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Investors' Sentiment and Enterprise's Non-Efficient investment: The Intermediary Effect of Stock Price Volatility

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ABSTRACT

Based on the bounded rationality hypothesis, the purpose of this paper is to explore the influence of investors' irrational sentiment on the enterprise's non-efficient investment by taking the Chinese A-shares listed company data as the research object. The research method is the fixed effect regression method of panel data, and the findings are that: (1) the investors irrational sentiment is significantly affecting the enterprise's non-efficient investment, the stock price volatility plays a mediating role between the two; and (2) the investors' sentiment is one of the reasons for the fluctuation of market share price, which deviates from the fundamental value; we also find that (3) the over-valued stock promote the over-investment, the under-valued stock sharpen the under-investment seriously. Therefore, we think that, in emerging market of Chinese, the investors' irrational sentiment and the stock price volatility have been becoming the external economic environment of enterprise investment indirectly affect its investment efficiency. These findings reveal that it is important to understand investors' irrational behaviors in enterprise investment decision-making. The contribution of this paper complements the Tobin Q theory and validates that stock price volatility plays a mediating role between investors' irrational sentiment and enterprise inefficient investment.

Keywords: Investors' Sentiment, Irrational Behavior, Non-Efficient Investment, Stock Price Volatility, Tobin Q Value.
JEL Code: G12, G14, G31, G32

1. Introduction

The irrational behavior of investors is more prominent due to the immature development of

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Chinese capital market and the various cognitive biases caused by Chinese social culture. Such as investors' sentiment, overconfidence, herd behavior, loss aversion, overreaction and so on will cause price ups and downs, and which ultimately indirectly affects the enterprise production and operation (Min & Dixing, 2010). With the development of behavioral finance, the topic of the influence of investors' irrational behavior and enterprise investment efficiency has become a hot issue.

Behavioral corporate theory believes that managers' irrational behaviors often lead to non-efficient investment, namely, managers don't choose investment projects in accordance with the goal of maximizing shareholder value, but the goal of maximizing their personal benefits. They may invest projects with a negative NPV (Net Present Value) or withdraw from projects with a positive NPV, called over-investment and under-investment respectively (Jensen & Meckling, 1976), and both called non-efficient investment.

The aim of this study is to explore the influence of the investors' irrational sentiment on the non-efficient investment of Chinese A listed companies during 2009-2015 using the fixed effect regression analysis, and the results provide further understanding and empirical evidence relevant to the investors' irrational behaviors and investment efficiency. This paper finds that, the investors' irrational sentiment plays an important role in the market, and we believe that the stock price of the company which Tobin Q value greater than 1 is overvalued, on the contrary, the stock price is undervalued. The more overvalued the company is, the more over-investment, the more undervalued the company is, the more under-investment is. Therefore, this paper proves that the stock price volatility plays a partial mediating effect between the investors' irrational sentiment and the non-efficient investment of enterprise in Chinese capital market.

Previous studies on this topic mainly relied on the data from the developed countries (Heng & Niblock, 2014), and only a small stream reported empirical analysis with data from the emerging market of Chinese (Yangkai, 2016). Hence, this paper fills the gap in the literature by investigating the impact of investors' irrational behaviors on non-efficient investment in China, which has been regarded as the biggest developing country and the biggest emerging market in the world. These contributions further expand the existing research, provide reference for practical work, and have certain significance to the effective utilization of social resources and the sustainable development of social economy.

This paper proceeds as follows: the next section reviews prior literature and motivates our hypotheses, section three describes research design, section four presents the main empirical results, and section five is the robustness test, and section six discuss the results and conclude this paper.

2. Literature review and research hypothesis

2.1 Investor's irrational sentiment and stock price volatility

Investors' irrational sentiment is a kind of subjective and objective comprehensive evaluation of the assets' future value due to the investors' cognitive biases and information environment uncertainty (Vivian & Xu, 2017), which is closely related to the investors' educational experience, knowledge background, investment experience and information, personality preference, etc. Stock price volatility refers to the fluctuation of stock prices ups and downs over time. Many studies show that investors' sentiment have an important influence on the stock price volatility (Fisher & Statman, 2000; Hirshleifer, Low, & Teoh, 2012; Shiller, 1987; Thaler & Bondt, 1984). Investors' sentiment in the US, France, Germany, Spain and the UK has significantly influenced stock pricing (Baker & J. Wurgler, 2006; Corredor, Ferrer, & Santamaria, 2013); Investors' sentiment in China's a-share market also helps explain the reasons for the stocks wrong pricing in the Fama-french model (Xu & Green, 2013). Not only the A-share market, but the cross-share market also significantly affects the stock prices volatility (Lujing & Zhouyuan, 2015).

Based on the hypothesis of "rational economic man" and "efficient market", the traditional financial theory holds that stock price can reflect the discounted value of expected cash flow effectively, and the change of cross section of stock depends on the systemic risk in the market, which is irrelevant to investor's sentiment. However, in recent years, behavioral finance scholars have theoretically demonstrated the limitation of arbitrage, arguing that stock prices tend to deviate from their intrinsic value obviously. The "emotional hypothesis" of behavioral finance theory holds that investors' sentiment may cause the stock price to deviate from its intrinsic value for a long time, and it

is synchronized with the stock price volatility. Rising investor sentiment tends to lead a rise of stock price, which in turn, when investors' sentiment is depressed, which leads a decline of stock price (Caldarola, 2014). So, the paper puts forward the following hypothesis:

Hypothesis 1: Investors' sentiment causes stock prices to deviate from the fundamental price, resulting in stock mispriced.

