Influence of Investor Sentiment on Stock Returns- Analysis of A- shares in China

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ABSTRACT
On the basis of constructing investor sentiment indexes, this paper uses linear and nonlinear Granger Causality Test respectively to study the relationship between investor sentiment and stock returns, and further studies the relationship between bull market and bear market. The results show that there are one-way linear causality and two-way non-linear causality between stock returns and investor sentiment, which indicates that there is a non-linear relationship between investor sentiment and stock returns. Under the conditions of bull market and bear market, the non-linear causality between investor sentiment and stock returns is inconsistent, which is in conformance with the actual situation of China stock market, indicating that there are a lot of irrational sentiment in China stock market, and such irrational sentiment affect stock returns.

Key Words: Investor Sentiment, Stock Return, Nonlinear Granger Causality

Introduction
The efficient market hypothesis (EMH) proposed by Malkiel & Fama (1970) is one of the core hypotheses in the traditional financial research field, and holds that in the efficient securities market, the prices of financial assets such as stocks already contain all existing, new and even hidden information. Investors only need to adopt "buy - hold" and other passive trading strategies, without spending time and efforts on active investment. However, the existence of many arbitrage opportunities in the real securities market makes EMH theory generally questioned. The reason is that EMH is based on the complete rationality of investors. It is assumed that when faced with the same information, all investors have the same interpretation of the information and ignore the heterogeneity among investors. In the challenge to EMH, behavioral finance is gradually formed. Based on the theory of limited arbitrage and limited rationality, it analyzes the returns of assets from the aspects of noise, psychological bias and investor sentiment. Behavioral finance holds that securities returns are not only influenced by their intrinsic value, but also by investors' sentiments to a large extent.

Since China established the securities market in the early 1990s, the capital market has developed rapidly, and formed prominent features different from the western developed market such as imperfect financial regulations, inadequacy financial supervision, and the majority of small and medium-sized retail investors, which lead to the phenomenon of sharp rise and fall in the stock market frequently, like "1,000- stock limit-up," "1,000- stock limit-down", and "demon stock" phenomenon. Therefore, China's capital market investment is obviously emotional. The research of behavioral finance can be generally divided into three aspects:
the experiment of neuron medicine, the experiment of psychology and behavior, and the empirical test of data. The research of these three aspects hastened the birth of neuroeconomics, financial psychology and financial metrology respectively. Neuroeconomics uses the functional resonance magnetic imaging (fMRI), event-related potentials (PET), electron emission tomography (ERP) and other neuroscience techniques to determine the neural mechanisms associated with economic decision-making, and mainly studies the relationship between financial economy and its neural-anatomical basis. Sutton et al., (2010) suggested that the asymmetry of pre-frontal cortex (PFC) was associated with different sentiment and behavior patterns, the left PFC region was associated with positive emotion and approach behavior, and the right PFC region was associated with negative emotion and withdrawal behavior. Beauregard et al., (2001) and Hsu et al., (2005) used neuroscience research tools to study the influence of emotion on decision-making and confirmed the important influence of emotion on decision-making. Psychological and behavioral experiments are conducted to investigate whether investors' sentiment influence people's judgment and thus affect investors' investment decision-making behavior. Baumann & Keynes (1936), Arkes et al., (1988), Wright & Bower (1992) and Breiter et al., (2012) used neuroscience research tools to study the influence of emotion on decision-making and confirmed the important influence of emotion on decision-making. Therefore, both psychological behavior experiment and neuromedicine experiment verify the influence of emotion on investors' behavior decision-making, emphasize the important function of investor's emotion on their behavior decision-making, and thus stress the important function of emotion on financial market (Wang, 2017). The empirical test of the data focuses on the measurement of investor sentiment and its relationship with market performance. Brown & Cliff (2004), Baker & Wurgler (2006), Stambaugh et al., (2012), Lux (2011), Jin & Zou (2014), Gao et al., (2015), Bathia et al., (2016) and Chen (2017) studied the investor sentiment and its relationship with stock price by statistical and quantitative methods and thought that investor sentiment affects stock returns. This paper studies the relationship between investor sentiment and stock returns in China by constructing investor sentiment indicators and selecting reasonable sentiment proxy indicators, and further studies the relationship between the two in different market conditions.

Methods
In this paper, linear and nonlinear Granger causality tests are used to study the influence of investor sentiment on stock returns. Linear Granger causality test was proposed by Granger in 1969 based on "prediction", and mainly tests linear Granger causality of two stationary time series X_t and Y_t by Vector autoexpression model:

\[ X_t = \sum_{i=1}^{m} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_i Y_{t-j} + \epsilon_t, \ t = 1,2,\cdots;(1) \]

\[ Y_t = \sum_{i=1}^{p} \lambda_i X_{t-i} + \sum_{j=1}^{q} \gamma_i Y_{t-j} + \eta_t, \ t = 1,2,\cdots;(2) \]

Where, \( \epsilon_t \overset{\text{i.i.d.}}{\sim} N(0,\delta^2_e) \) and \( \eta_t \overset{\text{i.i.d.}}{\sim} N(0,\delta^2_\eta) \). If in Equation (1), assuming \( \beta = 0 \) is rejected, then \( X_t \) is the linear Granger cause of \( Y_t \). If in Equation (2), assuming \( \lambda = 0 \) is rejected, then \( X_t \) is the linear Granger cause of \( Y_t \).

