

Advertising, Investor Attention and Stock Price Crash Risk

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Abstract. The rapid development of the advertising industry fits the background of the rise of new Internet media, and its impact on the stock value of listed companies has also attracted much attention from both theoretical and practical circles. This paper selects investor attention as a mediating variable to investigate the relationship and impact path of advertising investment and stock price crash risk. This paper selects 6115 data of listed companies in Shanghai and Shenzhen A-shares from 2013 to 2019 to construct a curvilinear mediation model, and use the hierarchical regression analysis to find that: there is an inverted U-shaped relationship between advertising input and stock price crash risk; advertising input positively affects investor attention; there is an inverted U-shaped relationship between investor attention and stock price crash risk; advertising input has an indirect impact on stock price crash risk through the curvilinear relationship between investor attention and stock price crash risk. The contribution of this paper mainly lies in revealing the non-linear mechanism of advertising input's impact on stock price crash risk by exploring the monitoring and contagion effects of advertising under different input levels, which breaks through the previous research on the linear relationship between advertising, investor attention and stock price. The study also examines the impact of advertising input on stock price crash risk by exploring the monitoring and contagion effects of advertising under different input levels, which breaks through the previous research on the linear relationship between them, and also has important implications for the advertising decisions of managers of listed companies.

Keywords: Advertising; Stock Price Crash Risk; Investor Attention; Curvilinear Mediation Model.

1. Introduction

Since 2022, China's stock market continued to slump. 25 April, A share price downturn, with major stock indices falling more than 2%. Especially, the Shanghai Stock Exchange Index fell below the 3,000-point integer mark, hitting a new low of nearly 2 years. As of April 25, the first day opening breakout rate of listed companies in Shanghai and Shenzhen in 2022 was over 30%... ..The fall or even crash of the share price not only involves the interests of the relevant listed companies, but also the stability of the financial market and the safety of the financial system. Meanwhile, with the rapid development of the Internet and social media, China's advertising industry has entered a period of vigorous development. Data show that from 2013 to 2019, the turnover of China's advertising industry grew from RMB 502 billion to RMB 867.4 billion, with an average growth rate of 9.20%, accounting for 0.88% of GDP. There is now an extensive literature (Barron, 1971; Boyd and Schonfeld, 1977[1]; Lou, 2014[2]) that advertising by listed companies can influence not only consumer purchasing behaviour, but also stock value by influencing investor decisions.

Although advertising is intuitively attractive, does more of this marketing action necessarily pay off? Current research on the impact of advertising on stock markets has reached mixed conclusions, but the idea that advertising investment can successfully attract investor attention has been better argued in studies by scholars such as Lou, D. (2014) and Madsen & Niessner (2019) [7]. Starting from the influence path of investor attention, there are two main views on the impact of advertising investment on stock price crash: firstly, information monitoring, advertising can improve investor attention to financial information of listed companies by improving information channels and broadening information sources, and reduce information transparency in order to reduce the stock price crash risk; secondly, irrational contagion, advertising may excessively attract investor attention

and amplify sentiment and the extent of stock mispricing, thereby exacerbating the risk of a share price crash.

In view of the inconsistent findings on the impact of advertising on the share prices and the lack of targeted research on the advertising's impact on share price crash risk, this paper conducts an empirical analysis on the above issue based on the data of listed companies in Shanghai and Shenzhen A-shares from 2013 to 2019 to explore the "monitoring effect" and "contagion effect" of advertising under different input levels. The paper argues that the monitoring effect of advertising dominates when the input level is low, and the contagion effect dominates when the level is high, i.e. advertising input has an inverted U-shaped effect on stock price crash risk through the mediating variable of investor attention. The contribution of this paper is mainly in the following three points. Firstly, the selection of advertising input as an influencing factor broadens the study of the factors influencing stock price crash risk; secondly, it selects investor attention as the mediating variable and confirms that advertising input indirectly influences the stock price crash risk through the path of investor attention curve, revealing the non-linear influence mechanism of advertising on share price crash risk, which breaks through the previous research on the linear relationship between them; thirdly, this paper has important implications for listed companies' managers. It shows that both too much and too little advertising will lead to a higher rate of share price crash risk. This finding may prompt managers to adjust their advertising decisions, keep advertising input within a reasonable range and take the initiative to improve information transparency in order to achieve smooth operation and sustainable development of the company.

The second part of the paper presents a theoretical analysis and research hypothesis based on the literature research. The third part is the sample selection and research design. The fourth part is the empirical results and analysis. The fifth part is the conclusion and recommendations.

2. Theoretical Analysis and Research Hypothesis

2.1 Advertising and the risk of share price collapse

The impact of advertising on stock price crash risk is mainly based on the information asymmetry theory and the information hiding hypothesis. From an information asymmetry perspective, there is an information asymmetry between insiders and outside investors, and some of the negative news cannot be exposed, and as time passes, it may be exposed to the public, leading to a stock price crash. The "information hiding hypothesis" suggests that if a company's management hides bad news, the transparency of the news is reduced and as the company continues to operate, the news accumulates and external parties overvalue the company's share price, creating a bubble. At the end of the day, when the negative news reaches a critical mass, it will explode on the external markets and the company's share price will be greatly affected, leading to a crash.

