The Empirical Study of Investor Sentiment on Stock Return Prediction

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ABSTRACT

In Taiwan stock market, most participants are individual investors. Thus, the objective of this empirical study is to explore whether the investor sentiment and investor behavior have considerably influence on the stock return. The study tries to search for predictable indicators and measure them based on two approaches: One is the investor behavior indicator measured by using proxy variables (such as short-term rate of return, long-term average rate of return, turnover rate, and earning-to-price ratio) and the other is the investor sentiment measured by using proxy variables (investor sentiment index, the consumer confidence index, and the market volatility index). In addition, this study creates a stock prediction using the neural networks technique and examines whether the predicted returns reflect the actual returns. Finally, this study expects that the empirical results not only provide the important academic value in financial field, but also provide efficiently an investment strategy for investors and financial institutions.

Keywords: Artificial Neural Networks, Investor Sentiment, Behavioral Finance, Stock Return Prediction
JEL Classifications: F37, F39

1. INTRODUCTION

A number of previous studies tried to search for investing strategies and create stock predictions based on the traditional financial theories such as the capital asset pricing model and efficient market hypothesis (EMH). However, they found that several abnormal phenomena in stock market cannot be explained by the traditional financial theory. Haugen (1999) pointed out that financial markets are less efficient than investors have believed. Anomalies not clearly explained by EMH, such as the small-firm effect and the calendar effect, have received attention from behavioral finance, which is based on psychological and social science. Therefore, behavioral finance theory generally illuminates the irrationality of investors and highlights their fallibility in stock markets.

In Taiwan stock market, the major participants are individual investors, and only 5% of participants are institutional investors (Huang and Yang, 2001). By contrast, most stock market participants in the U.S.

and Japan are institutional investors (Shen, 1992). The extremely high turnover rate and volatility happened in Taiwan stock market cannot be explained by traditional financial and economics. This phenomenon may likely to explain on the influence of investor sentiment. More recent studies, such as Baker and Wurgler (2006), and Qiu and Welch (2006), suggested that investor sentiment measures are closely related to stock market returns and others, such as Neal and Wheatley (1998) and Fisher and Statman (2000) evidenced that the investor sentiment measures have predictive power. In the present study, the factors of investor sentiment will be examined and tried to investigate whether the investor sentiment is related to stock returns.

This study explores the predictive power on stock returns based on two different approaches: One approach is using individual investor behavior as indicators, such as overreaction, underreaction, overconfidence, and representativeness heuristics; the other approach developed is using investor sentiment as indicators, such as investor sentiment index, the consumer

confidence index (CCI), and the market volatility index (VIX). The objective of this empirical study is to build a stock prediction by using a neural network model and to compare the predicted returns with the actual market returns. The study tries to provide an investment strategy and examine whether individual investors can predict returns in the subsequent periods.

The study can be summarized as having two objectives:
1. To investigate whether average returns of common stock are related to proxy variables of investor sentiment between the years 2012 and 2016.
2. To compare stock returns and indicate whether the predicted returns performed by behavioral finance proxies and investor sentiment proxies closely reflect the actual returns between the years 2012 and 2016.

2. LITERATURE REVIEW

In Taiwan stock market, most participants are individual investors; thus, the recently empirical study, such as Baker and Wurgler (2007), tried to explore theoretical effects of investor sentiment on the stock market regarding the critical aspects of investigation which are how investor sentiment can be empirically measured and whether investor sentiment can predict future returns.

According to the study of Zhou et al. (2007), the author showed that only turnover rate has explainable power on Taiwan stock returns by testing three proxies as the investor sentiments which are ratio of the equity share in new issues, ratio of margin to short balance, and market turnover rate. Moreover, the study of Lin (2009) suggested that the Taiwan market VIX may consider as one of explaining variables for investor sentiment and showed that VIX has significantly influence on the stock returns.

In addition, regarding to the study of Fisher and Statman (2003), the authors examined whether stock returns affect consumer confidence. The authors found that high consumer confidence is generally followed by low returns. Also, there is statistically significant relationship between consumer confidence and stock returns. In the study of Zhang (2007), the author examined the prediction of industrial market returns by using the CCI and found that consumer confident index has certain predictive power on the returns of electronics and automobile industries.