Nonlinear Granger causality test was proposed by Hiemstra and Jones (1994). For stationary and weakly correlated time series \( X_t \) and \( Y_t \), when \( m, l_x \) and \( l_y \) (both greater than or equal to 1) and \( e > 0 \) are given, we can further construct the following test statistics to perform a non-linear Granger causality test in estimating the density function of given local:

\[ T_n(e_n) = \frac{n^{-1}}{n(n-2)} \sum_{i=1}^{n-2} \left( f_{X,Y,Z}(X_i, Y_i, Z_i) f_Y(Y_i) - f_{X,Y}(X_i, Y_i) f_{Y,Z}(Y_i, Z_i) \right) \]  

Where \( f \) is a joint density function, and \( Z_t = Y_t+1 \).

In addition, Diks and Panchenko (2006) found that test statistics based on Equation (3) converge to a normal distribution, i.e.:

\[ \sqrt{n} \left( \frac{T_n(e_n)-q}{S_n} \right) \overset{D}{\rightarrow} N(0,1) \]  

Where, \( D \) represents convergence in distribution and \( S_n \) represents the estimated value of progressive variance \( T_n(e_n) \).

Data Selection and Processing
Selection of investor sentiment measurement index
Referring to the comprehensive sentiment index construction method of Baker & Wurgler (2007), and combining with the reality of stock market in Shanghai and Shenzhen and the availability of...
data, this study selects the discount rate of closed-end fund, the number of new investors, the market turnover rate and the consumer confidence index, which can reflect the indirect index of investor sentiment in domestic stock market and uses the principal component analysis method to construct the comprehensive sentiment index. Considering the availability of data, the sample cycle is from January 2005 to December 2017, with data from the CSMAR database and China Statistics Bureau.

(1) Discount of Closed-end Fund (DCEF)
This index has been favored by scholars at home and abroad, and it is the most widely used index in academic circles. Funds with small market capitalization are often controlled by institutional investors with many incorrect data. This study only selects the data of closed-end funds with large market capitalization (more than 2 billion) to calculate. The algorithm of closed-end funds in this study is based on the following formula: 

\[ CEDF_{it} = \frac{P_{it} - NAV_{it}}{NAV_{it}} \]

\( CEDF_{it} \) represents the discount rate of fund i in month t, \( P_{it} \) indicates the closing price of fund i in month t and \( NAV_{it} \) represents the net value of fund i at month t. Therefore, the end-of-month data of closed-end fund discount rate can be written as: 

\[ CEDF_t = \frac{1}{n} \sum_{i=1}^{n} CEDF_{it}. \]

(2) New Accounts (NEW)
The change of the number of newly opened trading accounts can indirectly reflect investors' investment intention and their views and attitudes towards the stock market. When investors are optimistic about the stock market, there will be more new investors coming to the stock market, resulting in a surge in new trading accounts; conversely, when investors take a pessimistic view of the stock market, many investors will choose to continue to stay on and delay in the market. The data come from China Securities Depository and Clearing Corporation Limited.

(3) Turnover Rate (TURN)
The turnover rate indicates the active degree of the investors in the securities market. When the investors are optimistic about the market, the transactions of stocks by the investors become very frequent. And when investor mood is low, the turnover rate in the stock market become lower in a certain degree.

(4) Consumer Confidence Index (CCI)
When the residents are optimistic about the overall economic situation of China, they will be optimistic about the securities market of China. Based on this, the consumer confidence index is set as an agent variable of investor sentiment.

Division of research cycle
The study chooses the logarithmic yield of Shanghai Composite Index as the research object of stock returns, and the research period is from January 2003 to December 2017. Drawing lessons from Pagan and Sossounov's (2001) method, the study divides the cycle of bull market and bear market of stock market. Compare the stock price of the current month with the share price of the previous 3 months: if the stock price of the current month is the highest, it is the peak; if the stock price of the month is the lowest, it is the trough. If a continuous peak or trough appears, compare them and select the one with high share price as peak and the one with low share price as trough. At the same time, the one-way operating cycle between the peak and the trough shall be limited to not less than 4 months, except where the stock price fluctuates by more than 20%. The results of dividing the stock market cycle are shown in Table 1.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>bear market</th>
<th>bull market</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2003.01-2003.05</td>
<td>2003.10-2004.03</td>
</tr>
<tr>
<td>2</td>
<td>2003.05-2005.06</td>
<td>2005.06-2007.10</td>
</tr>
<tr>
<td>3</td>
<td>2004.01-2005.06</td>
<td>2005.06-2007.10</td>
</tr>
<tr>
<td>5</td>
<td>2009.01-2010.07</td>
<td>2010.01-2012.06</td>
</tr>
<tr>
<td>6</td>
<td>2015.06-2016.01</td>
<td>2016.01-2017.12</td>
</tr>
</tbody>
</table>

Considering the high volatility of China stock market and the choice of lag period in empirical research, this study chooses bull and bear market cycle of not less than 24 months. The specific research periods: full sample (January 2003 to December 2017), bull market (May 2005 to October 2007), bear market (July 2009 to June 2013), and bull market (July 2013 to June 2015).

