Research on the Relationship between Investor Sentiment and Stock Price Change Based on VAR Model

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Abstract. In recent years, a large number of studies at home and abroad showed that speculative behavior caused by investors' emotional fluctuations in the A-share market can bring abnormal volatility to financial markets. China's GEM has a large number of retail investors, and investors tend to concentrate their irrational behavior. To deeply explore the interplay between investor sentiment and stock prices. This study constructs a comprehensive index (IS) of investor sentiment using the principal component analysis method based on the past 5 years GEM index of five sentiment indicators including one subjective sentiment and four objective sentiment. The VAR model is constructed and passed various unit root tests to provide its reliability. Using Granger causality test and impulse response analysis, the relationship and long-term dynamic effect between investors' comprehensive sentiment and GEM index closing price is discovered. The results of the study are as follows：(1) A long-term equilibrium relationship exists between investor sentiment and GEM Index price movement; (2) Investor Sentiment and GEM Index Price is Causally Related to Each Other; (3) In the short term, the responses of investor sentiment and GEM index price to each other are positive; the shock feedbacks between the two changes in investor sentiment and GEM index price the mutual impact are negligible in the long term.

Key words: Investor Sentiment; Stock Price; VAR Model; Impulse Response Analysis; Growth Enterprise Markets

1 Introduction

Rational investors in China's financial market make investment decisions based on fundamental data and other information. However, irrational investors often perform overconfidence, and blindly follows the trend. Thus, their investment decisions are lack of rationality. For a long time, the research results at home and abroad on the measurement of investors' psychological emotions are extremely rich. For instance, Meijin Wang(2004)[1] established a theoretical model according to the actual situation of domestic stock market, which proved that the emotions expressed by investors when they received the stock market price signal would systematically affect the equilibrium price. Baker(2006)[2] uses a proper algorithm synthesizing six indicators, such as new share issuance and dividend premium, to construct an investor sentiment index. Cohen(2008)[3] assessed the investors' sentiment through mutual fund flows and concluded that

there was a negative correlation between the investors' sentiment and the stock market returns. Jiangchuan Lu et al.(2012) [4] used to construct Fama-French three-factor model,In order to test the influence of investors' extreme pessimism or optimism on stock returns. Haichuan Xu(2018) [5] took China Volatility Index as an emotional proxy variable and combines it with other traditional emotional variables to construct a comprehensive investor sentiment index. Nevertheless, Heng Xu et al.(2020)[6] constructed the index of investor's emotional characteristics based on the factors such as investor's vitality tendency and psychological state, and studied the positive correlation between investor's emotion and A-share market's yield in the margin market. In recent years, more research has focused on empirical research on the impact of investor sentiment on different types of financial products. Bethke et al.(2017) [7] investigated the relationship between the correlation of US corporate bonds and investor sentiment. Yiming Chen(2018)[8] selected "China investor confidence index" to measure investor sentiment directly, and established a VAR model to study the relationship between GEM index and investor sentiment changes. Liting Wang(2021)[9] also took GEM as the research object and found that high investor sentiment would make the liquidity of individual stocks in the market increase significantly. Bing Shen (2021)[10] established a VAR model to explore the relationship between market sentiment and stock market conditions. The empirical study of Xin Liao 's VAR model (2022) showed that China's monetary policy and investor sentiment had a positive impact on the liquidity of A-share market[11]. A large number of studies at home and abroad showed that speculation caused by investors' emotional fluctuations will bring abnormal fluctuations to the financial market. China's Growth Enterprise Market has a large number of retail investors and a large number of high-tech, high-growth and high-risk innovative companies, so it is easy for investors' irrational behavior to concentrate and the stock price to fluctuate greatly. This study takes GEM index as the research object, which enriches the related research on the influence of investor sentiment on China's financial market. The research on the relationship between investors' emotional fluctuation and the volatility of China's stock market plays an important role in protecting the interests of China's small and medium-sized investors and promoting the long-term development of China's economy and financial market.

