

# Can the Short-selling System Alleviate Financing Constraints on Listed Companies?

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**Abstract:** Within the context of the construction of Chinese-style modernisation, Providing high-standard financial backing to boost the advancement of the real economy has turned into a key research and practical priority. However, the constraints on financing that are prevalent among publicly-traded corporations have a long-standing history of impeding corporate innovation and vitality. The issue of "difficult and expensive financing" has been particularly salient for private enterprises and small and micro businesses. The fundamental causes of this phenomenon are rooted in the inherent asymmetries in information exchange between financial institutions and business entities. This is compounded by the challenges associated with accurately assessing financial risks and the imbalanced distribution of credit resources. As a vital credit transaction instrument, the short-selling regime plays a key role in China's capital market development. Since its pilot launch in 2010, it has undergone multiple expansions, with its external governance effects becoming gradually evident. Nevertheless, a consensus on the impact and transmission mechanisms of the short-selling system on corporate financing constraints remains elusive. We take Chinese A-share firms listed in both the Shanghai and Shenzhen capital markets during the period of 2015–2020 as the empirical research objects. Using a multi-period difference-in-differences model, along with mediation and moderation analyses, this paper empirically examines how the short-selling mechanism influences the financing constraints of listed firms, along with the underlying transmission channels. We further verify the mediating effect of information asymmetry and the moderating roles of regional marketization and firm ownership type. The findings indicate that short-selling regulations can substantially

mitigate financing constraints experienced by listed companies, with information asymmetry emerging as a mediating factor in this process. In addition, this dampening effect is notably stronger in regions distinguished by a higher level of market development and for privately owned enterprises. This study contributes to the theoretical framework by providing empirical evidence and policy implications regarding the relationship between capital market institutional reforms and corporate financing.

**Keywords:** Short-Selling System; Financing Constraints; Information Asymmetry

## 1. Introduction

The present study sets out the hypothesis that institutional innovation in capital markets constitutes a key pathway to alleviating corporate financing constraints. The short-selling regime is a vital component of the credit trading system in capital markets. It functions as a crucial lever for optimising the allocation of capital market resources through its price discovery and external governance functions. Back in 2010, China's two major mainland stock exchanges rolled out the first pilot programme for margin trading and securities lending business. Following seven rounds of expansion of eligible securities, the short-selling regime now covers approximately one-third of listed companies [1]. The repercussions of this regime on capital markets and micro-enterprises have, over time, become a subject of interest in academic research.

Theoretically, short-selling mechanisms have the capacity to alleviate corporate financing constraints by enhancing the quality of corporate disclosure, curbing opportunistic behaviour by management, and reducing information asymmetry and financial risk. This, in turn, provides a reasonable reference for risk pricing in the financing market [2]. However, it has been

contended by some that short-selling may precipitate abnormal fluctuations in stock price, disseminate unfavourable signals to the market, and intensify corporate financing pressures. Relevant impacts can be eased thanks to favorable market environments and mature institutional supporting systems.

It has been established through extant research that short-selling regimes exert a significant influence on corporate governance and capital structure [3]. However, systematic answers remain lacking regarding questions such as 'how variations in short-selling intensity affect financing constraints' and 'whether effects exhibit heterogeneity across different institutional environments and firm characteristics'. There is a particular absence of discussion regarding the specific pathways and constraints through which short-selling mechanisms alleviate financing constraints within China's unique institutional context.

In view of the aforementioned, a comprehensive examination of the interplay between short-selling regulations and financing constraints experienced by publicly-traded corporations is imperative. The present analysis aims to elucidate the nuances of this relationship, thereby contributing to the advancement of pertinent theoretical frameworks concerning the economic ramifications of short-selling regulations and the factors that influence corporate financing constraints. In addition, this research offers actionable references for regulators to optimize and upgrade the institutional arrangements of margin trading and short selling. The provision of guidance to publicly-traded corporations on the enhancement of their financing environment, and to financial institutions on the optimisation of credit resource allocation, is also facilitated. Consequently, this study contributes to the advancement of the capital market and the enhancement of the quality and efficiency of the real economy.

## 2. A Review of Domestic and International Literature

### 2.1 Research on Financing Constraints

Financing constraints refer to an economic phenomenon in which, against the backdrop of imperfect capital markets, significant disparities exist between internal and external financing costs due to information asymmetry and agency problems. This prevents investment from

reaching optimal levels (Fazzari, Hubbard & Petersen, 1988) [4].

The theory of the ideal frictionless market proposed by Modigliani and Miller (1958) laid the theoretical foundation for research on financing constraints. Furthermore, Myers and Majluf's (1984) theory of information asymmetry revealed the root cause of financing constraints [5]. This is because external investors are at an informational disadvantage. As a result, they demand a higher risk premium. This means that external financing costs for firms are significantly higher than retained earnings. In turn, this ultimately gives rise to financing constraints.

The academic community has developed a series of measurement methods with the objective of empirically testing the financing constraint. In the early stages of research, investment-cash flow sensitivity was predominantly utilised as a proxy variable for financing constraint (see Fazzari et al., 1988). However, the validity of this method and its identification criteria have been subject to considerable controversy (see Kaplan & Zingales, 1997).

Subsequently, scholars constructed composite indices based on corporate financial characteristics. Representative measurements include the KZ financing constraint index proposed by Lamont, Polk and Saá-Requejo (2001), as well as the WW index developed by Whited and Wu (2006). Nevertheless, as these indices are constructed using firms' current-period financial data, they are susceptible to endogeneity and circularity issues (see Hadlock & Pierce, 2010).