Overview the previous researches, the scholars still explored the role of investor sentiment in the stock market and test it in various ways. This study focus on the approach of behavior finance theory and expect to create a predictive model on stock returns. As a result, the study will contribute to investors' understanding about which significant indicators could be effectively considered for investing predictions created through the neural networks technique. Furthermore, the findings of this study will be proved especially helpful to investors in the Taiwan stock market.

3. RESEARCH METHODOLOGY

The research methodology was twofold. First, this study used a nonlinear model (i.e. neural networks) to predict stock returns from the set of all stocks listed on the Taiwan Stock Exchange (TSE). Second, two statistical calculations were conducted: The Pearson correlation test and the dependent samples (paired samples) t-test in the SPSS software. All statistics were performed at the 0.05 level of significance (alpha set to 0.05).

The Pearson correlation tested the relationship between stock returns and each of the investor sentiment proxy variables (i.e., sentiment index, CCI, and market VIX). The dependent samples (paired samples) t-test investigated the differences between predicted stock returns (created through the neural networks by using behavioral finance proxies and investor sentiment proxies) and actual stock returns, and compared the mean of monthly predicted stock returns with the mean of monthly actual returns of the TSE. In addition, the descriptive statistics of variables were used to compute means, variances, and standard deviations.
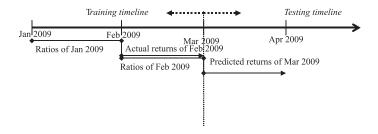
The neural networks model will be applied in this study. Neural networks, also called artificial neural networks (ANN), are mat hermetical and algorithmic software programs that operate similarly to the biological systems of the human brain. Regarding to Hill et al. (1994), the model of ANN can be used on the non-linear function and can construct different functions in different portions of sample space. More previous studies, such as Walczak (2001) and Fadlalla and Lin (2001) explored that the application of neural networks are useful for the analysis of stocks. Therefore, the ANN have been successfully applied within the various fields of finance and economics and have been widely used for forecasting financial markets.

The neural network typically consists of an input layer and output layer. In this study, the output is defined as the percentage of total stock return. In addition, the input data are classified into two approaches. One approach focuses on the investor sentiment and other approach focuses on the investor behavior; those are built on the assumptions of behavioral finance. The data are measured annually from December 2009 to June 2016 in Taiwan stock market. The input data is determined as follows:
- Investor sentiment indicators – the sentiment index, the CCI, and the market VIX.
- Investor behavior indicators – the short-term rate of return (a proxy for overreaction), the long-term average rate of return (a proxy for underreaction), turnover rate (a proxy for overconfidence), and earning-to-price ratio (a proxy for representativeness heuristics).

Training and testing are the most important issues in the neural network design because the network system tries to minimize its errors and improve its performance. The procedure of training and testing in the networks involves training on most of the patterns (usually around 90%) and then testing on the remaining patterns. If the performance on the testing set is poor, the configuration or learning parameters of the networks can be changed. The network will retrain the input data until its performance is satisfied. Regarding to Eakins and Stansell (2003), the model of the timeline for training and testing the

networks is shown as below.

3.1. Definitions of Terms

3.1.1. Short-term rate of return
Conceptually, the rate of return on a monthly basis is expressed as a percentage of the total amount invested in the stock.

Operationally, $SR_{i,t} = \dfrac{p_{i,t}^c - p_{i,t-1}^c}{p_{i,t-1}^c} \times 100\%$

$SR_{i,t}$ represents the short-term rate of return for stock i in the t period, which is on a monthly basis.

$p_{i,t}^c$ represents the closing price of stock i in t period.

$p_{i,t-1}^c$ represents the closing price of stock i in t-1 period.

3.1.2. Long-term rate of return
Conceptually, the rate of return on a yearly basis is expressed as a percentage of the total amount invested in the stock.

Operationally, $LR_{i,t} = \dfrac{p_{i,t}^c - p_{i,t-12}^c}{p_{i,t-12}^c} \times 100\%$

$LR_{i,t}$ represents the long-term rate of return for stock i in the t period, which is on a yearly basis.