Empirical Analysis
Construction of investor sentiment index
After removing the influence of macro-economic factors on each investor's emotion measurement index by regression analysis method, the study uses the statistical software SPSS19.0 to carry out factor analysis and construct the investor
sentiment index. According to Table 2, two principal components are extracted to construct an investor sentiment index $IS_t$ under the principal component extraction principle that the eigenvalue of the principal component is greater than 1 and the sum of cumulative contribution rates of extracted principal components is more than 80%.

$$IS_t = 0.211 DCEF_t + 0.261 NEW_t + 0.180 Turn_t + 0.251 CC_l_t$$  \hspace{1cm} (5)$$

It can be seen that the investor sentiment is positively related to the discount rate of closed-end fund, the number of new accounts, the turnover rate and the consumer confidence index, which is consistent with the relationship between the investor sentiment and each index specified in the index selection.

**Results of Linear Granger causality test**

Prior to the linear Granger causality test, ADF unit root test is performed on the investor sentiment index sequence $(IS_t)$ and the Shanghai Composite Index yield sequence $(R_t)$ under the full sample and different market conditions, and second-order difference processing is performed on the unstable original sequence. The results are shown in Table 3. It is pointed out in Table 3 that under the conditions of full sample, bull market and bear market, the investor sentiment index sequence and the return rate sequence are significantly stable at a confidence level of 1%. Therefore, the investor sentiment index sequence and the return rate sequence are considered to be stable. The linear Granger causality test is carried out for the two sequences and studied by the statistical software Eviews7.2. Taking into account the timeliness of the stock market and the optimal lag order, we choose lag order 1 and lag order 2 to carry out the study, and the results are shown in Table 4.

It can be seen from Table 4 that under the conditions of full sample, bull market and bear market, stock returns which are a significant linear Granger causality of investor sentiment at a confidence level of 1%, but investor sentiment is not a linear Granger cause of stock returns. This result is consistent with the conclusions of Yang Yang (2010) and Jin and Zou (2014), which may be due to the low level of professional knowledge and ability of investors in China stock market, which results in failing to reasonably predict the future trend of stock market, and investors in the China stock market are easily influenced by the change of stock market yield. In order to further study the internal relations between the two, a non-linear Granger causality test is carried out for investor sentiment and stock returns.

**Results of non-linear Granger causality test**

We test the residual components of VAR system after linear filtering and use Matlab R2015a programming to perform nonlinear Granger causality test on investor sentiment and stock returns. The test results based on common lag order $(L_x=L_y)$ 1-2 are listed in Table 5:

As can be seen from Table 5, there is a significant bi-directional non-linear Granger causality between investor sentiment and stock returns at a confidence level of 5% over the full sample. In the bull market, there is only the non-linear causality between stock returns and investor sentiment. In the bear market, there is a bi-directional non-linear Granger relationship between investor sentiment and stock returns in the lag of second-order; and there is only a non-linear causality between stock returns and

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**Table 2. Result of principal component analysis**

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>1</td>
<td>1.773</td>
<td>44.329</td>
</tr>
<tr>
<td>2</td>
<td>1.579</td>
<td>39.477</td>
</tr>
<tr>
<td>3</td>
<td>.415</td>
<td>10.368</td>
</tr>
<tr>
<td>4</td>
<td>.233</td>
<td>5.826</td>
</tr>
</tbody>
</table>

**Table 3. ADF unit root test**

<table>
<thead>
<tr>
<th>Unit root test</th>
<th>Full sample</th>
<th>Bull market</th>
<th>Bear market</th>
</tr>
</thead>
<tbody>
<tr>
<td>$IS_t$</td>
<td>-15.479</td>
<td>-5.240</td>
<td>-7.531</td>
</tr>
<tr>
<td>T-statistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Stationary</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

*Note: The first-order and second-order in parentheses indicate the stability after the first-order difference and the second-order difference respectively*
Conclusions

(1) Under the full sample, by comparing the results of linear and non-linear Granger causality test, it is found that there is a bi-directional non-linear Granger causality between investor sentiment and stock returns in China, which is consistent with the reality of China’s stock market. As an emerging market, China’s stock market is at the imperfect development stage, and has unreasonable structure of investors, which are easily affected by the volatility of stock returns and also makes China’s stock market be affected by the irrational sentiment and behavior of investors. By using the method of nonlinear Granger causality test, the relationship between China investor sentiment and stock returns can be more fully presented.

(2) In the conditions of bull market and bear market, the linear and non-linear causality between investor sentiment and stock returns are not consistent, which is also caused by the high degree of irrationality of investor in China stock market. Therefore, in order to ensure more stable development of China stock market, we should strengthen market supervision and regulation, and stress on improving the quality of investors and their rational degree of investment behavior.

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