

Study of the Impact of Annual Report Text Tone on Corporate Financing Constraints

Mingjie Wu

School of economic & management, Northeast Agriculture University, Heilongjiang 150000, China
wmeejie@163.com

Abstract. Based on the incremental information theory, this paper examines the impact of annual report text tone on corporate financing constraints using a fixed-effects model with a sample of listed Chinese A-share enterprises in Shanghai and Shenzhen from 2008 to 2021. The findings show that positive annual report text tone can effectively alleviate firms' financing constraints, which remains robust after considering the self-selection problem of the model, omitted variables and the lagged effects of the independent variables. Further, the paper analyses the mediating and moderating effects of the relationship between the tone of annual report texts and corporate financing constraints. For the mechanism analysis, the paper examines the mechanism role of media attention. In terms of moderating effects, two macro-level variables, namely the level of regional economic development and the quality of the institutional environment; one meso-level variable, industry concentration; and three micro-level variables, namely the quality of internal control, equity structure and life cycle, are selected for analysis. The findings obtained from this paper have implications for the expansion of effective disclosure of annual reports by companies and for investors' proper understanding of the role of incremental textual information in annual reports for investment decisions.

Keywords: Annual Report Text Tone; Financing Constraints; Media Attention.

1. Introduction

Since 2013, the Shanghai Stock Exchange and Shenzhen Stock Exchange have issued 54 consecutive guidelines on information disclosure in the industry, including *the Guidelines on the Format of Information Disclosure by Companies Issuing Public Securities in relation to Content No. 2*, aiming to further improve the disclosure system and norms for listed companies and reduce internal and external information asymmetry. Information asymmetry is a fundamental cause of financing constraints, and expanding information disclosure is an effective way to reduce information asymmetry [1]. In China's high contextual communication, accounting information dissemination is highly dependent on the environment, with characteristics such as implicit and implicit, internal and external differentiation and high commitment. As textual information other than financial report data, the text of annual report has rich connotation and higher research value different from structured financial figures, and has an important role in expanding information disclosure, further reducing information asymmetry and alleviating financing constraints [2].

With the development of big data and text mining technology in recent years, the use of natural language processing to analyze annual report text information has become a research hotspot and is increasingly valued by investors. Among them, positive or negative tone, is one of the most basic and important features of textual information [3]. Regarding annual report text tone, most existing studies focus on the complementary effect of annual report text tone as an information text manipulation tool to earnings report numerical manipulation tools such as surplus management [4] or analyse the impact of external regulatory inquiries on management tone management [5]; for financing constraints, most of the existing literature analyses its economic consequences, i.e. how financing For financing constraints, most of the existing literature analyses the economic consequences, i.e. how the mitigation of financing constraints affects corporate performance [6] and enhances corporate share price and market capitalisation [7], but few scholars have specifically analysed the mechanism of the influence of annual report text tone on corporate financing constraints. In view of this, this paper applies sentiment analysis to annual report texts to measure disclosure tone and asks the first research

question, namely, does annual report text tone moderate or exacerbate the impact on financing constraints? In the context of capital markets' "listen and listen" communication, what kind of signalling intermediaries are at play, whether they are information media or otherwise? This is the second question of interest in this paper. Does the tone of the annual report affect the financing constraints differently for firms at different macro, meso and micro levels? This is the third question of interest in this paper.

Compared with the existing literature, this paper attempts to contribute in the following aspects: (1) the existing literature measures annual report texts from a lexical approach and proves that annual report readability can increase firm value by improving financing constraints, but focuses more on the back-end economic consequences, while this paper analyses from a lexical tone approach how exactly the heuristic information under the hidden linguistic sentiment behind annual report texts positively or negatively affects firm financing constraints; (2) from incremental information theory, media attention is used as a mediating variable to discover its partial mediating role for private firms and to analyse the reasons for the failure of the mediation mechanism for state-owned enterprises. (3) Further, this paper also conducts a heterogeneity analysis at three levels: macroeconomic environment, industry and firm, and examines in detail the differences in the impact of annual report text tone on financing constraints under different scenarios, deepening the study of the interaction mechanism between the two; (4) At the same time, this paper uses various methods such as instrumental variables, systematic GMM, Heckman regression and PSM to conduct robustness tests and deal with relevant endogeneity issues.

The subsequent parts of the paper are organised as follows: Part II contains theoretical analysis and research hypotheses; Part III contains data description, variable selection and econometric model setting; Part IV contains analysis of empirical results, endogeneity treatment and robustness testing; Part V contains mechanism testing and heterogeneity analysis; and Part VI contains conclusions and implications.

2. Theoretical Analysis and Research Hypothesis

2.1 Studies Related to Financing Constraints

The financing constraint [8] is a constraint that prevents firms from investing at an optimal level due to imperfect markets, imperfect substitution between internal and external financing, and a high premium on external financing, which makes them more dependent on internal funding, with the typical consequence of significantly altering the risk and return match of the firm's investment compared to the situation in a perfect market. It combines the risk premium of investing in the firm [9] with the cost and difficulty of equity and debt financing under the current capital structure. The prevailing measure of financing constraints is the sensitivity of investment to cash flows [8, 10], but cash flows contain information other than financing constraints (e.g. investment opportunities), and their sensitivity is easily amplified [11], thus changing the positive and negative direction of investment sensitivity to cash flows. The conclusions are not uniform. Second is the single-indicator method, which only selects a single financial indicator enterprise size, interest coverage multiple and bond rating to measure financing constraints, with obvious limitations and less use. The third is the comprehensive index quantification method, which mainly includes the *KZ index* [10], *WW index* [12], *SA index* [13], and *FC index* [14], which are obtained by measuring multiple financial indicators to comprehensively measure the specific financing status of enterprises. situation and overcome the drawbacks of single indicators.

The main factors influencing the financing constraint are the following: first, the size of the company's assets [15] and the time to go public [16], the larger the size of different companies and the longer they have been listed, the more relevant operational and creditworthiness information they can provide and the lower the financing cost; second, the firm's resource perspective, such as introducing government subsidies [17], introducing [18], increasing the shareholding of institutional investors [19], and increasing the proportion of bankers as company directors [20], can effectively

reduce the difficulty of obtaining external financing and reduce the cost of capital sought by investors; third, the information factor, from a third-party perspective, the higher the attention of analysts [21] and an unqualified opinion in the external audit report [22], the lower the financing constraint; from the perspective of the quality of the company's own information disclosure, the higher the robustness of accounting information [14] and the more readable the annual report [23], the lower the financing constraint.

2.2 Annual Report Text Intonation-related Studies

Annual report text tone refers to the textual analysis and sentiment measurement of the publicly disclosed textual information of annual reports of listed companies, and the textual analysis is conducted to calculate the net tone as positive or negative through the financial dictionary's sentiment definition of words. It is mainly defined through the Loughran and McDonald dictionary [24] (hereafter referred to as LM dictionary) and the NTUSD Taiwan University Chinese Affective Polarity Dictionary (Huajie Wang and Kemin Wang, 2018). It is measured in two ways, either as the ratio of the difference between the number of positive words and the number of negative words to the total number of words in the annual report, or as the ratio of the difference between the number of positive words and the number of negative words to the sum of

There are two main factors influencing the tone of the annual report text: first, corporate surplus management [4], and correlation tests have been conducted to show that accrual surplus management shows a significant positive correlation with the tone of the annual report, i.e. positive surplus management corresponds to a positive tone and negative surplus management corresponds to a negative tone, in the sense that the tone of the annual report text actually becomes a kind of cooperation and cover for surplus management behaviour manipulative tool and complementary effect. Secondly, external regulation. Non-punitive regulation of financial reporting inquiry letters can improve the accuracy of earnings forecasts and the quality of textual information [25] and discourage management from optimistic tone manipulation.

There are two main views on the role of annual report text tone in corporate information disclosure. One is the incremental information theory [26], which argues that management can objectively use its narrative discretion to provide investors with incremental information and mitigate internal and external information asymmetries through signalling-related intermediaries, thus effectively aiding investment decisions. Where signalling [27] refers to the existence of information asymmetry in imperfect capital markets where the party with the superior information emits a signal through some economic action to tell the party with the inferior information its true value. And for a type of information of the same nature, there exists a lower cost for one part of the population to transmit that type of information to the other part, thus causing the information-disadvantaged party to believe that type of information. Most of the early literature has confirmed that management tone in management discussion and analysis (MD&A), prospectuses, listing announcements, takeover reports, quarterly earnings announcements and other disclosures of listed companies have predictive power for the future performance of the company and that the market will respond to qualitative information in the text [28, 29]. The more positive the tone of the annual report text, the more positive it is. Also, the more positive the tone of the annual report text, the lower the probability of issuing a non-standard audit opinion [30] and the lower the audit input and cost [31].

Second, the impression management doctrine [32] suggests that management will cover up bad news and announce good news through strategic disclosure, which is essentially a textual manipulation tactic and opportunistic behaviour. The management's speculative self-interest in upward "speculation" on the tone of the text to raise the share price and then sell it for profit generates a lot of reverse insider trading behaviour [3], which also leads to the risk of share price collapse [33].