Different scholars have also given different conclusions about the effect of advertising inputs on the share price of a company. Boyd and Schonfeld (1977)[1] mentioned in their study that financial news advertisements can positively affect the value of securities by reducing investors' information search costs or search behaviour, changing investor preferences or providing new information. Grullon, Kanatask and Weston (2004)[5] have shown that advertising expenditures increase investors' familiarity with listed companies, which in turn increases the number of institutional investors and optimises the liquidity of their common stock. Joshua Madsen and Marina Niessner (2019)[7] propose that stock trading volume and quote depth increase with the presence of advertisements in business publications. Combining the formation mechanism of stock crash risk with the positive impact of advertising on the stock market as argued in the above study, this paper argues that when the level of advertising input is low, increasing advertising input can be effective in improving information channels, increasing company visibility and improving information transparency to cut the level of bad news accumulation, which has a dampening effect on stock crash risk. However, Lou (2014)[2] found that an increase in advertising spending can lead to an increase in abnormal stock returns, but with a concomitant fall in returns. Chemmanur and Yan (2009)[8] show that superior companies show

their higher valuation by increasing product market advertising prior to stock issuance subsequently experience lower IPO/SEO first day returns. Compared to the views of scholars such as Boyd and Schonfeld (1977) on the positive impact of advertising, studies such as Lou (2014) focus more on exploring the temporary return effect of advertising and its negative impact on the stock market. Therefore, this paper argues that when the level of advertising input exceeds a certain threshold value, continuing to increase it will trigger irrational buying and selling behaviour of investors, which will increase the volatility of stock prices, cause stock prices to be inflated, intensify the formation of bubbles and raise the risk of stock price crash. Accordingly, this paper proposes the first research hypothesis.

H1 :Company advertising input has an inverted U-shaped impact on stock price crash risk.

2.2 Advertising and investor attention

Research on the relationship between advertising inputs and investor attention is based on the limited attention theory. In the model of Hirshleifer and Teoh's (2003)[9], investors prefer to accept information that is simple, salient, and easy to convey, and ignore relatively complex public information. Barber and Odean (2008) find that investors respond quickly to information that catches their attention quickly (e.g., information published in the New York Times) and that the form of information presentation directly affects investors' processing of information and the price of securities. Slovic (1972) and Payne (1993) suggest that limited information processing capabilities encourage individuals to use information without adapting it to its true form, and to use it directly.

There is also more discussion about the relationship between advertising and investor attention. Joshua Madsen and Marina Niessner (2019)[7] show that a temporary surge in investor attention is triggered through the use of print advertisements, particularly in business publications. In attention-constrained situations, advertisements appear to alert current and potential investors to pay more attention to a company's information and can increase their search for financial information. Body and Schonfeld (1977)[1] specifically mention in their paper that advertising can reduce passive search costs and that its catalytic effect can stimulate extensive searches by investors. Lou's study (2014)[2] notes that, under an opportunistic managerial behavioural view, advertising expenditures shortly before an insider deal are rarely motivated by a sound business plan, but more by the desire to attract investor attention. On this basis, we conclude that advertising input is positively related to investor attention, i.e. the more money a company spends on advertising, the more investors pay attention to the company.

H2 : Advertising input has a significant positive effect on investor attention.

2.3 Investor attention and stock price crash risk

Research addressing the relationship between investor attention and stock price crash risk is supported by a relatively large literature. Tang, S. Yuan and Li, Dan (2018) measured investor attention by the total number of stock bar postings and found that it was significantly positively related to the risk of future stock price crash. Jiang Jie, Qiu Jacheng, Zhu Ran and Hu Haifeng (2020)[3] (2020) proposed the "crash effect of attention", which means that an increase in investor attention will significantly increase the risk of stock price crash in the next period, and this effect only exists in companies with low institutional shareholding and in bullish market conditions; Ding and Xin (2020)[4] pointed out that the high proportion of individual investors in China often lacks professional investment judgment and is unable to make more rational decisions on the information appearing in the market, so investor attention will strengthen the positive relationship between listed companies' goodwill and stock price crash risk; while Hao Jing (2019)[16] pointed out from a monitoring perspective that investor attention behavior in obtaining corporate information can be regarded as a kind of active management of the company, and that in the Internet information era, negative information is more easily exposed, and the enhancement of investor attention will make it more difficult for management to conceal negative news, thus reducing its share price crash risk. Similarly,

Gu Zheyong (2020) shows that investor attention is negatively related to stock price crash risk, all else being equal.