$p_{i,t}^c$ represents the closing price of stock i in t period.

$p_{i,t-12}^c$ represents the closing price of stock i in t-12 period.

3.1.3. Turnover rate
Conceptually, the trading volume in a particular stock during a time period (generally 1 year) is a percentage of the total number of shares of that stock outstanding. The turnover rate adjusts for the differences in outstanding shares and provides a measure of the relative activity in a stock.

Operationally, $TO_{i,t} = \dfrac{Volume_{i,}}{Shares_{i,t}} \times 100\%$

$TO_{i,t}$ represents the turnover rate for stock i in the t period.

$Volume_{i,t}$ represents the trade volumes of stock i in the t period.

$Shares_{i,t}$ represents the shares outstanding of stock i in the t period.

3.1.4. Earning to price (E/P) ratio
Conceptually, earning-price ratio is a relationship of earnings per share to current stock price. It is also known as *earnings yield.* It is used in comparing the relative attractiveness of stocks, bonds, and money market instruments.

Operationally, $EP_{i,t} = \dfrac{EPS_{i,t}}{P_{i,t}} \times 100\%$

$EP_{i,t}$ represents the earning per share to price ratio of stock i in the t period

$EPS_{i,t}$ represents the earning per share of stock i in the t period.

$P_{i,t}$ represents the price of stock i in the t period.

3.1.5. Sentiment index
Conceptually, a possible definition of investor sentiment is the propensity to speculate (Baker and Wurgler, 2006). In this study, the investor sentiment index is calculated on the basis of seven questions, which cover the personal financial dimension and the macroeconomic dimension of investments.

Operationally, sentiment index (optimism index) = personal index + economic index;

The data is used through the Department of Banking Financial Emotional Team in Shih Hsin University.

3.1.6. CCI
Conceptually, CCI is an indicator as the degree of optimism on the national economy that consumers are expressing through their activities of savings and spending.

Operationally, the CCI consists of six indicators which included the domestic price conditions for the next 6 months, family income status for the next 6 months, the domestic employment conditions for the next 6 months, business conditions for the next 6 months, time to purchase the durability and goods for the next 6 months, and time to invest in stocks for the next 6 months. The data is calculated and collected through the Taiwan's National Central University Research Center for Economic Development.

3.1.7. Market VIX
Conceptually, the first VIX, introduced by the Chicago Board Options Exchange (CBOE) in 1993, was a weighted measure of the implied volatility of eight S&P 100 at-the-money put and call options. 10 years later, it expanded to use options based on a broader index, the S&P 500, which allows for a more accurate view of investors' expectations on future market volatility.

Operationally, the calculation of the VIX index uses two series of SPX option contracts - the front month and the 2nd month - as long as the front month has at least 1 week until expiration. When the front month series is 1 week from expiration, then the current 2nd month series rolls up to become the new front month in the VIX index calculation, and the current 3rd month becomes the new 2nd month. The data is collected through the Taiwan Future Exchange.

3.2. Data Source
The database is secondary data and obtained from the Taiwan Economic Journal, an institution that collects financial data on the Taiwan stock market. All data, including monthly stock returns, stock prices, and annual firms' accounting information, relate to

the listed common stocks in the TSE Corporation (TSEC). The data of the company's financial ratios are calculated in the local currency unit (New Taiwanese Dollars) and cover the period from December 01, 2009 to June 30, 2016. The data utilized in this study comprises nominal monthly values listed on the TSEC from December 2009 to June 2016 inclusively – a total of 79 months. During the period of study, some data may not be completely listed for a specific month or term. In order to maintain sufficient sample size and to remove survivorship bias, incomplete data from the specific period were eliminated, but the rest of the data were still included over the full sample period.

3.3. Limitations
The limitations of this study are as follows:
1. All incomplete data are excluded from the study.
2. The data collected for variables of investor sentiment is not easy.
3. It is assumed that theories of behavior finance developed based on research conducted in the United States are generalizable to Asian investors.

4. HYPOTHESES AND FINDINGS

RQ1: Is there a significant relationship between sentiment index and stock returns in the Taiwan stock market during the period from December 2009 to June 2016?

