



# Heterogeneous Innovation and IPO Underpricing: Evidence from Patent Quality Dimensions in China's Registration-Based Market

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**Abstract.** Under the comprehensive registration system, how heterogeneous firm-level innovation influences Initial Public Offering (IPO) pricing efficiency has become an important issue. This study uses nonfinancial firms listed on the A-share market from 2019 to 2025 as the sample and classifies patents along three dimensions, including substantive innovation (invention patents), strategic innovation (utility models and designs), and citation frequency. It examines their effects and mechanisms on IPO first-day underpricing. Empirical results indicate that total patent counts, substantive innovation, strategic innovation, and citation frequency each have a significant positive effect on the first-day underpricing rate. The estimated difference in effects between substantive and strategic innovation is not statistically significant. Investor sentiment exerts a significant negative moderating effect on the relationship between total patent counts and underpricing, suggesting that the marginal pricing effect of patent signals is attenuated in high sentiment environments. Venture Capital/Private Equity (VC/PE) backing has a significant negative moderating effect, consistent with a substitution relationship between institutional certification and patent signals. The hypothesized mediating role of conservative pricing by underwriters or issuing institutions is not supported, implying that underpricing is primarily driven by secondary market sentiment rather than by compensation for information asymmetry in the primary market. The findings extend the application of behavioral finance theory in IPO markets and offer policy-relevant implications for disclosure of innovation information and optimization of investor composition under the registration system.

**Keywords:** Substantive Innovation, Strategic Innovation, IPO Underpricing, Investor Sentiment, VC/PE Certification.

## 1 Introduction

With the transition from the approval system to a comprehensive registration regime in the A-share market, the pricing of new equity issues has become predominantly market driven [1]. Amid intensified global technological competition and China's macro strat-

egies that emphasize independent core technologies and the development of new quality productivity, capital markets have shown strong interest in technologically advanced firms with substantial patent portfolios.

Initial Public Offering (IPO) first-day underpricing, defined as the positive difference between the first-day closing price and the offer price, remains a salient anomaly in modern finance [1]. Since the registration system reduced regulatory constraints on pricing, primary market valuation has become more susceptible to market dynamics. Consequently, the extent to which firms' intrinsic value and innovation capabilities are reflected in IPO pricing warrants renewed investigation. Prelisting innovation behavior is heterogeneous. To satisfy listing requirements and achieve favorable valuations, some firms pursue genuine breakthroughs in core technologies that generate high-quality substantive innovation, typically reflected by invention patents; other firms may engage in strategic innovation by obtaining large numbers of lower-technology patents, such as utility models and designs, to present a more favorable innovation profile [2]. Under the registration system, it is important to examine how these divergent innovation strategies affect IPO pricing efficiency and whether their impacts differ in magnitude or mechanism.

This study links national science and technology policy with firm-level IPO pricing by investigating how heterogeneous innovation influences first-day underpricing and the pricing efficiency of primary and secondary markets. Using nonfinancial A-share listings from 2019 to 2025, the analysis distinguishes between substantive and strategic patents and systematically assesses their effects on IPO underpricing. The paper contributes to the literature in three respects. First, in innovation measurement, it moves beyond the common practice of treating patents as homogeneous signals by introducing a three-dimensional framework comprising substantive patents, strategic patents, and citation frequency. This framework offers a refined instrument for assessing market recognition of innovation quality. Second, in institutional context, the study integrates the limited attention hypothesis from behavioral finance with the signal substitution perspective from information economics to illuminate the distinctive pricing ecology of the A-share market, characterized by emotional dynamics and information congestion. This integration extends the applicability of classical theories to transitional economies. Third, in methodological design, by contrasting empirical strategies that capture primary market institutional behavior and secondary market investor reactions, the study identifies the principal drivers of IPO underpricing in China and provides microlevel evidence for evaluating the effects of the registration reform.

## **2 Theoretical Basis and Research Hypotheses**

### **2.1 The Relationship between Firm Innovation and IPO First-Day Underpricing**

The ex-ante uncertainty hypothesis and information asymmetry theory imply that, during the IPO process, greater difficulty in assessing a firm's true value increases the need for underwriters to set a lower offer price to compensate investors for informational disadvantages [3]. The core logic is that severe information asymmetry between issuers

and investors induces rational institutional investors to demand price discounts to hedge the adverse selection risk of acquiring lower-quality assets, thereby elevating the IPO first-day underpricing rate.

Innovation activities generate pronounced information asymmetries. Technical details of innovative outcomes frequently involve trade secrets that issuers cannot fully disclose, and the future commercialization potential of these outcomes is highly uncertain, even for sophisticated investors [4]. Hence, higher firm innovation intensity increases valuation difficulty, exacerbates information asymmetry, and should be associated with greater IPO underpricing. Prior literature often treats corporate innovation as a homogeneous signal, however, and thus overlooks fundamental differences in signal strength and technological barriers across patent types. Building on the substantive versus strategic innovation distinction in Li & Zheng (2016) [2], this study contends that heterogeneous innovation qualities differentially exacerbate information asymmetry and therefore exert distinct effects on IPO underpricing.