2.3 Research on the Tone of Annual Report Text in Relation to Financing Constraints

The existing literature has rarely developed a systematic study on the relationship between the tone of annual report texts and financing constraints. When a higher proportion of uncertain words and

weak sentiment words appear in annual reports [34], it leads to difficulties for external creditors, such as banks, to assess the risk characteristics of the firm, bringing about higher borrowing costs and more restrictive covenants. And the riskier keywords in the annual report [35], the lower the bank lending rate. Zhao Yuliang [36] analyses the positive effect of tone from the perspective of financing costs and finds that the net tone of annual reports is positively related to the size of debt financing and inversely related to the cost of corporate financing.

Therefore, the following research hypothesis is proposed in this paper:

H1: The more positive the tone of the text of the annual report, the lower the financing constraints of the company.

Based on the incremental information theory, this paper analyses the impact of the textual tone of annual reports on corporate financing constraints as follows: as external creditors and shareholders are unable to obtain true and accurate information about the firm, and are also unable to discern and judge the information provided by the firm, in order to compensate for the additional risks arising from information asymmetry, they accordingly demand additional risk premiums from the firm, resulting in increased financing constraints, with the consequence that the firm is forced to abandon profitable investment projects [8]. The consequence is that firms are forced to abandon profitable investments [8], thus preventing the maximisation of wealth for shareholders and stakeholders at large. In contrast, companies can send positive or negative signals to the outside world through the text of their annual reports, conveying textual information other than earnings figures, thus assisting investors in their financial decisions and improving the information asymmetry that exists due to agency theory. The more positive the tone of the annual report, the higher the external media attention and the stronger the effect on the mitigation of corporate financing constraints.

3. Study Design

3.1 Data Sources and Sample Selection

In order to exclude the impact of the financial crisis, this paper selects A-share listed companies in Shanghai and Shenzhen in China from 2008 to 2021 as the research sample, and makes the following screening of the raw data according to the research needs: (1) exclude ST, ST* and PT companies with poor performance; (2) exclude financial and insurance listed companies; (3) exclude obviously erroneous data; (4) exclude companies with missing data. The intonation data of listed companies' annual reports were obtained from the CNDRS database, while the rest of the data were obtained from the CSMAR database. To eliminate the influence of extreme values, this paper adopts Winsorize treatment for continuous variables at 1% and 99% quartiles, and finally obtains 24,666 observations for 3415 companies.

3.2 Variable Measures

1. Explained variables

In this paper, we refer to Fazzari [8], Hadlock and Pierce [13] and Jinxin Zhang and Yi Wang [14] to combine internal and external factors to effectively reduce the use of endogenous variables to calculate the financing constraint (*FC*). The dummy variable for financing constraint (*fc*) was determined based on the mean values of the standardised variables, with the mean value above the one-third quantile being taken as 0 if the firm had a lesser degree of financing constraint, and 1 otherwise; the Logit The probability of the occurrence of financing constraints based on cash dividends declared in the year (*CASHDIV*), net working capital (*NWC*) and EBIT relative to the size of total assets (*TA*) for each year is then fitted using a logit model and defined as the financing constraint index. It takes values in the range [0, 1], with higher values indicating more severe financing constraints.

$$FC(fc = 1 | Z_{i,t}) = e^{Z_{i,t}} / (1 + e^{Z_{i,t}}) \quad (1)$$

$$Z_{i,t} = \alpha_0 + \alpha_1 size_{i,t} + \alpha_2 lev_{i,t} + \alpha_3 (CASHDIV/ta)_{i,t} + \alpha_4 MB_{i,t} + \alpha_5 (NWC/ta)_{i,t} + \alpha_6 (EBIT/ta)_{i,t} \quad (2)$$

Initially Fazzari [8] proposed an indirect measure of financing constraint using only a single indicator of investment-cash flow sensitivity, then Kaplan and Zingales [10] proposed the *KZ index* and Whited and Wu [12] proposed the *WW index*, which uses multiple financial indicators to measure financing constraint, but all still contain endogenous variables such as cash flow and leverage, therefore Hadlock and Pierce [13] redesigned the financing constraint by using only two exogenous and time-varying variables, firm size and age, to calculate the *SA index to measure the financing constraint*, which is used in this paper as a robustness check to replace the *FC index*.

2. Explanatory variables

The explanatory variable was the tone of the annual report text (*Tone*). Based on Price et al. [37] and Xie, Deren and Lin, Le [38], the number of annual report words, positive words and negative words in the annual report text was calculated using the LM dictionary (Loughran and McDonald, 2011) as the basis and the Chinese dictionary translated by Youdao Dictionary and Jinshan Word Bar as the tone, and then the following formula was used to calculate the annual report text *Tone*: $Tone = (\text{number of positive words} - \text{number of negative words}) / (\text{number of positive words} + \text{number of negative words})$, which is a positive indicator and takes values in the range of $[-1, 1]$, the larger the value, the more positive the tone of the annual report text information.

3. Control variables

According to Wu et al. [39] and Qiang Haofan et al. [18], this paper selects company size (*Size*), gearing ratio (*Lev*), total assets net profit ratio (*ROA*), total assets turnover ratio (*ATO*), growth rate of operating revenue (*Growth*), proportion of independent directors (*Indep*), proportion of shares held by the largest shareholder (*Top1*), proportion of accounts receivable (*REC*), nature of equity (*SOE*), proportion of shares held by institutional investors (*INST*), and number of directors (*Board*) as control variables. *REC*, nature of equity (*SOE*), shareholding of institutional investors (*INST*) and number of directors (*Board*) as control variables, as measured in Table 1.

Table 1. Definition of variables

Variable name	Variable symbols	Variable Description
Annual Report Text Tone	<i>Tone</i>	(number of positive words - number of negative words) / (number of positive words + number of negative words)
Financing constraints	<i>FC</i>	Calculated from models (1) and (2)
Company size	<i>Size</i>	Natural logarithm of total assets
Gearing ratio	<i>Lev</i>	Total liabilities/total assets
Net profit margin on total assets	<i>ROA</i>	Total profit / average total assets
Total asset turnover ratio	<i>ATO</i>	Operating income/average total assets
Operating income growth rate	<i>Growth</i>	Operating income for the year / Operating income for the previous year - 1
Percentage of independent directors	<i>Indep</i>	Independent directors divided by the number of directors
Percentage of shareholding of the largest shareholder	<i>Top1</i>	Number of shares held by the largest shareholder / Total number of shares
Accounts receivable as a percentage	<i>REC</i>	Ratio of net receivables to total assets
Nature of shareholding	<i>SOE</i>	1 for state-owned enterprises, 0 otherwise
Shareholding of institutional investors	<i>INST</i>	Total number of shares held by institutional investors divided by the number of shares outstanding
Number of Directors	<i>Board</i>	The number of board members is taken as the natural logarithm
Year	<i>Year</i>	Controlling for year effects
Industries	<i>Industry</i>	Controlling industry effects

3.3 Model Setting

$$FC_{i,t+1} = \alpha_0 + \alpha_1 Tone_{i,t} + \alpha_2 Size_{i,t} + \alpha_3 Lev_{i,t} + \alpha_4 Roa_{i,t} + \alpha_5 Ato_{i,t} + \alpha_6 Growth_{i,t} + \alpha_7 Indep_{i,t} + \alpha_8 Top1_{i,t} + \alpha_9 Rec_{i,t} + \alpha_{10} Soe_{i,t} + \alpha_{11} Inst_{i,t} + \alpha_{12} Board_{i,t} + Year + Industry + \varepsilon_{i,t} + \mu_i \quad (3)$$

Considering that there is a lagged effect of annual report text tone on the impact of financing constraints, this paper refers to Bu Danlu and Wang Xiaoyan [40] and Dai Lu and Song Di [41], and takes period t+1 for the explained variables and period t for the rest of the variables in the model. The fixed effects, controlling for Year and Industry, are included to address possible omitted variables. μ_i is the individual fixed effect that does not vary over time. $\varepsilon_{i,t}$ is the error term.

4. Analysis of the Empirical Results

4.1 Descriptive Statistics and Correlation Analysis

Table 2. Descriptive statistics

Variables	Number of observations	Average	Standard deviation	Minimum value	Maximum value
FC	24666	0.4934	0.2732	0.0066	0.9403
Tone	24666	0.0086	0.0668	-0.1527	0.1817
Size	24666	22.173	1.2702	19.8745	26.1812
Lev	24666	0.4275	0.2008	0.0071	1.0181
Roa	24666	0.0435	0.0570	-0.2205	0.2136
Ato	24666	0.6605	0.4463	0.0776	2.6387
Growth	24666	0.1703	0.3933	-0.5442	2.5016
Indep	24666	0.3738	0.0530	0.3333	0.5714
Top1	24666	0.3473	0.1484	0.0857	0.7530
Rec	24666	0.1167	0.1009	0.0002	0.4558
Soe	24666	0.3818	0.4858	0	1
Inst	24666	0.3895	0.2343	0.0005	0.8803
Board	24666	2.1390	0.1976	1.6094	2.7081