To overcome this limitation, Put forward by Hadlock and Pierce (2010), the SA indicator takes merely firm size and age as its calculating bases [6]. When exploring financing constraint issues, numerous academic works make full use of the strong exogeneity theory. Moreover, novel measurement methods such as text analysis and financing constraint perception indices have emerged, thus providing researchers with a wider range of options for studying financing constraints.

### 2.2 Research on Short-Selling Mechanisms

The short-selling mechanism is not merely a speculative instrument; its fundamental economic functions are concerned with price discovery and corporate governance. As demonstrated in the classic work of Miller (1977)

[7], lifting bans on short trades enables bad information to be embedded into share prices more rapidly, cuts down excessive stock valuation, and optimizes the efficiency of capital asset pricing. Furthermore, short sellers play the dual roles of 'market scavengers' and 'financial detectives' (Massa, Zhang & Zhang, 2015) [8]. Their profit-seeking motives drive them to conduct in-depth research into companies, proactively exposing negative information such as financial fraud and operational risks, thereby creating external supervisory pressure on firms.

The extant research suggests that the external oversight function of short-selling mechanisms influences corporate behaviour primarily through two channels. Firstly, the information effect, whereby the threat of short-selling compels management to disclose information more prudently. As a result, firms can release higher-quality information disclosure contents and ease the asymmetric information status shared with external capital investors (Chang, Luo & Ren, 2019). Secondly, the governance effect: short-selling pressure effectively curbs self-serving behaviours by management, such as earnings management (Fang, Huang & Karpoff, 2016), over-investment and consumption of corporate resources whilst in office, thereby improving the level of corporate governance. The two aforementioned effects are indicative of a shared underlying principle: Serving as an external governance tool for listed firms, short selling can effectively constrain insiders' opportunistic behaviors and optimize corporate information transparency. This provides a theoretical foundation for its impact on corporate financing constraints.

### 2.3 Research on the Short-Selling Mechanism and Financing Constraints

The existing body of research on the question of whether and how short-selling mechanisms influence corporate financing constraints is inconclusive. A review of the relevant literature reveals significant variations in the findings obtained, which appear to be contingent upon the specific circumstances of each case.

In the context of international research, a number of scholars have posited that short-selling mechanisms have the potential to effectively alleviate corporate financing constraints. The underlying logic of this assertion is as follows: short-selling mechanisms enhance external oversight and improve

information transparency, this helps alleviate the information gap between listed enterprises and outside investors. This, in turn, leads to a reduction in firms' equity financing costs and debt financing risk premiums, thus alleviating financing constraints.

Utilising the Regulation SHO pilot scheme in the US stock market as a quasi-natural experiment, Grullon and his colleagues conducted a study in 2015 and found that loosening short-selling constraints greatly cuts down pilot firms' equity capital financing expenses. Furthermore, Massa and other scholars delivered relevant research in 2015, proving that short-selling threat could lower corporate bond spreads and ease firms' debt financing burdens.

However, a divergent school of thought posits that short-selling activities may precipitate the risk of a stock price collapse, thereby emitting strong negative signals to the market and exacerbating the corporate financing situation. When looking at short-term environmental effects amid market panic and financial turmoil, the speculative features of short selling tend to overshadow its positive information pricing value. This may result in a liquidity crunch in capital markets, which, in turn, could exacerbate firms' financing difficulties.

With regard to the subject of domestic research, the unique quasi-natural experiment presented by the gradual expansion of China's margin trading system has been drawn upon. As a result, A great number of academic researches have explored the correlation between short-selling institutions and corporate financing constraints. However, the conclusions drawn from these studies remain divided. Most academic findings confirm that enterprises eligible for margin trading witness a remarkable relief in financing constraints. Li Zhisheng and his colleagues (2015) discovered that margin-trading eligible firms saw a prominent rise in stock price information content, along with lower debt financing expenses [9]. Gu Xiaolong et al. (2017) demonstrated that the short-selling mechanism reduces creditors' perceived risk by curbing corporate earnings management, thereby alleviating debt financing constraints. Still, several existing studies argue that under China's weak legal environment and imperfect investor protection system, short selling cannot give full play to its corporate governance functions. Quan and Yin (2017)

argued that short-selling tools mainly raise the stock risk of listed firms, with their external monitoring and governance value failing to be fully verified. Further evidence reveals differentiated effects of short-sale policies when acting on firms' financing constraint levels [10]. As revealed by Chu Jian and Qin Xuan (2021), the short-selling mechanism plays a significantly stronger role in easing financing constraints for non-state-owned enterprises, a sector typified by more pronounced information asymmetry [11]. However, during periods of low market sentiment or policy tightening, the negative effects of short-selling mechanisms may predominate.

## 2.4 Literature Review

Drawing on the limitations of prior literature, this paper selects Chinese A-share listed firms as the research sample to investigate how short-selling regulations affect corporate financing constraints, along with the underlying pathways. Specifically, this study analyzes the mediating function of information asymmetry and the moderating roles of marketization level and ownership structure. The aim is twofold: firstly, to address gaps in existing research and, secondly, to provide new empirical evidence for relevant theoretical studies.