First, aggregate patent counts serve as a broad indicator of a firm's innovation output capacity. Independent of patent quality, a larger number of granted patents signals greater intellectual property holdings and technological competitiveness. Under information asymmetry theory, a more extensive patent portfolio increases the complexity of a firm's technology landscape and heightens external evaluative difficulty, which warrants greater risk compensation. Accordingly, the paper posits the Hypothesis 1-a.

H1-a: Controlling for other factors, a greater total number of granted patents prior to listing is associated with a higher IPO first-day underpricing rate.

Within aggregate patent counts, invention patents differ substantively from utility model and design patents. Substantive innovation, proxied by invention patents, typically reflects breakthroughs in underlying technologies, entails high technological barriers, long research and development cycles, substantial commercialization uncertainty, and rigorous substantive examination, yielding stronger signal quality. For hard technology firms with a high share of invention patents, technological advantages are often frontier and require specialized expertise to evaluate, which increases market risk premia and creates scope for larger first-day underpricing. In contrast, strategic innovation, represented by utility models and design patents, often involves lower technological barriers, is easier to imitate, and is less difficult for external parties to evaluate, thereby exerting a weaker effect on primary market pricing. Thus, two further hypotheses are proposed.

H1-b: Controlling for other factors, greater substantive innovation capability is associated with a significantly higher IPO first-day underpricing rate.

H1-c: The positive effect of strategic innovation on the IPO first-day underpricing rate is weaker than that of substantive innovation.

Finally, patent counts capture the breadth of innovation but do not distinguish quality. Patent citation frequency reflects the depth and external recognition of innovation [5]. Under information asymmetry logic, more highly cited patents indicate greater technological influence and stronger imitation barriers, increasing evaluative difficulty for external investors and thus elevating valuation uncertainty and required risk compensation. Therefore, a H1-d is proposed.

H1-d: A higher citation frequency of a firm's invention patents prior to listing is associated with a higher IPO first-day underpricing rate.

## **2.2 The Moderating Effect of Investor Sentiment**

Investor sentiment theory in behavioral finance posits that asset prices are frequently influenced by investors' subjective emotions and constrained cognitive resources [6]. Investor sentiment affects asset prices through two channels [7]. First, sentiment can directly inflate valuations, generating irrational premiums. Second, sentiment can alter the weight investors assign to fundamental information, causing certain signals to be overemphasized in high sentiment states and underweighted in low sentiment states. Within the current strategic environment that emphasizes domestic technological substitution, innovation functions as a salient emotional trigger. Retail investors in secondary markets typically lack the expertise to evaluate patented technologies, which predisposes them to cognitive biases. Media coverage of a firm's technological achievements can readily induce retail investor enthusiasm and herd-like demand [8]. This study defines secondary market investor sentiment as irrational trend-chasing and speculative fervor toward new listings. In high sentiment states, investors become more sensitive to the innovation label, and patent counts, as an intuitive signal of innovation, receive disproportionate pricing weight. Accordingly, the paper posits a Hypothesis 2.

H2: Secondary market investor sentiment positively moderates the relationship between total patent counts and IPO first-day underpricing, such that higher investor sentiment strengthens the positive effect of total patent counts on underpricing.

## **2.3 The Moderating Effect of Venture Capital/Private Equity Certification**

Signaling theory suggests that in markets characterized by information asymmetry, high-quality firms send costly signals to reveal their type, and third-party certification can reduce information search costs [9]. In IPO markets, Venture Capital/Private Equity (VC/PE) investors act as professional financial intermediaries and provide certification through their investment decisions [10]. VC/PE firms typically conduct extensive due diligence covering technical feasibility, business models, and management quality. Their investments convey two signals: that the firm has passed professional screening and that the VC/PE firm's reputation is implicitly aligned with the firm's prospects. Consequently, firms backed by VC/PE face lower information asymmetry. According to signal substitution logic, when multiple information sources are available, investors tend to rely on signals that are lower cost to interpret and higher in credibility. VC/PE certification can substitute for the informational role of patent counts. For VC/PE-backed firms, investor assessments rely in part on institutional validation, reducing reliance on patent quantity as a self-interpreted signal. In other words, the marginal premium associated with additional patents is attenuated for VC/PE-backed firms. Therefore, the paper proposes the Hypothesis 3.

H3: VC/PE backing negatively moderates the relationship between total patent counts and IPO first-day underpricing, such that it weakens the positive effect of patent counts on underpricing.

## 2.4 Primary Market Inquiry Mechanism and Mediation Hypothesis

From the perspective of the inquiry game in the primary market, a firm's prelisting accumulation of patents increases information asymmetry. During the IPO bookbuilding process, institutional investors must assess firm value within a constrained time window, and a complex patent portfolio raises the difficulty of such assessments. A larger patent stock typically implies broader technological coverage and greater uncertainty regarding commercialization prospects and intrinsic value, which amplifies pricing uncertainty. As patent quantity increases, institutional investors face higher information processing costs. This uncertainty is transmitted to conservative pricing through two complementary mechanisms.

