

Data Modeling on Volatility Character of the Main Board and GEM Stock Market Investor Sentiment Based on Change Point Detecting

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Abstract

Investor sentiment volatility has a significant influence on asset transactions and price determination. In this paper, different from previous studies on asset price fluctuations, characteristics of investor sentiment volatility in the main board and growth enterprise market (GEM) are explored from the perspective of behavioral finance, and in consideration of time varying points, an empirical study on investor sentiment volatility in the main board and GEM is conducted by using GARCH-class models. The results show that in both the main board and GEM, investor sentiment volatility presents leptokurtosis, volatility clustering, continuity, asymmetry and other characteristics. For different information impacts, after varying point dummy variables are added, bad news has a greater impact on investor sentiment volatility in the main board, while good news has a greater impact on investor sentiment volatility in GEM.

Keywords: *Investor sentiment, Change point detecting, GARCH model, Volatility*

1. Introduction

Study on financial volatility of the market has been a focus of research in academic circles and practical circles, the research conclusion and practical experience shows that the volatility of financial asset prices will not only cause serious impact on financial markets, systemic risk will lead to economic and financial [1]. With the traditional theory of investor's subjective attribute set to be constant, behavioral finance, asset prices rise and fall, which may be affected by the economic fundamentals, investors are more likely by psychological factors and behavior change.

Shleifer (1990) for the first time, investor sentiment into the stock price decision model, pointed out that investor sentiment will become influence system risk of the financial asset price equilibrium; Mehra (2002) for the first time to study the relationship between mood swings and asset price volatility [2], they find that subjective factor is small changes can lead to stock price fluctuations; Zhang (2009) pointed out that investor sentiment is the system factor affecting the stock price, the stock price fluctuates with the fluctuation of investor sentiment, and the mood of the rising and falling of the stock price effect is asymmetric [3]. Zhang (2013) mechanism through the demonstration of investor sentiment and subjective belief adjustment and market volatility [4], that investor sentiment on the market rate of return there is a positive impact and volatility significantly. In existing research, scholars have studied the relationship between emotion and asset prices from different angles, but few studies have holistic grasp of investor sentiment volatility, Wen (2014) by using dummy variable regression model [5], GARCH model and RV-AR model to examine the characteristics of asymmetric effects of investor sentiment on stock price behavior, results show that investor sentiment the fluctuation of stock return volatility has a significant impact; Yao (2010) test the actual situation of institutional investor sentiment correction based on DSSW model, Chinese shows that institutional investor sentiment has a first-order autoregressive heteroscedasticity variance

[6]. Wang (2008) studies show that ARCH effect exists in China investor sentiment index, has a spillover effect on the return of stock market [7].

Compared with the mature stock market, the stock market China emerging and transitional characteristics have stronger psychological characteristics, practice shows that the dramatic changes in investor sentiment in the stock market irrational exuberance and panic down play an important role, therefore, to study and grasp the fluctuations in investor sentiment in China is very important for the level and characteristics the significance of financial macro policy and guard against systemic risk[8-10], this paper will construct more in line with the characteristics of the securities market investors China main board and gem index based on sentiment measures under consideration, sudden change of mood effect, further study on the fluctuation of the level and characteristics of main board and gem overall investor sentiment.

2. Research Methods and Models

The volatility of financial time series, often appear volatility clustering phenomenon, that most of the sequences of the stage showed a relatively stable and exhibit the characteristic of volatility, according to the characteristics of Bollerslev (1986) GARCH model is proposed, in order to describe the tail characteristics of financial time series better, GARCH model in the variance equation with self the latter can predict lag regression, variance, affect the conditional variance by the new information and the previous conditional variance. Its variance equation is expressed as:

$$\sigma^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_q \sigma_{t-q}^2 \quad (1)$$

I_t is from time t-1 to t time in a market investor sentiment, investors make decision in the next stage of the time t-1 information set is $L(t-1)$, the investor sentiment volatility and risk are the conditional mean and variance:

$$y_t = E(I_t | L_{t-1}), \quad h_t = Var(I_t | L_{t-1}) \quad (2)$$

The deviation in the investor mood swings at the t time is:

$$\varepsilon_t = I_t - y_t \quad (3)$$

Random variables ε_t can be used as measure market news, $\varepsilon_t < 0$ said the market had "bad news", $\varepsilon_t > 0$ said the market appeared "good news", $|\varepsilon_t|$ said news strength is reflected in the square wave corresponding to the extent.