2.2 Stock prices volatility and non-efficient investment of enterprises

Many scholars have concluded that stock price' volatility directly affects the enterprise investment efficiency (Udani Chathurika Edirisinghe,2014; Nazmul Hassan, Hasan Md. Mahmood Ul Haque, 2017). Stock price volatility leads to the managers' short-term behavior to reduce the enterprise investment efficiency (Asker, Farre-Mensa, & Ljungqvist, 2014). Chinese scholar Liuduan and Chenshou (2006) find that the effect of stock price on managers' investment behavior is very significant. Moreover, the stock price is positively correlated with the company's short-term investment behavior. Yeian and Songxiang (2010) based on the data of a-share manufacturing listed company, find that the higher the stock price is, the more the company's investment is, and vice versa. By decomposing Tobin Q as a proxy variable of the stock price bubble, Hong, Scheinkman, and Xiong (2008) find that the stock price bubble and the enterprise investment expenditure rate have the significant positive sensitivity.

This paper measures the stock price volatility as Tobin Q which equals to the ratio of the stock market value to the book value, that is the value of the stock price exceeding the company's fundamental value, in other words, the price volatility is the deviation value of stock market can not directly reflect the real value. When the stock price is greater than the fundamentals value (i.e., Tobin Q>1), the company's value is overvalued, whereas the price is less than fundamentals value (i.e. Tobin q<1), the company's value is undervalued (M. Baker & J. Wurgler, 2006) .

This paper holds that the managers tend to generate the investment impulse, which causes over-investment when the stock is overvalued (Gilchrist, W.Sim, & Zakrajšek, 2013); and when the stock is undervalued, the manager will buy back the stocks for preventing the price from falling or reduce the normal investment, which results in under-investment. So, this paper puts forward the following hypothesis:

Hypothesis 2: Stock price volatility is positively correlated with non-efficient investment of enterprises, and when the stock is overvalued, overinvestment is increased, and when the stock is undervalued, underinvestment is increased.

2.3 Investors' sentiment and non-efficient investment of enterprise

As for the research on the path of investors' irrational sentiment affecting enterprise non-efficient investment, the existing literatures mainly study through three paths. One is "equity financing dependence Channel", which thinks that when investors' sentiment is rising, the cost of equity financing is lower, so that the rational managers will make equity financing and make a large-scale investment (Baker & Wurgler, 2004), which is possible to invest in some projects of NPV<0 resulting in over-investment. When investors' sentiment is declining, and stock price falling, the value of company is undervalued and the managers do not raise equity financing because of the high financing cost, they may abandon some investment projects of NPV>0, resulting in under-investment. (Bakke & Whited, 2010; Bali, Demirtas, & Hovakimian, 2010)。

The second is "rational catering channel" (Polk & Sapienza, 2009). When the investors' sentiment changes, the managers will cater proactively the investors to arrange their investment project, thus managers' investment behavior changes with the investors' sentiment. That is, when the stock price is rising with the investors' sentiment, the rational managers will cater the expectations of most investors to increase the investment level, which may lead to over-investment; On the contrary, when the stock price is declining, rational managers have to consider cutting back on investment or buying back stocks to sustain development, which may result in under-investment (Dixing, 2011 ; Nikolic & Yan, 2014).

The third is "false signal channel" (Wu & Wang, 2016). It is difficult for managers to separate the irrational factors of the stock price from the basic value, so the information that managers can get from the stock price may be deviation, which will affect their investment decision. Some scholars also think that the investors' irrational sentiment has a direct impact on the enterprise investment efficiency.

From the above research literatures, the research on the influence path of investors' irrational sentiment on the non-efficient investment is not uniform, and the results are not identical. Ru-Jing, Xue-song, and Ming-ming (2007) believe that the investors' irrational sentiment is bound to distort the resources allocation in China. Yujiao (2016) believes that the upsurge of investors' sentiment in China's capital market can increase the enterprise's investment level, but it does not improve the investment efficiency. Dingyi (2015) and Guiru, Zhiyuan, and Xuqian (2010) think that the investors' irrational sentiment will "worsen" and "correct" the efficiency of enterprise resource allocation, not only exacerbates overinvestment, but also eases under-investment. Hongbin, Guanghui, and Jingnan (2016) empirically conclude that investors' sentiment is positively correlated with overinvestment and negatively correlated with under-investment.

This paper holds that under the assumption of investors' bounded rationality, the influence of irrational sentiment on enterprise investment is based on the stock price volatility. When the investor's irrational sentiment is up, the stock price rises, the lower financing cost leads to the rational managers to invest blindly in a large amount of equity financing, which may invest in some NPV<0 projects based on catering to the market sentiment. When the investor's irrational sentiment is down, the stock price falls, the catering incentive and the funds source of the low cost do not exist, and the rational managers instinctively reduce the investment level, which may lead to the lack of funds in some NPV>0 projects. Therefore, the reason of investors' irrational sentiments influencing on the enterprises non-efficient investment is that the stock price acts a intermediary role between the two, that is, the investors' irrational sentiment is infected to the managers' instinctive investment behavior by the stock price volatility,and the managers' investment is no efficiency, which not only may increase over-investment, but also may aggravate under-investment. Therefore, this paper puts forward the hypothesis that needs to be tested.