This shows that there are two mainstream academic views on the impact of investor attention on stock price crash risk. First, investor attention has a "monitoring effect", investor attention may reduce the risk of stock price crash by expanding the information set, promoting information dissemination and other ways to reduce information opacity; second, investor attention has a "contagion effect", whereby it may exacerbate the risk of a stock crash by increasing the degree of heterogeneous investor beliefs and amplifying sentiment, leading to stock mispricing. This paper argues that both channels of action exist, with the monitoring effect dominating when investor attention is low and the contagion effect dominating when investor attention is high. Accordingly, the paper proposes a third hypothesis.

H3 : Investor attention has an inverted U-shaped effect on stock price crash risk.

2.4 Curvilinear mediation effect of investor attention

The above theoretical analysis illustrates that both advertising input and investor attention have an inverted U-shaped effect on the risk of stock price collapse and that there is a significant positive correlation between investor attention and advertising placement. Lou (2014) mentions in his study that although advertisements almost never portray their products or companies in an objective and comprehensive manner, investors with limited attention spans may start with the face value of the advertisement and make an over optimistic reactions, which can lead to temporary price overshooting. This affirms the mediating effect that investor attention plays in the role of advertising in financial markets. Combining H2 with H3 , this paper proposes a fourth hypothesis.

H4 : Advertising placement can have an impact on stock price crash risk indirectly through the curvilinear path of investor attention.

3. Sample Selection and Study Design

3.1 Sample selection and data sources

This paper takes listed companies in the Shanghai and Shenzhen A-share markets from 2013-2019 as the research sample and treats the sample observations as follows: (1) exclude data with missing samples for each indicator in the target year; (2) exclude samples of financial companies; (3) exclude samples whose annual reports are ST in the year; and (4) exclude samples with trading weeks of less than 30. All data are obtained from CSMAR and Wind databases. The proxy variable for investor attention - the annual average of the Baidu search index for the stock code - was crawled through Python. Finally, through sample exclusion and data pre-processing, we obtained a total of 1076 stocks of listed companies and their related indicators, with a total of 6115 sample observations.

3.2 Definition of variables

3.2.1 Stock Price Crash Risk

In this paper, stock price crash risk (Crashrisk) as the explanatory variable, drawing on studies by Chenetal (2001), Kimetal (2011a,2011b) and Nianxing Xu (2012)[11] and others, we use the negative return skewness coefficient (NCSKEW) and the upward and downward earnings volatility ratio (DUVOL) to measure it.

First, using the weekly return data for stock *i* for each year, the adjusted return for stock *i* is calculated as follows.

$$r_{i,t} = \alpha_i + \beta_1 R_{m,t-2} + \beta_2 R_{m,t-1} + \beta_3 R_{m,t} + \beta_4 R_{m,t+1} + \beta_5 R_{m,t+2} + \varepsilon_{i,t} \quad (1)$$

where $r_{i,t}$ is return rate of the stock at week *t* of each year considering reinvestment of cash dividends. $R_{m,t}$ is the average return on all A-share stocks weighted by market capitalisation outstanding in week *t*. To adjust for the effect of non-synchronous stock trading (Dimson, 1979), this

paper adds lagged and ahead terms of the average market return to model (1). $\varepsilon_{i,t}$ is a residual term representing the portion of individual stock returns that cannot be explained by market returns. Since the $\varepsilon_{i,t}$ distribution is non-standard normal, it is first transformed into a roughly symmetric distribution (Huttonetal, 2019), and the returns specific to stock i in week t are obtained after the following treatment $W_{i,t}$:

$$W_{i,t} = \ln(1 + \varepsilon_{i,t}) \tag{2}$$

Secondly, using the $W_{i,t}$ constructing the following two indicator variables.

(1) Negative skewness coefficient (NCSKEW) of the market-adjusted weekly return of stock i:

$$NCSKEW_{i,t} = - \frac{[n(n-1)^{\frac{3}{2}} \sum W_{i,t}^3]}{[(n-1)(n-2)(\sum W_{i,t}^2)^{\frac{3}{2}}]} \tag{3}$$

where n is the number of trading weeks per year for stock i. A larger value of NCSKEW indicates a greater risk of a share price crash for the firm.

(2) Upward and downward volatility ratio of returns (DUVVOL), which measures the difference in volatility between the upward and downward phases of share prices.

$$DUVOL_{i,t} = \frac{\log\{[(n_u-1) \sum_{DOWN} W_{i,t}^2]\}}{[(n_d-1) \sum_{UP} W_{i,t}^2]} \tag{4}$$

where n_u is the week-specific rate of return for stock i. $W_{i,t}$ is the number of weeks for which the average annual return W_i is greater than the average annual return, n_d is the number of weeks in which stock i's weekly characteristic return $W_{i,t}$ is less than the average annual return W_i , and DUVOL is the annual stock price crash risk indicator for a company. A higher value of DUVOL indicates a higher risk of stock price collapse. The above two risk indicators have been adjusted to exclude market factors and represent stock-specific crash risk only.