First, the winner's curse argument indicates that, under high technological uncertainty and informational opacity typical of hard technology firms, institutional investors fear adverse selection, i.e., quoting too high raises the risk of overpaying for low-quality assets [11]. To avoid potential losses from the winner's curse, institutional investors tend to adopt defensive pricing strategies and submit lower bids. Second, drawing on information extraction theory, firms with extensive patent portfolios impose substantial professional identification costs on evaluators [12]. To induce institutions with screening capabilities to incur costly investigative efforts, underwriters and issuers may provide compensatory concessions, manifested as downward adjustments to the offer price. Since information asymmetry is difficult to observe directly, this study focuses on its observable behavioral consequence, which is conservative pricing by primary market participants, composed of institutional defensive bids and underwriter concessions, and treats this behavior as a mediating variable. In sum, greater prelisting patent counts increase institutional evaluation difficulty and information processing costs, prompting more conservative pricing by primary market actors. Conservative pricing reduces the offer price in the primary market, thereby enlarging the scope for first-day gains in the secondary market. Accordingly, a Hypothesis 4 is proposed.

H4: Conservative pricing behavior by primary market institutions mediates the positive relationship between total patent counts and IPO first-day underpricing.

## 3 Data and Methodology

### 3.1 Sample Selection and Data Sources

This study selects firms listed on the A-share market between January 1, 2019 and December 31, 2025 as the initial sample and applies the following screening procedures. First, firms in the financial and real estate sectors are excluded. Second, firms that failed to issue or whose trading was suspended on their first listing day are removed. Third, firms with missing values for core variables are excluded. Finally, all continuous variables are winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentiles to mitigate the influence of extreme values. The final sample consists of 1,413 firm-year observations. IPO issuance and trading data, financial data, investor sentiment measures, and offline institutional inquiry data are drawn from the *Choice* database. Patent and VC/PE data are obtained from the *CNRDS* database.

### 3.2 Variable Definition and Measurement

**Explained Variable – IPO First-Day Underpricing (*Underpricing*).** This variable is expressed as the percentage obtained by taking the difference between the first-day closing price and the issue price, dividing that difference by the issue price, and multiplying the result by one hundred [13].

**Explanatory Variables – Innovation (*Innovation*).** ① Total number of patents (*Total\_patents*) is measured as the natural logarithm of one plus the number of patent grants in the three years preceding listing. This measure captures the scale of a firm's innovation output. Higher values indicate larger intellectual property holdings and stronger signals of technological competitiveness, but also greater complexity in the technology portfolio and increased difficulty for external investors to assess true value. ② Substantive innovation (*Substantive*) is measured as the natural logarithm of one plus the number of invention patent grants in the three years prior to listing. Invention patents undergo substantive examination, imply higher technical barriers and longer Research and Development (R&D) cycles. Higher values indicate stronger core technological breakthroughs but greater uncertainty regarding commercialization prospects. ③ Strategic innovation (*Strategic*) is measured as the natural logarithm of one plus the number of utility model and design patent grants in the three years prior to listing. Utility model and design patents have lower thresholds and shorter examination cycles. Higher values reflect a strategic patent layout oriented to policy and market preferences, while indicating relatively lower technical barriers. ④ Total number of cited invention patents (*Total\_cites*) is measured as the natural logarithm of one plus the number of citations to invention patents in the three years preceding listing. This indicator reflects the technological influence and external recognition of a firm's innovations. Higher citation counts suggest greater technical value and imitation resistance but also raise market expectations and valuation challenges.

**Moderator Variables.** ① Investor sentiment (*Sentiment*) is proxied by the first-day turnover rate, defined as first-day trading volume divided by circulating shares, multiplied by 100% [14]. Higher turnover rates indicate stronger speculative interest from retail investors and a hotter secondary market reception of new issues. ② VC/PE support (*VCPE*) is a binary indicator equal to one if the firm received VC/PE backing prior to listing and zero otherwise. *VCPE* = 1 signals that the firm has undergone professional screening and due diligence, reducing information asymmetry through third-party certification.

**Mediating Variable – Conservative Pricing (*Conservative*).** It is defined as the issuance price minus the median of offline subscription prices divided by the median of offline subscription prices multiplied by one hundred percent. A negative value indicates that the issuance price is lower than the median offline institutional quote. A more negative value denotes a larger downward adjustment of the issuance price by underwriters during the inquiry process, implying more conservative primary market

pricing and reflecting the degree of risk compensation demanded by institutional investors due to information asymmetry [15].

**Control Variables.** The research includes the following control variables. *Size* is the natural logarithm of total assets in the year prior to listing. *Age* is the natural logarithm of firm age, defined as listing year minus establishment year plus one. *Leverage* is calculated as total liabilities divided by total assets in the year prior to listing. Return on equity (*ROE*) is net income divided by net assets in the year prior to listing. R&D intensity (*RD*) is R&D expenditures divided by operating revenue in the year prior to listing. Issue size (*Issue*) is the natural logarithm of the total proceeds raised. Price-earnings ratio (*PE*) is the issue price divided by pre-issue earnings per share. Market return (*Market*) is the cumulative return of the CSI 300 Index over the 30 days preceding listing. Underwriter reputation (*UwRep*) is a binary indicator equal to one if the lead underwriter ranks among the top ten underwriters for IPOs in that year and zero otherwise. Subsidy intensity (*Subsidy*) is total government subsidies in the year prior to listing divided by operating revenue. The models also include industry fixed effects, using the China Securities Regulatory Commission's 2012 industry classification, and year fixed effects based on the listing year.