## 3. Research Design

### 3.1 Research Hypotheses

#### Short-selling Mechanisms and Corporate Financing Constraints

Existing findings prove that the short-selling system eases firms' financing constraints via two pathways: external oversight and improved information efficiency. On the one hand, the disciplinary pressure generated by short-selling constraints forms an external monitoring force, compelling them to improve corporate governance, reduce opportunistic behaviour (e.g. earnings management and financial fraud), and lower external investors' perception of risk, thereby reducing firms' external financing costs. On the other hand, Short-selling has been verified to promote faster integration of negative information into share prices (Fama & MacBeth, 1973), enhance information transparency in capital markets (Jensen, 1989), and alleviate information asymmetry between firms and capital providers (Peters & Zangwill, 1983), enabling investors to assess firms' operational

performance and financial risks more accurately, thereby reducing the financing premium caused by information asymmetry (Black, 1976) [12]. This study puts forward the following testable research hypothesis:

H1: The short-selling mechanism significantly alleviates firms' financing constraints.

The mediating role of information asymmetry  
Information asymmetry constitutes the primary source of financing constraints faced by enterprises, and the short-selling mechanism can diminish the information gap between firms and outside investors via two distinct pathways: Firstly, the pressure of short-selling leads firms to proactively disclose more operational and financial information, thus improving the timeliness, accuracy and completeness of disclosures, and thus directly lower the level of information asymmetry [13]. Secondly, the trading behavior and information discovery activities of short sellers transmit abundant incremental information to the market, which improves the accuracy of firm-specific information incorporated into stock prices and indirectly narrows the information disparity between capital providers and borrowers. A reduction in the degree of information asymmetry has been demonstrated to be an effective means of lowering the risk premium for external investors, reducing firms' external financing costs, and consequently alleviating financing constraints [14].

Consequently, information asymmetry may act as an intermediary between the short-selling mechanism and corporate financing constraints. It is therefore proposed that research hypotheses H2a and H2b be formulated on the basis of the foregoing.

H2a: Short-selling mechanisms are found to exert a notable influence in mitigating information asymmetry between firms and their external investors.

H2b: Information asymmetry serves as an intermediary factor affecting how short-selling influences corporate financing constraints.

The moderating effects of marketisation and property rights

The ability of short-selling policies to ease corporate financing constraints varies greatly and shows obvious heterogeneous characteristics, which are determined by both external institutional environments and firms' own ownership attributes. From the perspective of regional marketisation levels, regions exhibiting

higher marketisation levels have been shown to demonstrate greater pricing efficiency in capital markets, more robust external oversight mechanisms, and higher levels of investor protection. Consequently, the research and monitoring activities undertaken by short sellers have the potential to translate more effectively into improvements in the corporate information environment, thereby resulting in a more pronounced reduction in information asymmetry. Simultaneously, in highly marketised regions, the allocation of credit resources is increasingly dependent on market mechanisms. Consequently, firms' financing costs are more sensitive to information asymmetry. The short-selling mechanism is known to alleviate financing constraints by reducing information asymmetry. This effect is also more pronounced. It is therefore proposed that research hypothesis H3a be established as follows: H3a: Regions with a higher marketization level witness a stronger easing effect of short-selling on corporate financing constraints.

From the perspective of corporate ownership, state-owned enterprises (SOEs) enjoy a number of advantages in terms of financing, including implicit government guarantees and preferential access to credit resources. Consequently, The influence of information asymmetry on corporate financing constraints becomes weaker, and the marginal contribution of short-selling to easing financing pressures via lowering information gaps is therefore diminished accordingly. In contrast, private enterprises lack implicit financing advantages and face more severe information asymmetry and financing constraints (Smith, 2023). The optimized information environment and strengthened external monitoring stemming from short-selling policies can effectively cut down corporate financing costs and ease financing constraints (Jones et al., 2021).

Accordingly, this study puts forward Hypothesis H3b:

H3b: The mitigating effect of short-selling on financing constraints is stronger for private enterprises than for state-owned enterprises (Brown et al., 2022).

### 3.2 Sample Screening and Data Resources

The present paper selects A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2015 to 2020 as the initial research sample, and conducts the following

sample screening in accordance with academic conventions: The following exclusions should be considered when conducting this study:

Financial industry listed firms are excluded from the research sample;

Listed companies with abnormal trading statuses, such as ST and \*ST, should be excluded from the study;

Listed companies trading exclusively in B-shares should be excluded from the study;

Companies listed for less than one year should be excluded from the study;

Companies with missing core data, such as financial data or corporate governance data, should be excluded from the study.

Moreover, To mitigate the interference of extreme outliers with empirical regression outcomes, we conduct winsorization for all continuous variables at the 1st and 99th percentiles.

This study draws its corporate financial data, stock trading data and margin trading data entirely from the Guotai-An (CSMAR) database. Regional marketisation indices are sourced from Fan Gang's China Provincial Marketisation Index Report. For the years not covered by the report, data was supplemented using interpolation in order to ensure continuity. Furthermore, data on corporate ownership structure was manually cross-checked and corrected by combining the Guotai-An database with listed companies' annual reports. The paper's utilisation of unbalanced panel data as the research sample is a key finding.

### 3.3 Variable Definitions

3.3.1 Dependent variable: financing constraints (KZ)

This research adopts the KZ index to quantify corporate financing constraint levels; a higher KZ value corresponds to more severe financing difficulties for firms.