Table 3. Correlation analysis

	FC	Tone	Size	Lev	Roa	Ato
FC						
Tone	0.1306*					
Size	-0.8648*	-0.1422*				
Lev	-0.6270*	-0.1095*	0.5190*			
Roz	0.1007*	0.0325*	-0.0261*	-0.3350*		
Ato	-0.0880*	-0.0204*	0.0427*	0.1577*	0.1592*	
Growth	-0.0274*	0.0269*	0.0417*	0.0485*	0.2414*	0.1183*
Indep	0.0176*	0.0214*	0.0135*	-0.0157*	-0.0217*	-0.0338*
Top1	-0.1590*	-0.0237*	0.1852*	0.0725*	0.1156*	0.0780*
Rec	0.2513*	0.1012*	-0.1898*	-0.0188*	-0.0180*	0.1415*
Soe	-0.3730*	-0.1440*	0.3201*	0.2967*	-0.1029*	0.0690*
Inst	-0.4507*	-0.0854*	0.4378*	0.2013*	0.1115*	0.1012*
Board	-0.2601*	-0.0641*	0.2485*	0.1635*	0.0131*	0.0438*
	Growth	Indep	Top1	Rec	Soe	Inst
Indep	0.0006*					
Top1	0.0142*	0.0361*				
Rec	0.0468*	0.0277*	-0.1193*			
Soe	-0.0594*	-0.0628*	0.2280*	-0.2298*		
Inst	-0.0012*	-0.0487*	0.3457*	-0.1710*	0.3428*	
Board	-0.0071*	-0.5175*	0.0236&	-0.1174*	0.2694*	0.1975*

Table 2 presents the results of the descriptive statistics for each variable, with a valid sample size of 24,666 items. The mean value of the annual report text tone (Tone) was 0.0086, indicating that the net tone vocabulary represented by the difference between positive and negative tone was 0.86% of the total annual report sentiment vocabulary with a standard deviation of 0.0668; the mean value of the financing constraint was 0.4934 with a standard deviation of 0.2732. The results of the descriptive statistics for each variable were not significantly different from previous studies and will not be repeated. The Pearson correlation coefficients of the variables were also calculated, and the correlation coefficients between the explanatory variables and the control variables were less than 0.7. The variance inflation factor (VIF) was used to test again, and as can be seen from column (4) of Table 3, the maximum value of VIF was 2.11 and the mean value was 1.49, which was much smaller than the threshold value of multicollinearity of 5 or 10, so the problem of multicollinearity among the explanatory variables was weak. Not reported, available for inspection.

4.2 Baseline Regression

Table 4. Baseline regression

	F.FC		
	(1)	(2)	(3)
Tone	-0.0337*** (0.0127)	-0.0473*** (0.0124)	-0.0445*** (0.0123)
Size	-0.144*** (0.000872)	-0.153*** (0.000908)	-0.154*** (0.000918)
Lev	-0.310*** (0.00549)	-0.277*** (0.00550)	-0.302*** (0.00575)
Roa	-0.274*** (0.0170)	-0.219*** (0.0168)	-0.237*** (0.0167)
Ato	-0.0203*** (0.00198)	-0.0154*** (0.00194)	-0.00606*** (0.00216)
Growth	-0.00946*** (0.00221)	-0.00239 (0.00219)	-0.00348 (0.00217)
Indep	0.0186 (0.0186)	0.0413** (0.0182)	0.0534*** (0.0181)
Top1	0.0273*** (0.00608)	0.0466*** (0.00598)	0.0381*** (0.00600)
Rec	0.263*** (0.00875)	0.213*** (0.00871)	0.235*** (0.00959)
Soe	-0.0178*** (0.00199)	-0.00670*** (0.00198)	-0.00433** (0.00200)
Inst	-0.0660*** (0.00428)	-0.0742*** (0.00422)	-0.0735*** (0.00420)
Board	-0.0265*** (0.00527)	0.00195 (0.00523)	0.00848 (0.00521)
Constant	3.856*** (0.0218)	3.919*** (0.0217)	3.938*** (0.0227)
Control variables	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes
Industry fixed effects	No	No	Yes
Observations	24,666	24,666	24,666
R ²	0.769	0.780	0.784

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

In this paper, we use panel data and choose a fixed effects model (fixed industry and year) using equation (3) after Hausman's test to conduct an empirical test with stepwise controls for fixed effects.

Table 4, columns (1)-(3), reports the test results of the benchmark regressions. Column (1) is the joint fixed effect without the inclusion of time and industry, and the regression coefficient remains significantly negative at the 1% level. Columns (2) and (3) progressively include joint time and industry fixed effects, capturing the effect of annual report text tone (*Tone*) on financing constraints (*FC*) when fixing time only, time and industry simultaneously, respectively, and both annual report text tone (*Tone*) has a significant negative effect on financing constraints (*FC*) ($\beta = -0.0445$, $p < 0.01$), with H1 being support. This suggests that the more positive the tone of the annual report text, the more positive the disclosure of sentiment is, the more incremental information can be conveyed to improve the financing constraint and effectively relieve the financing difficulties of enterprises.

Under imperfect capital markets, managers of enterprises with information advantages launch signals through the economic act of disclosing the emotional tone of the text of the annual report, revealing to the media, market investors or shareholders whether the enterprise's operating conditions or asset quality are good, telling the information disadvantaged party the true value and reducing information asymmetry. However, it is undeniable that a small number of enterprises whose actual operating conditions are not good need to manipulate their earnings figures through management surplus management and other means, and accordingly raise the cost of their own disclosure in order to convince the information disadvantaged party of the qualitative information.

4.3 Endogenous Treatment

1. Instrumental variables method

Considering that firms with stronger financing capacity themselves tend to express themselves more positively in their annual report text disclosure, in order to deal with reverse causality, as well as possible omitted variables and measurement errors in the model, drawing on existing studies [42, 3], this paper selects the industry mean of annual report text tone for the same year and the same province as the instrumental variable (IV). This instrumental variable satisfies the requirements of relevance and exogeneity: in terms of relevance, companies in the same year and province face similar industry characteristics and external environment, and thus their annual report text tones are somewhat correlated. There is no evidence that the tone of annual reports of companies in the same year and province affects their own financing constraints, so the principle of exogeneity is satisfied.

Using second-order least squares to generate the most asymptotically effective instrumental variables of all linear combinations and using heteroskedasticity robust standard errors, the statistical results show that the instrumental variables coefficient in the first stage (column (1) of Table 4) is positively significant at the 0.1% level and the regression coefficient in the second stage (column (2) of Table 5) is still negatively significant at the 0.1% level, indicating that the positive annual report text tone after adopting the instrumental variables approach has a significant effect on corporate financing constraints remains significantly mitigated.

The explanatory variable *Tone* regression coefficient remains negatively significant at more than the 5% confidence level, indicating that the tone of the annual report text still has a significant mitigating effect on firms' financing constraints after adopting the instrumental variables approach, thereby excluding endogeneity from the findings.

In order to ensure the reliability of the results, the following tests were conducted: the "minimum eigenvalue statistic" Sheas partial R^2 is 0.1483, while the F-statistic is 6992.09, which is greater than the critical value of 10 and the p-value is 0.0000, so the original hypothesis of the existence of weak instrumental variables is rejected, indicating that the instrumental variables meet the correlation with the endogenous explanatory variables and the instrumental variables are reasonable.

The DWH (Durbin-Wu-Hausman) test, which was also chosen to take into account heteroskedasticity on the basis of the Hausman test, showed a p-value of 0.0012, so the original hypothesis of exogeneity was rejected and it was concluded that there were endogenous explanatory variables and that it was necessary to use the industry mean of annual report text tone for the same year and province as an instrumental variable.

The exclusion constraint holds because the number of instrumental variables and the number of endogenous explanatory variables are both one, and the quantitative test of over-identification cannot be performed in the case of exactly identification, while usually the industry average of annual report text tone for the same year and province does not have a direct impact on the financing constraints of listed companies.

2. Heckman returns

Table 5. Endogenous treatments

	IV		Heckman	
	(1)	(2)	(3)	(4)
	first	two	first	two
	F.FC	F.FC	F.FC	F.FC
Tone	0.9656***	-0.1640***		-0.0809***
	(-0.0117)	(-5.05)		(0.0173)
Size	-0.0029	-0.1631***	-0.0747***	-0.154***
	(0.0005)	(-119.23)	(0.00840)	(0.000918)
Lev	0.0042	-0.2867***	0.0357	-0.302***
	(0.0028)	(-42.76)	(0.0529)	(0.00575)
Roa	0.0012**	-0.2036***	0.309*	-0.237***
	(0.0082)	(-9.86)	(0.164)	(0.164)
Ato	-0.0027*	-0.0056**	-0.0814***	-0.00606***
	(0.0010)	(-2.46)	(0.0191)	(0.00216)
Growth	0.0027	-0.0038	0.0522**	-0.00344
	(0.0010)	(-1.50)	(0.0213)	(0.00217)
Indep	0.0139	0.0599***	0.565***	0.0526***
	(0.0085)	(3.39)	(0.180)	(0.0181)
Top1	-0.0017	-0.0104*	0.167***	0.0383***
	(0.0030)	(-1.67)	(0.0586)	(0.00600)
Rec	0.0136**	0.2075***	0.104	0.235***
	(0.0086)	(21.39)	(0.0842)	(0.00959)
Soe	-0.0016	0.0064***	-0.0657***	-0.00442**
	(0.0010)	(3.01)	(0.0191)	(0.00200)
Inst	0.0010	-0.0361***	-0.0504	-0.0734***
	(0.0020)	(-7.56)	(0.0412)	(0.00420)
Board	-0.0001	0.0015	0.0919*	0.00841
	(0.0024)	(0.30)	(0.0508)	(0.00521)
imr			1.298***	0.00413***
			(0.209)	(0.00139)
Constant	0.0888***	4.1916***		3.938***
	(0.0121)	(129.36)		(0.0227)
Observations	24,666	24,666	24,666	24,666
R ²	0.795	0.795		0.784
Weak instrumental variable test F-value	6992.09[0.0000]			
DWH test F-value	10.4734[0.0012]			

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

Whether the tone of an enterprise's annual report text is positive or negative often takes into account many factors such as operating performance, cash flow, financial risk, operating efficiency,

etc. The presence of these factors makes the enterprise have lower financing constraints, in other words, financing constraints are also an important consideration for the enterprise's optimism about operating conditions and future development prospects, and the positive annual report text tone is selective. In this regard, the Heckman model two-stage method is used to avoid the estimation bias caused by sample self-selectivity.