### 3.3 Empirical Models

First, to test the main effect model, the paper estimates the following equation (1).

$$\text{Underpricing}_{i,t} = \alpha_0 + \alpha_1 \text{Innovation}_{i,t} + \alpha_2 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (1)$$

Here, *Innovation* is alternatively *Total\_patents*, *Substantive*, *Strategic*, or *Total\_cites*.  $\alpha_1$  is the coefficient of the key explanatory variable.  $\varepsilon_{i,t}$  denotes the stochastic error term.

Equations (2) and (3) test hypotheses H2 and H3 via interaction models.

$$\text{Underpricing}_{i,t} = \beta_0 + \beta_1 \text{Total\_patents}_{i,t} + \beta_2 \text{Sentiment}_{i,t} + \beta_3 (\text{Total\_patents}_{i,t} \times \text{Sentiment}_{i,t}) + \beta_4 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (2)$$

$$\text{Underpricing}_{i,t} = \delta_0 + \delta_1 \text{Total\_patents}_{i,t} + \delta_2 \text{VCPE}_{i,t} + \delta_3 (\text{Total\_patents}_{i,t} \times \text{VCPE}_{i,t}) + \delta_4 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (3)$$

If  $\beta_3$  is significantly positive, H2 is supported. If  $\delta_3$  is significantly negative, H3 is supported.

Finally, following the review by Wen & Ye [16], this paper employs a three-step procedure to test mediation and estimate the following equations (4)–(6). Mediation is assessed using Preacher and Hayes's bootstrap percentile confidence interval method with 5,000 resamples.

$$\text{Underpricing}_{i,t} = \theta_0 + \theta_1 \text{Total\_patents}_{i,t} + \theta_2 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (4)$$

$$\text{Conservative}_{i,t} = \eta_0 + \eta_1 \text{Total\_patents}_{i,t} + \eta_2 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (5)$$

$$\text{Underpricing}_{i,t} = \mu_0 + \mu_1 \text{Total\_patents}_{i,t} + \mu_2 \text{Conservative}_{i,t} + \mu_3 \text{Controls}'_{i,t} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t} \quad (6)$$

Here,  $\theta_1$  captures the total effect of total patents on IPO underpricing.  $\eta_1$  captures the effect of total patents on conservative pricing.  $\mu_2$  captures the effect of conservative pricing on IPO underpricing.  $\mu_1$  is the direct effect of total patents after accounting for conservative pricing. The indirect effect is  $\eta_1 \times \mu_2$ . If the indirect effect is significant (bootstrap 95% confidence interval does not include zero) and  $\mu_1$  is not significant, the mediation is complete. If both the indirect effect and  $\mu_1$  are significant, the mediation is partial. All three equations include industry fixed effects and year fixed effects.

## 4 Research Results and Analysis

### 4.1 Descriptive Analysis

Table 1 reports the descriptive statistics for the main variables. The IPO underpricing rate on the first trading day has a mean of 113.36%, and a median of 45.22%, indicating substantial average underpricing for new issues in the A-share market and pronounced cross-sectional heterogeneity. Regarding the explanatory variables, the distribution of *Total\_patents*, *Substantive*, and *Strategic* are all right skewed and exhibit considerable zero inflation, since 30.7% of firms were not granted invention patents in the three years prior to listing and 26.6% received no utility model or design authorizations. The mean of *Total\_cites* is 0.22 and the median is 0, which indicates that most authorized patents were not cited by peers during the observation period and that patent influence is concentrated in a small number of firms. Investor sentiment, proxied by the first-day turnover rate, has a mean of 51.07%, and a median of 67.93%; the distribution is left skewed, suggesting that most observations exhibit high sentiment while a minority of poorly received issues with very low turnover reduce the overall mean, and approximately half of the sample records a turnover rate above 67.93% on the first trading day, reflecting a high degree of speculative trading in the A-share IPO market. The average VC/PE support indicator is 0.497, implying that about half of firms received VC/PE investment prior to listing. The mean conservative pricing by institutions is -3.12% and the median is -0.37%, indicating that, on average, the issue price is roughly 3% points below the median offline quoted price. The distributions of the remaining control variables fall within reasonable ranges for empirical analysis.