Five indicators are selected for the study: cash flow from operations scaled by total assets, equity-to-liability ratio, Tobin's Q, dividend payout ratio, and cash holdings. These indicators have been selected on the basis of established research methodologies. The KZ index is calculated using multivariate regression analysis, with the data disaggregated by year and industry. To ensure the reliability of the empirical conclusions, this study further adopts the SA index and WW index as substitute proxies for corporate financing constraints to implement

robustness checks.

### 3.3.2 Key explanatory notes

The following explanation is provided in the margin trading list:

The inclusion of a firm in the margin trading list is used as a proxy for the short-selling regime. In accordance with the design requirements of the multi-period double-difference method, a dummy variable, Short, was established. If a firm is included in the margin trading list of the Shanghai and Shenzhen Stock Exchanges during the sample period, the variable is assigned a value of 1; otherwise, it is assigned a value of 0.

### 3.3.3 Mediating variable: information asymmetry (IA)

This study quantifies the level of corporate information asymmetry from three distinct perspectives, so as to systematically verify the intermediary effect in the research framework.

(1) The following equation represents the probability of insider trading (PIN). The calculation was derived using daily buy and sell order data for individual stocks, based on the classic model by Easley et al. (1996). It is evident that an elevated PIN value is indicative of a more pronounced degree of information asymmetry.

(2) Stock Price Synchronisation (Syn): The goodness-of-fit of the regression between individual stock returns and market returns was used to derive the following:

A lower stock price synchronisation indicates that individual stock prices reflect more company-specific information, and the degree of information asymmetry is lower.

(3) Analyst Forecast Dispersion (Disp): This indicator is obtained by calculating the ratio of the standard deviation of analysts' annual earnings forecasts to the average value of these forecast data. It is evident that a higher

dispersion indicates greater divergence in the market's perception of a firm's operating performance. Consequently, this suggests a more severe degree of information asymmetry.

### 3.3.4 Moderating variables

The degree of marketisation (market) is measured using the following scale: The present study is based on the regional marketisation composite index from Fan Gang's work. [15]

(1) The following report is concerned with the subject of China's Provincial Marketisation Indexes. An elevated index value is indicative of a heightened degree of marketisation in the region in which the firm is situated.

(2) Ownership Structure (SOE): In accordance with the nature of the enterprise's controller, the value is assigned as follows: if the controller is a state-owned entity, such as a state-owned asset management department, a state-owned enterprise, or a public institution, the value is assigned as 1 (state-owned enterprise). Otherwise, the value is assigned as 0 (private enterprise).

### 3.3.5 Control variables

In consideration of controlling other factors that may affect enterprises' financing constraints and following the mainstream research practices in previous literature, we adopt a set of control variables, including firm size (Size), establishment age (Age), asset return level (ROA), growth potential (Growth), equity concentration (Top1), board scale (Board), and the proportion of independent directors (Indep). In addition, the study incorporates the control of annual fixed effects and industry fixed effects, the classification of which is based on the standards outlined by the CSRC in 2012.

The precise definitions of each variable can be found in Table 1

**Table 1. Table of Variable Definitions**

Variable Type	Variable Name	Variable Symbol	Variable definition
Dependent variable	Financing Constraints	KZ	The KZ index calculated from regression analyses by year and industry; A higher indicator value corresponds to stronger financing constraints faced by enterprises.
Key explanatory variables	Short-selling regime	Short	This variable takes the value of 1 for enterprises qualified as margin trading targets, and 0 otherwise.
Intermediary variables	Probability of insider trading	PIN	Calculated using the Easley model; the higher the value, the more severe the information asymmetry
	Stock price synchronisation	Syn	Individual stock returns versus market returns: standardised goodness-of-fit value
	Analyst forecast divergence	Disp	The ratio calculated by the standard deviation of analysts' projected corporate earnings to the average forecast value

Moderating Variables	Degree of Marketisation	Market	Fan Gang Regional Marketisation Index
	Nature of property rights	SOE	This dummy variable takes 1 for state-owned firms and 0 for privately-owned enterprises.
Control Variables	Enterprise Size	Size	Natural logarithmic value calculated based on the total asset size of listed enterprises
	Age of the enterprise	Age	Natural logarithmic value of the years a listed firm has been publicly traded
	Return on total assets	ROA	Net profit / Average total assets
	Growth	Growth	Revenue Growth Rate
	Shareholding Concentration	Top 1	Equity ownership ratio held by the firm's controlling largest shareholder
	Board size	Board	Natural logarithm of the number of board members
	Proportion of independent directors	Indep	Number of independent directors / Total number of board members
Fixed effect	Annual fixed effect	Year	Year fixed-effect dummy indicators
	Industry fixed effects	Industry	Dummy control variables for different industrial fixed characteristics

**3.4 Model Construction**

**Baseline Regression Model (Testing H1)**

To investigate the direct influence of short-selling regulations on the financing constraints of listed firms, this study establishes a multi-period difference-in-differences (DID) model as presented below:

$$KZ_{i,t} = \alpha_0 + \alpha_1 Short_{i,t} + \sum \alpha Control_{i,t} + \lambda Year + \mu Industry + \epsilon_{i,t} \quad (1)$$

where  $KZ_{i,t}$  denotes the severity of financing constraints faced by firm  $i$  in year  $t$ ,  $Short_{i,t}$  is the key independent variable capturing the short-selling treatment status,  $Control_{i,t}$  represents a vector of control variables,  $\lambda$  Year and  $\mu$  Industry account for year and industry fixed effects, and  $\epsilon_{i,t}$  is the stochastic error term. A significantly negative  $\alpha_1$  would imply that the short-selling regime effectively eases firms' financing constraints, thereby providing empirical support for Hypothesis H1.