The IMR values calculated from the one-stage regression to correct for sample selection bias were introduced into the original regression equation as control variables. Column (4) of Table 5 shows that the IMR for the second stage is significant, indicating that the original regression sample does have a sample selection bias that needs to be mitigated using the sample selection model. The results show that the explanatory variable *Tone* remains significant, while the regression coefficients for the remaining variables are more robust to mitigating the sample selection bias.

4.4 Robustness Tests

1. Replacement of empirical methods

In order to address the problem of omitted variables, reduce model-setting bias and to take into account the fact that the financing situation of firms has a certain degree of continuity or inertia, this paper is further extended to a dynamic panel model by introducing a first-order lagged term (*L.FC*) for the explained variables based on the baseline regression.

To address the endogeneity problem that exists in dynamic panels, this paper refers to the Systematic Generalised Moment Estimation (SYS-GMM) proposed by Arellano and Bover [43] for testing. On the one hand, the lagged term of the difference variable (*L.FC*) is used as the instrumental variable in the level equation, and both the level equation and the difference equation are used in the estimation process, which further increases the available instrumental variables and ameliorates the problem that the instrumental variable of the difference GMM is often an instrumental variable when the financing constraint (FC) exhibits strong serial correlation, i.e. the coefficient of *L.FC* is large. On the other hand, the heteroskedasticity problem is controlled by effectively using the information from the level equation to reduce the bias of a limited sample, which leads to a significant improvement in the validity of the estimation results. As the two-step GMM criterion misunderstood the severe downward bias, the one-step SYS-GMM estimation was chosen and tested by Arellano-Bond second-order serial statistics, with the original hypothesis accepted at first order (p-value $0.000 < 0.05$) and rejected at second order (p-value $0.112 > 0.1$), demonstrating the existence of first-order autocorrelation in the difference of perturbation terms and the absence of second-order autocorrelation.

As there is only one instrumental variable, no over-identification test is performed. The regression results are presented in column (1) of Table 7, which shows that there is indeed some continuity in financing constraints, i.e. firms with financing difficulties in the previous period are more likely to face financing constraints in the current period, while the moderating effect of annual report text tone on financing constraints remains highly significant at the 1% level, indicating that the possible endogeneity of annual report text tone and the endogeneity issues arising from the first-order lagged term of financing constraints have a manageable impact on the regression results, the regression results remain unchanged and the findings are robust.

2. Propensity score matching analysis

The annual report texts in this paper are measured using a lexical tone approach, whereas managers' management of textual information tone is not entirely random or exogenous and can be influenced by their own opportunistic and short-sighted traits, etc. and other factors in the firm. This would produce a sample selectivity bias between the experimental group (i.e. more positive annual report tone) and the control group (less positive annual report tone), thus affecting their comparability. Therefore, comparable control groups were selected using propensity score matching (PSM) to assess the 'treatment effect' of annual report text tone on financing constraints, with dummy variables generated by dividing the independent variables by median and re-running the regressions.

In this paper, the most-neighbourly-in matching method was chosen, and matching was carried out in a 1:1 ratio. In the first stage of propensity value calculation, the control variables were obtained as covariates by logistic regression. According to the results of the equilibrium test in Table 6, it can be seen that there is a substantial decrease in the standardised deviation before and after matching, and the standardised deviations with control variables are all less than 2% after matching. Therefore the t-test for the control variables does not reject the original hypothesis of no selection bias in the experimental and control groups. Also based on the results of the propensity score matching in column (2) of Table 7, it can be seen that the regression coefficient of annual report text tone is negatively significant at the 1% level and the regression results are robust.

Table 6. Balance test

Variables	Before/after matching	Experimental group	Control group	Standardised deviation %	Standardisation deviation Reduced %	T-value	P-value
Size	Before matching	22.009	22.332	-25.6		-20.11	0
	After matching	22.009	22.012	-0.2	99.3	-0.14	0.885
Lev	Before matching	0.40713	0.44735	-20.1		-15.81	0
	After matching	0.40717	0.40878	-0.8	96	-0.64	0.525
Roa	Before matching	0.04492	0.04213	4.9		3.84	0
	After matching	0.04492	0.04474	0.3	93.6	0.24	0.811
Ato	Before matching	0.65077	0.66998	-4.3		-3.38	0.001
	After matching	0.65086	0.64567	1.2	73	0.96	0.339
Growth	Before matching	0.17864	0.16219	4.2		3.28	0.001
	After matching	0.17863	0.17462	1.0	75.6	0.79	0.429
Indep	Before matching	0.37511	0.37252	4.9		3.85	0.000
	After matching	0.3751	0.37498	0.2	95.4	0.17	0.862
Top1	Before matching	0.34293	0.35145	-5.8		-4.52	0.000
	After matching	0.34291	0.34497	-1.4	75.8	-1.10	0.273
Rec	Before matching	0.12571	0.10802	17.6		13.81	0.000
	After matching	0.12564	0.12526	0.4	97.8	0.29	0.772
Soe	Before matching	0.31855	0.44321	-25.9		-20.31	0.000
	After matching	0.31857	0.31611	0.5	98	0.41	0.679
Inst	Before matching	0.36972	0.40875	-16.7		-13.13	0.000
	After matching	0.36973	0.36921	0.2	98.6	0.18	0.860
Board	Before matching	2.1268	2.1509	-12.2		-9.58	0.000
	After matching	2.1269	2.1283	-0.7	94	-0.58	0.562

3. Two-way cluster adjustment

To address the issue of autocorrelation on the time series contained in the panel data, this paper draws on Petersen [44] to adjust the estimated standard errors for clustering at the firm and year levels using clustering robust standard errors, showing that the same firm and year observations are allowed to be correlated between groups and uncorrelated within groups when heteroskedasticity is taken into account, as can be seen from the results in column (3) of Table 7, where the regression coefficients for annual report text tone are 1% level is negatively significant and the regression results are robust.

4. Replacement of variable measurements

One is to replace the annual report text tone (*Tone*) measure. To further enhance the robustness of the results, this paper uses (number of positive words - number of negative words) / number of annual

report words as a proxy variable for annual report text tone (*Tone2*), drawing on Davis et al. [45] and Zeng, Q. et al. [3], and as can be seen from the results in column (4) of Table 7, the regression results are still significantly negative significant at the 1% level.

Table 7. Robustness tests

	SYS-GMM	PSM	Two-way cluster	Changing the Tone measurement	Replacement of the F.FC measurement method
	F.FC	F.FC	F.FC	F.FC	F SA
	(1)	(2)	(3)	(4)	(5)
L.FC	0.209*** (0.0255)				
Tone	-0.114*** (0.0214)	-0.0757*** (0.0189)	-0.0445*** (0.0122)		-0.258*** (0.0218)
Size	-0.167*** (0.00861)	-0.155*** (0.00194)	-0.154*** (0.00119)	-0.154*** (0.000918)	-0.0455*** (0.00162)
Lev	-0.254*** (0.0224)	-0.301*** (0.0108)	-0.302*** (0.00708)	-0.302*** (0.00575)	0.161*** (0.0102)
Roa	0.344*** (0.0359)	-0.232*** (0.0319)	-0.237*** (0.0200)	-0.237*** (0.0167)	0.144*** (0.0295)
Ato	0.00796 (0.0108)	-0.00221 (0.00438)	-0.00606*** (0.00233)	-0.00606*** (0.00216)	0.00688* (0.00381)
Growth	-0.0207*** (0.00438)	-0.00815* (0.00456)	-0.00348 (0.00258)	-0.00347 (0.00217)	-0.0149*** (0.00384)
Indep	-0.0301 (0.0561)	0.0570* (0.0301)	0.0534*** (0.0182)	0.0534*** (0.0181)	-0.258*** (0.0318)
Top1	0.0949*** (0.0279)	0.0411*** (0.0102)	0.0381*** (0.00610)	0.0382*** (0.00600)	-0.254*** (0.0106)
Rec	0.120*** (0.0464)	0.237*** (0.0160)	0.235*** (0.0101)	0.235*** (0.00959)	-0.117*** (0.0169)
Soe	0.00740 (0.00997)	-0.00354 (0.00324)	-0.00433** (0.00203)	-0.00435** (0.00200)	0.0838*** (0.00352)
Inst	-0.0728*** (0.0113)	-0.0670*** (0.00730)	-0.0735*** (0.00429)	-0.0735*** (0.00420)	0.0474*** (0.00739)
Board	-0.00898 (0.0199)	0.0115 (0.00875)	0.00848 (0.00520)	0.00849 (0.00521)	-0.0150 (0.00916)
Tone2				-0.328*** (0.0891)	
Constant		3.928*** (0.0431)	3.938*** (0.0264)	3.938*** (0.0227)	4.665*** (0.0400)
Observations	24,414	13,297	24,666	24,666	24,414
R ²	3,409	0.780	0.784	0.784	0.276

