lev	-0.018	-0.037	-0.128***	0.123***	-0.293***	0.074**	-0.075**	0.076**	0.532***	-0.324***	0.028	1	
TP	-0.026	0.068**	-0.125***	0.052	-0.001	0.087***	-0.082***	0.015	0.026	0.08**	0.021	0.077**	1

Annotation: ***, **, * represent 1 %, 5 %, 10 % significance level respectively.

Through the correlation test based on the Pearson correlation coefficient in Table 6, it is found that the first-day price-to-book ratio variable has a statistically significant and strong correlation with the first-day price-to-earnings ratio, the registration system variable, and the first-day turnover rate of new shares. To avoid regression failure, the variable is removed from the model.

4.2.2 Multicollinearity Test

Because there are few samples of enterprises with P0304 and P0399, both variables automatically default as missing variables in regression, and the results of each index in regression are missing, so

VIF cannot be used for multicollinearity tests. Therefore, these two variables are eliminated from the regression model and are no longer regarded as control variables. Therefore, the final industry is divided into 5 categories. The modified model has regressed again and the multicollinearity test is carried out. The test results are as follows:

Table 7. Multicollinearity Test Table

Variable	TP	CR	CG	Regist	RD	PE	PB	Size	ROA
VIF	1.065	1.916	1.092	1.601	1.294	3.059	3.515	2.216	1.402
Variable	Lev	Underwrite	Estbdt	TopShare	X0001	X0002	X0003	X0004	X0005
VIF	1.878	1.021	1.228	1.138	2.175	12.035	1.618	1.886	13.128

According to Table 7, due to the uneven distribution of sample values of industry nature and business nature, there is a serious multicollinearity in the model. The industry variables are eliminated when the corresponding VIF is greater than 10, such as X0002, representing utilities, and X0005, representing the industry. Then the model is adjusted and modified.

4.2.3 Stability Test

Table 8. Stability Statistical Test

Variables	RIPO	MRIPO	RPB	TP	CR	CG	Regist
Dickey-Fuller	-4.9596	-5.0836	-4.478	-7.3922	-2.2207	-9.862	-3.7234
p-value	0.01	0.01	0.01	0.01	0.4849	0.01	0.02283
Variables	RD	PE	Size	ROA	Lev	Underwriter	Estbdt
Dickey-Fuller	-8.7955	-5.3342	-8.8444	-6.8777	-9.9075	-9.493	-8.6146
p-value	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Variables	TopShare	CR _{lag=1}					
Dickey-Fuller	-9.0961	-14.716					
p-value	0.01	0.01					

Through the unit root test in Table 8, it is found that the statistical results of the first-day turnover rate of new shares are not significant and the null hypothesis cannot be rejected, so the data is not stable. After the first-order difference processing of the first-day turnover rate of new shares, the unit root test was carried out again and the statistical results were significant. Then the paper replaces the original first-day turnover rate data of new shares with the first-order differential data, then the stationarity test of all variables passed.

4.2.4 Cointegration Test

The least squares regression is performed on the model to obtain the sequence error term, and the sequence error term is tested for stationarity to complete the cointegration test of the model. Through the test results in Table 9, it is found that the statistics are significant and reject the null hypothesis, so the cointegration test is passed.

Table 9. Augmented Dickey-Fuller Test

Variable	Dickey-Fuller	Lag order	p-value
Sequence error	-3.9848	9	0.01

4.3 Analysis of Empirical Results

Based on the model (4), the OLS model, fixed effect model, and random effect model are used for regression analysis respectively. At the same time, the samples are divided into full samples and GEM samples for regression. Finally, the regression model is selected based on the Breusch-Pagan test and the Hausman test. The regression results and model selection test results are shown in Table 10.

