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R&D investment, IPO underpricing, investor sentiment and long-term performance: A study on the Chinese star market

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ABSTRACT

This study examines the factors influencing sustained post-IPO performance in China's STAR Market, emphasizing the combined effects of R&D expenditure, IPO underpricing, and investor sentiment on long-term outcomes in this innovation-driven exchange. Using event study analysis and multiple regression, the research evaluates 342 companies listed between July 2019 and December 2021. Long-term performance is measured via one-year cumulative abnormal returns (CAR) and buy-and-hold abnormal returns (BHAR). R&D expenditure significantly enhances long-term performance for non-high-tech firms by signaling growth potential in environments with limited information. High-tech firms, however, show minimal incremental gains, as market expectations pre-price their innovative status. IPO underpricing consistently correlates negatively with long-term performance across sectors, indicating agency costs or adverse signaling. Investor sentiment, proxied by initial trading turnover, exerts negligible lasting impact, revealing a disconnect between speculative activity and sustained valuation. Sector-specific R&D signaling and IPO underpricing risks drive long-term outcomes. Market expectations dominate pre-IPO valuations for high-tech firms, while short-term speculation fails to predict enduring performance. Firms should align R&D strategies with sector-specific valuation drivers. Investors must prioritize fundamentals over transient hype. Policymakers can enhance market efficiency by fostering transparency and incentivizing innovation, particularly in non-high-tech sectors, to support sustainable growth in emerging markets.

Contribution/ Originality: This study pioneers the exploration of industry-specific R&D signaling effects within China's STAR Market, revealing divergent impacts between high-tech and non-high-tech firms, while establishing IPO underpricing's persistent adverse influence on long-term performance, addressing critical gaps in innovation-driven IPO research.

1. INTRODUCTION

Initial Public Offerings (IPOs) allow companies to raise capital and improve liquidity; however, they often show underpricing and sustained underperformance, particularly in emerging markets such as China. Recent research indicates that IPO underpricing considerably influences long-term performance in markets such as Indonesia (Hillier, Ross, Westerfield, Jaffe, & Jordan, 2019), the China A-share market (Wang & Wang, 2021), and the United States (Lahti, 2021). The long-term dynamics of IPOs in innovation-driven markets, especially the STAR Market, are still underexplored.

The Shanghai Stock Exchange Science and Technology Innovation Board (STAR), inaugurated on July 22, 2019, aims to promote the development of high-tech, innovation-centric enterprises in China. Unlike other domestic markets, its registration system allows companies to list publicly without demonstrating profitability and employs a pricing mechanism driven by market dynamics (Ma, Liu, & Qi, 2022). These features intensify information asymmetry and the influence of investor sentiment on IPO behavior, making the STAR Market an ideal setting to examine the relationship between R&D investment, IPO underpricing, and long-term performance.

Despite being a major factor in the long-term growth of high-tech companies, R&D expenditure is sometimes undervalued at the IPO stage because of information asymmetry. Recent research from Zhang and Zhang (2020) found that technological innovation (R&D characteristics) positively affects long-term performance. In the Chinese stock market from 2000 to 2018, if optimistic investors who cannot engage in short selling possess all the stocks of a representative firm, the current period returns are inversely correlated with their optimism regarding the probability of reforms. Consequently, based on the concept of "investor behavioral biases," the cause of low returns is the unreasonable expectations of overly optimistic investors regarding the reform (Allen, Qian, Shan, & Zhu, 2024). Investor sentiment is a key mediating factor in the STAR Market, where a large number of businesses are small, startup companies with intangible assets. This is because it influences how the market perceives the potential advantages of R&D efforts and price dynamics during the IPO process.

Although prior research has thoroughly examined short-term IPO results, the long-term performance in innovation-centric markets, particularly in the STAR Market, is still inadequately investigated (Sun, Yin, Zhou, & Zhu, 2022; Wang, Wang, Cebula, & Foley, 2023). Research integrating R&D investment, IPO underpricing, and investor sentiment within the context of the STAR Market's distinctive institutional and trading procedures is insufficient. This study addresses these deficiencies by examining the influence of R&D investment and IPO underpricing on long-term IPO success, with investor sentiment serving as a mediating factor, thereby tackling the distinct intricacies of this market. This research employs event study and regression analysis techniques on a sample of STAR Market IPOs from 2019 to 2021, assessing long-term performance using cumulative abnormal return (CAR) and buy-and-hold abnormal return (BHAR) metrics. This research examines crucial gaps in understanding IPO dynamics in the STAR Market by integrating R&D investment and IPO underpricing, with investor sentiment serving as a mediator.

Academically, this study contributes to the understanding of how R&D investment and IPO underpricing influence long-term IPO performance, highlighting the moderating role of industry classification. It illustrates that R&D investment substantially improves long-term performance in non-high-tech organizations, acting as an indicator of innovation potential, whereas its effect is lessened in high-tech firms due to established market expectations. The persistent adverse impact of IPO underpricing across several industries underscores its harmful influence on long-term performance. This study offers practical insights for investors to more effectively evaluate IPO risks by differentiating between high-tech and non-high-tech companies and highlighting the significance of pricing strategies and firm fundamentals. For issuers, it emphasizes the importance of utilizing R&D investment disclosures in non-high-tech industries to mitigate information asymmetry. For policymakers, the findings suggest the need for tailored disclosure requirements and pricing regulations to foster more transparent, efficient, and innovation-driven markets.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. R&D Investment and Long-Term Performance