3.2.2 Advertising Input

We obtained data on company advertising input from the wind database of annual reports of listed companies. Drawing on the work of Grullon, Kanatask and Weston (2004), the explanatory variable of advertising input is defined as the cost of advertising media (radio, television, newspapers and periodicals, etc.) and promotion costs. We use the absolute value of a firm's advertising expenditures rather than the ratio of advertising to sales or assets as a measure because they do not provide a true measure of the effect of advertising. In this paper, we standardise the annual advertising spend of listed companies to obtain the explanatory variable AD .

3.2.3 Investor Attention

This paper explores the role that investor attention plays when advertising affects stock price crash risk from a behavioural finance perspective. Therefore, this paper uses investor attention as the mediating variable in the empirical model. Based on the rapid development of China's search engine market in recent years and Baidu's leading position in China's search engine market, this paper draws on Ding-Xin's (2020) research methodology and chooses a direct measure - the sum of Baidu search indices for stock tickers to quantify investor attention. In terms of sample data processing, this paper first averages the weekly Baidu index for each stock as the annual search volume. Due to the large difference between the initial data and the stock price crash risk magnitude, this paper standardises the Baidu search index of stock code to obtain the investor attention indicator $AT_{i,t}$ as the mediating variable.

3.2.4 Control Variables

Drawing on the studies of Grullong, Kanatask and Weston (2004), Ding-Xin (2020), we choose firm size (Size), market capitalization-to-book ratio (MB), return on total assets (ROA), gearing ratio

(Lev), mean of firm's adjusted weekly returns (Ret), firm's adjusted weekly return volatility (Sigma), year effect (Year), industry effect (Industry) as control variables. The detailed description is shown in Table 1.

Table 1. Summary of model variables

	Variable name	Variable symbols	Variable definitions and formulas	Data sources
Explained variables	Risk of share price collapse	$CrashRisk_{i,t+1}$	respectively, using the one-year backward equity negative return skewness coefficient $NCSKEW_{i,t}$ and equity up/down volatility ratio measures $DUVOL_{i,t}$	CSMAR Stata Calculation
Explanation Variables	Advertising input	$AD_{i,t}$	Natural logarithm of the total amount spent on advertising by listed company i in period t	Wind
Intermediaries Variables	Investor attention	$AT_{i,t}$	Natural logarithm of the weekly Baidu search index for security code i of listed companies in period t	Python Crawl
	Company size	$Size_{i,t}$	Natural logarithm of company total assets	CSMAR
Control Variables	Market capitalisation-to-book ratio	$MB_{i,t}$	$MB_{i,t} = (\text{Stock price at the end of year } t \times \text{number of tradable shares} + \text{net assets per share} \times \text{number of non-tradable shares}) / \text{book equity value} = (\text{share price at the end of year } t * \text{number of shares outstanding} + \text{net assets per share} * \text{number of non-marketable shares}) / \text{book equity value}$	CSMAR
	Return on total assets	$ROA_{i,t}$	$ROA_{i,t} = NI_{i,t} / Asset_{i,t-1}$ $NI_{i,t}$ is the net profit of company i in year t, and $Asset_{i,t-1}$ is the total assets of company i in year t - 1	CSMAR
	Gearing ratio	$Lev_{i,t}$	$Lev_{i,t} = Liability_{i,t} / Asset_{i,t}$, $Liability_{i,t}$ is the total liability of company i in year t	CSMAR
	Holding Yield	$Ret_{i,t}$	Average weekly rate of return for firm i in year t	CSMAR
	Holding Return Volatility	$Sigma_{i,t}$	fluctuations in earnings of firm i in year t. Specifically, the standard deviation of week t-specific returns	CSMAR
	Annual Effect	Year	dummy variable, taking 1 when the sample belongs to a particular year. Otherwise take 0	
	Industries Effect	Industry	dummy variable, taking 1 when the sample belongs to an industry. Otherwise take 0	

3.3 Empirical model design

This paper uses hierarchical regression analysis[14] to conduct hypothesis testing. Firstly, standardise advertising input and investor attention and construct the quadratic terms. In order to test hypothesis one, introduce advertising input and its quadratic terms in turn for regression analysis using stock price crash risk as the outcome variable, and construct models (7) and (8) to verify the effect of advertising input of listed companies on stock price crash risk as follows.

$$CrashRisk_{i,t+1} = \alpha_0 + \alpha_1 AD_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (7)$$

$$CrashRisk_{i,t+1} = \beta_0 + \beta_1 AD_{i,t} + \beta_2 AD_{i,t}^2 + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (8)$$

Where $CrashRisk_{i,t+1}$ represents stock price crash risk one year in the future and is replaced by $NCSKEW_{i,t}$ and $DUVOL_{i,t}$ respectively.