Table 10. Regression Test Results

	OLS		FE		RE	
	All samples	GEB samples	All samples	GEB samples	All samples	GEB samples
R&D	-1.751***	-2.145**	-1.878***	-2.178**	-1.723***	-2.156**
CG	-0.014	0.012	-0.035	0.011	-0.011	0.012
Underwriter	-0.119*	-0.265***	-0.131*	-0.284***	-0.118*	-0.269***
TP	-0.026**	-0.112*	-0.032**	-0.097	-0.026**	-0.113*
CR	0.027	0.866***	0.102	0.804***	0.029	0.862***
Regist	0.584***	0.484***	0.542***	0.413***	0.575***	0.476***
PE	0.011***	0.012***	0.012***	0.012***	0.012***	0.012***
Size	0.079**	0.179**	0.117***	0.158*	0.093**	0.181**
ROA	-0.934*	-0.522	-1.022*	-0.682	-0.937*	-0.527
Lev	-0.488**	-0.648*	-0.532**	-0.661*	-0.489**	-0.637*
Estbdt	0.005	0.009	0.006	0.008	0.006	0.009
TopShare	-0.220	-0.373	-0.298	-0.368	-0.244	-0.372
Industry	Control	Control	Control	Control	Control	Control
Year	--	--	Control	Control	Control	Control
R2	0.42	0.46	0.43	0.47	0.42	
N	990	592	990	592	990	592

Annotation: ***, **, * represent 1 %, 5 %, 10 % significance level respectively.

Model comparison testing

Test	Statistic	Conclusion
Breusch-Pagan test	103.14***	Model error terms are heterogeneous and cannot use the least squares model
Hausman Test	12.262	There is no significant difference between the coefficients of the FE model and the RE model, they are both unbiased estimators, but the estimator of the RE model is more effective, so we choose the RE model

According to the results of the Breusch-Pagan test and Hausman test, this paper selects the regression results of the random effect model to analyze and discuss the influencing factors of IPO underpricing:

By observing the regression analysis results of the random effect model, it is found that:

In the full sample regression analysis: the regression coefficient of the level of innovation (R & D) is significantly negative, indicating that the stronger the innovation ability brought by the R & D investment of the enterprise, the lower the degree of IPO underpricing. There are two main reasons. Firstly, the higher the R & D investment of the enterprise, the more funds it needs to raise based on the public offering activities carried out by the fundraising, so the issue pricing will be relatively higher, and the corresponding IPO underpricing will be lower. Secondly, the high level of innovation will improve business performance and convey to investors a good prospect for the future signal, which can reduce the yield required by investors, thereby reducing corporate financing costs. Therefore, a higher level of innovation may become an important signal and convey a high-quality signal to investors, forming a substitution effect on low-price issuance, thereby alleviating IPO underpricing.

The coefficient of corporate governance level (CG) is not significant in all models. There may be two reasons. Firstly, although the level of corporate governance is an important factor affecting the level of corporate management, the Chinese capital market is dominated by retail investors who are difficult to form an accurate judgment on the level of corporate governance (Zou, Zhang, & Xu, 2012). Therefore, a high governance level cannot be used as an effective signal to convey high-quality information to investors. Secondly, the corporate governance level in this paper is obtained by principal component analysis of six variables. And the variables may not be the main influencing factors of governance level or the main influencing factors of IPO underpricing, which lead that the regression results based on the comprehensive governance level index are not significant. Whether there are more accurate methods to measure CG is worth further study.

The regression coefficient of the underwriter level (Underwrite) is significantly negative, indicating that a higher underwriter's underwriting level may lead to a higher degree of IPO underpricing. The reason is that the higher the underwriter's underwriting level often means the IPO issue price can reflect more market information timely (Bradley, Jordan, Yi, & Roten, 2014), and thus the degree of

IPO underpricing is lower.