R&D investment entails significant time lags and uncertainty, particularly for high-growth, science-driven enterprises where technical advancements take time to generate measurable financial outcomes (Aboody & Lev, 2000) demonstrated that R&D-driven technological innovation positively impacts long-term performance by building investor confidence and enhancing stock value. Similarly, Chen, Wang, Zhao, and Xu (2023) highlighted that in

China's capital market, investors often tolerate short-term risks in exchange for the potential long-term benefits of R&D, reflecting both rational and irrational investor behavior. This indicates that R&D expenditure increases a firm's present market worth as expectations evolve over time. In the STAR Market, characterized by mostly tiny, youthful, and high-tech enterprises, initial information asymmetry results in undervaluation during the IPO phase. As R&D disclosures improve over time, investors recognize the long-term advantages of R&D, resulting in elevated company prices. Thus, this study hypothesizes.

H_1: R&D investment is positively associated with long-term performance. Firms with higher R&D investment are more likely to enhance their competitiveness and market valuation over time.

Research and development (R&D) is often a critical component of high-tech firms' operations. However, since high levels of R&D are anticipated and already taken into account when determining valuations, this dependence may weaken the signaling effect of R&D spending (Zhang & Zhang, 2020). Conversely, for non-high-tech companies, R&D spending may indicate unforeseen innovation potential, resulting in a more pronounced effect on long-term success (Aboody & Lev, 2000). Previous studies have noted the relationship between R&D and industry categorization, indicating that high-tech organizations require extended durations to convert R&D into quantifiable results due to the uncertainty and intricacy of innovation processes (Chen et al., 2023). This indicates that industry classification influences the relationship between R&D expenditure and long-term performance, with non-high-tech enterprises demonstrating a more pronounced positive correlation. Therefore, the following is hypothesized.

H_{1a}: The relationship between R&D investment and long-term performance is significant for non-high-technology firms.

H_{1b}: The relationship between R&D investment and long-term performance is weaker or insignificant for high-technology firms.

2.2. IPO Underpricing and Long-Term Performance

The Fads Hypothesis Akerlof (1970) attributes IPO underpricing to overoptimistic 'Fads investors' who inflate first-day prices, resulting in higher initial returns (Wang & Wang, 2021). As time progresses and reality becomes apparent, stock prices realign with their underlying values, resulting in IPOs that exhibit greater initial underpricing to yield diminished long-term abnormal returns (Gandolfi, Regalli, Soana, & Arcuri, 2018).

Wei, Zeng, Wu, and Li (2019) discovered that China's IPO first-day price limit policy stimulates speculative fervor, resulting in discrepancies from intrinsic values and diminished long-term performance. Similarly, Fang Xianming and Zhang Ruoxuan (2020) emphasized that the transfer of substantial initial gains from the primary market to the secondary market intensifies IPO underpricing and results in suboptimal long-term performance. These studies collectively indicate that excessive initial gains frequently reduce long-term profits, a pattern also observed in the STAR Market. This study aims to investigate the correlation between IPO underpricing and long-term performance in this environment. Therefore, the following hypothesis is proposed:

H_2: IPO underpricing is negatively associated with long-term performance. While underpricing may attract short-term investors, it often undermines the firm's long-term returns.

2.3. Investor Sentiment and Long-Term Performance

Investor sentiment significantly influences IPO performance. In emerging markets such as Korea, elevated individual investor sentiment adversely affects long-term results (Chung, Kim, & Park, 2017). Similarly, in mature markets such as the US, Saade (2015) found that optimistic investor sentiment correlates with reduced aftermarket returns for IPOs, particularly in technology firms. Conversely, some studies, such as Fang, Yu, and Huang (2018), identified a positive relationship between investor sentiment and performance in specific contexts, such as the bond market, demonstrating that the effect of sentiment may vary based on market and asset class.

In the Chinese market, restrictions such as the prohibition on short selling intensify the effects of investor optimism, often leading to inversely proportional relationships between sentiment and returns (Allen et al., 2024).

Based on this outcome, it could be inferred that negative investor sentiment in the Chinese stock market is associated with long-term success. Jia, Wang, and Xiong (2017) construct measures of investor sentiment at both the market and firm levels. Based on the previously mentioned studies in the Chinese market, it is expected that the STAR market also exhibits a similar correlation between investor sentiment and long-term performance. Therefore, the following hypothesis is proposed:

H_5: Investor sentiment is negatively associated with long-term performance. Heightened sentiment often leads to speculative trading, which negatively impacts sustained performance.

3. RESEARCH DEVELOPMENT

3.1. Data Sources

This study employs event study methodology and cross-sectional financial data analysis to assess the long-term performance of IPOs on China's STAR Market, focusing on the effects of R&D investment, IPO underpricing, and investor sentiment. The event study method Ritter (1991) expects that efficient markets incorporate IPO effects into stock prices, while the distinctive regulations of the STAR Market (e.g., no price limits) may affect outcomes. This study examines 342 companies listed between July 22, 2019, and December 31, 2021, sourced from the CSMAR database. This timeframe encompasses the market's first expansion, excluding disruptions from COVID-19 in 2022, and omitting incomplete or delisted companies. Daily and monthly stock returns, along with tradable market values, were sourced from the CSMAR database, a reliable repository for Chinese financial data (Allen et al., 2024).

