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Nonlinear analysis and empirical test of the investor sentiment index system based on OLS theory and the DSSW model

Hua Li^{1,2}, Li-na Zhao¹, Qiu-bai Sun^{1*}¹School of Business Administration, University of Science and Technology Liaoning, Anshan 114051, (CHINA)²Institute of Quantitative & Technical Economics, Chinese Academy of Social Sciences, Beijing 100732, (CHINA)

E-mail:14581579@qq.cm

ABSTRACT

Investor sentiment is a very important factor affecting stock returns, but its influential way and degree has become a hotspot of behavioural finance research. To further illustrate the problem and understand the role of investor sentiment in stock returns, on the basis of the behavioural finance theory and the DSSW model, this paper measures investor sentiment by constructing an index system including turnover rate, new accounts, consumer confidence index, price earnings ratio. By using Ordinary Least Squares method, the stock returns and investor sentiment's comprehensive nonlinear model is established and subsequently the empirical test is made. The innovation is that this paper comprehensively selected the sentiment indicators of previous literature, quantified the investor sentiment, and then added to the model, which can be observed macroscopically effect of the investor sentiment fluctuations on stock returns. The test result shows that investor sentiment can significantly affect the stock returns, thereby influence the investment decisions. The research result provides a reference basis for securities investors and regulators' decision-making, which has very important theoretical and practical value to predict the stock market volatility and ensure China's stock market stable operation.

KEYWORDS

Investor sentiment; Stock return; Irrational behaviour; Nonlinear relation.



INTRODUCTION

Whether the investors' irrational behaviours will affect investment decisions thereby affect the stock price and earnings is the debate focus of modern financial theory and behavioural finance theory. Modern financial theory deems that some investors may not be rational, but due to the random trade between them, irrational behaviour can be offset, share prices wouldn't be affected. Even if in some cases it cannot cancel, the arbitrageurs would also utilize the price difference to eliminate their impact on stock price, so the price is equal to the true value. However behavioural finance theory suggests that most investors have difficulty judging the true stock value based on market information, being the excessive reliance on public opinion or public behaviour, so the investment behaviours have the great blindness and unpredictability; Arbitrageurs' arbitrages do not completely rectify the deviation caused by irrational trading between stock price and real value^[1]. So besides systemic risk and unsystematic risk, the stock price and earnings are also affected by investors' mispricing. Wang Meijin, Sun Jianjun (2004) defined the investor sentiment as investors in investing activities have a formation of "based on the emotional judgment", the cognitive, or psychological deviation caused incorrect views on risky asset expected return distribution^[2].

Robert.J. shiller (2000) analyzed the prosperity of American stock market. Through in-depth investor sentiment study, he pointed out the important role of the emotion in the stock market investment, and successfully predicted the Nasdaq stock market crash in 2000^[3]. Even the Los Angeles times divided the emotion cycle of investors into seven stages. Mood fluctuations leads to cognitive bias and emotional deviation, amplify optimistic or pessimistic mood, thereby result in financial vision. Therefore, we cannot ignore the important influence of the emotion factors in asset pricing or in the asset return judgment^[4].

Compared with mature capital markets, China stock market has the serious over-investment problem and a stronger psychological characteristic^[5], so this article does the empirical research of the relationship between China's stock market investor sentiment volatility and stock returns, which has the important theory significance and the practical value for understanding the China stock market movement and increasing its operating efficiency.

LITERATURE REVIEW

Debondt and Thaler (1985) wrote the article "Does the stock market overreact?" it caused the revival of the behavioural finance theory research, regarded as the foundation for the behavioural finance study^[6]. De long, Shieifer, Summers and Waldmann (1990) raised noise deal theory, namely DSSW model. This article studied the effect of two types of investors on stock price: rational traders and noise traders^[7]. Barberis, Shieifer and Vishny (1998) constructed a BSV model involving conservative bias and representative bias. This model points out that the investors have different response speed to new information, which results in share price being insufficient and excessive reaction, compared to intrinsic value. The model explains how investors' decision-makings lead to securities market price deviation^[8]. Hong and Stein (1999) put forward the HS model of information spreading. The model holds that there are widespread two types of investors on the market: information observer and momentum traders. This model unifies under reaction and overreaction as basic information value gradually diffusion. In the process of information diffusion, prices are inadequate response in the short-term, it means that momentum traders can profit from the "Chase after go up kill drop". However, this arbitrage behaviour inevitably leads to long-term price overreaction^[9].