To test hypothesis two, construct regression models (9) using investor attention as the outcome variable and advertising input as the explanatory variable.

$$AT_{i,t} = b_0 + b_1AD_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (9)$$

To test hypothesis three, construct models (10) and (11) to test the effect of investor attention on stock price crash risk by sequentially introducing a regression analysis with investor attention and its quadratic term of using stock price crash risk as the outcome variable.

$$CrashRisk_{i,t+1} = c_0 + c_1AT_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (10)$$

$$CrashRisk_{i,t+1} = d_0 + d_1AT_{i,t} + d_2AT_{i,t}^2 + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (11)$$

To test hypothesis four, construct a curve mediation model[17] . On the basis of model (8), introduce the mediating variable investor attention and its quadratic term to construct model (12) to initially test the mediating role of investor attention.

$$CrashRisk_{i,t+1} = e_0 + e_1AD_{i,t} + e_2AD_{i,t}^2 + e_3AT_{i,t} + e_4AT_{i,t}^2 + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (12)$$

Finally the whole curve mediation model was further tested using Bootstrap[15] to construct the parametric IND:

$$IND = b_1 \times e_4 \quad (13)$$

IND is the product of the coefficient b1 in model (9) and the coefficient e4 in model (12) and represents the strength of the indirect effect of advertising input on the curve of stock price crash risk through investor attention. Therefore, the strength of the significance of IND can be used as a test for mediating effects.

4. Empirical Results and Analysis

4.1 Descriptive Statistics

The data of listed companies in Shanghai and Shenzhen A-shares from 2013-2019 are screened and pre-processed to total 6,115 items. This paper applies Stata to conduct descriptive statistics for following ten indicators of above data. The results are shown in Table 2.

Table 2. Descriptive statistics for key variables

Variables	Sample size	Average value	Standard deviation	Median	Minimum value	Maximum value
<i>NCSKEW_{i,t}</i>	6115	-0.305	0.720	-0.260	-2.707	2.139
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<i>DUVOL_{i,t}</i>	6115	-0.194	0.480	-0.199	-1.588	1.272
<i>AD_{i,t}</i>	6115	15.689	2.215	15.570	5.814	23.331
<i>AT_{i,t}</i>	6115	3.474	0.982	3.689	0	7.191
<i>Size_{i,t}</i>	6115	22.307	1.268	22.148	18.626	28.341
<i>MB_{i,t}</i>	6115	0.614	0.247	0.604	0.025	1.422
<i>ROA_{i,t}</i>	6115	0.038	0.067	0.037	-1.068	0.494
<i>Lev_{i,t}</i>	6115	0.425	0.209	0.412	0.008	1.237
<i>Ret_{i,t}</i>	6115	0.151	0.552	0.037	-0.822	6.618
<i>Sigma_{i,t}</i>	6115	0.063	0.026	0.057	0.014	0.46

The mean value of *NCSKEW_{i,t}* and *DUVOL_{i,t}* are -0.305 and -0.194 respectively, indicating that the overall stock price crash risk of the sample companies is not high, but their maximum values are 2.139 and 1.272 respectively, indicating that there are individual companies with a high risk of share price collapse, and with standard deviations of 0.72 and 0.48, the share price risk profile varies widely between companies; the explanatory variable *AD_{i,t}*'s mean (15.689) and median (15.570) are very close, indicating that the sample companies are more symmetrically distributed in terms of advertising input. But the maximum value is 23.331 and the minimum value is 5.814, with a large extreme difference and a standard deviation of 2.215, indicating that there is a large difference between companies in terms of advertising input; the mediating variable *AT_{i,t}*'s mean value (3.474) is slightly smaller than the median (3.689) and the data shows a slightly left-skewed distribution,

indicating that there are some companies with only small attention values and a standard deviation of 0.982, a more dispersed distribution.

4.2 Correlation Analysis

In order to initially test whether the hypothesis is valid and to check whether there is a problem of multicollinearity between the variables, a correlation analysis was conducted and the results are shown in Table 3.

Table 3. Variable correlation analysis table

	NCSKEW	DUVOL	AT	AD	Size	Ret	MB	Sigma	ROA	Lev
NCSKEW	1	.876**	.027*	.008**	-.080**	-.107**	-.076**	-.022	.040**	-.083**
DUVOL		1	.038	.000	.000	.000	.000	.084	.002	.000
AT			1	.142**	.134**	.412**	-.082**	.152**	-.022	.120**
AD				1	.421**	-.024	.191**	-.057**	.058**	.210**
Size					1	-.085**	.485**	-.134**	-.003	.490**
Ret						1	.000	.000	.823	.000
MB							1	.000	.001	.000
Sigma								1	-.058**	.000
ROA									1	-.311**
Lev										1

Continuation Sheet

Note: Where** represents a significance level of 1% and* represents a significance level of 5%.

The correlation coefficient between AT and AD was 0.142 at the 1% significance level, which initially tested hypothesis two. In addition, we used the correlation coefficient of 0.5 as the threshold for defining whether there is co-collinearity, and ranked the correlation coefficients between the respective variables. From the above table, it can be seen that the correlation coefficients between the respective variables are less than 0.5, indicating that there is no serious problem of multicollinearity.