3.2. Variable Measurement

Dependent variable: The CAR uses a simple summation of returns, which can retain information on the variability of returns among individual IPOs and is consistent with a statistically normal distribution. The disadvantage is that it cannot quantify the volatility of returns. Ritter (1991) first used this method to study long-term performance in the US between 1975 and 1984. The CAR of the IPO shares week t to week n calculation formula is as follows:

$$CAR_{it} = \sum_{i=1}^{n} AR_{it} = \sum_{i=1}^{n} [R_{it} - E(R_{it})] \quad (1)$$

$E(R_{it})$ Usually use the rate of return of the stock index.

A one-year time period was selected as the time window. To mitigate the impact of high returns in the first month, the starting point was set as the 21st day after listing; the entire year range is [21,272].

The BHAR commonly uses monthly returns as a baseline measure of yield. To reduce the influence of unusual returns on the first day of each month, this study chooses companies listed in the second month as the beginning of the time period, and the endpoint of the time period is the 13th month after listing. The BHAR calculation formula is as follows:

$$BHAR_{i,t} = \prod_{t=1}^{t} [1 + r_{i,t}] - \prod_{t=1}^{t} [1 + E(r_{m,t})] \quad (2)$$

$E(r_{m,t})$ usually use the rate of return of the stock index.

Both CAR and BHAR rely on the SSE Index as the benchmark rate, following prior studies, Allen et al. (2024) and Qian, Ritter, and Shao (2024), as it reflects the overall market's performance during the sample period. These methods allow for a robust evaluation of IPO performance in the one-year post-listing period.

Independent variables: R&D investment is defined as the ratio of a firm's R&D expenditure to its main business income in the year(s) leading up to its IPO (Guo, Li, Yu, & Wei, 2021). To account for the delayed impact of R&D activities, the variable is measured across three lagged periods: the R&D investment to main business income ratio one year before the IPO (RD1), the R&D investment to main business income ratio two years before the IPO (RD2), and the R&D investment to main business income ratio three years before the IPO (RD3). These lagged variables enable the study to examine the time-sensitive effects of R&D on IPO underpricing and long-term performance.

The level of IPO underpricing is measured by the index of IPO underpricing rate. This method is from Ritter (1991) who first calculated the IPO underpricing rate or initial returns. The STAR market is different from other

Chinese markets; it has no daily price limit, so it can use the first-day closing price to calculate the IPO underpricing rate here. The calculated formula is the following:

$$UP = \frac{P_{ij} - P_i}{P_i} \qquad (3)$$

UP = IPO underpricing rate P_{ij}= First-day closing price P_i = Offer price.

Investor sentiment is gauged by the IPO turnover rate, which indicates trading activity in relation to the shares outstanding during the early period following the IPO. The average turnover rate in the first month following listing serves as an indicator of investor sentiment. An elevated turnover rate signifies increased speculative trading and investor fervor, typically propelled by short-term optimism rather than intrinsic value. This measure is especially pertinent in the STAR Market, where trading mechanisms such as T+0 and the lack of daily price caps promote elevated trading volumes. This article examines the impact of investor emotion on long-term IPO performance by analyzing the IPO turnover rate in a market marked by considerable speculative activity.

Control variables: Recent studies Allen et al. (2024); Qin and Xiao (2023) and Zhou and Sadeghi (2021) found company age, company size, price-book ratio, return over assets, market condition, and venture capital backing related to long-term performance, making them essential control variables. The measurements of these variables are summarized and shown in Table 1.

Table 1. Meaning and measurement of variables.

Symbol	Meaning	Measurement
CAR	Cumulative abnormal return	Sum of abnormal returns for IPO shares over a one-year period.
BHAR	Buy-and-hold abnormal return	Compounded holding return of IPOs relative to market performance over one year.
RD1	R&D investment (Lag one period)	The ratio of R&D expenditure to main business income one year before IPO.
RD2	R&D investment (Lag two period)	The ratio of R&D expenditure to main business income two years before IPO.
RD3	R&D investment (Lag three period)	The ratio of R&D expenditure to main business income three years before IPO.
UP	IPO underpricing	The first-day closing price minus the offer price is divided by the offer price.
IS	Investor sentiment	Turnover rate of companies on the first day of listing.
HITECH	High-technology industry	An IPO company is classified as a high-tech industry equal to 1; otherwise, it is 0.
LNA	Company age	LNA = Ln (1 + the age of the company). The age of the company = The number of days between the company's establishment and its listing/365
LNSIZE	Company size	Ln (Total company assets one year before IPO)
ROA	Return on assets	Net income / End of period assets
PB	Price-to-book ratio	The ratio of IPO price to net assets per share
MAR	Market condition	The cumulative return of the SSE index in the first 30 days of IPO
VC	Venture capital	If the company is venturing, capital-backed equals 1; otherwise, it is 0.

3.3. Measurement

Performance is evaluated over 252 trading days (one year, according to Shanghai Stock Exchange rules), commencing on day 21 post-IPO to avoid initial volatility. Cumulative abnormal returns (CAR) encompass days 21 to 41 (one month) and 21 to 272 (one year), whereas buy-and-hold abnormal returns (BHAR) utilize monthly returns from months 2 to 13, with the SSE Index as the benchmark (Qian et al., 2024). CAR and BHAR were chosen for their direct focus on abnormal returns and comparability (Barber & Lyon, 1997), unlike multi-factor models. This quantitative methodology (Creswell, 2014) employs OLS regression, with robustness checks (e.g., the White test) ensuring reliability.