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

Table 8. Robustness tests

	Adding control variables	There is no U-shaped relationship	Replacement lag handling	No lag	Explained variable two periods ahead
	F.FC	F.FC	FC	FC	F2_FC
	(1)	(2)	(3)	(4)	(5)
Tone	-0.0659*** (0.0121)	-0.0403*** (0.0127)	-0.0862*** (0.0121)	-0.0670*** (0.0102)	-0.0801*** (0.0143)
Size	-0.163*** (0.000995)	-0.154*** (0.000919)	-0.157*** (0.000904)	-0.156*** (0.000748)	-0.153*** (0.00107)
Lev	-0.287*** (0.00564)	-0.302*** (0.00575)	-0.290*** (0.00566)	-0.312*** (0.00468)	-0.266*** (0.00670)
Roa	-0.203***	-0.237***	-0.231***	0.152***	-0.332***

	(0.0168)	(0.0167)	(0.0164)	(0.0132)	(0.0200)
Ato	-0.00534**	-0.00605***	-0.00617***	-0.00429**	-0.0151***
	(0.00210)	(0.00216)	(0.00212)	(0.00179)	(0.00248)
Growth	-0.00410*	-0.00348	-0.00328	0.00521***	-0.00341
	(0.00212)	(0.00217)	(0.00214)	(0.00179)	(0.00248)
Indep	0.0587***	0.0533***	0.0669***	0.0631***	0.0371*
	(0.0176)	(0.0181)	(0.0177)	(0.0150)	(0.0208)
Top1	-0.0102*	0.0380***	0.0396***	0.0635***	0.0108
	(0.00608)	(0.00600)	(0.00588)	(0.00501)	(0.00691)
Rec	0.206***	0.235***	0.236***	0.285***	0.200***
	(0.00940)	(0.00959)	(0.00940)	(0.00791)	(0.0111)
Soe	0.00662***	-0.00428**	-0.00659***	-0.00820***	0.00146
	(0.00206)	(0.00200)	(0.00196)	(0.00166)	(0.00231)
Inst	-0.0364***	-0.0735***	-0.0712***	-0.100***	-0.0555***
	(0.00424)	(0.00420)	(0.00411)	(0.00350)	(0.00485)
Board	0.00134	0.00842	0.0111**	0.0124***	0.000455
	(0.00508)	(0.00521)	(0.00509)	(0.00432)	(0.00597)
TobinQ	-0.0155***				
	(0.000547)				
Listage	-0.0234***				
	(0.00145)				
Opinion	0.0241***				
	(0.00578)				
Dturn	0.00102				
	(0.00164)				
Big4	0.0395***				
	(0.00363)				
Tone ²		-0.169			
		(0.133)			
Constant	4.182***	3.938***	3.978***	3.962***	3.939***
	(0.0246)	(0.0227)	(0.0223)	(0.0188)	(0.0262)
Observations	24,666	24,666	24,414	29,813	21,125
R ²	0.795	0.784	0.794	0.823	0.749

Note: ***, **, * denote 1%, 5%, 10% significance levels respectively; t-values of regression coefficients in parentheses. The corresponding variables in each row of column (3) are lagged by one period and are not shown in space at.

The second is the replacement financing constraint (*F.FC*) measure. Drawing on Hadlock and Pierce [13], as the SA index is negative, the larger the absolute value, the higher the financing constraint of the firm. Therefore, this paper takes the absolute value of the SA index and processes the first-order advance term to generate the SA index as a proxy variable (*F.SA*) for financing constraint (*F.FC*). re-runs the regression, and according to column (5) of Table 7, the regression results are still negatively significant at the 1% level.

5. Adding control variables

Based on the original control variables, four control variables are added and re-regressed with reference to Jiang Fuxiu et al. [46], Qi Jiangna et al. [47], and Yi Zhihong et al. [48]. year of listing (*ListAge*): $\ln(\text{current year} - \text{year of listing} + 1)$; audit opinion (*Opinion*): if the company's financial report in the current year was According to column (1) of Table 8, the regression results are still negative at the 1% level. The regression results are still negatively significant at the 1% level.

6. U-shaped relationship test

In order to rule out the existence of a U-shaped relationship between annual report text tone and financing constraints, this paper adds the quadratic term of annual report text tone to the benchmark regression. According to the results in column (2) of Table 8, it can be seen that the quadratic term of annual report text tone is not significant, so the possibility of a U-shaped relationship between annual report text tone and financing constraints is ruled out.

7. Replacement of the treatment lag effect approach

In the baseline regression, the explained variables are taken for period $t+1$ and the remaining variables are taken for period t , with the loss of 2021 data. This paper uses an alternative approach to achieve the lagged effect, i.e., the explained variables are taken to period t . To avoid endogeneity, the explanatory variables and control variables are taken to period $t-1$, with the loss of 2008 data, and the regression results are still negatively significant at the 1% level as can be seen from column (3) of Table 8.

In addition, when lagged effects are not considered, i.e., all variables in the model are taken at period t , the regression results are still negative at the 1% level according to column (4) of Table 8. Further, when the explained variables are advanced by two periods to period $t-2$ and the remaining explanatory variables are taken to period t to deal with the lagged effects, the regression results are still negative at the 1% level according to column (5) of Table 8.

5. Further Analysis

5.1 Analysis of Impact Mechanisms

Information asymmetry is inevitable in imperfect capital markets, and the media, as an information transfer intermediary [49], has the ability to receive, process and analyse information better than the public, and can sharply capture the tone and emotion information conveyed in the texts of corporate annual reports, effectively improving information transparency. In the information age, online news reports have wider coverage and more timely reporting than newspaper financial news. Therefore, this paper uses quantitative statistics of online news from the CNRDS database to generate the mediating variable media attention (*MED*) by taking the logarithm of the total number of occurrences of headlines and the total number of occurrences of content in all online news containing neutral, positive and negative reports and adding one to make the data obey a normal distribution.

Referring to the three-step mediation test of Wen Zhonglin et al. [50], the first step is to test whether the tone of the annual report text can significantly reduce the firm's financing constraint, which is verified in the benchmark regression in Table 4; the second step is to test whether the tone of the annual report text is more positive with higher media attention. In the third step, the effect of both media attention and text tone on firms' financing constraints is examined.

In the full sample, the mediating effect of media attention does not hold. Further group regressions on firm ownership heterogeneity reveal that the mediating effect of media attention holds among private firms (non-state owned) but not among state owned firms. This suggests that non-SOEs, which themselves have higher financing costs and thresholds, have more incentives for management to play the signaling role of annual report text tone to reduce corporate financing constraints, while SOEs, which themselves can already reduce financing constraints through means such as lower principal-agent costs and political connections as credit backing, do not choose to improve information transparency due to prudence, economic consequences and high information disclosure compliance costs.

Table 9. Mediating variables

	State-owned enterprises			Private enterprises		
		Tone	F.FC		Tone	F.FC
	(1)	(2)	(3)	(4)	(5)	(6)
Tone	-0.0587*** (0.0183)		-0.0589*** (0.0183)	-0.0430*** (0.0161)		-0.0405** (0.0161)
MED3		0.000000918 -0.00000189	0.0000149*** -0.00000365		0.00000846*** -0.00000163	-0.0000138*** -0.00000353
Size	-0.135*** (0.00131)	-0.00490*** (0.000735)	-0.138*** (0.00145)	-0.173*** (0.00128)	-0.00756*** (0.000599)	-0.172*** (0.00135)
Lev	-0.339*** (0.00870)	0.00952** (0.00443)	-0.338*** (0.00870)	-0.249*** (0.00762)	-0.00343 (0.00339)	-0.249*** (0.00762)
ROA	-0.155*** (0.0298)	-0.00167 (0.0145)	-0.169*** (0.0300)	-0.242*** (0.0202)	0.0248*** (0.00876)	-0.237*** (0.0202)
ATO	0.00125 (0.00302)	-0.00665*** (0.00156)	0.000487 (0.00302)	-0.0115*** (0.00299)	-0.000967 (0.00135)	-0.0113*** (0.00299)
Growth	-0.00178 (0.00341)	0.00320* (0.00175)	-0.00144 (0.00341)	-0.00369 (0.00276)	0.00428*** (0.00124)	-0.00346 (0.00276)
Indep	0.0200 (0.0257)	0.0149 (0.0133)	0.0140 (0.0257)	0.00932 (0.0252)	0.00379 (0.0115)	0.0155 (0.0252)
Top1	0.0169* (0.00936)	0.0204*** (0.00489)	0.0194** (0.00937)	0.0246*** (0.00785)	0.00393 (0.00359)	0.0232*** (0.00785)
REC	0.147*** (0.0157)	0.0345*** (0.00806)	0.154*** (0.0157)	0.272*** (0.0119)	0.0176*** (0.00542)	0.271*** (0.0119)
INST	-0.0611*** (0.00734)	0.00105 (0.00383)	-0.0626*** (0.00734)	-0.0684*** (0.00509)	-0.00389* (0.00233)	-0.0673*** (0.00510)
Board	-0.0100 (0.00727)	0.00933** (0.00378)	-0.0112 (0.00727)	0.0107 (0.00728)	-0.00148 (0.00330)	0.0118 (0.00728)
Constant	3.622*** (0.0304)	0.0533*** (0.0172)	3.681*** (0.0335)	4.326*** (0.0337)	0.164*** (0.0159)	4.288*** (0.0351)
Observations	9,417	11,144	9,417	15,249	18,669	15,249
R ²	0.773	0.021	0.774	0.755	0.033	0.755