**Table 1.** Descriptive statistical results.

| Variable             | Count | Mean    | Standard deviation | Minimum | Median | Maximum |
|----------------------|-------|---------|--------------------|---------|--------|---------|
| <i>Underpricing</i>  | 1413  | 113.359 | 131.090            | -20.074 | 45.215 | 628.389 |
| <i>Total_patents</i> | 1413  | 2.591   | 1.573              | 0.000   | 2.890  | 5.904   |
| <i>Substantive</i>   | 1413  | 1.345   | 1.205              | 0.000   | 1.386  | 4.584   |
| <i>Strategic</i>     | 1413  | 2.180   | 1.638              | 0.000   | 2.485  | 5.709   |
| <i>Total_cites</i>   | 1413  | 0.219   | 0.600              | 0.000   | 0.000  | 5.743   |
| <i>Sentiment</i>     | 1413  | 51.074  | 31.723             | 0.076   | 67.929 | 87.385  |
| <i>VCPE</i>          | 1413  | 0.497   | 0.500              | 0.000   | 0.000  | 1.000   |
| <i>Conservative</i>  | 1413  | -3.117  | 4.693              | -21.426 | -0.369 | 0.297   |
| <i>Size</i>          | 1413  | 20.981  | 0.920              | 19.459  | 20.805 | 24.373  |
| <i>Age</i>           | 1413  | 2.799   | 0.369              | 1.792   | 2.833  | 3.634   |
| <i>Leverage</i>      | 1413  | 38.638  | 17.006             | 8.051   | 38.278 | 79.748  |
| <i>ROE</i>           | 1413  | 21.422  | 13.486             | -33.719 | 19.970 | 72.780  |
| <i>RD</i>            | 1413  | 0.086   | 0.114              | 0.001   | 0.051  | 0.784   |
| <i>Issue</i>         | 1413  | 20.497  | 0.753              | 18.892  | 20.435 | 22.813  |
| <i>PE</i>            | 1413  | 38.834  | 36.152             | 10.440  | 26.120 | 258.332 |
| <i>Market</i>        | 1413  | 0.006   | 0.065              | -0.116  | -0.004 | 0.200   |
| <i>UwRep</i>         | 1413  | 0.618   | 0.486              | 0.000   | 1.000  | 1.000   |
| <i>Subsidy</i>       | 1413  | 0.008   | 0.020              | 0.000   | 0.000  | 0.115   |

## 4.2 Correlation Analysis

The paper computes the Pearson correlation matrix for the variables. Apart from pairwise correlations among the different innovation measures, the absolute values of the correlation coefficients among the remaining variables are all below 0.7, implying that the models do not suffer from serious multicollinearity and that all the variables can be retained.

## 4.3 Panel Regression Analysis

**Results of Hypothesis 1.** Table 2 presents the regression results for the main effects. In column (1), the coefficient on *Total\_patents* is 4.809 ( $p = 0.016$ ), positive and significant at the 5% level, providing empirical support for hypothesis H1-a. This finding suggests that firms with larger patent endowments tend to face more conservative pricing in the primary market and higher IPO underpricing on the first day. Under the registration system, patents function as a comprehensive signal of firm innovation. Although recognized by the market, their technological complexity increases valuation difficulty and exacerbates information asymmetry between issuers and investors,

thereby driving up underpricing. When the independent variable is replaced by substantive innovation, the coefficient is 6.305 ( $p = 0.014$ ), also positive and significant at the 5% level, supporting H1-b. When the independent variable is strategic innovation, the coefficient is 4.306 ( $p = 0.023$ ), again positive and significant at the 5% level. An F test from the joint regression indicates that the difference between the coefficients on substantive and strategic innovation is not statistically significant ( $F = 0.19$ ,  $p = 0.661$ ), so that hypothesis H1-c is not supported. Although the coefficient for substantive innovation is numerically larger than that for strategic innovation, their impacts on IPO underpricing are not statistically different. This result implies that while both substantive and strategic innovation significantly increase IPO underpricing, the market does not yet make a clear pricing distinction between them. Invention patents involve higher technological barriers and stricter substantive examination, leading to greater valuation uncertainty and deeper information asymmetry, which manifests as higher first-day underpricing. At the same time, strategic innovation also produces a significant positive effect, indicating that the innovation label alone is sufficient to trigger market reactions to information asymmetry; even patents with lower technological content can be used to construct a technological narrative that facilitates larger price concessions during the inquiry. Finally, when the independent variable is *Total\_cites*, the coefficient is 12.577 ( $p = 0.031$ ), positive and significant at the 5% level, supporting H1-d. This result indicates that citation-based signals of technological influence are likely to amplify valuation divergence in the primary market. In an environment of severe IPO information asymmetry, externally verified citations increase signal credibility but also raise market expectations and complicate valuation, inducing institutions to adopt defensive pricing strategies that lower the issue price and expand the scope for first-day underpricing.

**Table 2.** Regression results for Hypothesis 1.

|                      | (1) Total  | (2) Substantive | (3) Strategic | (4) Cites  |
|----------------------|------------|-----------------|---------------|------------|
| <i>Total_patents</i> | 4.809**    | /               | /             | /          |
| <i>Substantive</i>   | /          | 6.305**         | /             | /          |
| <i>Strategic</i>     | /          | /               | 4.306**       | /          |
| <i>Total_cites</i>   | /          | /               | /             | 12.577**   |
| <i>Size</i>          | 26.155***  | 25.362***       | 26.383***     | 26.410***  |
| <i>Age</i>           | -5.593     | -5.493          | -5.409        | -5.609     |
| <i>Leverage</i>      | -0.379*    | -0.341*         | -0.389*       | -0.339*    |
| <i>ROE</i>           | -0.021     | -0.001          | -0.017        | 0.027      |
| <i>RD</i>            | 97.780***  | 90.457***       | 101.459***    | 98.184***  |
| <i>Issue</i>         | -67.527*** | -67.461***      | -67.511***    | -67.515*** |
| <i>PE</i>            | 0.035      | 0.018           | 0.046         | 0.034      |
| <i>Market</i>        | -32.658    | -34.855         | -34.312       | -37.010    |
| <i>UwRep</i>         | 0.370      | 0.669           | 0.471         | 0.780      |

|                    | (1) Total | (2) Substantive | (3) Strategic | (4) Cites |
|--------------------|-----------|-----------------|---------------|-----------|
| <i>Subsidy</i>     | 224.593   | 227.082         | 231.361       | 244.678   |
| <i>Year FE</i>     | Yes       | Yes             | Yes           | Yes       |
| <i>Industry FE</i> | Yes       | Yes             | Yes           | Yes       |
| <i>R-squared</i>   | 0.3556    | 0.356           | 0.355         | 0.356     |
| <i>N</i>           | 1413      | 1413            | 1413          | 1413      |

Note: The data in the table are regression coefficients of each variable, and \*\*\*, \*\*, and \* are significant at the significance level of 1%, 5% and 10% respectively.