Domestic scholars have no raised their own original theory; merely modify research results abroad to be more in line with the real situation of China. Wang Meijin and Sun Jianjun (2004) extended the DSSW model; they divided the noise traders into the noise traders affected by emotion and other traders. It confirmed that sentiment had a significant effect on the market return, indicating sentiment is systemic factors affecting equilibrium price. Zhang Qiang and Yang Shu'e (2009) fixed the DSSW model, thinking that the current investor sentiment volatility has a positive impact on stock returns, a negative impact on the stock expected returns^[10]. Chen Qi'an, Zhu Min, Lai Qinyun (2012) established an investment portfolio model based on investor sentiment. The model assumes that the investor is risk aversion and the degree of aversion affected by emotion, making decisions based on utility maximization. It theoretically studies that how investor sentiment can affect portfolio structure and the relationship between return and risk^[11].

ESTABLISHMENT OF INVESTOR SENTIMENT INDEX SYSTEM

Before the study of the relationship between investor sentiment and stock returns, we should know how to measure investor sentiment. So far there is no a unified and authoritative quantification standard. Many scholars carried out extensive researches in this aspect and made a lot of achievements. Considering China market as an emerging capital market, retail investors are the majority and they have a low understanding for the capital markets, their investment with blindness; compared with western institutional investors, China institutional investors are inexperienced. So, investor's emotion direct indicators may exist the characteristics of the larger subjectivity, poor availability and continuity, thus, the specific data of the market itself reflected is more persuasive.

This paper adopts Ordinary Least Squares method (OLS) to analyze the relationship between investor sentiment changes and stock returns. Turnover rate (TURN), new accounts (ACC), consumer confidence index (CCI), price earnings ratio (PER) are chose as Investor sentiment quantitative indicators^[12]. According to the data can be obtained continuity and

considered persuasiveness of the empirical results, this paper will choose 2011.4 to 2013.12 as empirical interval, Shanghai and Shenzhen stock market as empirical sample. Stock returns adopts monthly average yield, the data from RESSET Financial Research Database. TABLE 1 lists the various quantitative indicators and the selection reasons.

TABLE 1: Investor Sentiment Quantitative Indicators

Index Name	Interpretation
Turnover rate	The higher investor sentiment, the higher turnover rate. Source: RESSET Financial Research Database
Price earnings ratio	Evaluation index of the price level reasonableness, representing the stock is overvalued or undervalued, the higher the price earnings ratio is, the more bubbles stock price have, value is overestimation. Source: CASS Financial Statistics Database
Consumer confidence index	The subjective indicators of consumers about the economic outlook, The more optimistic about the market outlook, the greater the confidence index. Source: Eastmoney Data Center
New accounts	On behalf of the investor demand and participation degree for securities, the higher the new accounts is on behalf of the investor sentiment is high. Source: CASS Financial Statistics Database

CONSTRUCTION OF THE MODEL

According to the econometric theory, this paper sets up a multiple nonlinear regression model to construct the relationship between investor sentiment and stock returns.

The OLS Theory

The OLS method is used to solve the problem which how to seek reliable values from a set of observations. Its basic principle is: according to the measurement data $X_i, Y_i (i=1,2,\dots,n)$, finding a best fitting straight-line to let the square of the difference (each point on this fitting curve and the observed) be a minimum among all the fitted line. The OLS method is also known as curve fitting. The so-called "fitting" does not require all points through curve, requiring that the curve can reflect the basic trend of the data on it.