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

In the second step, according to column (1) of Table 9, it can be seen that the coefficient of media attention of private enterprises is positively significant at the 1% level. Private enterprises are less compliant and less externally binding, and are more likely to attract external public attention and monitoring questions. Therefore, in order to meet the public and media's information disclosure needs, they are more inclined to express a positive annual report tone, show good corporate performance and demonstrate optimism about their financial situation and future development prospects, in response to the social pressure of public opinion to create more economic benefits and employment opportunities. The third step according to column (2) of Table 9 shows that the *MED* coefficient of private enterprises is negatively significant at the 1% level and the significance of the *Tone* coefficient has decreased, reflecting the partial mediating role of media attention, a finding that passes the Sobel and Bootstrap tests. This suggests that the more positive tone of private companies' annual reports can indeed amplify management's narrative discretion through media attention, to some extent as a predictor of future performance, thus reducing the financing constraints of companies and influencing whether investors place their "monetary votes".

5.2 Heterogeneity Analysis

1. Macro level

(1) Level of regional economic development

China has the objective status quo of uneven levels of economic development, the higher the level of development, the more prosperous the production transactions of enterprises, the more positive the tone of the annual report, for the alleviation of financing constraints, reduce financing costs, not only to attract capital agglomeration ability is stronger, but also the economies of scale of capital is also conducive to reducing transaction costs.

This paper calculates the regional economic development level (*PGDP*) of each province by using the actual regional GDP / total number of people in that region at the end of the year (using 2008 as the base period), where the regional GDP index is obtained from the China Statistical Yearbook and the total number of people at the end of the year is obtained from the RESSET database. Using the median regional development level in the same year as the classification criterion, group regressions are conducted. According to column (1)(2) of Table 10, it can be seen that the higher the development level of the province in which the firm is located, the greater the moderating effect of a positive annual report text tone on the firm's financing constraints.

Table 10. Analysis of heterogeneity

	PGDP		MAR		HHI	
	High regional economic development level	Low regional economic development level	High institutional quality environment	Low institutional quality environment	High level of industry competition	Low level of industry competition
	(1)	(2)	(3)	(4)	(5)	(6)
Tone	-0.0534*** (0.0169)	-0.0313* (0.0179)	-0.0438*** (0.0168)	-0.0430** (0.0180)	-0.0800*** (0.0173)	-0.00578 (0.0173)
Size	-0.156*** (0.00127)	-0.154*** (0.00134)	-0.155*** (0.00124)	-0.154*** (0.00138)	-0.144*** (0.00124)	-0.168*** (0.00136)
Lev	-0.301*** (0.00794)	-0.295*** (0.00843)	-0.296*** (0.00783)	-0.301*** (0.00856)	-0.317*** (0.00799)	-0.285*** (0.00830)
Roa	-0.293*** (0.0224)	-0.164*** (0.0252)	-0.278*** (0.0227)	-0.183*** (0.0246)	-0.271*** (0.0238)	-0.206*** (0.0235)
Ato	-0.00592** (0.00297)	-0.00638** (0.00317)	-0.00941*** (0.00292)	-0.00298 (0.00320)	-0.00928*** (0.00273)	-0.00318 (0.00359)
Growth	-0.00444 (0.00306)	-0.00190 (0.00309)	-0.00371 (0.00291)	-0.00326 (0.00326)	-0.00230 (0.00292)	-0.00341 (0.00324)
Indep	0.124*** (0.0256)	-0.00454 (0.0257)	0.123*** (0.0250)	-0.0184 (0.0262)	0.0858*** (0.0253)	0.0221 (0.0256)
Top1	0.0460*** (0.00809)	0.0242*** (0.00897)	0.0490*** (0.00816)	0.0224** (0.00887)	0.0368*** (0.00832)	0.0338*** (0.00861)
Rec	0.221*** (0.0129)	0.247*** (0.0145)	0.215*** (0.0128)	0.255*** (0.0146)	0.256*** (0.0135)	0.204*** (0.0139)
Soe	-0.00664** (0.00286)	-0.000724 (0.00288)	-0.00297 (0.00271)	-0.00428 (0.00299)	-0.00615** (0.00273)	-0.000765 (0.00293)
Inst	-0.0814*** (0.00549)	-0.0644*** (0.00649)	-0.0794*** (0.00561)	-0.0671*** (0.00632)	-0.0771*** (0.00591)	-0.0689*** (0.00591)
Board	0.0255*** (0.00731)	-0.00701 (0.00747)	0.0210*** (0.00718)	-0.00141 (0.00757)	0.000590 (0.00726)	0.0186** (0.00740)
Constant	3.915*** (0.0325)	3.978*** (0.0325)	3.924*** (0.0315)	3.974*** (0.0332)	3.746*** (0.0303)	4.363*** (0.0562)
Observations	13,418	11,248	13,275	11,391	12,844	11,822
R ²	0.784	0.786	0.788	0.783	0.783	0.784

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

(2) Institutional quality environment

As a financial soft environment for financing, a good institutional quality and a high level of marketisation accompanied by an advanced property rights system, a well-developed capital market system and an adequate supply of internal information [18] will be more conducive to the free flow of information elements and the signalling effect of the tone of the annual report text on external financing constraints.

This paper adopts the marketization index (*MAR*) calculation method of Wang Xiaolu et al. [51] as a proxy variable for institutional quality, and calculates the marketization level by scoring five main aspects: government-market relationship, degree of non-state economic development, degree of product market development, degree of factor market development, and intermediary organization and law. Using the median marketisation index of the same year as a classification criterion, group regressions were conducted, and according to column (3)(4) of Table 10, it can be seen that the more positive the tone of the annual report text is in the group with higher marketisation levels, the greater the mitigation effect on corporate financing constraints.

2. Industry-level heterogeneity

When the level of industry competition is high, in order to reduce the risk of competition brought about by information disclosure, firms tend not to disclose true and valid information in their annual reports in full, and the text tends to be neutral in tone, so the need of outside investors to reduce information asymmetry becomes more urgent [52]. Meanwhile, the risk of dismissal due to industry competition [53] can restrain management's opportunistic tone manipulation, making the upward tone of the annual report more credible and persuasive, and more conducive to reducing financing constraints.

Industry concentration is expressed by the Herfindahl Index (*HHI*), which is the cumulative sum of the squared market shares of each company in the industry, where market share is equal to the proportion of the main business revenue of the individual company to the main business revenue of the industry to which it belongs. A larger *HHI* indicates a more concentrated industry, a higher degree of monopoly and a lower degree of competition. According to column (5)(6) of Table 10, it can be seen that the more positive the tone of the annual report text, the greater the mitigation effect on corporate financing constraints in the subgroup with a higher Herfindahl index.

3. Enterprise level

(1) Quality of internal controls

In addition to earnings report numerical manipulation techniques such as management surplus management, textual manipulation and emotional implication through the tone of the annual report are more insidious disclosure manipulation techniques. With the accrual-based restatement of earnings and the weak internal control features of auditor assurance, firms are more inclined to hide negative news [54] and engage in positive manipulation of annual report tone to spread false news and mislead external investors, thereby achieving the goal of reducing financing difficulties and financing costs.

This paper uses the Dibble Internal Control Index score (*ICI*), which is based on the five elements of corporate internal control, to comprehensively measure the effectiveness and efficiency of the implementation of corporate internal control norms and effectively reflect the quality of internal control. The index takes values in the range of [0, 1000], which is logarithmically processed in this paper. The median of the internal control index in the same year is used as the classification criterion for group regression. According to column (1)(2) of Table 11, it can be seen that in the subgroup with poorer internal control governance, firms are more inclined to reduce external financing constraints through positive manipulation of the tone of their annual reports.

(2) Shareholding structure

The higher the shareholding ratio of institutional investors (*Inst*) or the lower the shareholding ratio of executives (*Mshare*), the greater the separation between ownership and management, the greater the degree of information opacity and asymmetry, the greater the external expectations of corporate information disclosure, the more positive the tone of the annual report text, the greater the value of the information utility generated, and the signal brought by the incremental information on external financing constraints will be further amplified. The signal effect of incremental information on external financing constraints will be further amplified. The median shareholding ratio of institutional investors and the median shareholding ratio of executives in the same year were used as classification criteria for group regressions respectively. According to columns (3)-(6) of Table 11, it can be seen that in the subgroups with higher shareholding of institutional investors or lower

shareholding of executives, the more positive tone of firms' annual reports, the more effective they are in reducing financing costs and alleviating financing constraints.