H_{01}: There is no significant relationship between sentiment index and stock returns in the Taiwan stock market during the period from December 2009 to June 2016.

The statistical results for this hypothesis revealed a significant relationship between sentiment index and stock returns in the Taiwan stock market from December 2009 to June 2016. The result of the Pearson correlation test was significant; thus, the null hypothesis was rejected. Table 1 shows that there was a significant positive relationship between sentiment index and stock returns ($r = 0.055, P < 0.01$). Thus, higher sentiment index were associated with a higher percentage of stock returns from December 2009 to June 2016.

RQ2: Is there a significant relationship between CCI and stock returns in the Taiwan stock market during the period from December 2009 to June 2016?

H_{02}: There is no significant relationship between CCI and stock returns in the Taiwan stock market during the period from December 2009 to June 2016.

The statistical results for this hypothesis revealed a significant relationship between CCI and stock returns in the Taiwan stock market from December 2009 to June 2016. The result of the Pearson correlation test was significant; thus, the null hypothesis was rejected. Table 2 shows that there was a significant negative relationship between CCI and stock returns ($r = -0.050, P < 0.01$). Thus, higher CCI was associated with a lower percentage of stock returns from December 2009 to June 2016.

RQ3: Is there a significant relationship between investor market volatility and stock returns in the Taiwan stock market during the period from December 2009 to June 2016?

H_{03}: There is no significant relationship between market VIX and stock returns in the Taiwan stock market during the period from December 2009 to June 2016.

The statistical results for this hypothesis revealed a significant relationship between market VIX and stock returns in the Taiwan stock market from December 2009 to June 2016. The result of the Pearson correlation test was significant; thus, the null hypothesis was rejected. Table 3 shows that there was a significant negative relationship between CCI and stock returns ($r = -0.017, P < 0.05$). Thus, higher market VIX were associated with a lower percentage of stock returns from December 2009 to June 2016.

In order to investigate whether the predicted returns performed by behavioral finance proxies and investor sentiment proxies closely reflect the actual returns, the alternative hypotheses below state the significant difference between predicted stock returns (created through neural network by using behavioral finance proxies and investor sentiment proxies) and actual returns in Taiwan stock market:

RQ4: Is there a significant difference between predicted stock returns and actual returns in Taiwan stock market during the period from December 2012 to June 2016? (Predicted stock returns are created through neural networks by using behavioral finance proxies: The short-term rate of return, the long-term average rate of return, turnover rate, and E/P ratio.)

Table 1: Pearson correlation between sentiment index and stock returns

Sentiment index		
Stock returns	0.055**	Pearson's *r*
	0.000	P
	15865	N

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Table 2: Pearson correlation between consumer confidence index and stock returns

Consumer confidence index		
Stock returns	−0.050**	Pearson's r
	0.000	P
	15865	N

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Table 3: Pearson correlation between market volatility index and stock returns

Market volatility index		
Stock returns	−0.017*	Pearson's r
	0.034	P
	15865	N

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Table 4: Descriptive statistics comparing with mean of predicted stock returns (using behavioral finance proxies) and mean of actual stock returns

	N	Mean±SD
Predicted stock returns	5165	0.83346621±2.794409945
Actual stock returns	5165	0.71912364±13.074452522

SD: Standard deviation

Table 5: Paired samples t-test comparing with predicted stock returns (using behavioral finance proxies) and actual stock returns

Stock Returns	t	df	Significant (2-tailed)
Predicted - actual	−0.616	5164	0.538

**P<0.05 (2-tailed)

H_{04}: There is no significant difference between predicted stock returns and actual returns in Taiwan stock market during the period from December 2012 to June 2016.

The statistical results for this hypothesis revealed no significant difference between predicted stock returns and actual returns in Taiwan stock market. Paired sample t test was used to test the difference for the two experimental conditions: Predicted stock returns created through neural networks by using behavioral finance proxies, and actual returns. For each condition, an equal number of samples were selected. Table 4 presents the mean and standard deviations of predicted stock returns and actual returns during the testing periods from December 2012 to June 2016.