4.3 Empirical Test Results

The results of the hypothesis testing are shown in Table 4, with (1) (3) (9) listed as the baseline model with the introduction of control variables only.

To test hypothesis one, perform regression analysis on model (7) (8). Columns (4)(10) are the regression results with advertising input as the only explanatory variable and NCSKEW and DUVOL as the explanatory variables with a one-period lag. Column (5)(11) is the regression result of introducing the quadratic term of advertising input based on column (4)(10). The regression results from (4) and (5), (10) and (11) show that the coefficient of advertising input becomes insignificant after the inclusion of its quadratic term, while the coefficient of the quadratic term is significantly negative at the 1% level. And from ΔR^2 , it can be seen that model (8) has additional explanatory

power for stock price crash risk compared to model (7), and hypothesis one holds, i.e. company advertising input has an inverted U-shaped effect on stock price crash risk.

In order to test hypothesis two, this paper regressed model (9) and the results are shown in columns (1)(2), where there is a significant positive effect of advertising input on investor attention at the 1% level of significance and hypothesis two holds.

In order to test hypothesis three, perform regression analysis on model (10) (11). Columns (6)(12) are the regression results with investor attention as the only explanatory variable and NCSKEW and DUVOL as the explanatory variables with a one-period lag. Column (7)(13) is the regression result of introducing the quadratic term of investor attention based on column (6)(12). The comparison shows that the coefficient of investor attention is no longer significant after the inclusion of its quadratic term of investor attention, while the coefficient of the quadratic term is significantly negative at the 1% level. And from ΔR^2 , it can be seen that model (11) has additional explanatory power for stock price crash risk compared to model (10), and investor attention has an inverted U-shaped effect on stock price crash risk, hypothesis three holds.

Table 4. Hypothesis testing results

	AT		NCSKEW _{t+1}							DUVOL _{t+1}				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
AD		0.019*** (0.004)		0.015** (0.005)	0.001 (0.002)					0.014** (0.003)	0.001 (0.001)			0.021 (0.019)
AD ²					-0.017** (0.002)						-0.018** (0.006)			-0.002 (0.001)
AT						0.043** (0.018)	0.098 (0.299)	0.100*** (0.030)				0.031** (0.012)	0.003 (0.002)	0.053*** (0.020)
AT ²							-0.007*** (0.002)	-0.006** (0.003)					-0.053*** (0.019)	-0.013*** (0.002)
Size	0.214*** (0.011)	0.280*** (0.010)	-0.014 (0.016)	-0.020 (0.012)	-0.017 (0.017)	-0.030* (0.017)	-0.040* (0.017)	-0.039** (0.018)	-0.035*** (0.010)	-0.032*** (0.008)	-0.038*** (0.011)	-0.047*** (0.012)	-0.050*** (0.008)	-0.050*** (0.012)
MB	-0.629*** (0.044)	-0.985*** (0.045)	-0.048 (0.062)	-0.194 (0.535)	-0.042 (0.063)	-0.009 (0.064)	0.015 (0.065)	0.016 (0.065)	0.027 (0.041)	-0.069 (0.035)	0.032 (0.042)	-0.098* (0.056)	-0.006 (0.037)	0.066 (0.043)
ROA	-0.748*** (0.131)	-1.401*** (0.126)	0.090 (0.203)	0.333 (0.151)	0.097 (0.203)	0.137 (0.204)	0.195 (0.205)	0.197 (0.205)	0.099 (0.135)	0.206 (0.100)	0.106 (0.135)	0.047*** (0.153)	0.296*** (0.101)	0.159 (0.137)
Lev	0.317*** (0.051)	-0.058* (0.051)	-0.191*** (0.070)	-0.971*** (0.061)	-0.187*** (0.070)	-0.058* (0.051)	-0.176** (0.070)	-0.178** (0.070)	-0.145*** (0.046)	-0.090*** (0.400)	-0.141*** (0.047)	-0.091 (0.060)	-0.086** (0.040)	-0.136*** (0.047)
Ret	0.093*** (0.019)	0.088*** (0.018)	0.199*** (0.025)	-0.223*** (0.215)	0.199*** (0.025)	0.088*** (0.018)	0.198*** (0.025)	0.197*** (0.025)	0.119*** (0.017)	-0.166*** (0.014)	0.119*** (0.017)	-0.232*** (0.022)	-0.171*** (0.014)	0.118*** (0.017)
Sigma	0.975*** (0.329)	1.356*** (0.313)	0.189 (0.420)	-0.688 (0.375)	0.178 (0.420)	1.356*** (0.313)	0.114 (0.420)	0.110 (0.420)	-0.034 (0.280)	-0.386 (0.248)	-0.045 (0.280)	-0.819 (0.374)	-0.4722 (0.2478)	-0.083 (0.280)
Adjust R ²	0.616	0.654	0.022	0.066	0.092	0.043	0.064	0.104	0.029	0.065	0.090	0.050	0.071	0.101
ΔR^2	0.616	0.038***	0.022	0.044***	0.026***	0.021***	0.021***	0.040***	0.029	0.036***	0.025***	0.021***	0.021***	0.030***

Note: Where *** represents significance at 1%, ** represents significance at 5% and * indicates significance at 10%. Standard errors are in brackets, as below.