Table 11. Analysis of heterogeneity

	ICI		Inst		Mshare		Lifec		
	High quality of internal control	Low quality of internal controls	High institutional holdings	Low institutional holdings	High executive shareholding	Low executive shareholding	Growth	Maturity	Recession
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tone	-0.0153 (0.0166)	-0.0736*** (0.0178)	-0.0818*** (0.0171)	-0.0105 (0.0174)	-0.0286* (0.0170)	-0.0827*** (0.0175)	-0.0435 (0.0282)	-0.0342 (0.0208)	-0.0436** (0.0180)
Size	-0.153*** (0.00122)	-0.161*** (0.00142)	-0.148*** (0.00124)	-0.165*** (0.00141)	-0.177*** (0.00142)	-0.142*** (0.00124)	-0.146*** (0.00224)	-0.150*** (0.00150)	-0.161*** (0.00135)
Lev	-0.293*** (0.00847)	-0.302*** (0.00783)	-0.287*** (0.00841)	-0.311*** (0.00791)	-0.267*** (0.00811)	-0.305*** (0.00816)	-0.402*** (0.0142)	-0.324*** (0.00971)	-0.245*** (0.00828)
Roa	-0.401*** (0.0274)	-0.168*** (0.0227)	-0.318*** (0.0253)	-0.163*** (0.0223)	-0.223*** (0.0215)	-0.256*** (0.0261)	-0.305*** (0.0388)	-0.256*** (0.0262)	-0.207*** (0.0278)
Ato	0.00605** (0.00279)	0.0113*** (0.00340)	-0.0101*** (0.00287)	-0.000914 (0.00325)	-0.00414 (0.00320)	-0.00325 (0.00292)	0.0152*** (0.00481)	-0.00319 (0.00355)	-0.00209 (0.00332)
Growth	0.0101*** (0.00283)	0.000677 (0.00337)	0.00358 (0.00315)	0.00856*** (0.00297)	-0.00864*** (0.00306)	0.000877 (0.00303)	0.0108*** (0.00396)	0.00355 (0.00373)	0.0162*** (0.00512)
Indep	0.0507** (0.0239)	0.0427 (0.0269)	0.0256 (0.0251)	0.0514** (0.0260)	0.0748*** (0.0258)	0.000942 (0.0252)	0.102** (0.0415)	0.105*** (0.0302)	-0.0264 (0.0266)
Top1	0.0327*** (0.00796)	0.0420*** (0.00894)	0.0160* (0.00907)	0.0439*** (0.00859)	0.0107 (0.00848)	0.0330*** (0.00875)	0.0558*** (0.0137)	0.0426*** (0.00982)	0.0218** (0.00917)
Rec	0.202*** (0.0128)	0.264*** (0.0141)	0.179*** (0.0137)	0.280*** (0.0133)	0.232*** (0.0124)	0.215*** (0.0148)	0.235*** (0.0229)	0.233*** (0.0162)	0.238*** (0.0138)
Soe	0.00590** (0.00273)	-0.00343 (0.00289)	-0.00255 (0.00258)	-0.00615* (0.00318)	0.000365 (0.00359)	-0.00356 (0.00270)	-0.00914* (0.00517)	0.0110*** (0.00346)	-0.000915 (0.00281)
Inst	0.0768*** (0.00553)	0.0719*** (0.00633)	-0.0644*** (0.0105)	-0.0404*** (0.0100)	-0.0705*** (0.00553)	-0.0599*** (0.00685)	0.0671*** (0.00903)	0.0802*** (0.00683)	0.0694*** (0.00663)
Board	0.00924 (0.00693)	0.00429 (0.00771)	-0.00531 (0.00710)	0.0188** (0.00759)	0.0357*** (0.00749)	-0.0193*** (0.00717)	0.0235* (0.0121)	0.0175** (0.00868)	-0.0109 (0.00765)
Constant	3.931*** (0.0309)	4.102*** (0.0344)	3.880*** (0.0299)	4.121*** (0.0353)	4.351*** (0.0362)	3.771*** (0.0298)	3.751*** (0.0530)	3.832*** (0.0373)	4.119*** (0.0341)
Observations	12,511	12,155	12,343	12,323	12,550	12,116	4,820	9,118	10,662
R ²	0.807	0.761	0.771	0.747	0.770	0.767	0.767	0.781	0.803

Note: ***, ** and * denote 1%, 5% and 10% significance levels respectively; t-values of regression coefficients are in brackets.

(3) Life cycle

In this paper, we refer to Li Yunhe [55] method of calculating the life cycle (*Lifec*) score of enterprises, and calculate the scores of sales revenue growth rate, capital expenditure rate, retained earnings rate and age of enterprises, and sort the total sample by industry in descending order. According to columns (7)-(9) of Table 11, the positive tone of the annual report is more significant in relieving financing constraints for enterprises in the recessionary stage compared to those in the mature stage, mainly because enterprises in the mature stage and the mature stage are on the right

track in terms of management, good image and less external the positive tone brings less incremental information than that of declining companies.

In summary, there are significant differences in the ability of a positive annual report tone to alleviate financing constraints for firms with different characteristics. On the one hand, the tone of annual reports of companies with a high level of regional development, a good institutional quality environment, a high degree of separation of ownership and management, and a recessionary period are more effective in releasing incremental information, and the market "listens to the voice" and reflects more significantly the qualitative vocabulary and tone of sentiment in the annual report text. The positive tone of annual reports of companies in highly competitive industries is more convincing and has a more significant effect on the mitigation of financing constraints. On the other hand, for companies with poor internal controls, a positive tone is a means of disclosure manipulation, and the "false prosperity" deliberately created by management can mislead investors into making poor investment decisions.

6. Conclusion and Insights

This paper empirically investigates the relationship between annual report text tone and corporate financing constraints based on the annual report text information of non-financial listed companies in China's A-shares from 2008-2021. It is found that positive annual report text tone can reduce corporate financing constraints, and the mechanism test shows that for private enterprises, positive annual report text tone conveys incremental information through media attention and plays a moderating role in financing constraints, while for state-owned enterprises it does not play an effective mediating effect, mainly because state-owned enterprises' annual report text information disclosure is more cautious and information disclosure costs are higher, and therefore lack The main reason is that SOEs are less willing to reduce their financing costs through external disclosure due to their higher prudence and disclosure costs. Further heterogeneity analysis revealed that the tone of annual reports may be a "double-edged sword" for investors: the positive tone of annual reports of firms with a higher level of regional development, better institutional quality environment, greater separation of ownership and operation, recessionary period and high industry competition is more significantly negatively related to financing constraints, reflecting the signalling effect of annual report tone. The signalling effect of tone. Positive annual report text tone is more significantly related to financing constraints for firms with poorer quality internal controls, reflecting the masking effect of annual report text tone.

Therefore, this paper makes the following recommendations: Firstly, the SFC and other regulatory bodies should continuously refine the guidelines on text disclosure in annual reports of listed companies to encourage enterprises to expand effective disclosure on the one hand, and to include the quality of text information in the scope of audit on the other, so as to form a disciplinary mechanism with parallel rewards and punishments to prevent the abuse of management's narrative discretion and false text statements. Secondly, enterprises should correctly understand the role of the tone of the annual report as a "baton" for capital, based on the true financial performance and operating conditions of the enterprise, so as to be "true to its name" rather than "inconsistent with its appearance" Thirdly, investors should calmly analyse and critically accept incremental information such as annual reports, avoiding the risky investment of "one up and one down", so as to make correct investment decisions. Thirdly, investors should calmly discern and critically accept incremental information such as annual reports, avoiding a "rush to invest" and thus making the right investment decisions.

At the same time, there are certain limitations in this paper: firstly, the lexical semantics of annual report text information has not been defined in a categorical manner and studied in depth in order to analyse the impact of different types of text information on corporate financing constraints. Future research on natural language processing of annual reports is expected to be advanced through machine learning. Secondly, further in-depth studies on other forms of information disclosure, such as

management discussion and analysis (MD&A), prospectuses and quarterly surplus announcements, are needed to examine which forms of information disclosure have the greatest effect on the mitigation of financing constraints. Thirdly, this paper focuses on the direction of the tone of the annual report text, and also analyses whether strategic management disclosure is a short-term tactic or a long-term strategy in terms of the coherence of positive and negative tone.