2 Investor sentiment index Construction

2.1 Selection of Investor Sentiment Indicators

Subjective mood indicators have certain data bias for investors' trading decisions in financial markets, while objective mood indicators reflect investors' emotions when making decisions through some objective trading data in financial markets, and modify the data bias existing in subjective mood indicators. This study constructs a comprehensive investor sentiment index which can measure investor sentiment more comprehensively

The subjective mood index consumer confidence index data are selected from the National Bureau of Statistics, and the objective mood index data are obtained from Wind and Choice databases. The statistical period of the five indicators is from January 1, 2018 to April 30, 2023, with a total of 1292 working days of GEM index sample data. The sentiment indicators are shown in Table 1.

Table 1. Index of Investor Sentiment Selection

category	Indicator name	Indicator code	Implications of the indicators
Subjective Sentiment Indicators	consumer confidence index	CCI	Reflect and quantify consumers' evaluation of economic situations and circumstances as well as subjective perceptions of the psychological state of consumption
Objective mood indicators	PE ratio	PE	Reflects the investor's expectations of the company in which the investor intends to invest during the investment process
	Market volume	VOL	A reflection of the liquidity of the invested stocks and can measure the liquidity of the stock market
	change hands rate	TR	One of the indicators of the strength of stock liquidity, which is positively correlated with sentiment
	rise or fall in price	AD	Reflects the state of the stock market over time, moving in the same direction as sentiment

2.2 Construction of sentiment index

Due to the time lag effect between investor sentiment and market transactions in financial markets, the data of investor sentiment indicators in this study all lag one period. Through the KMO test and Bartlett ball test, the results are presented in Table 2 .The statistical value of KMO is 0.561>0.5, and the p value is 0.000<0.5, showing that the five indicators are highly correlated with the 5% significance level, and the Principal Component Analysis (PCA) can be applied to reduce the dimensionality through linear transformation to screen for the composite indicators that can significantly represent the investor sentiment as a whole.

Table 2. KMO and Bartlett's test

KMO sampling suitability quantity		0.561
Bartlett sphericity test	Approximate chi-square	398.799
	degrees of freedom (physics)	15
	significance	0.000

After principal component analysis, the contribution rate of Y1 is 47.586%, the contribution rate of Y2 is 28.252%, and the cumulative contribution rate reaches 75.838%.

From the contribution rates of Y1 and Y2, the investor sentiment index is constructed as follows:

$$IS=0.321AD+0.397VOL+0.395TR+0.494PE+0.185CCI \qquad (1)$$

According to the correlation between the above-mentioned investor sentiment index test and the closing price of the GEM Index (price). The correlation test results show that the correlation coefficient between IS and price is 0.65, and there is a significant correlation between them.

3 Empirical research

3.1 unit root test

In order to avoid the pseudo-regression phenomenon in the process of establishing the model. Three unit root test methods, ADF, PP and KPSS, are used for investor sentiment and GEM index to ensure the reliability of the test. The original assumption of ADF and PP test is the existence of unit root, and the original assumption of KPSS test is the absence of unit root. Results are shown in Table 3.

Table 3. Unit root test

	ADF		PP		KPSS	
	C	CT	C	CT	C	CT
IS	-3.576***	-4.553***	-19.019**	-31.451***	0.366***	0.366***
price	-1.200	-1.073	-2.617	-3.576	0.897***	0.897***
dIS	-9.913***	-9.831***	-10.820***	-10.719***	0.0163	0.0163
dprice	-6.425***	-6.408***	-6.311***	-6.290***	0.142	0.142

***. correlation is significant at the 0.01 level

The results in Table 3 show that IS can reject the original hypothesis under the significance level of 1% in all three unit root tests. The price cannot reject the original hypothesis at a significance level of 10% in the ADF and PP tests, but rejects the original hypothesis at a significance level of 1% in KPSS. Based on the test results, this means IS does not have a unit root and price does. In this study, the results obtained by first-order differencing the two variables show that IS is a stable series, and the price is a first-order single-integer sequence.

3.2 cointegration test

In this study, the traditional co-integration test E-G two-step method is used to verify whether there is a long-term equilibrium relationship between the two variables. The results of the following cointegration test are shown in table 4 rejecting the original hypothesis that there is no cointegration relationship between the two variables at the significance level of 1%, indicating that the GEM index price and investor sentiment are in a long-term equilibrium relationship.