Hypothesis 3: the investors' irrational sentiment positively affects the non-efficient investment through the stock price volatility, and the stock prices volatility plays an intermediary role between the two.

3. Research design

3.1 Research data and samples

This paper selects a-share listed companies as the research object since China's a-share market value has been close to the annual GDP in recent years. The stock market was mainly listed by state-owned enterprises 2008 years ago, there was a "Share Splitting" phenomenon. Until 2008 the "Share Splitting" phenomenon were lifted, the liquidity of the Chinese stock market normalized, and the value of Tobin Q was positively associated with the stock price (Wenxiu, Jinhua, & Huangyin, 2013). As a result, the data before 2008 is not available for the study. Since in 2016 the Chinese government fully implemented the tax reform system of VAT (Value-Added Tax), resulting in the data after 2016 is no longer comparable with before 2016 Therefore, this paper chooses the period of 2009-2015 as the research sample, and all the data of the research samples are collected from the wind information financial database.

To ensure the feasibility of research samples, that samples of the data missing, negative net assets, all samples of ST (Special Treatment) or PT (Particular Transfer), less than eight years, and the samples of financial and cross listed companies are eliminated (Hongbin et al., 2016; Wabwile et al., 2014). Finally, 8809 observations across 1363 individual companies are selected.

3.2 Variable measurements

3.2.1 Non-efficient investment of enterprise

In this paper, we employ the investment residual model of Richardson (2006) to measure the enterprises' non-efficient investment, which divides the total investment into two parts: capital maintenance expenditure and new project investment expenditure, and the new investment expenditure includes the project investment with the expected new NPV>0 and the unexpected investment.

The expected new investment is to be calculated by the regression of the factors that affect the enterprise's new investment (Including: investment opportunities, asset-liability ratio, the level of cash, enterprise age, enterprise size, return on assets, and the enterprise investment expenditure in the last period). The residuals in the regression model are the deviations from the expected new investment to the actual new investment, that is, the unexpected new investment (called the non-efficient investment, ***ne***), and the positive residuals is overinvestment (***Over-ne***), and the negative residuals is underinvestment (***Under-ne***) (Jung, Lee, & Weber, 2014). Our proxy variables for non-efficient investment are the absolute value of residuals, and higher value means a higher degree of non-efficient investment. The regression model is as follows:

$$I_{new,t} = \alpha + \beta_1 Growth_{t-1} + \beta_2 Lev_{t-1} + \beta_3 Cash_{t-1} + \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 Stock\ \mathrm{Re}\ turn_{t-1} + \beta_7 I_{new,t-1} + \sum Year + \sum Industry + \varepsilon$$

Where $I_{new,t}$ is enterprise's expected new investment expenditure; α is the constant; β is the regression coefficient for each variable; ε is the residual; i is the enterprise index; t is the time index; $Growth_{t-1}$ is the growth of investment opportunities measured by the main business income growth rate at year t-1; Lev_{t-1} is the asset liability rate; $Cash_{t-1}$ is monetary capital stock; Age_{t-1} is the lasting years from listed; $Size_{t-1}$ is natural log of enterprise total assets; $Stock\ \mathrm{Re}turn_{t-1}$ is stock returns; and $I_{new,t-1}$ is the investment at year t-1. $\sum$***Year*** and $\sum$***Industry*** are represented by dummy variables.

The regression results of 8,809 residuals are obtained by the fixed effects regression, as shown in Table 1, the results show that the adjusting R-square was 0.2429, showing that the model fits the data well. In addition to the constant term, all the other variables are significant, indicating that the regression results are of economic significance.

Table 1: The regression results of Richardson investment residual model

variables	Coef.	Std. Err.	t-value	P>|t|	[95% Conf.	Interval]
constant	0.3213	0.2947	1.09	0.0760	-0.2565	0.8990
growth	0.0882	0.0203	4.35	0.0000	0.0484	0.1280
lev	-0.0007	0.0003	-2.68	0.0070	-0.0012	-0.0002
cash	0.2300	0.0329	6.99	0.0000	0.1655	0.2945
age	0.0019	0.0010	1.95	0.0520	0.0000	0.0037
size	-0.0200	0.0036	-5.63	0.0000	-0.0270	-0.0131
Stock return	0.0005	0.0001	5.05	0.0000	0.0003	0.0006
I_{t-1}	0.8533	0.0181	47.25	0.0000	0.8179	0.8887
year						
industry						*controlled*
Adj R-squared						0.2429
Observations						8809

Based on the data above, the distribution features of over-investment and under-investment are illustrated in the Table 2. It can be seen that both over-investment and under-investment existed among Chinese listed companies. Specifically, 2920 of the 8809 samples are over-investment, whereas 5889 are under-investment. Compared with the results of Gongfu (2009) and Huangyi (2016) that used similar data from 2001 to 2008 and 2010 to 2014, respectively, the ratio of underinvestment is increasing, showing that non-efficient investment in Chinese-listed companies is common and has not been improved since 2001.