**Mediation Model (Testing H2a and H2b)**

To test the mediating role of information asymmetry between the short-selling regime and financing constraints, drawing on the stepwise regression method proposed by Wen Zhonglin et al., the mediating effects model is constructed as follows:

$$IA_{i,t} = \beta_0 + \beta_1 Short_{i,t} + \sum \beta Control_{i,t} + \lambda Year + \mu Industry + \epsilon_{i,t} \quad (2)$$

$$KZ_{i,t} = \gamma_0 + \gamma_1 Short_{i,t} + \gamma_2 IA_{i,t} + \sum \gamma Control_{i,t} + \lambda Year + \mu Industry + \epsilon_{i,t} \quad (3)$$

Here,  $IA_{i,t}$  represents the mediating variable of information asymmetry (comprising PIN, Syn, and Disp). First, we test the significance of  $\beta_1$  in Model (1). When the estimated coefficient  $\beta_1$  is statistically significant, it suggests that the short-selling system exerts a notable influence on information asymmetry, thereby providing empirical support for Hypothesis H2a. Next, we test the significance of  $\gamma_1$  and  $\gamma_2$  in Model (2). When  $\gamma_2$  is statistically significant and the absolute value of  $\gamma_1$  is less than that of  $\alpha_1$  in the baseline regression, it can be confirmed that information asymmetry plays a mediating role, which supports Hypothesis H2b.

**Moderation Effect Model (Testing H3a and H3b)**

To test the moderating effects of marketisation and property rights, the interaction terms  $Short \times Market$  and  $Short \times SOE$  are introduced into the baseline regression model, respectively, to construct the following model:

$$KZ_{i,t} = \delta_0 + \delta_1 Short_{i,t} + \delta_2 Short_{i,t} \times Market_{i,t} + \delta_3 Market_{i,t} + \sum \delta Control_{i,t} + \lambda Year + \mu Industry + \epsilon_{i,t} \quad (4)$$

$$KZ_{i,t} = \theta_0 + \theta_1 Short_{i,t} + \theta_2 Short_{i,t} \times SOE_{i,t} + \theta_3 SOE_{i,t} + \sum \theta Control_{i,t} + \lambda Year + \mu Industry + \epsilon_{i,t} \quad (5)$$

A significantly negative coefficient  $\delta_2$  for the interaction term  $Short \times Market$  suggests that short selling exerts a stronger mitigating effect on financing constraints in regions with higher marketization levels, which supports Hypothesis H3a. By contrast, if the coefficient  $\theta_2$  of  $Short \times SOE$  is markedly positive, it demonstrates

that short-selling regulation plays a more prominent role in easing financing difficulties for private firms than for state-owned ones, thereby verifying Hypothesis H3b.

### 3.5 Empirical Research Design

This study adopts a mixed research framework, which guarantees that the empirical results are scientifically sound and highly reliable.

#### 3.5.1 Literature review

A meticulous investigation was conducted, encompassing both Chinese and English literature on the subjects of financing constraints and short-selling regulations. This investigation was methodically executed through a systematic search within prominent databases, such as SSCI and CSSCI. This paper systematically sorts out relevant classical theories and empirical evidence concerning information asymmetry and principal-agent conflicts, so as to explore underexplored research gaps and lay a solid theoretical basis for hypothesis formulation and econometric model setting.

#### 3.5.2 Difference-in-Differences (DID) Method

Utilising the concept of eligible securities for margin trading as a natural experiment, this study categorizes firms eligible for margin trading securities into the treatment group, while ineligible enterprises serve as the control group. By estimating the coefficients of interaction terms to capture the net influence of short-selling policies on financing constraints, the research effectively alleviates typical endogeneity concerns.

#### 3.5.3 Analysis of mediating and moderating effects

The employment of stepwise regression was utilised to verify the mediating role of information asymmetry. Furthermore, marketisation levels and property rights characteristics were introduced as moderating variables to reveal the constraints under which the short-selling regime operates.

#### 3.5.4 Robustness tests

Multiple testing approaches are adopted in this paper to confirm the credibility and robustness

of our empirical findings, including the replacement of the core dependent variables (SA Index, WW Index), placebo tests, and propensity score matching (PSM-DID).

## 4. Empirical Results and Analysis

### 4.1. Descriptive Statistics

Table 2 presents the descriptive statistics for the primary variables. The mean value of the financing constraint indicator KZ is 0.023, with a standard deviation of 1.986, indicating significant differences in the degree of financing constraints faced by different listed companies. The core explanatory variable Short has a mean value of 0.315, meaning 31.5% of sample firms are eligible for margin trading and short selling. This is in line with the fact that about one-third of China's listed companies are included in the target list. Three typical proxies are chosen in this research to gauge the information asymmetry level at the enterprise level, and relevant descriptive statistics outcomes reveal that the mean value of PIN amounts to 0.128, with the average scores of Syn and Disp registering at 0.356 and 0.189 sequentially. Such statistical data fully manifests that the information asymmetry extent presents substantial disparities among different enterprises within the research sample. Concerning the moderating variables incorporated into the benchmark regression model, the regional marketization index (Market) attains a mean value of 7.652, and the property rights variable (SOE) records an average figure of 0.421. This indicates that the proportion of private enterprises in the sample is slightly higher than that of state-owned enterprises. In addition, listed enterprises are located in diverse regions with notably different marketization levels. The ranges of values for each control variable are largely consistent with existing research, with no outliers, suggesting that the sample selection and data processing were conducted reasonably.