3.4. Model

In order to verify H1, H2, and H3, this paper builds the regression model (4). RD represents three periods of R&D investment (RD1, RD2, RD3). UP is IPO underpricing, and IS represents investor sentiment.

$$CAR/BHAR = \beta_0 + \beta_1 RD + \beta_2 \mathrm{UP} + \beta_3 \mathrm{IS} + \beta_4 Controls_i + \varepsilon \quad (4)$$

This study groups the companies listed on the STAR market based on high-technology or non-high-technology sectors, examines the influence of R&D investment on long-term performance across different industries, and then tests H1a and H1b.

4. EMPIRICAL FINDINGS

4.1. Long-Term Performance Event Study Results of CAR

Que and Zhang (2019) research indicates that the long-term performance of listed companies in China has different results depending on the methodology used in the analysis. Thus, this research uses CAR and BHAR methods to study the STAR market's newly listed stocks' long-term performance from July 2019 to December 2022.

Table 2 delineates a time-series analysis of CAR over a 12-month period, with each month representing a distinct time window. The analysis encompasses 342 observations for each interval. The CAR values exhibit variability across the months, revealing both positive and negative returns. Notably, Month 6 registers the highest positive CAR at 2.51%, which is statistically significant, evidenced by a t-test value of 2.62 (denoted by ***). In contrast, Month 11 documents the most pronounced negative CAR at -2.63%, also statistically significant, with a t-test value of -3.06 (denoted by ***). Subsequent months display diminished and less statistically significant CAR values, reflecting intervals of both positive and negative performance without robust statistical significance. Figure 1 delineates the monthly CAR trends for IPOs on the Chinese STAR market over a twelve-month span. Initially, the figure reveals a substantial negative CAR of -1.98% in the first month, indicating a decline immediately post-IPO. This is succeeded by a brief positive increase in the second month, with CAR attaining 1.30%. However, the ensuing months exhibit a pattern of variability, with CAR values oscillating between negative and positive yet remaining relatively proximate to zero, indicating negligible abnormal returns. A significant peak is noted in the sixth month, where CAR reaches a maximum of 2.51%, underscoring a transient phase of positive abnormal performance.

Table 2. Average monthly abnormal returns of IPOs offered during 2019-2021.

Month	Time window	N	CAR	t-test
1	21-41	342	-1.98%	-2.02**
2	42-62	342	1.30%	1.35
3	63-83	342	-1.26%	-1.32
4	84-104	342	-0.72%	-0.85
5	105-125	342	-1.28%	-1.36
6	126-146	342	2.51%	2.62***
7	147-167	342	-0.57%	-0.67
8	168-188	342	0.41%	0.50
9	189-209	342	0.36%	0.42
10	210-230	342	-0.61%	-0.78
11	231-251	342	-2.63%	-3.06***
12	252-272	342	-0.25%	-0.30

Note: ** P-value is significant at the 5% level. *** P-value is significant at the 1% level.

4.2. Long-Term Performance Event Study Results of BHAR

Table 3 provides an analysis of Buy-and-Hold Abnormal Returns (BHAR) over 12 months, with each month based on 342 observations. The BHAR values indicate a general trend of negative abnormal returns across most months. The most significant negative BHAR occurs in Month 11 at -9.05%, with a highly significant t-test value of -3.03 (marked with ***), followed by Month 12 with a BHAR of -8.20% and a t-test value of -2.51 (also marked with ***). Other months, such as Month 10 and Month 4, show smaller negative BHARs with moderate statistical

significance (marked with *). Several months, like months 2, 6, and 7, exhibit minimal or statistically insignificant BHARs, indicating less pronounced abnormal returns during these periods.

The analysis of CAR and BHAR results indicates that CAR displays volatility in returns, both positive and negative. It peaks around the sixth month, showcasing a statistically significant positive return, but subsequently declines, experiencing a substantial drop in the eleventh month. In contrast, BHAR reveals a predominantly downward trajectory, marked by consistently negative returns throughout most of the period. Notably, BHAR experiences its most pronounced decline in the eleventh month, mirroring the decrease observed in CAR. While the CAR metric reflects ephemeral phases of investor optimism and favorable returns, the BHAR metric signifies a persistent and considerable decline, suggesting that despite potential short-term gains, the long-term performance of these IPOs is generally unfavorable. This contrast highlights the difference between the incremental buildup of CAR and the compounded effect observed in BHAR over time. Figure 1 illustrates the divergent trajectories of BHAR and CAR, with BHAR exhibiting a persistently negative trend, whilst CAR reveals greater variability and intermittent phases of positive returns. It is clear that the CAR does not demonstrate significant underperformance over a one-year duration in the STAR market. Nonetheless, the BHAR exhibits considerable underperformance in the majority of monthly assessments inside the STAR market. Nonetheless, both the CAR and BHAR demonstrate a negative return, as evidenced by the findings of Fang Xianming and Zhang Ruoxuan (2020) and Qian et al. (2024).

Table 3. Buy and hold abnormal returns of IPOs offered during 2019-2021.

Month	N	BHAR	t-test
1	342	-3.16%	-2.11**
2	342	-1.44%	-0.75
3	342	-3.15%	-1.52
4	342	-4.10%	-1.79*
5	342	-3.70%	-1.28
6	342	-0.54%	-0.15
7	342	-0.86%	-0.26
8	342	-2.56%	-0.80
9	342	-1.51%	-0.46
10	342	-5.05%	-1.63*
11	342	-9.05%	-3.03***
12	342	-8.20%	-2.51***

Note: * P-value is significant at the 10% level. ** P-value is significant at the 5% level. *** P-value is significant at the 1% level.