Table 2: The statistics of model residuals

Index	Sample	Min	Max	Mean	Std Dev	Rate (%)
Under-investment	5889	-4.3539	0	-0.1004	0.6194	66.85%
Over-investment	2920	0	10.0887	0.2016	0.1419	33.15%
Total	8809	-	-	-	-	-

3.2.2 Investor irrational sentiment

This paper measures the investors' irrational sentiment index using the most widely momentum effect indicators (Baker & Wurgler, 2006; Ben-Ami, Feldman, & Rosenfeld, 2014; Goyal & Yamada, 2004; Polk & Sapienza, 2009). The momentum effect is expressed by the stock return rate. The higher the stock return rate is, the more optimistic investors are, the lower the stock return rate and the more pessimistic investors. The measurement formula is as follows:

$$Isent_{i,t} = \frac{1}{12}\sum_{j=1}^{12} R_{i,t-1,j}$$

$Isent_{i,t}$ is the investors' sentiment, "i" is the year, "j" is the industry; $R_{i,t-1,j}$ is the monthly stock return, which is equals that, the closing price on the last day of the month minus the opening price on the first day of the month, and then is divided by the opening price on the first day of the month.

3.2.3 Stock price volatility

This paper employs the Tobin *Q* value to measure the stock price volatility, which can indicate the extent of the stock price deviating from the fundamentals caused by the investors' irrational sentiment. Because the Tobin *Q* value equals the ratio of the company's market value to the book replacement cost. And when the market value is greater than the replacement cost, that is, the *Q*>1, it indicates the stock price rise, and the stock price is higher than its fundamental price, the part of above 1 is the investors' irrational expectations for the future of the company. Conversely, when the market value is less than the book value, the *Q*<1, it indicates that the stock price falling below the company's fundamental price. The specific formula is as follows:

Stock price volatility (***Pv***) = (year-end liabilities + circulating stock market value + non-tradable stock quantity * net assets per share) / (initial total assets + total assets) ÷2.

3.2.4 Control variables

Because the mangers' investment behavior and the investment efficiency will be affected by other factors, according to related theories and literature (Liuyan, 2016), we set up some control variables including: enterprise size (***Size***), financial leverage (***Lev***), growth opportunity (***Growth***), free cash flow (***Cf***), cash holdings (***Cash***) and total assets profit rate (***Roa***), and listed years, industry category. The specific measurement methods are shown in Table 3.

Table 3: The control variables definition

Symbol	Variable name	Variable definitions
Size	Enterprise size	Log (the final total assets)
Lev	Ratio of liabilities to assets	Liability/asset *100
Growth	Increase rate of main business Revenue	(Current turnover-previous turnover)/turnover *100
Cf	Free cash flow	Net cash flow in operating activities /final total assets
Cash	Cash holdings	Monetary Fund / (initial total assets + final total assets) ÷2
Roa	Returns on total assets	Net income/ final average total assets *100
∑*Year*	Listed years	Dummy variable
∑*Industry*	Industry category	Dummy variable

4. Results

4.1 Descriptive statistics

To meet the needs of the research, the unbalanced panel data is adjusted to the balance panel data which is n=1043, t=7, N=7301, and obtained the descriptive statistic results in Table 4.

The maximum of non-efficient investment is 10.0887, and the minimum is -4.3539, showing that over-investment in Chinese listed companies is far more common than underinvestment. The average value of absolute value of ***non-efficient investment*** is 0.1343. Combined with the data in Table 1, it can be seen that although there are more samples of under-investment, but the degree is not very large.

The maximum value of investors' sentiment (***Isent***) is far greater than the minimum value, with a mean of 2.7261, indicating that the average stock return on the market is more than zero on the whole,

and the investors' sentiment is more optimistic.

The highest value of stock price volatility (***Pv***) is also far exceeding its lowest value, which shows that the amplitude of stock overvalued is much wider than that of undervalued, and its mean value is 2.394, that is the stock market price is higher 1.394 times of the fundamental value, which indicates that the stock price volatility is larger.

The mean of the natural logarithm of the total assets (***Size***) is 22.0663, the difference between the enterprise size is hard to see from the natural logarithm, but because the original value is based on the natural logarithm, so the scale difference among enterprises is quite large.

The mean of leverage (***Lev***) maintains at 50.10% level which is a high ratio. It can be seen that most of enterprises are confident about their future development. On the other hand, enterprises should also be careful about financial troubles.

The net cash flow (***Cf***) from operating activities is accounts for 4.47% of the total assets, despite the fact that the value is small, but it reflects the net cash flow generated by the enterprise's operating activities. However, it is positive, indicating that the inflow enterprise's business activities are greater than outflow. The cash situation of China's listed companies in general is relatively stable, and has the "self-hematopoiesis" function, which is the investment capital to expand the invest scale.

The mean of the main business growth rate (***growth***) is 16.74%, indicating that most of the company's products are in the growth period, will continue to maintain a good growth momentum, there is more growth opportunities. However, because of its high standard deviation, it shows high volatility.

The mean of the stock price volatility (***Pv***) is 2.3943, indicating that the market price is more than twice times of its basic book value. At the same time, the ***Stock price volatility*** gap between enterprises is also very large, the minimum only 0.3374, and the maximum of 41.2202.

In addition, to avoid the influence of outliers, we standardized each continuous variable.