Therefore, Y_t represents stock returns, $X_i (i=1,2,\dots,n)$ said some functional form of all the indexes, Y_t and X_i can establish the multiple regression equation, the form of the equation as follows:

$$Y_t = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + u_t \tag{4.1}$$

In the formula, b_0, b_1, \dots, b_4 is regression coefficient, undetermined parameters; u_t is random disturbance, meeting the classical assumptions.

Regression model establishment

By observing of the data scatter plot distribution, the OLS method is suitable to establish the regression equation between stock returns and investor sentiment quantitative indicators. In regression analysis, the primary task is to estimate the unknown parameters in the regression equation, then to do statistical judgment to overall regression equation. The result is shown in TABLE 4.1.

TABLE 4.1 : Least-squares Regression Output Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.179337	0.070076	-2.559	0.0169
LOG (TURN)	0.160485	0.024596	6.525	0
TURN (-1)	-0.005317	0.001417	-3.752	0.0009
PER	0.038665	0.0062	6.237	0
PER (-1)	-0.016415	0.004382	-3.746	0.0009
1/EXP (CCI)	-3.07E+40	1.34E+40	-2.293	0.0305
LOG (ACC)	-0.117055	0.021539	-5.435	0

TABLE 4.2 : Data Statistics

R-squared	0.814089	Mean dependent var	-0.005003
Adjusted R-squared	0.76947	S.D. dependent var	0.0595
S.E. of regression	0.028568	Akaike info criterion	-4.08242
Sum squared resid	0.020403	Schwarz criterion	-3.76179
Log likelihood	72.31872	Hannan-Quinn criter.	-3.97614
F-statistic	18.24545	Durbin-Watson stat	2.308855
Prob (F-statistic)	0		

According to the result of Eviews output (TABLE 4.1), the regression equation is:

$$\begin{aligned}
 Y_t = & -0.18 + 0.16\text{LOG}(\text{TURN}) - 0.01\text{TURN}(-1) + 0.04\text{PER} \\
 & (-2.56) \quad (6.52) \quad (-3.75) \quad (6.24) \\
 & -0.02\text{PER}(-1) + (-3.07E + 40)1 / \text{EXP}(\text{CCI}) \\
 & (-3.70) \quad (-2.29) \\
 & -0.12\text{LOG}(\text{ACCOU}) \\
 & (-5.43) \quad \text{t value} \\
 \overline{R^2} = & 0.77 \quad F = 18.25 \quad T = 33 (2011.4 - 2013.12)
 \end{aligned}
 \tag{4.2}$$

Empirical Results Analysis

TABLE 4.2 shows the regression results numerical characteristics of investor sentiment changes and stock returns. It can be seen that equation explanation ability -- adjusted R^2 value is 77%, the better explaining the effect of investor sentiment changes on stock returns.

From the Eviews output result, stock returns are in proportional to the current turnover rate, and in inversely proportional to the lagging turnover rate. If the stock turnover rate increases suddenly, ie volumes amplification, it may imply that investors are in numerous buying, share prices rising, so yield rate will increase; if the stock price continues to rise in a period of time, turnover rate rises again, it may mean that the gainers wants to cash out, which lead to share prices falling and yield rate reducing. Thus, the relationship performance between turnover rate and stock returns is in current period turnover rate rises and stock returns increases, however in the long term, stock returns will fall.

The price earnings ratio is the rate of the listed companies' stock price divided by earnings per share. It links the stock price and enterprise's profitability organically, becoming an important indicator to measure the real stock price, and a way to measure the investment value. Generally, the ratio between the 20-30 times is normal. It is small means that stock prices are low, the small risk and worthy buying; too large, it means the high price and risk, a high possibility having price bubble, so the stock value is overvalued and should be cautious to buy. The price earnings ratio integrates the investment costs and benefits two aspects, which can reflect the stock market development outline, so it has great significance in the analysis.