The positive and negative regression coefficients of the remaining control variables are also basically consistent with expectations, which further demonstrates the current mainstream view. The regression coefficient of the total winning rate (TP) is significantly negative, which indicates that a lower total winning rate may lead to a higher degree of underpricing of new stock issuance. The reason is that IPO underpricing is essentially the inconsistency between the issue price and the market price, and the market price is determined by the supply and demand relationship of the market. And the greater demand and the less supply lead to the higher market price. The essence of the total winning rate is the preview of market supply and demand. So the lower total winning rate means greater demand and less supply, and thus the higher market price, which leads that a degree of IPO underpricing is higher. The regression coefficient of the registration system (Regist) is significantly positive, indicating that the IPO underpricing of the registered system is more serious than that of the non-registered system. The reason may be that after the registration system reform, the CSRC will not conduct substantive audits of listed companies but procedural audits, so the overall quality of listed companies under the registration system audit is relatively low (Zhao, Xu, & Li, 2022), and thus the initial average issuance price is often lower than that of listed companies under the approval system. It also demonstrates that the issuance system is not the reason for the high IPO underpricing in China.

In the regression results of the GEM samples, the positive and negative coefficients of each core explanatory variable are consistent with the regression coefficients in the full sample regression, so the main conclusions have not changed. The only change is that the turnover rate (CR) on the first day of the new shares also has a significant positive impact on IPO underpricing, indicating that the more frequently new shares are traded on the first day of issuance, the higher degree of IPO underpricing will be. The reason is that frequent transactions reflect the sharp fluctuation of the stock price. Under the influence of the herd effect, the degree of IPO underpricing is higher because the stock prices are more likely to deviate from the true value. And the reason why this variable is not significant in the full sample regression may be that contains a large number of IPO observations of listed companies on the main board. Compared with the GEM samples, its transaction turnover rate will be lower, so the impact on IPO underpricing will be smaller, which may lead to insignificant regression results.

4.4 Robustness Test

In this paper, the explained variable in Model (4) is changed from the first-day return rate of new shares (MRIPO) excluding market fluctuations to the relative issue price-to-book ratio (RBP), and the return on total assets (ROA) is replaced by the return on net assets (ROE) to obtain Model (5). The regression analysis is also carried out, and the difference between the regression results of the two models is compared to test the robustness of the regression results of Model (4), which makes the research conclusions more reliable. The regression results are shown in Table 10.

Table 11. Robustness Test Results

	OLS		FE		RE	
	All	GEB	All	GEB	All	GEB
	samples	samples	samples	samples	samples	samples
R&D	-4.828***	-6.445***	-4.685***	-6.389***	-4.712***	-6.367***
CG	-0.052	-0.064	-0.044	-0.092	-0.046	-0.066
Underwriter	0.021	0.003	0.064	0.006	0.024	0.009
TP	0.056**	0.243*	0.058**	0.307**	0.053**	0.263**
CR	-0.126	0.308	-0.114	0.327	-0.118	0.315
Regist	0.131	0.437**	0.187	0.465**	0.168	0.452**
PE	0.037***	0.035***	0.037***	0.035***	0.037***	0.035***
Size	-0.236***	-0.413***	-0.226***	-0.414***	-0.220***	-0.404***
ROE	6.422***	5.372***	5.124***	4.416***	4.738***	3.839***
Lev	2.225***	2.083***	1.458***	1.411**	1.322***	1.392**
Estbdt	-0.047***	-0.044***	-0.049***	-0.041**	-0.047***	-0.044***
TopShare	0.317	-0.059	0.232	-0.075	0.261	-0.082
Industry	Control	Control	Control	Control	Control	Control
Year	--	--	Control	Control	Control	Control
R2	0.59	0.62	0.56	0.66	0.61	0.64
N	990	592	990	592	990	592

Annotation: ***, **, * represent 1 %, 5 %, 10 % significance level respectively.