**Results of Hypothesis 2 & 3.** To test hypotheses H2 and H3, interaction terms are introduced into the baseline model. To reduce multicollinearity between interaction terms and their components, each variable is mean centered before constructing the interaction terms  $Total\_patents \times Sentiment$  and  $Total\_patents \times VCPE$ . Table 3 reports the estimated moderation results.

The coefficient on the  $Total\_patents \times Sentiment$  interaction is -0.150 and is significant at the 1% level, which runs counter to the positive moderating effect posited in H2. One possible interpretation is that retail investors face attention constraints [17]. In high sentiment states, investors rely more on readily accessible heuristics such as industry labels and media coverage and pay insufficient attention to fine grained technical information such as patent counts that require specialized knowledge. In other words, the informativeness of patent signals depends on the market information environment. When the market is calm, patent counts serve as a scarce signal that helps differentiate firm quality; when the market is overheated, patent signals are crowded out by sentiment driven noise and their marginal pricing effect diminishes. This finding is consistent with an attention allocation perspective on speculative behavior.

The coefficient on  $Total\_patents \times VCPE$  is negative and significant at the 5% level, supporting H3. This result suggests a substitution relationship between the certification role of VC/PE and the signaling role of patents. In the Chinese pre-IPO context, VC/PE investors often provide endorsement value, i.e., the participation of reputable institutions conveys regulatory compliance and quality signals to the market. As a result, VC/PE certification functions not only as information transmission but also as an institutional guarantee. When investors observe participation by high reputation VC/PE, their reliance on patent counts is substantially reduced because the due diligence performed by VC/PE effectively substitutes for external technical screening.

**Table 3.** Regression results for Hypothesis 2 & 3.

|                                                | Hypothesis 2 | Hypothesis 3 |
|------------------------------------------------|--------------|--------------|
| <i>Total_patents</i>                           | 3.802**      | 4.454**      |
| <i>Total_patents</i> $\times$ <i>Sentiment</i> | -0.150***    | /            |
| <i>Sentiment</i>                               | 2.361***     | /            |

|                                    | Hypothesis 2 | Hypothesis 3 |
|------------------------------------|--------------|--------------|
| <i>Total_patents</i> × <i>VCPE</i> | /            | -9.287**     |
| <i>VCPE</i>                        | /            | 69.627***    |
| <i>Size</i>                        | 42.899***    | 27.267***    |
| <i>Age</i>                         | -4.939       | -6.910       |
| <i>Leverage</i>                    | -0.584***    | -0.390*      |
| <i>ROE</i>                         | 0.354        | 0.014        |
| <i>RD</i>                          | 101.781***   | 100.506***   |
| <i>Issue</i>                       | -84.830***   | -68.972***   |
| <i>PE</i>                          | -0.130       | 0.041        |
| <i>Market</i>                      | 19.371       | -29.025      |
| <i>UwRep</i>                       | 2.120        | 0.259        |
| <i>Subsidy</i>                     | 150.926      | 219.016      |
| <i>Year FE</i>                     | Yes          | Yes          |
| <i>Industry FE</i>                 | Yes          | Yes          |
| <i>R-squared</i>                   | 0.534        | 0.358        |
| <i>N</i>                           | 1413         | 1413         |

Note: The data in the table are regression coefficient of each variable, and \*\*\*, \*\*, and \* are significant at the significance level of 1%, 5% and 10% respectively.

**Results of Hypothesis 4.** The three step regression results for the mediation test are reported. The total effect of total patent count on IPO underpricing ( $\theta_1$ ) is 4.809 ( $p = 0.016$ ), satisfying the prerequisite for mediation analysis. The effect of total patent count on institutional conservative pricing is  $\eta_1 = 0.127$  ( $p = 0.069$ ), marginally significant. The effect of conservative pricing on IPO underpricing is  $\mu_2 = 0.308$  ( $p = 0.687$ ), not significant. A bootstrap test with 5 000 replications yields a 95% confidence interval for the indirect effect of  $[-0.165, 0.273]$ , which includes zero, indicating no mediation. Taken together, H4 is not supported by the evidence.

The pathway by which total patent count affects IPO underpricing through institutional conservative pricing is not established. Although patent volume exerts a weak influence on institutional quoting behavior, conservative pricing itself does not appear to be the principal mechanism driving underpricing. This suggests that high first-day IPO underpricing in China may be driven less by passive concessions in the primary market and more by active demand in the secondary market, namely investor sentiment rather than institutional conservative pricing. In the Chinese offline inquiry mechanism institutional quotations are influenced by multiple nonmarket factors such as allocation rules, window guidance and underwriter relationship maintenance [18]. The issuance discount rate used as a proxy may therefore capture underwriter strategic pricing motives, for example to stabilize aftermarket performance or reward core investors, rather than purely compensating information asymmetry.