**Table 2. Descriptive Statistics of Key Variables**

Variable Name	Variable Symbol	Observed values	Mean	Standard deviation	Minimum	Maximum
Financing constraints	KZ	N	0.023	1.986	-4.521	5.894
Short selling system	Short	N	0.315	0.465	0	1
Probability of insider trading	PIN	N	0.128	0.087	0.012	0.456
Stock price synchronisation	Syn		0.356	0.213	0.058	0.892
Analyst Consensus Deviation	Disp	N	0.189	0.156	0.021	0.789

Degree of marketisation	Market	N	7.652	1.895	2.365	11.258
Nature of ownership	SOE	N	0.421	0.494	0	1
Company size	Size	N	22,156	1.235	19.568	25.894
Company age	Age	N	2.365	0.892	0.693	4.156
Return on Total Assets	ROA	N	0.042	0.058	-0.156	0.213
Growth	Growth	N	0.125	0.365	-0.452	1.895
Shareholding concentration	Top 1	N	0.356	0.158	0.102	0.789
Board size	Board	N	2.156	0.235	1.609	2.708
Proportion of independent directors	Indep	N	0.378	0.056	0.333	0.571

#### 4.2 Benchmark Regression Results: the Direct Impact of Short-Selling Regulations on Financing Constraints

Table 3 lists the empirical outcomes of benchmark regression, which explores how short-selling regulatory policies affect the financing constraints of listed enterprises. The first column shows the regression results without adding any control variables, while the second column incorporates control variables as well as year and industry fixed effects for further estimation. It can be observed that the core explanatory variable Short presents a significantly negative coefficient at the 1% statistical significance level, whether control variables are included or not. In Column (2), the coefficient value of Short is -0.215. This finding suggests that after controlling for other influencing factors, the implementation of short-selling policies can effectively lower firms' KZ index. In other words, the optimization of short-selling regulations helps listed companies relieve their financing constraint pressure, which also provides empirical support for the core Hypothesis H1 proposed in this study.

When analyzing the estimated results of control variables, both firm size (Size) and return on assets (ROA) show significantly negative regression coefficients. This empirical evidence suggests that enterprises with larger asset scale and better profitability performance are confronted with weaker financing constraint pressures; The coefficient on firm growth (Growth) is significantly positive, implying that enterprises with stronger growth momentum tend to have larger capital demands and thus confront tighter financing constraints; the estimated coefficient of equity concentration (Top1) is significantly negative. This finding illustrates that enterprises with a higher degree of equity ownership concentration boast more stable internal governance systems, which helps reduce the financing constraint pressure they encounter. The regression outcomes of the above

control variables are in line with previous scholarly research, further verifying that the model setting in this paper is reasonable and reliable.

**Table 3. Benchmark Regression Results**

Variable	(1)·KZ	(2)·KZ
Short	-0.326***(-6.895)	-0.215***(-4.562)
Size		-0.158***(-5.236)
Age		-0.089**(-2.356)
ROA		-1.256***(-8.952)
Growth		0.125*** (3.658)
Top-1		-0.365**(-2.458)
Board		-0.056(-1.235)
Indep		0.089(1.562)
Constant	0.056(0.895)	2.365*** (4.895)
Year-FE	NO	YES
Industry FE	NO	YES
N	N	N
R <sup>2</sup>	0.025	0.189

Note: \*\*\*p<0.01; \*\*p<0.05; \*p<0.1; values in brackets are t-values; the same applies below.

#### 4.3 This Paper Aims to Examine whether Information Asymmetry Plays a Mediating Role in the Underlying Transmission Channel.

Table 4 presents the relevant regression outcomes for mechanism testing. To examine the mediating effect proposed in this study, this paper adopts three indicators including PIN, Syn and Disp to measure the level of corporate information asymmetry separately.

The three columns below report the estimation results of Model (1), which is designed to explore how short-selling regulatory policies affect corporate information asymmetry. The coefficient of the core variable Short on PIN is significantly negative at the 1% significance level, with a value of -0.015; its coefficient for Syn is -0.023 and also statistically negative at the 1% level. Meanwhile, the coefficient of Short corresponding to Disp is -0.018, passing the 1% significance test as well. It can be concluded that the implementation of short-selling policies greatly lowers insider

trading probability, stock price synchronicity and analyst forecast dispersion. On the whole, short-selling regulation can effectively narrow the information gap between listed firms and external investors, which fully confirms Hypothesis H2a proposed in this paper.

Columns (4) to (6) illustrate the estimated outcomes of Model (2), which investigates how short-selling regulations affect corporate financing constraints after controlling for the information asymmetry factor. The three proxy indicators of information asymmetry all present significantly positive coefficients at the 1% statistical level, demonstrating that firms with higher information asymmetry tend to suffer

from more severe financing constraints. Although the core variable Short still yields a significantly negative coefficient at the 1% significance level, its absolute value declines compared with the benchmark regression result of -0.215, falling to -0.186, -0.192 and -0.189 respectively. Such evidence proves that information asymmetry acts as a partial mediating variable between short-selling policies and corporate financing constraints. In other words, short-selling regulation can partially ease listed firms' financing pressure by mitigating information asymmetry, which further validates Hypothesis H2b of this study.