Model comparison testing

Test	Statistic	Conclusion
Breusch-Pagan test	101.34***	Model error terms are heterogeneous and cannot use the least squares model
Hausman Test	9.602	There is no significant difference between the coefficients of the FE model and the RE model, they are both unbiased estimators, but the estimator of the RE model is more effective, so we choose the RE model

By observing the regression results of the robustness test, the underwriter level (Underwrite) in Model (5) changes from significantly negative to insignificant. So the regression analysis of the impact of underwriter level on IPO underpricing based on Model (4) is unreliable. This paper cannot conclude that the higher level of underwriters leads to the lower degree of IPO underpricing phenomenon. The possible reason is that in the context of market competition, the pricing level of each underwriter tends to be consistent and all the underwriters can give reasonable IPO pricing. Other variables, such as

investor sentiment, corporate innovation level, and registration system reform, have no significant change in the conclusion of the impact of IPO underpricing and pass the robustness test.

5. Conclusion

Based on the IPO market data of listed companies in the Shanghai Stock Exchange and Shenzhen Stock Exchange from 2006 to 2022 and GEM from 2009 to 2022, this paper uses the random effect model for empirical analysis and finds that the stronger the innovation level brought by R & D investment is, the lower the degree of IPO underpricing is. The level of corporate governance does not have a significant impact on IPO underpricing. The impact of the underwriter level on IPO underpricing has not passed the robustness test, and the impact of the underwriter level on IPO underpricing is not statistically significant. At the same time, according to the sample of 592 listed companies on the GEM, it is found that the IPO underpricing of the registered listing is more serious than that of the non-registered listing. Therefore, the high IPO underpricing in the Chinese capital market is not caused by government administrative intervention. To sum up, according to the existing literature on the composition of IPO underpricing in the Chinese capital market (Li & Xiao, 2022) and the research on the impact of underwriters' reputation and level on IPO underpricing (Li, Zhao, Cao, & Hu, 2022; Gong & Duan, 2022), this paper argues that the main reason for Chinese IPO underpricing is the active underpricing of issuers, which is essentially due to the information asymmetry in Chinese capital market (Ho & Gong, 2021). Under the background of an imperfect information disclosure system (Fang, 2022), there is no stable and reliable signal transmission channel between investors and financiers, so issuers transmit high-quality signals to investors through deliberate underpricing. However, through empirical research, this paper finds that the level of enterprise innovation can be used as a stable signal to transmit high-quality and potential signals to investors, thus playing a substitution role in underpricing. The level of corporate governance is difficult to form an effective signal transmission channel.

In summary, from the perspective of the enterprise, this paper proposes that the innovation level brought by the R & D intensity of the enterprise is an important factor supporting the stock price of the enterprise. Therefore, Chinese enterprises should pay attention to the construction of their innovation ability and strengthen the investment in technology R & D, to form a substitution effect on the underpricing issue when IPO pricing. At the same time, in the IPO of enterprises, large securities firms should be selected as far as possible to cooperate to reduce the low pricing of new shares. From the perspective of the country, China should firmly build a multi-level capital market and actively implement a comprehensive registration system reform. At the same time, we should encourage more institutional investors to participate in the capital market, improve the information disclosure system of listed companies and reduce the information asymmetry between investors and financiers as much as possible, so that the listed companies can send high-quality signals to investors through other channels, and form a substitution effect on the IPO active underpricing, to alleviate the high IPO underpricing in Chinese capital market.

6. Current & Future Developments

At present, the research on the Chinese IPO underpricing phenomenon is more on the issuance system, market sentiment and underwriters, and other factors. Few studies have focused on the impact of the company's characteristics and even the low issue price on IPO underpricing. Therefore, this paper complements the lack of this part of the study. However, the conclusions of this paper on the impact of corporate governance level and underwriter level on IPO underpricing are still worthy of further research and analysis. Whether there are other methods to measure corporate governance level and underwriter level variables may produce different conclusions. At the same time, it is also worth further analysis of whether other corporate characteristics can transmit high-quality signals to investors, thus forming a substitution effect on deliberate low-price issuance. Finally, as the institutional structure of the Chinese capital market continues to improve and mature, IPO underpricing may have new features, and the main influencing factors may also change. Therefore, it is necessary to continue to promote research as the market changes to help companies mitigate the value loss caused by IPO underpricing.

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