Table 4: The descriptive statistics of the main variables

Variable	Mean	Std. Dev.	Min	Max
ne	1.4839E-06	0.4012	-4.3539	10.0887
absne	0.1343	0.3780	0.0000	10.0887
isent	2.7261	4.6132	-7.9855	64.3821
pv	2.3943	1.9755	0.3374	41.2202
size	22.0663	1.3688	18.1624	28.5087
lev	50.1006	20.1160	0.7080	99.5793
growth	16.7429	115.6886	-97.7688	5835.6730
cf	0.0447	0.0990	-0.6577	0.7823
cash	0.1815	0.1361	0.0007	1.1096
roa	3.5339	6.3667	-99.8602	51.7210

4.2 Correlation test and vif test

In this paper, the Pearson correlation coefficient test of the main variables is shown in table 5, it can be seen that ***Investors' sentiment***, ***Stock price volatility*** and ***non-efficient investment*** are positively correlated, ***Investors' sentiment*** and ***Stock price volatility*** are positively correlated, and both are significant at 1% level, which preliminarily validates the above hypotheses. The correlation coefficients between the control variables and dependent variables are less than 0.5, which shows that there is no multicollinearity problem among the variables in the model.

Table 5: Pearson correlation test statistics of main variables

variable	*ne*	*absne*	*pv*	*Isent*	*size*	*lev*	*growth*	*cf*	*cash*	*roa*
ne	1.000									
absne	0.058***	1.000								
pv	0.108***	0.256***	1.000							
isent	0.047***	0.064***	0.365***	1.000						
size	0.201***	-0.138***	-0.535***	-0.124***	1.000					
lev	0.116***	-0.271***	-0.406***	-0.045***	0.450***	1.000				

growth	-0.046***	0.109***	0.073***	-0.023*	0.055***	0.051***	1.000			
cf	0.084***	0.029**	0.099***	0.111***	0.015	-0.168***	0.076***	1.000		
cash	-0.111***	0.250***	0.170***	-0.033***	-0.138***	-0.280***	0.091***	0.037***	1.000	
roa	0.049***	0.143***	0.246***	0.072***	-0.001	-0.373***	0.311***	0.388***	0.281***	1.000

In order to treat the multicollinearity problem more cautiously, the paper also calculates the expansion factor of each variable, and the result shows (in Table 6) that the vif of each variable is less than 2, and it is shown that there is no multicollinearity problem among the variables.

Table 6: The multicollinearity test results for each variable

Variable	*pv*	*size*	*roa*	*lev*	*cf*	*isent*	*growth*	*cash*	*Mean*
VIF	1.79	1.68	1.68	1.65	1.20	1.20	1.16	1.15	
1/VIF	0.56	0.60	0.60	0.61	0.83	0.83	0.86	0.87	1.44

4.3 Empirical analysis process

To verify the above hypotheses, this paper constructs the following four metering formulas:

$$Pv_{i,t} = \beta + \beta_1 Isent_{i,t} + \beta_n Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

$$Absne_{i,t} = \beta + \beta_1 Pv_{i,t} + \beta_n Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

$$Absne_{i,t} = \beta + \beta_1 Isent_{i,t} + \beta_n Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

$$Absne_{i,t} = \beta + \beta_1 Isent_{i,t} + \beta_2 Pv + \beta_n Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

4.3.1 The result of investors' irrational sentiment on stock price volatility

Based on the Hausman test, the fixed effect (Fe) regression analysis of the balanced data is carried out, and the results are shown in Table 8.

The regression results of model 1 and model 2 show that the adjusted R-square is over 70%, so the large samples can be obtained so high adjusted R-square, which shows that the model fitting is quite good. The coefficients of each explanatory variable are positive and statistically significant at 1% level, and the coefficients and statistically significant level of control variables are similar to those of related literatures. The coefficient of ***Investors' sentiment*** in model 2 is 0.0740, which indicates that one unit increase of ***Investors' sentiment*** leads to 0.074 increase of ***Stock price volatility***. The average ***Stock price volatility*** is 2.3942, suggesting that one increase of ***Investors' sentiment*** would make stock price overvalued by 3.09%. If the enterprise's book price is 10 Yuan RMB per share, the market value is 23.94 Yuan RMB per share, when one unit increase of ***Investors' sentiment*** will make stock price increased by 7.4 Yuan RMB. So, the hypothesis 1 is true, that is, the investors' irrational sentiment in Chinese stock market will cause the stock price to deviate from the fundamental price, resulting in market stock mispriced.

4.3.2 The result of stock price volatility on non-efficient investment

The results of models 3 and 4 show that the adjusted R-square are 0.2399 and 0.2785 respectively, which show that the fitting effect is good. The statistically significant of ***Stock price volatility*** is at 1% level, the coefficient is 0.1233 when the control variable is added, which indicates that an unit change of ***Stock price volatility*** lends to the change of ***Investors' sentiment*** by 0.123. Considering the mean of ***non-efficient investment*** is 0.1343, this change indicates that an unit change of ***Stock price volatility*** lends to the overall increase of ***non-efficient investment*** by 91.81%.

When ***Stock price volatility*** is more than 1, the stock price is considered to be higher than the intrinsic value, which is overvalued; when ***Stock price volatility*** is less than 1, the stock price is undervalued. To further verify the hypothesis 2, we divide the balance sample into three sub-groups by ***Stock price volatility***, the over-valued group, the middle group and the under-valued group, which is listed in Table 7.