#### 4.4 Robustness Checks

To ensure the reliability of the results this study conducts robustness checks by replacing key variables. Patent applications and granted patents reflect different aspects of firm innovation. Application counts emphasize firms' willingness to invest in innovation and the breadth of technological deployment while grant counts reflect innovation output quality after substantive examination [19]. Although different these measures both capture innovation activity and complement each other. Grant counts reflect innovation quality while application counts capture proactive innovation activity. Accordingly, this study replaces granted patent counts with application counts to construct *Total\_patents\_app*, *Substantive\_app*, and *Strategic\_app* and re-estimates the models. The regression results show that the coefficient on *Total\_patents\_app* is 3.533 ( $p = 0.057$ ), marginally significant at the 10% level. The coefficient on *Substantive\_app* is 1.815 ( $p = 0.386$ ), not significant. The coefficient on *Strategic\_app* is 4.775 ( $p = 0.010$ ), significant and positive at the 5% level.

These results indicate that when using application counts strategic innovation maintains a robust positive effect on IPO underpricing while the effect of substantive innovation becomes insignificant. This divergence aligns with institutional features of the two patent types. Utility model and design patents have small differences between application and grant with authorization rates above 90%, so application and grant counts are highly similar. In contrast, invention patents have a larger gap between application and grant with authorization rates around 40 to 50%, so that application counts contain many items that do not survive substantive examination and thus carry more signal noise [19]. Therefore, application counts can substitute for grant counts for strategic innovation but grant counts better capture pricing effects due to technological barriers for substantive innovation. This finding further corroborates the main result that the innovation label per se is sufficient to trigger market reactions to information asymmetry, while also demonstrating that, for substantive innovation, the examination-screening information embedded in patent grant status constitutes an important source of its pricing effect.

## 5 Conclusion and Policy Implications

This study examines nonfinancial firms listed on the A-share market from 2019 to 2025, decomposing corporate innovation into three dimensions, including substantive innovation, strategic innovation, and patent citation frequency. It systematically investigates the effects and mechanisms by which heterogeneous innovation influences IPO first-day underpricing. Empirical results indicate that total patent counts, substantive innovation, strategic innovation, and the number of citations to invention patents filed prior to listing each exert a significant positive effect on IPO first-day underpricing. Although the coefficient for substantive innovation is larger in magnitude than that for strategic innovation, the difference is not statistically significant, suggesting that market participants currently have limited ability to discriminate patent quality and instead respond to innovation signaling in aggregate. In addition, investor sentiment signifi-

cantly attenuates the positive relationship between total patent volume and underpricing, and VC/PE backing similarly weakens that relationship. Conservatively set institutional offer prices do not appear to mediate the effect of total patent volume on underpricing in a statistically meaningful way.

Drawing on these findings, the study proposes the following policy recommendations. First, optimize the investor mix and cultivate professional evaluative capacity. Regulators should seek to expand the share of institutional investors and promote the participation of long horizon capital such as mutual funds and insurance funds in offline inquiry processes. Concurrently, investor education should be strengthened to shift market behavior from “new-issue speculation” and “concept chasing” toward fundamental value investing. Second, enhance disclosure and verification requirements for VC and PE information. The certification role of VC and PE can substitute for patent signals in pricing and mitigate market overreaction to low quality patents. It is recommended to strengthen mandatory disclosure obligations for VC and PE investments in the pre-IPO stage, clarify their due diligence responsibilities, and position institutional certification as an initial screening mechanism for identifying high quality innovative firms. Third, reform the offline inquiry mechanism to increase the pricing salience of patent information. One reason the intermediary channel does not function effectively is that institutional quotations are influenced by nonmarket factors and patent information is not transmitted effectively to offer prices. The introduction of independent third-party technology assessment agencies into the inquiry process is recommended, with these agencies tasked to evaluate patent portfolios of deep technology firms and to incorporate assessment results into the offline quotation reference framework, so that patent information becomes a required input for pricing. Fourth, regulate marketing practices that exploit the innovation label with prudence. The continued positive premium associated with strategic innovation indicates that utility models and design patents are being used to construct corporate image narratives. It is advisable to implement tiered supervision of patent disclosures in IPO prospectuses, require firms to distinguish explicitly between invention patents and utility model or design patents in terms of counts and proportions, and strengthen ex post accountability for inflating patent totals in ways that mislead investors.

## References

1. Li, Q., He, L., Gou, X., Ren, Y.: The registration-based IPO reform and the cost of equity capital: evidence from China. *Finance Research Letters* **67**(A), 105790 (2024). <https://doi.org/10.1016/j.frl.2024.105790>.
2. Li, W., Zheng, M.: Is it Substantive Innovation or Strategic Innovation? Impact of Macroeconomic Policies on Micro-enterprises' Innovation [In Chinese]. *Economic Research Journal* (4), 60-73 (2016). <https://cyjj.ujs.edu.cn/info/1092/2713.htm>.
3. Zhang, J.: A Literature Review on the Theory of Asymmetric Information. *Advances in Economics Management and Political Sciences* **124**(1), 183-189 (2024). <https://doi.org/10.54254/2754-1169/2024.17727>.