To test hypothesis four, this paper first regressed model (12) and the results are shown in columns (8) and (12), which found that investor attention and its quadratic term have a significant effect on stock price crash risk at the 1% level, initially verifying the mediating role of investor attention. Bootstrap was used to test the significance of parameter (13) and the results show that the confidence interval of IND is [0.017, 0.057] does not contain 0 and p=0.000*** is significant at the 1% level, indicating that the curve mediation effect holds.

4.4 Robustness tests

4.4.1 Addition of a New Control Variable - Percentage of Shareholding of the Largest Shareholder

The percentage of shareholding of the first largest shareholder symbolizes the concentration of ownership of a listed company, with reference to the study in Bai Jingqi (2021) which showed that the first largest shareholders can have a significant impact on the control of a company and the higher the percentage, the lower the risk of share price collapse. In this paper, the regression test of model (8) (9) (11) (12) is re-run with the new control variable, and the results are shown in Table 5. All regression results are significant and consistent with those before the inclusion of the new control variables, and the regression coefficients have changed very little. The models can be considered to be robust.

Table 5. Regression results after adding new control variables

	AT		NCSKEW _{t+1}		DUVOL _{t+1}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
AD	0.021*** (0.004)	0.001 (0.028)		0.028 (0.029)	0.001 (0.018)		0.021 (0.019)
AD ²		-0.007*** (0.002)		-0.004*** (0.001)	-0.006*** (0.001)		-0.003*** (0.001)
AT			0.098 (0.099)	0.100 (0.090)		0.053 (0.049)	0.003 (0.002)
AT ²			-0.007** (0.003)	-0.006** (0.003)		-0.003*** (0.001)	-0.053*** (0.020)
Size	0.301*** (0.010)	-0.012 (0.015)	-0.033 (0.015)	-0.039** (0.018)	-0.031*** (0.001)	-0.0418*** (0.001)	-0.050*** (0.012)
MB	-0.935*** (0.044)	-0.081 (0.067)	-0.007 (0.069)	0.016 (0.065)	0.0169 (0.044)	0.0569 (0.045)	0.066 (0.043)
ROA	-1.127*** (0.127)	-0.072 (0.207)	0.041 (0.208)	0.197 (0.205)	.0202 (0.137)	0.0816 (0.137)	0.159 (0.137)
Lev	-0.119** (0.050)	-0.210*** (0.075)	-0.202*** (0.075)	-0.178 (0.070)	-0.1509 (0.049)	-0.1470*** (0.049)	-0.136*** (0.047)
Ret	-0.083 (1.276)	0.201*** (0.025)	0.196 (0.025)	0.197*** (0.025)	0.120 (0.017)	0.1171*** (0.017)	0.118*** (0.017)
Sigma	6.139*** (0.497)	0.239 (0.417)	0.159 (0.417)	0.110 (0.420)	-0.030 (0.279)	-0.0746 (0.279)	-0.083 (0.280)
first	-0.240*** (0.054)	0.050 (0.080)	0.067 (0.080)	0.043 (0.074)	0.049 (0.052)	0.0579 (0.052)	0.047 (0.049)
Continuation Sheet							
year&Ind	control						
Adjust R2	0.065	0.078	0.072	0.098	0.072	0.077	0.097

4.4.2 Lengthening the Lags of the Explanatory Variables

In order to avoid endogeneity issues, the previous paper uses data with the explanatory variables one period ahead in all regressions. For further robustness testing, the explanatory variables NCSKEW and DUVOL in model (8) (11) (12) are then treated two periods ahead in this paper, and the results are shown in Table 6. The regression results are all significant at the 5% level of significance, indicating that the original hypothesis is valid and robust.

4.4.3 Quantifying Stock Price Crash Risk with New Indicators

Another way to measure stock price crash risk - the occurrence or non-occurrence of a crash event - is mentioned in Jiang Jie (2019). Assigning the corresponding variable values to 1 and 0 according to whether a crash event occurred in the year of the sample company, and using it as a new explanatory variable *Crash*. Conduct a logistic regression of model (8) (11) (12) and the results are shown in Table 7. The regression results are still significant and can strongly prove that the original hypothesis holds.