Consumer confidence index is get by the consumer satisfaction index and consumer expectations index weighted average, which measures the degree of investor confidence and reflect consumers' views on the economy and purchase intent. The same as Wang Rufang and Tian Yejun views, the result shows that the more high investor sentiment, the more optimistic the market outlook, and the greater the stock returns^[13].

New investors accounts directly reflects the investor's investment sentiment. In the model, new accounts and stock returns is inversely proportional, indicating that the more new accounts, ie the higher investor sentiment, the more easily leading to price bubbles, prices overvalued, thereby affecting the investment income of the investors.

In conclusion, investor sentiment is one of the system factors affecting stock returns. Stock prices fluctuate as investor mood swings, the rise and fall of the investor sentiment will bring the change of stock trade, influencing investment income. The stock return volatility which investors sentiment volatility caused, constitutes the market system risk, getting the corresponding risk premium^[14].

THE MODEL TEST

Model significance test

Testing of the regression equation, the primary thing is to do F test on the whole. From TABLE 4.2, $F=18.25 > F_{0.05}(6,25)=2.49$, it can be seen that the model is through the F test, and the total regression equation exists a significant linear relationship. Secondly, do the significance test of the variable dependability by using T test. T test is to check the estimated

parameters are significantly not equal to zero. Inspection results shows that the explanatory variables' values are greater than $t_{0.025}(25)=2.06$, passing the significance test, which indicates that the choosed index has a significant influence on stock returns.

Random error term test

Whether the random error (u_t) of the model meets the classical hypothesis is an important factor in the successfully built model. If the violation of any hypothetical, it would cause the model to fail, thus the model's random error needs to test.

Heteroskedasticity test

Heteroskedasticity testing is to determine whether u_t meets with variance assumption, if not satisfied, the equation has the heteroskedasticity.

White test is generally used to determine the relationship between the amount of statistics TR^2 and $\chi^2(n)$: T is the sample quantity; R^2 is an the determination coefficient of the auxiliary regression; degrees of freedom n represents number of explanatory variables in an auxiliary regression (not counting the constant term). If $TR^2 \leq \chi_{\alpha}^2(n)$, then the random variable with the homogeneity of variances; Conversely, the equation with heteroskedasticity variances. Test results as shown in TABLE 5.1:

TABLE 5.1: Heteroskedasticity Test Results

F-statistic	7.154706	Prob. F (27,4)	0.034
Obs*R-squared	31.35084	Prob. Chi-Square (27)	0.257
Scaled explained SS	13.1998	Prob. Chi-Square (27)	0.9879

The figure shows that $TR^2 = 31.41 < \chi^2(26) = 38.89$, illustrates that the model has no heteroscedastic, random variables satisfy the classical assumptions.

Autocorrelation Test

Autocorrelation is the correlation between u_t and its lag variables. If the model exists autocorrelation, the estimate results would lose efficiency. The main test for autocorrelation is the DW test and LM test method. Due to the models includes lags of the dependent variable, it cannot use the DW test, and choose LM test.

LM test method constructs LM statistic to determine the size relationship between $LM=TR^2$ and $\chi^2(n)$. The test results in TABLE5.2

TABLE 5.2: Autocorrelation Test Results

F-statistic	1.522581	Prob. F (1,24)	0.2292
Obs*R-squared	1.909	Prob. Chi-Square (1)	0.1671

As $LM = TR^2 = 1.95 < \chi_{0.05}^2(1) = 3.84$, the LM test result shows that the equation has no autocorrelation, through model test.

Upon examination results, the random error term does not exist heteroskedasticity and autocorrelation, meeting the classical assumption, which illustrates the model not leave out important explanatory variables and it can ideally explain the actual economic.

Unit Root Tests

As the regression model established by the non-stationary economic variables will lead to spurious regression problem, it needs to do non-stationary inspection for the economic variables, namely the ADF test.