In summary, GARCH (1,1) model can be expressed as:

$$I_t = \mu + \sigma I_{t-1} + \varepsilon_t \quad (4)$$

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (5)$$

Among them, the conditional variance h_t for the average noise level ω , pre disturbance information Omega epsilon ε_{t-1}^2 and the forecast variance function h_{t-1} , calculate given shock caused by the volatility persistence of $\alpha + \beta$, by the above formula, the GRACH model assumes that the external shock effect of ε_t on the condition of epsilon method is not suitable for symmetric and asymmetric volatility describes investor sentiment volatility, so we take the Nelson (1991) EGARCH model, non negative parameters are no longer required. The conditional variance of EGARCH (1,1) model is:

$$\log(h_t) = \omega + \alpha|\varepsilon_{t-1}/\sqrt{h_{t-1}}| + \beta \log(h_{t-1}) + \delta(\varepsilon_{t-1})/\sqrt{h_{t-1}} \quad (6)$$

Because the EGARCH model takes the logarithmic transformation, the parameter constraint is not required. In addition, conditional variance is dependent on the absolute level of information impact, which can affect the impact direction. If $\delta \neq 0$, illustrate the role of asymmetric information, when the $\delta < 0$ leverage effect.

3. Research Methods and Models

3.1. Measure of investor sentiment index

The current literature on investor sentiment measures are direct method and indirect method, Baker and Wurgle (2006) select the closed-end fund discount rate, the number of IPO, listed on the first day returns, trading volume, stock issuance and issuance of securities/ratio 6 indicators using principal components to construct a composite that sentiment index BW index analysis method. Clushkov (2006) by investors intelligence index, base closures discount, trading volume, mutual fund inflows, bull and bear market ratio, dividend yield, the number of IPO and the return on the first day of 8 direct and indirect proxies to construct a composite index. Domestic scholars Yi (2006), Chi (2010) on the basis of the BW index, respectively, combined with China's national conditions, the establishment of a new composite index of investor sentiment. In considering the data base and reference to related research scholars at home and abroad, this paper selects the exchange rate (TURN), Pb (PB), price earnings ratio (PE), the number of new accounts (NA), to raise funds (MIPO), change the ratio (RADL), average price (ASP as the mood measure model index). This paper also believes that the establishment of the gem in the five years, the rapid growth of the controversy, from the index point of view, different from the motherboard market, has its own characteristics, the current domestic construction of the investor sentiment index model is the most Chinese stock market, in the choice of indicators, with the motherboard data GEM investors can not reflect the unique emotional patterns. To sum up, this article will use the principal component analysis method to establish the investor sentiment and the investor sentiment measure model of the main board market, respectively, to study the characteristics of investor sentiment. This paper selects the data are in a week, the sample period of the motherboard for the January 1997 to June 2015, the gem for June 2010 to June 2015, all the data are from the wind database.

In the structure of investor sentiment index, the first between the indexes and the sentiment index in advance and lag relationship analysis, to determine the early indicators into index (lag); second, using orthogonal regression method to eliminate macroeconomic fluctuations in the sentiment index, the industrial added value growth rate divided by the parameters of the factory price of industrial products after the index value as the orthogonal regression; third, the use of data processed, using principal components to construct the corresponding index of investor sentiment analysis (see formulas 7 and 8).

Motherboard market sentiment index:

$$\begin{aligned} ZISI_t = & 0.412TURN_t + 0.256PB_{t-1} + 0.312PE_{t-1} + 0.398NA_{t-1} + 0.334MIPO_t + \\ & 0.641RADL_t + 0.362ASP_{t-1} \end{aligned} \quad (7)$$

Gem market sentiment index:

$$\begin{aligned} CISI_t = & 0.378TURN_t + 0.124PB_{t-1} + 0.137PE_{t-1} + 0.205NA_{t-1} + 0.267MIPO_t + \\ & 0.608RADL_t + 0.351ASP_{t-1} \end{aligned} \quad (8)$$

In order to facilitate the research, reduce and smooth the volatility of the data, this paper defines the volatility of investor sentiment index as:

$$I_t = \log ISI_t - \log ISI_{t-1}$$

The main board and gem investor sentiment index volatility of the residual error by Figure1-2:

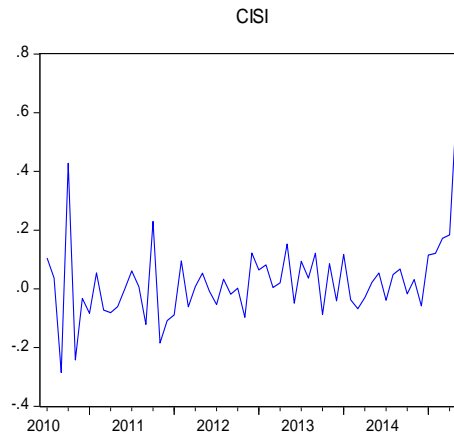


Figure 1. The residual diagram of the gem mood swings

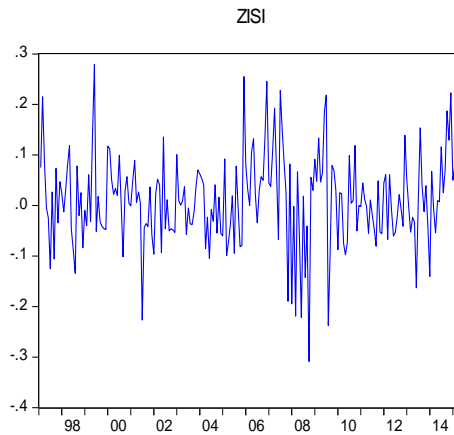


Figure 2. Investor sentiment volatility residual

From Figure 1 and Figure 2 , it shows the main board and gem investor sentiment index showed a typical volatility clustering phenomenon, that a certain degree of conditional heteroscedasticity existence of investor sentiment index fluctuations in the sequence, in addition, investor sentiment index series showed significant non-stationarity, abrupt mood changes the characteristics of these structural changes will affect investor sentiment index to a certain extent, the fluctuation characteristics, therefore, this article will first point mutation detection board and gem investor sentiment volatility series, the volatility model, re fitting effect on the mutation analysis of mood fluctuations of stock market investors mood swings.

3.2. Investor sentiment index volatility modeling

This paper uses Sanso (2004) ICSS algorithm modified the change point detection of the main board and gem emotion sequence, the modified ICSS method to relax the provisions of residuals obey and adjust the non-parametric, nonparametric statistics after correction for:

$$Y_1 = \sup \left| \frac{G_k}{\sqrt{T}} \right| \quad (9)$$

Among them:

$$G_k = \frac{1}{\sqrt{\omega_1}} \left[C_k - \frac{k}{T} C_T \right]$$

$$\widehat{\omega}_1 = \frac{1}{T} \sum_{t=1}^T (a_t^2 - \sigma^2) + \frac{2}{T} \sum_{t=1}^m \omega(l, m) \sum_{t=l+1}^T (a_t^2 - \widehat{\sigma}^2)(a_{t-l}^2 - \widehat{\sigma}^2)$$

$$\widehat{\sigma}^2 = \frac{C_T}{T} \quad (10)$$

According to the above formula, this paper uses statistical software Matlab7.0 programming, using the modified ICSS method on main board and gem mood fluctuations were detected, the reliability was 95%, results show that the test board investor sentiment volatility series has 38 point mutations; the gem emotion sequence has 16 point mutations. From Table 1 we can see, first, from the mutation point of time, main board and gem investor sentiment volatility series emotional sequence mutation point position is not exactly the same, the gem investor sentiment volatility has not received the board, relatively independent; second, main investor sentiment volatility series in 1997, 2007, 2008, 2014, and 2015, emotional sequence in 2011, 2010 and 2015 showed the characteristics of volatility, high frequency.

Table 1. Main board and gem mood swings sequence mutation point

Motherboard investor sentiment sequence mutation point				Gem sentiment sequence mutation point	
Serial	Date	Serial	Date	Serial	Date
1	1997/03	20	2007/06	1	2010/06
2	1997/07	21	2007/10	2	2010/07
3	1997/08	22	2008/04	3	2010/11
4	1997/11	23	2008/09	4	2011/01
5	1998/08	24	2008/10	5	2011/05
6	1999/06	25	2008/11	6	2012/02
7	1999/08	26	2009/07	7	2012/12
8	2000/04	27	2009/09	8	2013/05
9	2001/12	28	2010/10	9	2013/05
10	2002/03	29	2011/10	10	2014/03
11	2002/08	30	2012/12	11	2015/01
12	2004/09	31	2013/07	12	2015/02
13	2005/03	32	2014//07	13	2015/03
14	2005/06	33	2014/10	14	2015/04
15	2005/12	34	2014/11	15	2015/05
16	2006/05	35	2015/03	16	2015/06
17	2007/02	36	2015/04		
18	2006/12	37	2015/05		
19	2007/04	38	2015/06		

GARCH (1, 1) model was introduced into the main board and the gem index volatility model, respectively:

$$\sigma_t^2 = \omega + a\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (11)$$

EGARCH (1, 1) model:

$$\ln(\sigma_t^2) = \omega + a \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \beta \ln(\sigma_{t-1}^2) \quad (12)$$

Among them, $\omega > 0$; $\alpha, \beta \geq 0$.