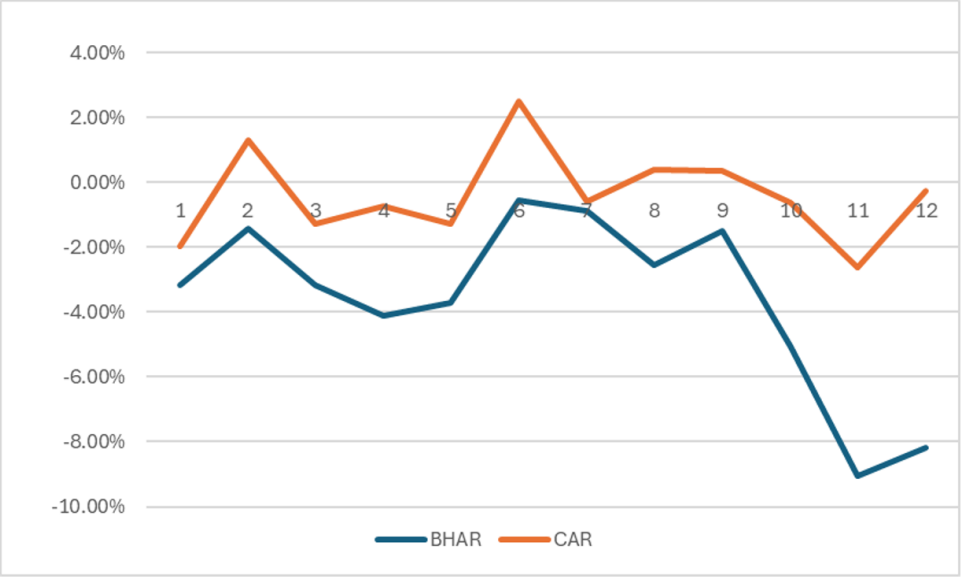

Figure 1. Cumulative abnormal return vs. Buy and hold abnormal return.

4.3. Descriptive Statistical Analysis

Table 4 displays the descriptive statistics for the variables in the IPO long-term performance model. The average long-term performance of CAR is -4.73%; the BHAR also demonstrates a notable distinction in its long-term performance, which stands at -8.2%. This indicates that it has underperformed in the STAR market over a period of one year. In general, equities from the STAR IPO have a consistent trend of performing below expectations over time. The average one-year performance of Chinese A-share markets for enterprises listed in 2019 was -32.1%, while for those listed in 2020, it was -33.7%. The average one-year performance for enterprises listed through IPOs from 1990 to 2020 was -10.7% (Qian et al., 2024). Although the STAR market did not demonstrate a positive return compared to the main market, its long-term performance surpassed that of the main A-share market. The R&D investment ratios for the sample show significant variation across the three lagged periods. For RD1 (one year before IPO), the mean is 12.47% with a standard deviation of 28.55%, ranging from 0.75% to 490.65%. For RD2 (two years before IPO), the mean is 15.29% with a standard deviation of 107.95%, ranging from 0.85% to 2001.90%. For RD3 (three years before IPO), the mean increases substantially to 84.59%, with a much larger standard deviation of 1390.58%, and ranges from 1.02% to 25,725.39%. This indicates increasing variability in R&D investment as the lag period extends further back.

Table 4. Variable descriptive statistics.

Variables	Observations	Average	Std. deviation	Minimum	Maximum
CAR	342	-4.73%	54.35%	-140.05%	155.14%
BHAR	342	-8.20%	60.40%	-89.58%	243.27%
RD1	342	12.47%	28.55%	0.75%	490.65%
RD2	342	15.29%	107.95%	0.85%	2001.90%
RD3	342	84.59%	1390.58%	1.02%	25725.39%
UP	342	178.06%	152.78%	-27.27%	1273.98%
IS	342	0.75	0.07	0.47	0.99
HITECH	342	0.89	0.32	0	1
LNA	342	2.70	0.35	1.61	3.69
LNSIZE	342	20.62	0.96	18.64	25.47
ROA	342	0.13	0.09	-0.30	0.69
PB	342	2.90	1.20	1.0	12.6
MAR	342	0.83%	4.09%	-5.40%	10.90%
VC	342	0.79	0.41	0	1

Note: CAR is the cumulative abnormal return of a one year period, BHAR is Buy-and-Hold Abnormal returns of a one year period, RD1, RD2, and RD3 are research and development ratios in three periods, UP is IPO underpricing, IS is investor sentiment, TECH is high-technology industry classification, LNA is the logarithm of company age, LNSIZE is the logarithm of company size, ROA returns on assets, PB is price book ratio, MAR is market condition, and VC is venture capital.

4.4. Regression Analysis of Long-Term Performance

4.4.1. R&D Investment, IPO Underpricing, Investor Sentiment Impact on Long-Term Performance

First, model (4) is used to test the R&D, IPO underpricing, and investor sentiment influence on the long-term performance of listed firms in the Chinese STAR market. The regression results are shown in Table 5. Across all these, IPO underpricing (UP) consistently exhibits a significant and negative effect on both CAR and BHAR, with coefficients of -0.07 ($p < 0.01$), confirming that higher IPO underpricing leads to weaker long-term performance; hypothesis H2 has been verified. Investor sentiment (IS) shows a weakly significant positive relationship with CAR ($p < 0.10$) but remains insignificant for BHAR, suggesting a limited influence of sentiment on long-term performance. Thus, hypothesis H3 is not supported. Other variables, including R&D investment (RD1, RD2, RD3), do not show any significant relationship with CAR or BHAR, suggesting that R&D expenditure does not directly influence long-term performance in the STAR Market; hypothesis H1 is not supported.