Table 4. E-G test results

Augmented Dickey-Fuller test for unit root			Number of obs = 61	
			Interpolated Dickey-Fuller	
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-6.037	-3.565	-2.921	-2.596
MacKinnon approximate p-value for Z(t) = 0.0000				

3.3 establishment of var model

As judged by the results of the unit root test and the cointegration test, the results of the subsequent empirical analyses in this study based on the serial data after first-order differencing are more accurate. Before establishing the VAR model, the optimal hysteresis order of the model is judged to be 1 order.

Therefore, the regression equation of VAR model is set as follows:

$$dprice_t = c_1 + \alpha_1 IS_{t-1} + \beta_1 dprice_{t-1} + \varepsilon_{1t} \tag{2}$$

$$IS_t = c_2 + \alpha_2 dprice_{t-1} + \beta_2 IS_{t-1} + \varepsilon_{2t} \tag{3}$$

Based on expressions (2) and (3), the model test is established and Table 5 is obtained.

Table 5. VAR equation regression results

	Coef.	Std.Err.	z	p>$|z|$
IS				
L1.	0.163	0.033	-1.910	0.056
dprice				
L1.	0.171	0.122	1.400	0.161
dprice				
L1.	0.826	0.341	2.420	0.015
IS				
L1.	0.649	0.092	7.050	0.000

From the results of table 5, when the index dprice is a dependent variable and the index IS is an independent variable, the coefficient is negative, indicating that investor sentiment has a positive impact on the stock price at a significant level of 10%. High investor sentiment will attract more investors and capital entering the GEM index market, which may push up the stock price. The index dprice is positive for its own lag of one period, indicating that the GEM index price has a positive impact on itself, but it is not significant, and the interpretation effect is not strong enough. When the index IS is the dependent variable and the index dprice is the independent variable, the coefficient is positive, indicating that the price positively affects the investor sentiment at a significant level of 5%. In short term, the growth of the GEM index price will boost the investor's mood, probably because the price increase will attract more funds to further stimulate the price increase, and then stimulate the investor's positive mood again. IS has a positive coefficient for its own lag of one period, indicating that investor sentiment will intensify its fluctuation range at a significance level of 1%. The unit circle test shows that the characteristic roots in the VAR model of dprice and IS are all located in the unit circle, which can prove that the VAR model is stable.

3.4 Granger Causality Test

After selecting the optimal hysteresis order 1, the Granger causality test results of the comprehensive index IS of investor sentiment and the index dprice are shown in table 6.

Table 6. Granger causality test

Equation	Excluded	Chi2	df	Prob>chi2
dprice	IS	3.9591	1	0.047
dprice	ALL	3.9591	1	0.047
IS	dprice	5.7415	1	0.017
IS	ALL	5.7415	1	0.017

From the table 6, p-values are less than 0.05, then the original hypotheses are rejected. The fluctuation of investor sentiment has driven the price change of the GEM index. It may be that high (low) investor sentiment increases (decreases) investment, resulting in changes in supply,

demand and prices in the GEM Index market. The change of GEM index price is the cause of the investors' mood fluctuation. When the price trend of the GEM index is upward, investors in the market tend to be optimistic and generally consider the price trend to be upward.

3.5 impulse response analysis

In this study, impulse response analysis is carried out to further analyze the interaction between investor sentiment and GEM index price.
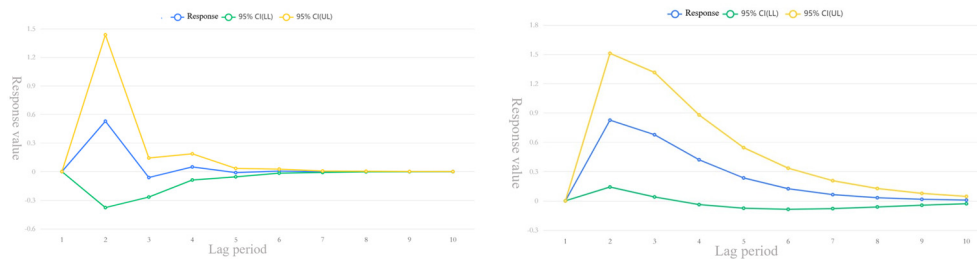