Table 7: The grouping statistics results

Groups	Obs	Mean	Std. Dev.	Min	Max
Undervalued	2434	1.2148	0.1790	0.3374	1.5031
Middle	2433	1.8604	0.2316	1.5032	2.3214
Overvalued	2434	4.1074	2.6478	2.3217	41.2202

Both the over-valued group and under-valued are 2,434 samples, the middle group is 2,433 samples. The maximum of over-valued group is 41.2202, the minimum is 2.3217, the mean is 4.1074; the maximum of under-valued group is 1.5031, and more than 1, that is, the market price of Chinese listed companies is higher than the fundamental price. The information of stock price includes not only the volatility caused by the investors' irrationality, but also the synchronism price caused by the market and industry factors, so it is reasonable to include some samples larger than 1 in the under-valued group.

To verify the polar reaction of stock price volatility, the middle group is given up, and the effects of the over-valued and under-valued group on the over-investment and under-investment are tested in the model 5 and 6 of the table 8.

The model 5 shows that the ***over-valued*** stock price is positively correlated with ***over-investment*** at 1% level, and the correlation coefficient reaches 0.2450. Considering that the mean of ***Over-investment*** is 0.2016, the coefficient of ***Stock price volatility*** indicates that one unit increase of ***Stock price volatility*** leads to an average increase of about 1.22 times of ***Over-investment*** (0.2450/0.2016≈1.22). The coefficients of most control variables are not significant, indicating that the impact of the company's basic information on over-investment is negligible when stock prices are being pulled up.

The model 6 shows that the coefficient of ***Stock price volatility*** is 0.4129 and statistically significant at 1% level (to understand easily, under-investment is the absolute value), which indicates that one unit decline of ***Stock price volatility*** will leads to the increase of ***Under-investment*** by 0.4129. Considering that the mean of ***Under-investment*** is only -0.1004, the coefficient indicates that one unit decline of ***Stock price volatility*** leads to an average increase of about 4.11 times of ***Under-investment***.

From the above results, we can see that in the Chinese market, the effect of the falling stock price on under-investment is far greater than the effect of the rising stock price on over-investment, on the one hand, it shows that the financing constraints of listed companies are serious, and on the other hand, it also shows that the negative effects of falling stock price are greater. Furthermore, our hypothesis 2 is verified.

4.3.3 The empirical analysis on the mediating effect of stock price volatility

The traditional practice of mediating effect testing is to test regression coefficients (Baron & Kenny, 1986; Judd & Kenny, 1981). It is the test step for the intermediary effect of stock price volatility in figure 1. Among it ***c*** is the total effect of ***Investors' sentiment*** on ***non-efficient investment***, ***ab*** is the indirect effect of the influence of ***Investors' sentiment*** on ***non-efficient investment*** through ***Stock price volatility***, and ***c*** is the direct effect of ***Investors' sentiment*** on ***non-efficient investment.*** If the coefficients ***c***, ***a*** and ***b*** all are significant, then the intermediary effect of ***Stock price volatility*** is verified, if the coefficient ***c'*** is not significant is a complete intermediary, if it is significant is part of the intermediary.

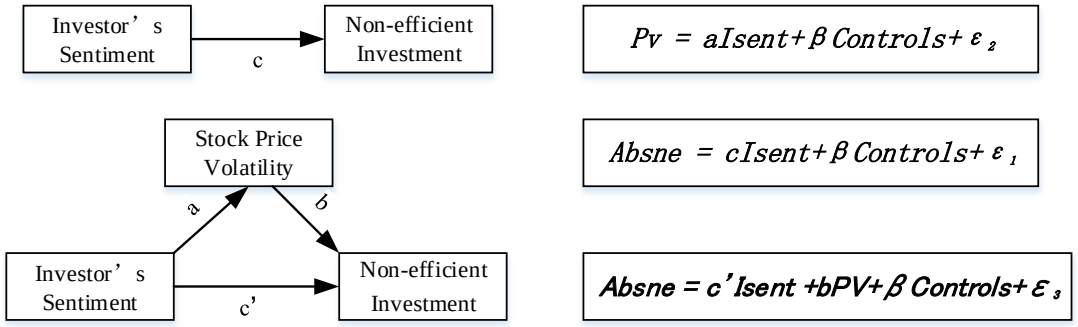

Figure 1 The Step Of Mediating Effect Of Stock Price Volatility

Corresponding to the above test steps, the coefficient of ***Investors' sentiment*** in model 2 is ***a***, the coefficient of ***Investors' sentiment*** in model 7 is ***c***, the coefficient of ***Investors' sentiment*** in model 8 is ***c '***, the coefficient of ***Stock price volatility*** is ***b***, these coefficients are all significant, which shows that ***Stock price volatility*** plays a partial mediating role between ***Investors' sentiment*** and ***non-efficient investment***. To facilitate understanding, these coefficients are summarized in Figure 2, it can be clearly seen that the overall effect of ***Investors' sentiment*** on ***non-efficient investment*** is greater than its direct effect ***c',*** the intermediary effect of ***Stock price volatility*** is verified. Therefore, the hypothesis 3 is also validated.