The models exhibit little explanatory ability, with modified R^2 values between 0.03 and 0.07, indicating the intrinsic complexity of IPO performance affected by unobservable variables. Notwithstanding the low R^2, the models exhibit statistical significance ($p<0.01$), and the absence of heteroscedasticity is confirmed by the White test results

(p>0.1). These data highlight the primary influence of IPO underpricing and market returns on long-term IPO performance, indicating minimal direct impact of R&D expenditure in this environment. The diminished adjusted R^2 in the CAR model signifies the intrinsic complexity of IPO performance, shaped by various observable and unobservable elements, such as macroeconomic conditions, market sentiment, firm-specific attributes, and external shocks. This corresponds with previous studies, Loughran and Ritter (2004) and Ritter (1991), which emphasize the challenge of comprehensively encapsulating IPO success determinants inside a singular model. Short-term performance is frequently influenced by investor emotion and market enthusiasm; however, long-term performance is primarily contingent upon firm fundamentals and post-IPO initiatives (Carter, Dark, & Singh, 1998).

Factors such as missing variables, measurement inaccuracies, and sample characteristics further diminish the explanatory power. Research by Beatty and Ritter (1986) and Su and Bangassa (2011) has similarly indicated poor R^2 values in IPO studies, highlighting this as a prevalent concern owing to the intricate and multifaceted character of IPO results. Despite the low adjusted R^2, the model offers valuable insights into the factors influencing long-term IPO performance in the STAR Market, making it relevant for understanding this unique market context.

Table 5. Full sample regression results.

Variables	CAR	BHAR	CAR	BHAR	CAR	BHAR
RD1	0.04 (0.36)	-0.00 (-0.02)				
RD2			0.01(0.41)	0.00 (0.11)		
RD3					0.001(0.32)	0.00 (0.02)
UP	-0.07*** (-3.19)	-0.07*** (-2.81)	-0.07*** (-3.17)	-0.07*** (-2.80)	-0.07*** (-3.17)	-0.07*** (-2.81)
IS	92.99* (1.80)	29.50 (0.52)	93.04*(1.81)	29.58 (0.53)	92.97* (1.80)	29.52 (0.53)
LNA	-8.75 (-1.04)	1.94 (0.21)	-8.90 (-1.06)	1.95 (0.21)	-8.92 (-1.06)	1.95 (0.21)
LNSIZE	4.54 (1.26)	2.30 (0.58)	4.56 (1.26)	2.36 (0.60)	4.51 (1.25)	2.32 (0.59)
ROA	79.11** (1.95)	26.38 (0.60)	80.16** (1.96)	28.01 (0.63)	79.01** (1.93)	26.92 (0.60)
PB	-4.95*(-1.86)	-5.54** (-1.91)	-4.87* (-1.86)	-5.58** (-1.95)	-4.83* (-1.85)	-5.56** (-1.95)
MAR	-2.28*** (-3.09)	-1.85** (-2.30)	-2.27*** (-3.08)	-1.85** (-2.30)	-2.27*** (-3.08)	-1.85** (-2.30)
VC	12.49*(1.67)	4.80 (0.59)	12.59*(1.68)	4.81 (0.59)	12.59*(1.68)	4.80 (0.59)
N	342	342	342	342	342	342
Adj R^2	0.09	0.03	0.09	0.03	0.09	0.03
F value	3.75	2.06	3.76	2.06	3.75	2.06
P value	0.00	0.03	0.00	0.03	0.00	0.03
White test	0.88	0.82	0.88	0.59	0.92	0.55

Note: *** p<0.01, ** p<0.05, * p<0.1. T-values are in parentheses.

4.4.2. High Technology Influence between R&D Investment and Long-Term Performance

To validate H1a and H1b, the data are categorized into high-technology and non-high-technology sectors and evaluated according to model (4). The regression outcomes for CAR are presented in Table 6, whereas BHAR is displayed in Table 7. The examination of Cumulative Abnormal Returns (CAR) and Buy-and-Hold Abnormal Returns (BHAR) reveals significant disparities in the effects of R&D expenditure between high-tech and non-high-tech companies. For non-high-tech enterprises (HITECH=0), R&D investment is consistently and significantly correlated with both CAR and BHAR throughout all lagged intervals (RD1, RD2, RD3). Coefficients vary from 7.69 (p<0.05) to 14.87 (p<0.01), demonstrating that R&D functions as a significant catalyst for long-term development in various sectors; H1a is affirmed. Conversely, for high-tech enterprises (HITECH=1), R&D investment is inconsequential for both CAR and BHAR, indicating that its influence is already included in valuations or eclipsed by other elements in high-tech sectors; H1b is not substantiated.

IPO underpricing (UP) consistently exerts a significant negative impact on long-term performance in both categories, with coefficients ranging from around -0.06 to -0.19 (p< 0.01 or p<0.05), so affirming its adverse effect. Investor sentiment (IS) has conflicting outcomes, demonstrating marginal relevance for CAR in high-tech firms (p<0.10) but showing no significant impact on BHAR in either category. The price-to-book ratio (PB) exhibits a negative correlation with long-term performance in non-high-tech enterprises, although it remains insignificant for high-tech firms. Conversely, market conditions (MAR) adversely affect the performance of high-tech firms (p<0.05), but do not influence non-high-tech firms.