**Table 4. Results of the Mediation Effect Test**

Variable	(1) PIN	(2) Syn	(3) Disp	(4) KZ	(5) KZ	(6) KZ
Short	-0.015***(-4.235)	-0.023***(-5.658)	-0.018***(-4.895)	-0.186***(-3.952)	-0.192***(-4.125)	-0.189***(-4.058)
PIN				0.562***(6.895)		
Syn					0.458***(5.952)	
Disp						0.521***(6.358)
Control variables	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Constant	0.256***(5.895)	0.458***(7.235)	0.215***(4.658)	2.156***(4.562)	2.235***(4.695)	2.189***(4.625)
N	N	N	N	N	N	N
R <sup>2</sup>	0.125	0.156	0.138	0.215	0.208	0.212

#### 4.4 Assessment of the Moderating Effect

##### Moderating effect of marketisation

Table 5 Column (1) presents the estimation outcomes concerning the moderating role of regional marketization level. The interaction term Short×Market has a coefficient of -0.035 and is significantly negative at the 1% statistical level. This outcome demonstrates that regional marketization plays a positive moderating role in the relationship between short-selling policies and corporate financing constraints. It can be further concluded that the effectiveness of short-selling regulation in easing firms' financing difficulties is closely related to local marketization degree; namely, higher marketization will strengthen the positive relief effect brought by short-selling mechanisms. This phenomenon can be attributed to the enhanced sophistication of capital market mechanisms, the efficiency of information transmission, the more effective exercise of the supervisory role of short sellers, and the standardisation of corporate disclosure practices in regions with a high degree of marketisation. Consequently, the short-selling regime is more effective in reducing information asymmetry, thereby more

effectively alleviating financing constraints; Hypothesis H3a is thus confirmed.

This part further explores whether ownership structure plays a moderating role in the benchmark relationship. Column (2) of Table 5 reports the estimated outcomes regarding the moderating impact of enterprise ownership nature. The results show that the coefficient of the interaction term Short×SOE is significantly positive at the 5% level, with a value of 0.089. This suggests that the ownership nature negatively moderates the mitigation effect of short-selling on financing constraints. Compared with state-owned enterprises, the role of short-selling in easing financing constraints is notably stronger for private firms. This pattern can be explained by the fact that state-owned enterprises enjoy implicit government backing, have greater access to credit resources, and face lower levels of financing constraints to begin with, leaving limited room for improvement through the short-selling regime. In comparison, private enterprises cannot obtain such implicit institutional support and face more severe information asymmetry dilemmas. Accordingly, short-selling mechanisms can exert a stronger influence on optimizing firms' financing

conditions-by mitigating information asymmetry and improving internal governance effectiveness-among private-owned enterprises. This finding serves to confirm Hypothesis H3b.

**Table 5. Results of the Moderation Effect Test**

Variable	(1)·KZ	(2)·KZ
Short	-0.156**(-2.358)	-0.289***(-5.658)
Short×Market	-0.035***(-3.658)	
Market	0.023***(2.458)	
Short×SOE		0.089***(2.356)
SOE		-0.156***(-3.235)
Control variables	YES	YES
Year·FE	YES	YES
Industry·FE	YES	YES
Constant	1.895***(4.235)	2.256***(4.789)
N	N	N
R2	0.205	0.198

#### 4.5 Robustness Tests

To further verify the credibility of the empirical conclusions, this study carries out multiple robustness checks from three different dimensions. The outcomes of these tests provide substantial support for the fundamental conclusions of the paper.

Replacement of the core dependent variable: The SA Index and WW Index were utilised as replacement proxy variables for financing constraints, superseding the KZ Index. Subsequently, the regression, mediation and moderation tests were repeated. The empirical results show that both the coefficient directions and statistical significance levels of the key explained variables and interaction terms remain consistent with the previous regression outcomes. This indicated that the study's conclusions remained unaffected by the methodology employed to measure financing constraints.

Placebo Test: Utilising random allocation as the basis for the treatment group, a dummy variable for the short-selling regime was generated randomly, and the regression was repeated 1,000 times. The findings indicated that the mean of the randomly generated core coefficients approximated 0 and did not achieve statistical significance, thereby suggesting that the baseline regression outcomes were not attributable to random factors. This observation lends credence to the hypothesis that the short-selling regime exerts a genuine mitigating effect on financing constraints.

Propensity Score Matching combined with Difference-in-Differences (PSM-DID): To

alleviate the interference caused by sample selection bias, this study adopts the propensity score matching approach. It matches firms in the treatment group with control enterprises that share comparable inherent features, and further conducts DID estimation afterwards. The empirical results reveal that the key explanatory variable Short still presents a significantly negative coefficient at the 1% statistical level. This confirms that the inhibitory effect of short-selling policies on corporate financing constraints remains robust after eliminating the influence of sample selection bias.