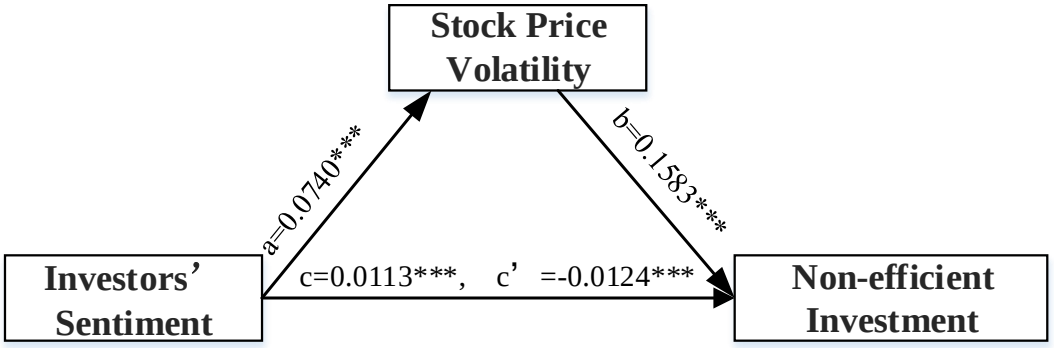

Figure 2 The Test Result Of Mediating Effect

5. Robustness test

In order to test the robustness of the above results, two-stage system moment estimation (SYS-GMM) method is used to test each model, and the robust estimator of Windmeijer (2005) is used to calculate the standard error. Because the volatility of sentiment and stock prices in the market can be extended forwards, that is, the volatility in the current period may have an impact on the next, moreover, ***investors' sentiment***, ***stock price volatility***, ***non-efficient investment*** and each control variable may be affected by other interfering items such as economic environment, etc. So, there may have endogenous problems. In this paper, a series of simulation estimates are used to find the tool variables to solve the endogenous problems, and the specific estimation results are shown in Table 9.

Model 9 is a two-stage sys-gmm estimate of the influence of ***Investors' sentiment*** on ***Stock price volatility***, setting ***Investors' sentiment*** and ***Stock price volatility*** as the difference equation and the level equation's tool variable respectively, all other control variables as exogenous variables. The abond test results show that there is a first order sequence correlation, but there is no second order correlation, which shows that the moment constraint of the difference equation is reasonable. The first-order lag of ***Stock price volatility*** is positively correlated with the current ***Stock price volatility*** at 1% level, which indicates that ***Investors' sentiment*** is still significantly correlated with ***Stock price volatility*** on the basis of considering endogenous variables.

Model 10 is a two-stage sys-gmm estimate of the influence of ***Stock price volatility*** on ***non-efficient investment***, setting ***non-efficient investment*** and ***Growth***, ***Cash flow*** *and* ***Returns on total assets*** with first lag as the difference equation's tool variable respectively, and setting ***non-efficient investment*** with first lag as the level equation's tool variable respectively, and other control variables are exogenous variables. The abond test shows that the ***P*** value of the second order correlation coefficient is 0.4088, which indicates that there is no sequence correlation. The lag of ***non-efficient investment*** is positively correlated to ***Stock price volatility*** at 1% level, which is consistent with the foregoing conclusion.

The results of model 11 and 12 are the two-stage sys-gmm estimate of the influence of ***Over-valued*** and ***Under-valued*** on ***Over-investment*** and ***Under-investment*** respectively, setting the first lag of ***Over-investment*** and ***Under-investment*** as the tool variable of the difference equation, setting ***Cash flow*** and ***Returns on total assets*** as the tool variable of the horizontal equation, and the other control variables are exogenous variables.

The results show that the lag coefficients and significance of ***Over-investment***, ***Under-investment*** and ***Stock price volatility*** are consistent with the test of the above fixed effect. So we think the results of the empirical analysis are steady.

Table 8: The FE regression of *Isent* and *Absne*

mod	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
var	*pv*	*pv*	*ne*	*ne*	*Over-ne*	*Under-ne*	*ne*	*ne*
isent	0.0830***	0.0740***					0.0113***	-0. 0124***
	(0.0021)	(0.0020)					(0. 0021)	(0. 0038)
pv			0.1017***	0.1233***	0.2450***	0.4129**		0. 1583***
			(0.0197)	(0.0204)	(0.0943)	(0.184)		(0. 0219)
size		-0.1332***		0.0480***	0.1475***	-0.1167***	0. 0890***	0. 0500***
		(0.0080)		(0.0113)	(0.0472)	(0.0247)	(0. 0092)	(0. 0115)
lev		0.0047		-0.0273***	-0.0155	-0.0513***	-0. 0391***	-0. 0265***
		(0.0044)		(0.0059)	(0.0222)	(0.0124)	(0. 0059)	(0. 0059)
growth		0.0132***		0.0936***	-0.0007	0.0197	0. 0807***	0. 0956***
		(0.0058)		(0.0095)	(0.0348)	(0.0180)	(0. 0087)	(0. 0096)
cf		-0.0055***		-0.0132***	-0.0050	-0.0230***	-0. 0141***	-0. 0126***
		(0.0024)		(0.0033)	(0.0096)	(0.0060)	(0.0034)	(0. 0033)
cash		-0.0060***		0.0344***	0.0550***	0.0595***	0. 0271***	0. 0341***
		(0.0028)		(0.0044)	(0.0112)	(0.0080)	(0.0044)	(0.0044)
roa		0.03381***		0.0049	0.0251	-0.0163*	0. 0009***	-0. 0061
		(0.0036)		(0.0047)	(0.0176)	(0.0097)	(0. 0046)	(0. 0047)
Year	included	included	included	included	included	included	-	included
Industry	included	included	included	included	included	included	included	included
constant	0.0162	-0.00392**	0.2774***	0.2888***	0.4616***	0.2836***	0. 2532***	0. 2938***
	(0.0300)	(0.0285)	(0.0534)	(0.0492)	(0.1529)	(0.0351)	(0. 0530)	(0. 04939)
Obs	7301	7301	7301	7301	1251	2476	7,301	7,301
Number of zqdm	1,043	1,043	1043	1043	473	519	1,043	1,043
Adj R-squ	0.7543	0.7881	0.2399	0.2785	0.2692	0.5647	0.2523	0.2797