For the time series y_t , the auto regression model is constructed to do unit root test. Autoregressive model such as:

$$Dy_t = \hat{\rho}y_{t-1} + \sum_{i=1}^k \hat{\nu}_i Dy_{t-i} + \hat{\nu}_t$$

calculates the ADF value and judges the size between the ADF values and the critical value of the corresponding confidence interval. If the $ADF \geq$ the critical value, y_t is accepted to be non-stationary; conversely, y_t is stationary. The Eviews test results is shown in TABLE 5.3:

TABLE 5.3: Unit Root Test Result

	t-Statistic	Prob.*
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Augmented Dickey-Fuller test statistic		-6.524052	0.0000
Test critical values:	1% level	-3.65373	
	5% level	-2.95711	
	10% level	-2.617434	

Results shows that $ADF = 6.7383$, is less than the statistics of 1% under the level, which can significantly reject the null hypothesis and accept that the economic data is stable, having no unit root. The built model can better reflect the true relationship between investor sentiment and stock returns.

In summary, the regression model passes the random error test, and unit root tests, faithful reflecting the effect of stock market investor sentiment on stock returns.

POLICY RECOMMENDATIONS

This study results show that investor sentiment has a significant impact on stock return. Stock market's the rises and falls phenomenon to a certain extent is caused by the irrational investor sentiment. Therefore, the securities market regulator should pay more attention to the role of investor sentiment, strengthen the research on investor sentiment and take positive measures to maintain the stock market stability and promote market development.

The stock market is flooded with investor sentiment, the correct understanding investor sentiment is the starting point for the securities market regulator to make the market policies, thus the focus of regulation should try to guide investor sentiment at the right time, rather than to eliminate it, so the securities market supervision department should do more work from the following aspects:

(1) To highlight the investors' supervision of China securities market. For many stock market of limited rational investors participated, market information cannot decide all the market price and the market price level is absolutely not the sum of market information. Behaviors of limited rational market participants may cause market failure, even the failure of the market regulation. So, we should be explicitly the stock market participants "human" as an important part of securities trading market regulation, the basic idea of people-oriented as the policy-formulating^[15].

(2) Based on the investment characteristics, securities market regulatory authorities should carry out the effective investor education to enhance investors' rationality. Two ways can be carried out: The first way is to instill risk awareness through knowledge popularization, advocacy and education into the hearts of investors; The second way is to vigorously develop and standardize the institutional investors as an important measures to guarantee the securities market healthy operation. It is necessary to reshape the investment philosophy and investment style, only in this way can restrict the problem of excessive speculation in the market^[16].

(3) When in the policy-making, the securities market regulatory should consider timely and reasonably guide sentiment trends. Lacking adequate self-control and decision-making power, when in the face of the complex stock market changes, most investors' trend to wait and follow the trend, so their behaviour would have the accordant trend, promoting the overall market sentiment changes. Therefore, one of the key points of the securities market supervision should be put in actively promoting the securities regulatory departments, news media and intermediary institutions to rationally guide investor sentiment. When the elation investors caused asset bubbles, regulators should utilize the relevant scientific theory to suppress the over expansion market bubble, preventing extreme fanaticism to disrupt the normal market order and safeguard the investors fundamental interests; However, when investor sentiment continued downturn to lead to the loss of market financing function, supervision department must actively adjust the expectations of investors and rebuild up market confidence.

CONCLUSIONS

In China, individual investors have the serious widespread phenomena with low quality, follow suit, blindly trusting experts. Investor sentiment has strong irrational psychology and behaviour affect on stock market. Based on the reference domestic and foreign scholars study, this paper choose turnover rate, new accounts, consumer confidence index, price earnings ratio as investor sentiment indicators, using the OLS method to set up the relationship between investor sentiment and stock returns and doing the empirical research. The result confirms that investor sentiment has a significant influence on stock returns. This conclusion has certain significance for the in-depth study China's stock market price behaviour and market regulation, which provides a decision-making basis for investors and market regulators and has a very important theoretical and practical significance for the prediction of future market volatility.

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