The adjusted R^2 values reveal stronger explanatory power for non-high-tech firms (up to 0.31 for BHAR and 0.23 for CAR) compared to high-tech firms (0.07 for CAR and 0.02 for BHAR). These results emphasize the importance of R&D investment in driving long-term performance for non-high-tech firms and highlight differences in the factors influencing long-term returns across industry types.

Table 6. Group regression results based on high technology (CAR).

Variables	CAR		CAR		CAR	
HITECH	0	1	0	1	0	1
RD1	7.69**(2.18)	0.03(0.29)				
RD2			7.02**(2.06)	0.01(0.39)		
RD3					10.90***(2.71)	0.00 (0.31)
UP	-0.19*** (-2.82)	-0.06*** (-2.71)	-0.14** (-2.20)	-0.06*** (-2.69)	-0.18*** (-2.79)	-0.06*** (-2.69)
IS	130.60 (1.14)	93.60*(1.63)	94.02(0.81)	93.62*(1.63)	130.99 (1.18)	93.52 (1.63)
LNA	-19.04 (-0.77)	9.79 (-1.08)	-12.04 (-0.47)	-9.93 (-1.10)	-11.83(-0.49)	-9.95 (-1.10)
LNSIZE	-12.77 (-0.80)	5.75 (1.50)	-15.28(-0.95)	5.78 (1.51)	-6.85(-0.44)	5.74 (1.50)
ROA	83.38 (0.29)	76.14*(1.83)	20.36(0.07)	77.65*(1.86)	177.81 (0.64)	76.65*(1.83)
PB	-27.68* (-1.88)	-4.28 (-1.56)	-35.28** (-2.36)	-4.23 (-1.56)	-41.66*** (-2.84)	-4.20 (-1.55)
MAR	-0.60 (-0.21)	-2.46*** (-3.19)	-1.21 (-0.42)	-2.45*** (-3.18)	-1.85 (-0.66)	-2.46*** (-3.18)
VC	30.62 (1.33)	10.09(-1.54)	17.98 (0.75)	10.19 (1.28)	19.45 (0.26)	10.20 (1.28)
N	38	304	38	304	38	304
Adj R^2	0.16	0.07	0.15	0.07	0.23	0.07

Note: *** p<0.01, ** p<0.05, * p<0.1. T-values are in parentheses.

Table 7. Group regression results based on high technology (BHAR).

Variables	BHAR		BHAR		BHAR	
HITECH	0	1	0	1	0	1
RD1	8.94** (2.48)	-0.01 (-0.05)				
RD2			10.12***(3.05)	0.00(0.09)		
RD3					14.87***(3.92)	0.00(0.03)
UP	-0.16** (-2.32)	-0.06** (-2.32)	-0.11*(-1.65)	-0.06**(- 2.31)	-0.15**(-2.50)	-0.06**(- 2.31)
IS	5.48(0.05)	42.58(0.67)	-44.06(-0.39)	42.71(0.68)	8.30(0.08)	42.66(0.68)
LNA	20.64(0.82)	-0.99(- 0.10)	33.15(1.33)	-0.97(-0.10)	32.23(1.41)	-0.97(- 0.10)
LNSIZE	1.72(0.11)	3.31(0.79)	-0.73(-0.05)	3.38(0.81)	10.63(0.71)	3.35(0.80)
ROA	244.82(0.83)	22.77(0.50)	158.25(0.56)	24.70(0.54)	376.65(1.43)	23.81(0.52)
PB	-15.86 (-1.05)	-4.89 (-1.62)	-26.00* (-1.79)	-4.95* (-1.66)	-34.35** (-2.48)	-4.93* (-1.66)
MAR	0.63(0.22)	-2.09** (-2.46)	-0.23 (-0.08)	-2.09** (-2.46)	-1.06(-0.40)	-2.09 (-2.46)
VC	21.00(0.89)	2.54(0.29)	2.55(0.11)	2.55(0.29)	5.60(0.26)	2.54(0.29)
N	38	304	38	304	38	304
Adj R^2	0.13	0.02	0.20	0.02	0.31	0.02

Note: *** p<0.01, ** p<0.05, * p<0.1. T-values are in parentheses.

4.5. Robust Test

To ensure the research's dependability, the following rigorous test analysis is performed: Changes in the measurement of R&D investment pertain to the average ratio of the three years preceding the listing of R&D investment. Measurement of investor mood shifts in response to the oversubscription of IPO firms. Subsequently, conduct the aforementioned regression tests for these new variables and perform a grouped test on high-technology and non-high-technology enterprises according to model (4); the findings are presented in Table 8. The findings indicate a uniform adverse effect of IPO underpricing on long-term performance (CAR and BHAR) across all cohorts, consistent with the primary results. The function of R&D investment varies considerably between non-high-tech and high-tech companies. For non-high-tech enterprises, R&D investment is significantly and positively correlated with both CAR and BHAR, underscoring its role as a catalyst for long-term performance, as indicated by the primary findings. Conversely, R&D expenditure remains negligible for high-tech companies, aligning with previous findings that its impact is likely already incorporated into valuations. Investor sentiment (IS2) remains devoid of any substantial impact on performance across all categories, reflecting the absence of evidence in the primary analysis. Control factors such as PB and MAR maintain their significance, with PB adversely impacting performance predominantly in non-high-tech enterprises, whereas MAR exerts a more pronounced influence on high-tech firms. The modified R2 values validate that the model elucidates performance more effectively for non-high-tech enterprises, akin to the primary findings, highlighting the varied influence of R&D expenditure across sectors.