Note: BS robustness standard error in parentheses; *** p<0.01, ** p<0.05, * p<0.1; The difference between different coefficients is tested by BS method.

Table 9: Two-stage Sys-Gmm estimation of ***Isent*** on ***Absne***

mod	(9)	(10)	(11)	(12)
var	pv	ne	over-ne	under-ne
L.ne		0.4630***	-0.7377***	0.0876
		(0.1292)	(0.2199)	(0.0873)
L.pv	0.7564***			
	(0.0309)			
isent	0.0959***			
	(0.0030)			

pv		0.1077***	1.8279***	0.2246**
		(0.0375)	(0. 5789)	(0.0886)
size	-0.0703***	0.0793***	1.3310***	0.1143
	(0.0086)	(0.0215)	(0.1668)	(0.0849)
lev	0.0116***	-0.0492***	-0.1446	-0.1240**
	(0.0057)	(0.0177)	(0. 1570)	(0.0594)
growth	-0.0068	0.1298*	0.0.1943	0.1622
	(0.0084)	(0.0734)	(0. 2402)	(0.1173)
L.growth		-0.0220		
		(0.0166)		
cf	-0.0016	-0.0540	-0.0056	-0.0796**
	(0.0028)	(0.0351)	(0.0740)	(0.0379)
L.cf		0.0519***	-0.0148	0.0192
		(0.0138)	(0. 0545)	(0.01365)
cash	-0.0890**	0.0242	0.0008	0.3517***
	(0.0038)	(0.0452)	(0.0865)	(0.0371)
L.cash		0.0997***	-0. 0907	0.0140
		(0.0325)	(0. 1143)	(0.0440)
roa	-0.0065***	-0.0081	-0.3517***	-0.0506
	(0.0046)	(0.0493)	(0. 1573)	(0.0445)
L.roa		0.0271	-0.0617	0.0245
		(0.0175)	(0. 0852)	(0.0192)
Year	control	control	control	control
Industry	control	control	control	control
Constant	0.0096***	0.1471***	-0.1762**	0.2537***
	(0.0030)	(0.0380)	(0. 1256)	(0.0385)
Obs	6258	6,258	1002	2127
Number of zqdm	1,043	1,043	451	493
Abond（P-ar(2)）	0.8351	0.4088	0.4606	0.4000

Note: BS robustness standard error in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Abond is a sequential correlation test, and the P value of the correlation coefficient of the second order sequence is greater than 0.05, it cannot reject the original hypothesis, there is no second order sequence correlation;

6. Conclusions and discussion

This paper examines the relationship between the investors' irrational sentiment and the enterprises' non-efficient investment breakthrough the agency theory and financing constraint. We find that investors' irrational sentiment has a direct impact on the stock price volatility, which not only validates the theoretical basis of Tobin Q, but also is in accordance with the conclusions of some scholars (Wu & Wang, 2016). We further find that investors' irrational sentiment indirectly affect the non-efficient investment of enterprises through the stock price volatility that is, the stock price volatility plays an intermediary role in the investors' irrational sentiment and the non-efficient investment. It can be seen that the investors' irrational sentiment in Chinese stock market not only causes the abnormal stock price volatility, but also increases indirectly the enterprises' non-efficient investment, which reduces the efficiency of the social resources allocation, and brings bad economic consequences to the healthy development of Chinese capital market and the operation of Chinese real economy.

In addition, we employ Tobin Q value to act as a proxy variable for stock price volatility. When Q>1, indicates that the stock price deviates from the fundamental price upward volatility; when Q<1, indicates the stock price deviates from the fundamental price downward volatility. We grouped the all samples according to the price fluctuation. It is found that the impact of stock prices falling on under-investment in the Chinese market is far greater than the impact of stock prices rising on over-investment, indicating a greater negative effect of the falling in stock price, which may also be one of the reasons why the under-investment is serious in the Chinese market. These findings are an unprecedented breakthrough and a powerful complement to the Tobin Q theory and reveal that it is important to understand these external factors of investors' irrational sentiment and stock price volatility in enterprise investment decision-makings.

So, we suggest that the Chinese investors should strengthen their own learning and make

rational investment and invest rationally, and the Chinese regulatory departments should reasonably guide investors to respect the actual value of the enterprises, to reduce excessive stock prices volatility, and reduce enterprise inefficient investment, and clarify the mechanism of investment and financing to increase the actual investments.

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