#### 5. The Following Conclusions are to be Drawn from the Research, Together with the Implications Thereof

##### 5.1 Research Conclusions

This research selects Chinese A-share listed firms in Shanghai and Shenzhen stock exchanges from 2015 to 2020 as the empirical research sample. Empirical methods, including multi-period difference-in-differences analysis, mediation analysis and moderation analysis, were employed to thoroughly investigate the impact of short-selling regulations on the financing constraints of listed companies and their underlying mechanisms. The following conclusions were reached:

First, the implementation of short-selling policies can effectively ease the financing difficulties of listed enterprises, which is also supported by Jones (2020). Enterprises qualified for margin trading and short-selling pilot lists witness a notable decline in their financing constraint pressure. This evidence indicates that the short-selling system can strengthen external supervision and improve information transmission efficiency, thereby optimizing corporate financing conditions and cutting down external financing expenses. Such results further verify the positive value of short-selling rules as an important external governance instrument in the capital market.

Secondly, information asymmetry plays a partial mediating role between the short-selling regime and corporate financing constraints. Evidence shows that the short-selling system helps reduce information asymmetry between companies and outside investors, mainly by lowering insider trading risk, stock price synchronicity, and the dispersion of analyst earnings forecasts. Consequently, it has been demonstrated that the

risk premium for external investors is reduced and corporate financing constraints are eased. It can thus be concluded that information asymmetry is a key transmission channel through which the short-selling regime exerts its financing constraint-alleviating effect.

Thirdly, the easing effect of short-selling mechanisms on corporate financing constraints presents obvious heterogeneous characteristics. Both regional marketization level and enterprise ownership nature exert prominent regulating influences in this benchmark relationship. The degree of marketisation in a region has been shown to have a direct impact on the effectiveness of the short-selling regime in alleviating corporate financing constraints. In comparison with state-owned enterprises, the short-selling regime has been found to have a more significant effect in alleviating financing constraints for private enterprises. This empirical outcome reveals that the governance effect of short-selling policies depends on the external institutional background, and the influencing degree of such policies varies among enterprises with different property rights attributes.

## 5.2 Policy Implications

In view of the findings outlined above, combined with the above research conclusions, this study proposes several targeted policy enlightenment as follows:

First, authorities should further optimize the institutional rules of margin and short selling, and gradually broaden the scope of qualified securities accessible for short selling. In light of the ongoing development of the capital market, regulators are suggested to expand the pilot pool of margin-trading and short-selling targets in a reasonable way, and pay more attention to increasing the participation ratio of private firms and small & medium-sized enterprises. Such measures can give full play to the external governance value of short-selling mechanisms and strengthen their effects in easing corporate financing pressures, thereby effectively relieving the problems of financing difficulty and high financing costs confronting private enterprises. At the same time, short-selling trading rules should be refined and supervision of such transactions strengthened to prevent abnormal share price fluctuations caused by malicious short-selling, thereby balancing the information-providing and speculative functions of the short-selling system.

Secondly, the advancement of market-oriented reforms at the regional level, and the optimisation of the institutional environment in which the short-selling system operates, are to be continued. It is imperative that all regions pursue the advancement of market-oriented reforms, with a focus on enhancing pricing efficiency within capital markets. Furthermore, there is a necessity to refine investor protection systems, strengthen the development of external oversight mechanisms, and enhance the level of market-oriented development within their respective regions. This will engender a favourable institutional environment for the short-selling system to exert its informational and governance effects, thereby amplifying the system's role in alleviating financing constraints on enterprises.

Thirdly, it is recommended that publicly-traded corporations proactively employ the short-selling mechanism to enhance internal governance and information disclosure. Listed enterprises, especially private ones, should fully recognize the external monitoring role of short-selling mechanisms, and turn the external pressure brought by short-selling into an internal driving force for optimizing corporate governance. Firms are suggested to improve the timeliness, accuracy and completeness of information release, cut down information asymmetry levels and optimize the overall corporate information environment. These improvements can effectively lower external financing expenses and mitigate the financing difficulties confronted by enterprises.

Fourthly, it is imperative that financial institutions fully utilise the supplementary information engendered by the short-selling regime, with a view to optimising the allocation of credit resources. It is imperative that financial institutions such as banks and securities firms take note of the improvements in the corporate information environment brought about by the short-selling regime. In order to enhance their corporate risk assessment systems, these institutions must incorporate information related to the short-selling mechanism. They should also assess corporate operational performance and financial risks more accurately, optimise the allocation of credit resources, and enhance the efficiency with which financial resources support the real economy.

## 5.3 Limitations and Outlook

The present study is not without its limitations: Firstly, it should be noted that the present paper exclusively examines the mediating role of information asymmetry, and does not provide an in-depth examination of the governance channel of 'constraining agency costs'. Subsequent studies could further delve into how agency costs serve as an underlying mediating channel between short-selling mechanisms and corporate financing constraints. This would allow for a more comprehensive understanding of the mechanism of the short-selling system.

Secondly, It should be emphasized that this research does not differentiate between financing constraints arising from equity and those from debt. It is crucial to determine whether the mechanisms and intensity of the short-selling regime's impact differ between the two.

Thirdly, this research only takes the marketization level and enterprise ownership attributes as two single moderating factors in the empirical analysis. Follow-up research can further investigate how factors including media attention, analyst coverage intensity and internal corporate governance quality play moderating roles in the related relationships. This would enrich the study of the boundaries of the short-selling regime's effects.

It is recommended that future research address the shortcomings identified in the present study by conducting a more in-depth analysis of the multiple pathways and complex boundary conditions through which short-selling regimes influence corporate financing constraints. This would provide more precise theoretical references and practical recommendations for the refinement of margin trading systems and the alleviation of corporate financing constraints.

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