The variable points detected by the modified ICSS algorithm are used as dummy variables, the introduction of GARCH (1, 1) model can be expressed as:

$$y_t = u + \varepsilon_t, \quad \varepsilon_t | K_{t-1} \sim N(0, \sigma_t^2)$$

$$h_t = \omega + d_1 D_1 + \dots + d_n D_n + a\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

Among them, $D_1 \dots D_n$ is the dummy variables with N means mean value is 0 and variance σ_t^2 normal probability density function, K_{t-1} is the t-1 time can get news.

The variable points detected by the modified ICSS algorithm are used as dummy variables, The introduction of EGARCH (1, 1) model can be expressed as:

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$$\ln(h_t) = \omega + d_1 D_1 + \dots + d_n D_n + a \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \beta \ln(\sigma_{t-1}^2) \quad (13)$$

4. Empirical Results and Analysis

From the above results, the main board and gem investor sentiment volatility series showed aggregation phenomenon, characteristics of heteroscedasticity, therefore in the modeling of the investor sentiment volatility series, first determine whether ARCH effect exists in the residual sequence obtained by the software of Eviews6.0 model, ARCH-LM test, test results are shown in Table 2:

Table 2. Main board and gem investor sentiment volatility sequence ARCH effect test

Main investor sentiment volatility sequences	F statistic	9.156321	Probability	0.000051
	T×R ² statistic	51.81054	Probability	0.000320
Main investor sentiment volatility sequences	F statistic	6.001245	Probability	0.000032
	T×R ² statistic	47.63189	Probability	0.000276

Can be seen from Table 2, the LM test statistic is large, larger than the critical value of the level of significance, and with a probability value of approximately zero, to reject the null hypothesis does not exist ARCH effect of residuals, and then regression test using ARCH-LM (respectively lagged 5 order and 9 order), R² with probability, 5 order as 0.0000, statistics significant, take 9 steps backward, there are also obvious heteroscedasticity, shows the existence of high order ARCH effect of

the main board and gem investor sentiment index, and according to the above detection of emotional catastrophe points by constructing a change point virtual variable structure method will be added to the GARCH mutation factor model in the influence of mutations in the further investigation of emotion model.

4.1. GARCH model test results

The Eviews6.0 software is used to re fit the mutation point, and the model estimates of the virtual variables with variable points can be obtained, as shown in Table 3:

Table 3. GARCH model estimates for investor sentiment index series

GARCH (1, 1) model parameters of the main board investor sentiment					
GARCH(1,1) no mutation point			GARCH(1,1) Contains all the mutation points		
α	β	$\alpha+\beta$	α	β	$\alpha+\beta$
0.10087	0.79451	0.89538	0.23218	0.76851	1.00069
Gem investor sentiment volatility series GARCH (1, 1) model parameters					
GARCH(1,1) no mutation point			GARCH(1,1) Contains all the mutation points		
α	β	$\alpha+\beta$	α	β	$\alpha+\beta$
0.23724	0.70112	0.93836	-0.03211	1.09213	1.06002

It can be seen from Table 3, the introduction of dummy variables before the main board and gem investor sentiment volatility series alpha + beta were less than 1, persistent information shows that the effects of impact on investor sentiment volatility is relatively short, this paper argues that this is because the stock market has the characteristics of China "city", the government will intervene when necessary and the regulation to the market, to avoid soaring prices, resulting in investor sentiment also sustained short. The change point virtual variable alpha + beta is close to 1, the gem investor sentiment volatility persistence is greater than 1, indicating the impact of information by the conditional variance is persistent, that the gem investor sentiment by the impact of abnormal fluctuations in the short term, generally do not decay, this may be because the economy is in a transition China the critical period, the government policy support for emerging industries is large, there are a lot of Companies in line with national gem emerging industry development direction, when the development of the industry of major policies, the gem investor sentiment production growth period and lasting effect.