Table 8. Robust test regression results.

Variables	Full sample		Non-high-tech		High-tech	
	CAR	BHAR	CAR	BHAR	CAR	BHAR
RD	0.00(0.31)	0.00(0.02)	9.65**(2.49)	12.67***(3.41)	0.00(0.02)	0.00(0.02)
UP	-0.05*** (-2.52)	-0.06*** (-2.79)	-0.16** (-2.53)	-0.16** (-2.57)	-0.05** (-2.07)	-0.05** (-2.18)
IS2	-0.00 (-0.29)	0.00 (0.26)	0.01 (0.70)	0.01 (0.73)	-0.00 (-0.36)	0.00 (0.15)
LNA	-8.76 (-1.01)	1.32 (0.14)	-11.16 (-0.45)	27.76 (1.17)	-9.96(-1.07)	-1.66 (-0.16)
LNSIZE	2.23 (0.63)	1.86 (0.49)	-14.57 (-0.94)	4.95 (0.33)	3.31 (0.90)	2.51 (0.62)
ROA	66.82*(1.65)	22.75(0.52)	11.09(0.04)	247.12(0.93)	64.59(1.56)	18.05(0.40)
PB	-5.38** (-1.93)	-5.39* (-1.78)	-33.35** (-2.29)	-24.83* (-1.79)	-4.87* (-1.69)	-4.90 (-1.55)
MAR	-2.43*** (-3.27)	-1.86** (-2.31)	-1.38(-0.48)	-0.52(-0.19)	-2.65*** (-3.40)	-2.14*** (-2.50)
VC	13.79*(1.82)	4.88(0.59)	20.70(0.90)	9.42(0.43)	11.61(1.44)	2.84 (0.32)
N	342	342	38	38	304	304
Adj R^2	0.06	0.03	0.18	0.25	0.06	0.02

Note: *** p<0.01, ** p<0.05, * p<0.1. T-values are in parentheses. RD is the average ratio of the three years before listing on R&D investment, and IS2 is the oversubscription of IPO firms.

5. DISCUSSION

This study offers new insights into the varying impact of R&D investment on long-term IPO performance between high-tech and non-high-tech firms in China's STAR Market. The findings reveal that R&D investment significantly enhances long-term performance in non-high-tech firms but has no measurable effect in high-tech industries. This divergence can be attributed to differences in investor expectations: in non-high-tech firms, R&D serves as a critical signal of innovation potential, reducing information asymmetry and fostering long-term market confidence. Conversely, in high-tech firms, where R&D activities are expected and commonplace, the signaling effect may be diminished, and the market may already incorporate such investments into IPO valuations. These results

align with prior studies indicating the varying roles of R&D across industries (Aboody & Lev, 2000; Zhang & Zhang, 2020) while extending the literature by focusing on the unique dynamics of an emerging innovation-driven market.

The efficacy of R&D investment in producing useful, marketable products or services can profoundly influence long-term profitability (Ravšelj & Aristovnik, 2020). Recent research by Chen et al. (2023) examined the Chinese A-share market. Investors may accept short-term performance declines in exchange for substantial R&D expenditure, and their responses to such investments can differ. Boiko (2021) examined R&D-related literature and determined that the relationship between long-term performance and R&D necessitates consideration of time lag. The temporal delay can hinder the establishment of a direct association between R&D expenditure and long-term performance. These observations highlight the necessity of considering both industry-specific dynamics and temporal aspects when evaluating the impact of R&D expenditure on IPO performance.

The enduring negative effect of IPO underpricing on long-term performance supports the Fads Hypothesis (Loughran & Ritter, 2004), highlighting the destabilizing influence of early market overvaluation. Issuers in non-high-tech sectors should utilize R&D investments to indicate development potential, whereas those in high-tech industries may need to prioritize other elements, such as operational efficiency or intellectual property assets, to improve long-term performance. Policymakers ought to promote enhanced transparency in R&D disclosures to mitigate knowledge asymmetry, particularly in non-high-tech industries. Ultimately, the data indicate that investors must meticulously assess IPO pricing and fundamental factors instead of depending on sentiment-driven approaches.

6. CONCLUSION

This study offers significant insights into the relationships among R&D investment, IPO underpricing, and long-term performance in innovation-driven markets like China's STAR Market. The results indicate that R&D expenditure markedly improves long-term performance in non-high-tech companies, acting as a crucial indicator of growth potential and innovation, hence diminishing information asymmetry. Conversely, R&D investment demonstrates little discernible effect on high-tech companies, presumably due to its anticipated characteristics and pre-existing market valuations. These findings underscore the intricate influence of R&D expenditure on IPO performance, contingent upon sector attributes.

These findings underscore the necessity for companies to implement transparent R&D disclosure processes and to collaborate with reputable venture capitalists to alleviate negative market impacts. Policymakers can improve the efficiency and equilibrium of the IPO market by customizing legislation to elevate information disclosure criteria. Future research should explore the long-term implications of these factors across various industrial sectors to assess broader generalizability.

In summary, whereas R&D investment is essential for promoting innovation, the strategy for controlling its market perception is vital for influencing both immediate IPO results and sustained business performance. This thorough viewpoint addresses significant gaps and enhances the comprehension of IPO dynamics in rising, innovation-driven economies.

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