Table 6. Regression results for the explanatory variables over two periods

	NCSKEW _{t+2}			DUVOL _{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
AD	0.026 (0.032)		0.040 (0.035)	0.017 (0.021)		0.023 (0.023)
AD ²	-0.003*** (0.001)		-0.003*** (0.001)	-0.003*** (0.001)		-0.004*** (0.001)
AT		0.058 (0.043)	0.068 (0.045)		0.017 (0.029)	0.021 (0.030)
AT ²		-0.005*** (0.002)	-0.005*** (0.002)		-0.003*** (0.001)	-0.003*** (0.001)
Size	-0.134 (0.017)	0.006 (0.017)	-0.020 (0.021)	-0.023** (0.011)	-0.030*** (0.011)	-0.029** (0.014)
MB	0.082 (0.017)	0.125 (0.079)	0.104 (0.075)	0.071 (0.051)	0.095* (0.052)	0.077 (0.050)
ROA	0.919*** (0.248)	0.980*** (0.248)	1.030*** (0.243)	0.528*** (0.163)	0.562*** (0.163)	0.580*** (0.161)
Lev	-0.129 (0.084)	-0.124 (0.083)	-0.120 (0.079)	-0.078 (0.055)	-0.076 (0.055)	-0.076 (0.052)
Ret	0.094*** (0.025)	0.088*** (0.025)	0.093*** (0.025)	0.051*** (0.017)	0.048*** (0.017)	0.050 (0.017)
Sigma	-0.889** (0.451)	-0.941 (0.451)	-0.926** (0.454)	-0.400 (0.299)	-0.431 (0.299)	-0.426 (0.300)
year&Ind				control		
Adjust R2	0.074	0.056	0.078	0.068	0.070	0.090

Table 7. Regression results for new explanatory variables

	<i>Crash_{t+1}</i>		
	(1)	(2)	(3)
AD	0.200 (0.150)		0.141 (0.161)
AD ²	-0.015*** (0.003)		-0.043*** (0.014)
AT		0.104 (0.120)	0.090 (0.123)
AT ²		-0.004*** (0.011)	-0.050*** (0.011)
Size	-0.125** (0.063)	-0.167 (0.067)	-0.149* (0.081)
MB	0.088 (0.290)	0.220 (0.299)	0.225 (0.294)
ROA	-1.785** (0.825)	-1.585 (0.831)	-0.953 (0.836)
Lev	-0.058 (0.310)	-0.041 (0.309)	-0.016 (0.308)
Ret	30.759*** (7.782)	30.510** (7.778)	0.308*** (0.108)
Sigma	-8.147 (3.180)	-8.935*** (3.207)	-0.447 (1.947)
year&Ind		control	

In summary, whether by adding new explanatory variables, extending the lags of the explanatory variables or selecting new indicators to quantify the explanatory variables, all regression results are significant at the 5% level and the hypotheses are valid, indicating that the conclusions of this paper are very robust.

5. Conclusions and Recommendations

This paper uses data from 2013-2019 for A-share listed companies in Shanghai and Shenzhen to explore the influence relationship between a company's advertising, investor attention and stock price crash risk, and draws the following main conclusions: first, there is an inverted U-shaped relationship between advertising input and stock price crash risk; second, advertising input positively influences investor attention; third, there is an inverted U-shaped relationship between investor attention and stock price crash risk. Fourth, advertising input has an indirect effect on stock price crash risk through the curvilinear path of investor attention.

Advertising can reduce the risk of share price collapse by directing investors to pay more attention to the company's operational and financial information, thereby increasing monitoring, while on the other hand, heavy advertising can increase the level of heterogeneous investor beliefs, amplify investor sentiment, lead to mispricing and exacerbate the risk of share price collapse. Accordingly, the impact of investor attention on stock price crash risk has both a "monitoring effect" and a "contagion effect". According to the findings of this paper, when the level of advertising input is low, investor attention also remains at a low level, so increasing advertising input and investor attention can effectively play a supervisory effect and suppress the stock price crash risk; when the level of advertising investment exceeds a certain value, investor attention is too high, so increasing advertising investment and investor attention will trigger a contagion effect and aggravate stock price crash risk.

In today's information explosion, many companies are keen to keep sending positive messages to the market through marketing tools such as advertising in order to attract investor attention. The right amount of advertising can indeed have a positive impact on the value of a stock, but too much of it triggers a herding effect in the short term, sending the stock price higher. Once the market calms down, the objective status of the company will contrast with the false prosperity created through advertising, and the information bubble will burst, eventually triggering stock price crash risk. Accordingly, the following recommendations are made to company managers and investors. Corporate managers should make sound advertising decisions in terms of both expenditure and content, formulate a long-term strategy with the ultimate goal of sustainable corporate development, keep the ratio of advertising input to sales within a reasonable threshold and avoid the phenomenon of product-light marketing. In addition, the root cause of advertising-induced stock price crash risk

lies in the information asymmetry between companies and managers. In this regard, companies should disclose financial and other objective information in a timely, accurate and truthful manner, improve the information disclosure quality, and respond to the market effectively and in a timely manner. For individual investors, they should avoid over-optimistic reactions to advertisements of listed companies, maintain independent thinking and analytical skills, stop blindly following the crowd and not be dominated by market opinions and emotions. Individual investors should also take the initiative to pay attention to the company's operation and financial situation and make an objective and sensible analysis of the company's situation before making an investment to avoid being misled by inaccurate information and incurring unnecessary financial losses.

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