4.2. EGARCH model test results

In order to study the leverage effect of investor sentiment volatility, EGARCH model is used to estimate the sequence of mood swings, Table 4 lists the variable before and after the dummy variable of the main board and gem investor sentiment volatility sequence in EGARCH (1, 1) model under the parameter estimation results:

Table 4. EGARCH model estimates for the main board and the gem sentiment series

EGARCH (1, 1) model parameters of the main board investor sentiment			
EGARCH(1,1) no mutation point		EGARCH(1,1) Contains all the mutation points	
ω	-0.23712	ω	0.08634
α	0.12451	α	0.14791
γ	-0.07342	γ	-0.09213
β	0.54312	β	0.62321
Gem investor sentiment volatility series GARCH (1, 1) model parameters			
EGARCH(1,1) no mutation point		EGARCH(1,1) Contains all the mutation points	
ω	0.22193	ω	0.24011
α	0.14649	α	0.14752
γ	0.05321	γ	0.06046
β	0.51006	β	0.54685

Table 4 shows the motherboard for investor sentiment volatility series, did not join the change point virtual variable, $\alpha+\beta$ value of 0.66763, with the virtual variable, $\alpha + \beta$ value increased to 0.77112, when the change point exists in the sequence of motherboard investor sentiment volatility, will increase the persistence of volatility if you ignore the volatility structure, mutation, would underestimate the sustained effects of main investor sentiment volatility; leverage effect coefficient γ was not zero, indicating that the impact of information asymmetry effect, after adding a dummy variable mutation, α value increased from 0.12451 to 0.14791, showing the motherboard investor sentiment volatility increased; in the virtual variable is not added, "bad news" to the conditional variance increases, the impact of bad news on the main investor sentiment volatility is 0.19793, the good news. Effect of emotional volatility is 0.05109, after adding the change point virtual variable, improve the leverage effect of news, "good news" impact on the main investor sentiment volatility is 0.05578, "bad news" impact on the main investor sentiment volatility is 0.24004, therefore, the board of investor sentiment Volatility Influenced by "bad news the existence of non symmetry degree.

For the gem investor sentiment volatility, table 4 shows, did not join the change point virtual variable, $\alpha+\beta$ of 0.65655, with the virtual variable, $\alpha+\beta$ value increased to 0.69437, when the change point exists in gem investor sentiment volatility series, persistent mood swings the same motherboard, enhancement; leverage effect coefficient was not zero, indicating that the impact of information asymmetry effect, after joining the change point virtual variable, α value increased from 0.14649 to 0.14752, showed that the gem investor sentiment volatility increased; and the motherboard investor sentiment volatility series is in. Before joining the change point virtual variable, "the impact of good news for mood fluctuations is 0.1997, the impact of bad news on mood swings of 0.09328, adding dummy variables change point After that, the asymmetric effect did not change, the "good news" impact of the impact of 0.20798, "bad news" the impact of the impact of 0.08706. Therefore, the gem investor sentiment volatility is vulnerable to the good news, there is a certain degree of asymmetry.

5. Conclusion

In conclusion, in this paper, by using EGARCH model, considering the time under the condition of the mutations, respectively to the main board and gem investor sentiment volatility characteristics of empirical research, mainly has the following conclusion:

First, overall, the volatility of the main board and gem investor sentiment showed volatility clustering, leptokurtic persistence and asymmetry; change point detection using modified ICSS algorithm, find the main board and gem respectively have an emotional sequence 38 and 16 time point mutation. The results of the study show that, regardless of the main board or gem, fluctuations in investor sentiment Chinese intense and vulnerable to "news", prone to extreme emotions, the same news impact on investor sentiment volatility under different conditions of different. It is proved that the Chinese stock market is a new developing market, and there is a serious noise trade phenomenon.

Second, by contrast, the main board and gem investor sentiment volatility has different characteristics, after adding the change point virtual variable, increasing leverage board investor sentiment volatility affected by the news, the impact of bad news than good news shock effect on the motherboard of investor sentiment, while the gem and the main board instead, both join change point virtual variable or not, "the impact of good news is greater than the impact of bad news on investor sentiment effect, this paper believes that the gem since its inception, has been in the whole process of rising, the GEM investors optimistic expectations for the future trend of the dominant position, speculation in the market increased significantly. This contributed to the GEM investors overreact to short-term" good news ", ignore the influence of bad news, a common form of an Irrational optimistic expectations, under the guidance of such expectations, it is easy to form a market bubble, increase the risk of regulatory prevention. Therefore, the management departments in the formulation of relevant policies should fully consider the rules and characteristics of Chinese fluctuations in investor sentiment, targeted, scientific and prudent to develop appropriate measures and policies, severity of slow fluctuations in investor sentiment, and promote stable and healthy development of the securities market Chinese.

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