The result of the paired sample t test was not significantly different; thus, the null hypothesis was not rejected. Table 5 summarizes the results of the statistical test, indicating no significant difference between predicted stock returns and actual returns. It shows that the returns predicted by using neural networks modeling based on behavioral finance analysis was fairly close to reality in Taiwan stock market during the periods from December 2012 to June 2016.

RQ5: Is there a significant difference between predicted stock returns and actual returns in Taiwan stock market during the period from December 2012 to June 2016? (Predicted stock returns are created through neural networks by using investor sentiment proxies: The sentiment index, the CCI, and the market VIX.)

H_{05}: There is no significant difference between predicted stock returns and actual returns in Taiwan stock market during the period from December 2012 to June 2016.

The statistical results for this hypothesis revealed a significant difference between predicted stock returns and actual returns in Taiwan stock market. Paired sample t test was used to test the difference for the two experimental conditions: Predicted stock returns created through neural networks by using investor sentiment proxies, and actual returns. For each condition, an equal number of samples were selected. Table 6 presents the mean and standard deviations of predicted stock returns and actual returns during the testing periods from December 2012 to June 2016.

Table 6: Descriptive statistics comparing with mean of predicted stock returns (using investor sentiment proxies) and mean of actual stock returns

	N	Mean±SD
Predicted stock returns	5165	4.634039483±2.514406439
Actual stock returns	5165	0.71912364±13.074452522

SD: Standard deviation

Table 7: Paired samples t-test comparing with predicted stock returns (using investor sentiment proxies) and actual stock returns

Stock Returns	t	df	Significant (2-tailed)
Predicted - actual	−7.570	5164	0.000

**P<0.05 (2-tailed)

The result of the paired sample t test was significantly different; thus, the null hypothesis was rejected. Table 7 summarizes the results of the statistical test, indicating no significant difference between predicted stock returns and actual returns. It shows that the returns predicted by using neural networks modeling based on investor sentiment analysis was not fairly close to reality in Taiwan stock market during the periods from December 2012 to June 2016.

5. CONCLUSION AND CONTRIBUTIONS

5.1. Conclusion
This study confirmed the usefulness of several financial factors in predicting stock returns. While previous research has examined many various fundamental and economic factors, in particular, this study attempted to test the relationships between factors of investor sentiment proxy and stock returns. The results showed that the factors (sentiment index, CCI, and market VIX) related significantly to stock returns and exhibited explanatory power for average stock returns in the Taiwan stock market during the periods from December 2012 to June 2016. These factors present important determinants in predicting stock returns. The findings were consistent with previous studies of stock returns (Neal and Wheatley, 1998; Baker and Wurgler, 2007; Zhang, 2007; Lin, 2009).

In addition, the study also attempted to examine the difference between predicted stock returns created through the neural networks and actual returns during a 4 years period (2012 – 2016).

This research found that there appeared to be no significant difference between stock returns predicted through neural networks using behavioral finance proxies and actual returns during the test period. Thus, predicted stock returns based on behavioral finance analysis were close to the reality of the Taiwan stock returns. Therefore, the result of H4 was useful predictive tools for investors because the predicted stock returns closely reflected the actual returns. However, the finding from H5 showed that the predicted stock returns based on investor sentiment analysis did not significantly reflect reality. Investors can still use the finding as references for financial decisions in other stock markets and time frames. The results demonstrated that behavioral

proxy factors and investor sentiment proxy factors significantly influenced stock prediction. These factors demonstrated different levels of explanatory power during the test period from 2012 through 2016 for the Taiwan stock market.

5.2. Contributions

Creating an exceptional investing model is one of the most critical challenges in investing strategy. Individual and institutional investors are constantly looking for significant investing indicators to enhance their returns. This empirical study was designed to address the practical financial problem of how to create and design investing strategies for stock markets in Taiwan. The study identified some significant indicators which can be useful for investing predictions created through the neural networks technique. Therefore, the contribution for the academic study is expected to provide individual investors in identifying the influential factors for the investment decision-making in the Taiwan stock market. Moreover, the results on the contribution of national development may provide the security firms or investment banks an important reference for improving their investment performance. Finally, this study also expects that the empirical results not only provide extremely the important academic value in financial field, but also help investors apply actually on their investing strategies.

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