4. Zhang, W.: The Uncertainty of Innovation. Re-Understanding Entrepreneurship: What It Is and Why It Matters. Cambridge University Press, United Kingdom, 180-201 (2024). <https://ideas.repec.org/b/cup/cbooks/9781009453363.html>.
5. Harhoff, D., Narin, F., Scherer, F. M., Vopel, K.: Citation Frequency and the Value of Patented Innovation. Discussion Paper FS IV 97-26, Wissenschaftszentrum Berlin (1997). [https://www.researchgate.net/publication/2394562\\_Citation\\_Frequency\\_and\\_the\\_Value\\_of\\_Patented\\_Innovation](https://www.researchgate.net/publication/2394562_Citation_Frequency_and_the_Value_of_Patented_Innovation).
6. Wang, Z.: Theoretical Research on the Impact of Investor Sentiment on Asset Pricing in Behavioral Finance. *Highlights in Business Economics and Management* **67**, 309-315 (2026). <https://doi.org/10.54097/gv8nk346>.
7. Zhang, X., Zhang, W.: Information asymmetry, sentiment interactions, and asset price. *The North American Journal of Economics and Finance* **67**, 101920 (2023). <https://doi.org/10.1016/j.najef.2023.101920>.
8. Barber, B. M., Odean, T.: All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. *The Review of Financial Studies* **21**(2), 785-818 (2008). <https://doi.org/10.1093/rfs/hhm079>.
9. Connelly, B. L., Certo, S. T., Reutzel, C. R., DesJardine, M. R., Zhou, Y. S.: Signaling Theory: State of the Theory and Its Future. *Journal of Management* **51**(1), 24-61 (2024). <https://doi.org/10.1177/01492063241268459>.
10. Megginson, W. L., Weiss, K. A.: Venture capitalist certification in initial public offerings. *Journal of Finance* **46**(3), 879-903 (1991). [https://econpapers.repec.org/article/blajfinan/v\\_3a46\\_3ay\\_3a1991\\_3ai\\_3a3\\_3ap\\_3a879-903.htm](https://econpapers.repec.org/article/blajfinan/v_3a46_3ay_3a1991_3ai_3a3_3ap_3a879-903.htm).
11. Hou, J., Kuzma, A. T., Kuzma, J. R.: Winner's Curse or Adverse Selection in Online Auctions: The Role of Quality Uncertainty and Information Disclosure. *Journal of Electronic Commerce Research* **10**(3), 144-154 (2009). [https://www.researchgate.net/publication/228652745\\_Winner's\\_Curse\\_or\\_Adverse\\_Selection\\_in\\_Online\\_Auctions\\_The\\_Role\\_of\\_Quality\\_Uncertainty\\_and\\_Information\\_Disclosure](https://www.researchgate.net/publication/228652745_Winner's_Curse_or_Adverse_Selection_in_Online_Auctions_The_Role_of_Quality_Uncertainty_and_Information_Disclosure).
12. Chemmanur, T. J., Ma, P., Yu, Q.: Information production by institutions and information extraction by underwriters in hybrid IPO auctions. *Review of Corporate Finance* **5**(3-4), 291-348 (2025). <https://doi.org/10.1561/114.00000076>.
13. Wang, J., Funaki, Y., Ishikawa, R., Ogura, Y.: An experimental analysis of the IPO pricing mechanism: The case of Book-building. WINPEC Working Paper Series No. E2513 (2025). <https://www.waseda.jp/fpse/winpec/assets/uploads/2025/06/5850f3f35646a4846fcdbfda7ead684e.pdf>.
14. Zhou, X., Li, C., Mei, D.: Investor Sentiment, Sentiment Volatility, and IPO Underpricing [In Chinese]. *Statistics & Decision* (4), 120-122 (2008). [https://www.zhangqiaokeyan.com/academic-journal-cn\\_detail\\_the-sis/0201295425529.html](https://www.zhangqiaokeyan.com/academic-journal-cn_detail_the-sis/0201295425529.html).
15. Mei, D., Xu, D., Xue, N.: Analysis of Underwriters' Conservative Bias in the Bookbuilding Process and IPO Underpricing [In Chinese]. *Economic Research Guide* (3), 97-98 (2009). <https://doi.org/10.3969/j.issn.1673-291X.2009.03.046>.
16. Wen, Z., Ye, B.: Analyses of Mediating Effects: The Development of Methods and Models. *Advances in Psychological Science* **22**(5), 731-745 (2014). <https://journal.psych.ac.cn/xlkxjz/CN/Y2014/V22/I5/731>.
17. Liu, H., Peng, L., Tang, Y.: Retail Attention, Institutional Attention. *Journal of Financial and Quantitative Analysis* **58**(3), 1005-1038 (2023). <https://doi.org/10.1017/S0022109022000734>.

18. Lin, Z., Guo, X.: Why Do Chinese Companies List Overseas? An Explanation from IPO Pricing “Window Guidance” [In Chinese]. *The Journal of World Economy* (7), 33-65 (2024). <https://d.wanfangdata.com.cn/periodical/sjjj202407003>.
19. Ess, A.: Patent status monitoring - What are the possible statuses and how to check them. *PAT Office* (2023). <https://www.patoffice.de/en/blog/patent-status-monitoring-what-are-the-possible-statuses>.

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