Fig. 1 Impulse Response Chart

The left graph of Figure 1, when the GEM index is positively impacted, the GEM index price gradually generates positive feedback, starts to fall back when lagging by two periods, brings negative change to below zero, and the price response of periods 3 to 4 gradually becomes positive, and then slowly returns to zero. In a short period of time, the surge in investor sentiment triggered a large number of investors to buy and quickly lifted the stock price. However, as time goes on, some rational investors begin to withdraw and drive the stock price down. The irrational factors in the GEM index price disappear with time and fluctuate slowly to the value of the price itself. As illustrated on right graph of Figure 1 above, the positive impact of the GEM index price increases the response value of investor sentiment rapidly, indicating that the investor sentiment is optimistic. With the change of time, the investor's emotional response fall back to near 0, and the response to the price change of GEM index tended to be stable after sixth period.

3.6 Variance Decomposition Analysis

In order to analyze the contribution degree of the impact between GEM index price and investor sentiment and further discuss the importance of the corresponding impact, the VAR regression model is subjected to variance decomposition to obtain the following result analysis chart, with the horizontal axis as the duration and the vertical axis as the contribution rate.

The upper two charts in Figure 2 show the evolution process of the comprehensive index of investor sentiment affected by the impact. In the first two periods, the contribution rate of investor sentiment reached 100% due to the impact brought by itself and then gradually decreases with time. Excluding the influence of investor sentiment itself, the contribution rate of GEM index price changes to the impact effect of investor sentiment continues to increase over time. The two charts below Figure 2 illustrate the evolution of the GEM index price shock. The contribution rate of GEM index price to its own impact decreased from nearly 60% to nearly 50%, and then remained stable. The contribution rate of investor sentiment to the impact on the GEM index price remained at about 50%.
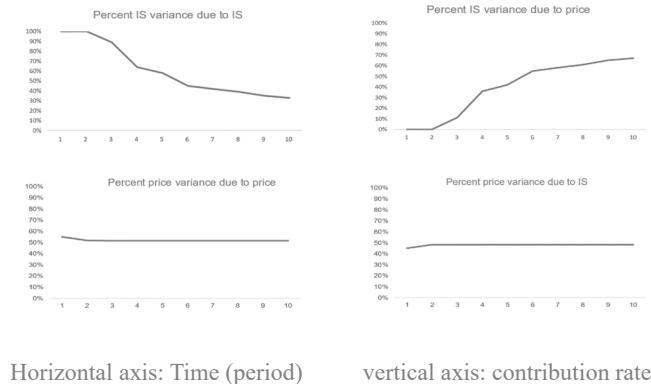
Horizontal axis: Time (period) vertical axis: contribution rate

Fig. 2 Variance decomposition chart

4 Research conclusions

The empirical results show that:

(1) There is a strong correlation between the change of investor sentiment and price changes in the GEM index. The results of co-integration test shows that there is a long-term equilibrium relationship between investor sentiment and the price change of GEM index.

(2) The reason of Granger causality between investor sentiment and GEM index price. The fluctuation of investor sentiment is the reason for the price change of the GEM index. Changes in investor sentiment affect investment in the GEM Index market, leading to changes in supply, demand and prices in the market. The change of GEM index price is the cause of the investors' mood fluctuation. When the price trend of GEM index is upward, investors will tend to be optimistic and generally think that the price will also show an upward trend in the near future.

(3) The positive impact of investor sentiment on the price changes of the GEM index changed the response value from the initial positive to negative, and then gradually recovered to near zero. The positive impact of GEM index price on investor sentiment has been positively responded with a rapid increase, and gradually tends to zero with the extension of time.

There are many individual investors in the China market. Their investment behavior is more susceptible to emotional influences than institutional investors, which in turn can have an impact on stock price. In the process of investment, individual investors should pay attention to control their own emotions, be alert to the financial market at all times, treat the ups and downs of stocks rationally and avoid blindly following the trend. They should judge whether the stock price is inflated or not, analyze the intrinsic value and the operating conditions of the company, etc. For the regulators in the market, they should guide investor to maintain a steady state of mind when the market is highly volatile, to investment rationally, not to appear too high or low mentality, to avoid the anomaly of stock price deviating from value to the maximum extent.

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