References

- [1] Healy P M, K G Palepu. The effect of firms financial disclosure strategies on stock prices [J]. *Accounting Horizons*, 1993, 7(1):1-11.
- [2] Hall E. T., *Beyond culture* [M]. Chicago, 1976, 43(7), 4-20.
- [3] Zeng Qingsheng, Zhou Bo, Zhang Cheng, Chen Xinyuan. Annual report tone and insider trading: "One voice" or "one mouth, one heart"? [J]. *Management World*, 2018, 34(09): 143-160.
- [4] Wang Huajie, Wang Kemin. A study on accrual manipulation and annual report text information tone manipulation [J]. *Accounting Research*, 2018, (04): 45-51.
- [5] Fu Wenbo, Zeng Hao. Can non-punitive regulation restrain management tone manipulation - empirical evidence based on annual report texts[J]. *Contemporary Finance and Economics*, 2022, (03): 89-101.
- [6] Sun Bo, Liu Shansi, Jiang Junhui, Ge Chunmian, Zhou Huai Kang. Corporate financing constraints and innovation performance: a human capital social network perspective [J]. *China Management Science*, 2019, 27(04): 179-189.
- [7] Yu Lifeng, Tang Ya, Xu Jianguo. Financing constraints, share price information content and investment - share price sensitivity [J]. *Financial Research*, 2014, (11): 159-174.
- [8] Fazzari S, Hubbard R G, Petersen B C. Financing constraints and corporate investment [R]. *Brookings Papers on Economic Activity*, 1988, (19), 141-195.
- [9] Hughes J S, Liu J. Information asymmetry, diversification, and cost of capital [J]. *The Accounting Review*, 2007, 82, (3):705-729.
- [10] Kaplan S. N, Zingales L. Do investment-cash flow sensitivities provide useful measures of financing constraints?[J]. *The Quarterly Journal of Economics*, 1997, 112(1): 169-215.
- [11] Wang Bijun, Tan Yuyan, Yu Miaojie, Huang Yiping. Does financing constraint inhibit outward foreign direct investment by Chinese private enterprises [J]. *World Economy*, 2015, (12): 54-78.
- [12] Whited T. M. and Wu G. Financial constraints risk [J]. *The Review of Financial Studies*, 2006, 19(2): 531-559.
- [13] Hadlock C J, J P Pierce. New evidence on measuring financial constraints: Moving Beyond the KZ Index. *Review of Financial Studies*, 2010, 23 (5): 1909- 1940.
- [14] Zhang JX, Wang Y. Accounting robustness and corporate finance constraints - a study based on two types of robustness perspectives [J]. *Accounting Research*, 2013(09): 44-50.
- [15] Lian Yunjun, Cheng Jian. Investment-cash flow sensitivity: financing constraints or agency costs? [J]. *Financial Research*, 2007, (02): 37-46.
- [16] Jiang Teng, Zhang Yongji, Zhao Xiaoli. Economic policy uncertainty and corporate debt financing [J]. *Management Review*, 2018, 30(03): 29-39.
- [17] Wang Wenhua, Zhang Zhuo. Financial development, government subsidies and R&D financing constraints - empirical evidence from A-share listed high-tech companies[J]. *Economic and Management Research*, 2013, (11): 51-57.
- [18] Qiang Haofan, Yan Han, Zhang Wencheng, Xiao Kangkang. State-owned venture capital and corporate financing constraints: As hoped or against the grain? [J]. *Financial Research*, 2021, 47(11): 154-169.
- [19] Fu Haoliang, Li Keo-Bo, Lu Yin. Annual report text tone manipulation and the risk of share price collapse [J]. *Financial Accounting Newsletter*, 2021, (17): 72-77.
- [20] Booth J R, Deli D N. On executives of financial institutions as outside directors [J]. *Journal of Corporate Finance*, 1999, 5(3): 227-250.
- [21] Lang M H, Lundholm R J. Corporate disclosure policy and analyst behavior [J]. *Accounting Review*, 1996, 71(4): 467-492.

- [22] Pittman J A, Fortin S. Auditor choice and the cost of debt capital for newly public firms [J]. *Journal of Accounting and Economics*, 2004, 37(1): 113-136.
- [23] Lu Dong, Song Xinbei. Media coverage, readability of listed companies' annual reports and financing constraints [J]. *Journal of Management Science*, 2021, 24(12): 45-61.
- [24] Loughran T, McDonald B. When is a liability not a liability? Textual analysis, dictionaries, and 10 Ks [J]. *Journal of Finance*, 2011, 66(1):35-65.
- [25] Li Xiaoxi, Rao Pingui, Yue Heng. Annual report inquiry letters and management performance forecasts [J]. *Management World*, 2019, 35(08): 173-188+192.
- [26] Baginski S P, Hassell J M, Hillison W A. Voluntary causal disclosures: tendencies and capital market reaction [J]. *Review of Quantitative Finance & Accounting*, 2000, 15(4):371-389.
- [27] Spence M, "Job Market Signaling", *Quarterly Journal of Economics*, 1973, 87(3), 355-374.
- [28] Tetlock P C, "Giving Content to Investor Sentiment: The Role of Media in the Stock Market", *Journal of Finance* [J], 2007. 62(3), 1139-1168.
- [29] Ferris S P, Q Hao and M Y Liao, "The Effect of Issuer Conservatism on IPO Pricing and Performance" [J], *Review of Finance*. 2013, 17(3), 993-1027.
- [30] Li Shigang, Jiang Yaoming. Does the tone of textual information in listed companies' annual reports affect audit opinions? [J]. *Accounting Research*, 2020, (05): 178-192.
- [31] Liang, Rixin., Li, Ying. Annual report text tone and audit fees - empirical data from A-share listed companies in China [J]. *Audit Research*, 2021, (05): 109-119.
- [32] Leung S, Parker L, Curtis J. Impression management through minimal narrative disclosure in annual reports [J]. *British Accounting Review*, 2015(3) : 275-289.
- [33] Zhou Bo, Zhang Cheng, Zeng Qingsheng. Annual report tone and share price crash risk - empirical evidence from Chinese A-share listed companies [J]. *Accounting Research*, 2019, (11): 41-48.
- [34] Ertugrul M, Lei J, Qiu J, Wan C. Annual Report Readability, Tone Ambiguity, and the Cost of Borrowing [J]. *Journal of Financial and Quantitative Analysis*, 2017, 52, (2): 811-836.
- [35] Wang Xiongyuan, Zeng Jing. Annual report risk disclosure and bank lending rates [J]. *Beijing: Financial Research*, 2019, (1): 54-71.
- [36] Price M K, Doran J S, Peterson D R, et al. Earnings conference calls and stock returns: the incremental informativeness of textual tone [J]. *Journal of Banking & Finance*, 2012, 36(4):992-1011.
- [37] Zhao Yuliang. A study on the impact of annual report net tone on corporate debt financing [J]. *Economic Management*, 2020, 42(07): 176-191.
- [38] Xie, D. R., Lin, L. Can management tone predict the future performance of a company? -- A textual analysis based on annual earnings presentations of listed companies in China [J]. *Accounting Research*, 2015, (02): 20-27+93.
- [39] Wu Wenfeng, Wu Chongfeng, Rui Meng. Government background and tax benefits of executives in Chinese listed companies [J]. *Management World*, 2009, (03): 134-142.
- [40] Bu Danlu, Wang Xiaoyan. Government subsidies, soft constraints and the pay gap [J]. *Nankai Management Review*, 2014, 17(02): 23-33.
- [41] Dai Lu, Song Di. The impact of mandatory design of executive equity incentive contract performance targets on firm management performance [J]. *China Industrial Economics*, 2018, (04):117-136.
- [42] Xu N, X Li, Q Yuan and K C Chan, "Excess perks and stock price crash risk: Evidence from china" [J], *Journal of Corporate Finance*, 2014, 25(2), 419-434.
- [43] Arellano M, Bover O. Another look at the instrumental variable estimation of error-components models [J]. *Journal of Econometrics*, 1995, 68(1):29-51.
- [44] Petersen M A. Estimating standard errors in finance panel data sets: Comparing approaches [J]. *Review of Financial Studies*, 2009, 22 (1): 435-480.
- [45] Davis A K, Piger J M, Sedor L M. Beyond the Numbers: Measuring the Information Content of Earnings Press Release Language[J]. *Contemporary Accounting Research*, 2012, 29, (3): 845-868.
- [46] Jiang Fuxiu, Zhang Min, Lu Zhengfei, Chen Caidong. Managerial overconfidence, corporate expansion and financial distress [J]. *Economic Research*, 2009, 44(01): 131-143.

- [47] Qi Jiangna, Chen Huilin, Zhang Qinyuan. Firm size, brand, price and audit quality: A study of fees and quality in the international "Big Four" audit market in China [J]. *Audit Research*, 2004, (03): 59-65.
- [48] Yi Zhihong, Zhu Lin, Chen Qinyuan. Negative disclosure of analyst research reports and the risk of stock price plunges [J]. *Nankai Management Review*, 2019, 22(05): 192-206.
- [49] Bushee B J, J E Core, W Guay, and J Wee, "The Role of the Business Press as an Information Intermediary" [J]. *Journal of Accounting Research*, 2010, (48): 1-19.
- [50] Wen Zhonglin, Zhang Lei, Hou Jietai et al. Mediated effects testing procedures and their applications [J]. *Journal of Psychology*, 2004, (05): 111-117.
- [51] Wang Xiaolu, Fan Gang, Hu Lipeng. China marketization index report by provinces (2018) [M]. Social Science Literature Press, 2019.
- [52] Dou Chao, Wang Qiaoyuan, Chen Xiao. Can government background customer relationship alleviate private enterprises' financing constraints? [J]. *Financial and Economic Research*, 2020, (11): 49-63+168.
- [53] Harford J. Corporate cash reserves and acquisitions [J]. *The Journal of Finance*, 1999, 54(6): 1969-1997.
- [54] Kim J B, Zhang L. Financial Reporting Opacity and Expected Crash Risk: Evidence from Implied Volatility Smirks [J]. *Contemporary Accounting Research*, 2014(31):851-875.
- [55] Li Yunhe, Li Zhan, Tang Songlian. Corporate life cycle, corporate governance and efficiency of corporate capital allocation [J]. *Nankai Management Review*, 2011, 14(03): 110-121.