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26 February 2017

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February 2017

Acknowledgments: We would like to thank Margaret Loo, Min Chen, Alex Yiu and Sophia Lok for able research assistance. The third author would also like to thank Robert B. Miller and Howard E. Thompson for their continuous guidance and encouragement. The research is partially supported by The Chinese University of Hong Kong, Hong Kong Baptist University, Asia University, Lingnan University, and the Research Grants Council (RGC) of Hong Kong (projects Nos. 12502814 and 12500915). All the remaining errors are ours.

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Abstract: In light of the increasing integration between China and Hong Kong, this paper develops a new market sentiment index for the Hong Kong stock market by including the CSI 300 index of the Chinese equity market. A threshold regression model using the sentiment index as a threshold variable is estimated to capture the state of the Hong Kong stock market.

Keywords: Principal component analysis; Market sentiment; CSI 300; Threshold model

JEL Classifications: C22, G17

1. Introduction

Over the past two decades, there has been an increasing interest in the study of investor sentiment. A number of studies have demonstrated that this can be used as a tool to forecast market volatility. Lee *et al.* (1991) find that reductions of closed-end funds can be used as an indicator for shifts in individual trader sentiment. Neal and Wheatley (1998) find a positive relationship between expected returns of small firms and fund discounts, while no correlation is found between expected returns of large firms and fund discounts. Wang (2001) suggests that measures of market sentiment can be used to forecast stock returns and their volatility.

More recently, Chen *et al*. (2010, 2014) develop a market sentiment index for the Hong Kong and Chinese stock markets respectively. The sentiment measure Chen *et al*. (2010) do not account for the Chinese stock market reform and its impact on the stock market of Hong Kong. Over the past decade, the Chinese stock market has grown rapidly in terms of turnover and market capitalization. The capitalization of the Chinese stock market increased

by 798% between 2002 to 2012, ranking second largest among G20 countries behind Indonesia. Zhou *et al*. (2012) show that since 2005, the volatility of the Chinese market has had a significant positive impact on world equity markets, including that of Hong Kong. In Novenmeber 2014, the Shanghai-Hong Kong Stock Connect was launched. It is a pilot programme that links the stock markets in Hong Kong and Shanghai. Under the programme, investors in China and Hong Kong can trade and settle shares listed on the other market via the home market's exchange and clearing house. In December 2016, the Shenzhen-Hong Kong stock connect was also launched. As a result, the interaction between the Chinese and Hong Kong markets is increasingly prominent. In light of the increasing integration between China and Hong Kong, this paper develops a new market sentiment index for the Hong Kong stock market by including the CSI 300 index of the Chinese equity market. We focus on the post-SOE reform and post-2008 financial crisis periods, which are not covered by Chen (2010).

2. Data and Methodology

Our data is obtained from various financial sources online. Historical daily turnover and prices of the Hang Seng Index (HSI) from 1 December 2008 to 31 December 2012 are obtained from Quamnet. Data for the short-selling volume is obtained from Yahoo Finance. The daily Hong Kong Interbank Offered Rate (HIBOR) is obtained from the Hong Kong Monetary Authority. Historical data for the S&P 500, the Nikkei 225, and the CSI 300 indices are gathered from Yahoo Finance. The stock market sentiment index is estimated using the principal-component method.

Chen *et al*. (2010) use the principal-component method to form a linear index with factors such as the short selling volume, market turnover, Hong Kong Interbank Offered Rate (HIBOR), relative strength index, money flow index, and the indices of foreign equity markets. Our investor sentiment index includes the following eight factors:

$$SMT_t = \alpha + \beta_1 TR_t + \beta_2 SST_t + \beta_3 RS_t + \beta_4 MF_t + \beta_5 HIBOR_t + \beta_6 SP_{t-1} + \beta_7 JAP_{t-1} + \beta_8 CSI_{t-1} \quad (1)$$

where

SMT_t is the stock market sentiment index;

TR_t is the turnover ratio;

SST_t is the short-selling turnover ratio;

RS_t is the relative strength index;

MF_t is the money flow index;

$HIBOR_t$ is the Hong Kong Interbank Offered Rate;

SP_t is the return of the S&P 500 index;

JAP_t is the return of the Nikkei 225 index;

CSI_t is the return of the CSI 300 index.

The turnover ratio is included in the sentiment measurement model because it measures the stock market's trading activity. Findings concerning the relationship between turnover and stock market trend suggest that a larger turnover is usually associated with a price rise, whereas a small turnover is associated with a price fall. The turnover rate is defined as:

$$TR_t = 100 \times \frac{VM10t}{VM250t} \tag{2}$$

where VM10t is the average turnover for the past 10 trading days and VM250t is the average turnover for the past 250 trading days.

We include the number of short-selling trades as a proxy for the amount of negative information in the sentiment model. The short-selling turnover ratio is defined as the amount of short-sold shares divided by the number of shares traded in one day:

$$SST_t = \frac{short-selling\ volume_t}{turnover_t} \tag{3}$$

where short-selling volume is the amount of stock shares sold short and turnover is the total amount of stock shares traded.

The RSI is used to indicate if the market is over-bought or over-sold. Here, the sum of

the positive stock price difference over the past 14 days is divided by the sum of the absolute value of price change in the same period to obtain the RSI index:

$$RS(14)_t = 100 \times \frac{\sum_{i=1}^{14}(P_{t-i}-P_{t-i-1})_+}{\sum_{i=1}^{14}|P_{t-i}-P_{t-i-1}|} \tag{3}$$

where $(P_{t-i} - P_{t-i-1})_+ = P_{t-i} - P_{t-i-1}$ if $P_{t-i} - P_{t-i-1} > 0$, otherwise = 0.

The Money Flow Index contains information on both daily stock price and turnover. To obtain the MF, we define

$$Daily\ Price = \frac{low+high+close}{3} \ . \tag{4}$$

We then define the money flow as:

$$Money\ Flow = Daily\ Price \times Turnover. \tag{5}$$

The money flow is defined as positive if the daily price is lower in the previous day. If the previous day's price is higher, the money flow is negative. We compute the positive money flow and negative money flow in the past 30 days. The money flow index is defined as:

$$MF = 100 \times \frac{Positive\ Money\ Flow_{30}}{Positive\ Money\ Flow_{30}+Negative\ Money\ Flow_{30}} . \tag{6}$$

HIBOR is used here to reflect the cost of investment. Lee (2006) shows that both the U.S. and Japanese stock markets significantly affect the Hong Kong stock market. To reflect these influences and the influence of the China's market,, we include the daily returns of China's CSI 300, the United States' S&P 500, and the Japanese Nikkei 225 in our sentiment measure. Their return series are defined as follows:

$$SP_t = \ln S\&P500_t - \ln S\&P500_{t-1}$$

$$JAP_t = \ln NIKKEI_t - \ln NIKKEI_{t-1} \quad (7)$$

$$CSI_t = \ln CSI300_t - \ln CSI300_{t-1}$$

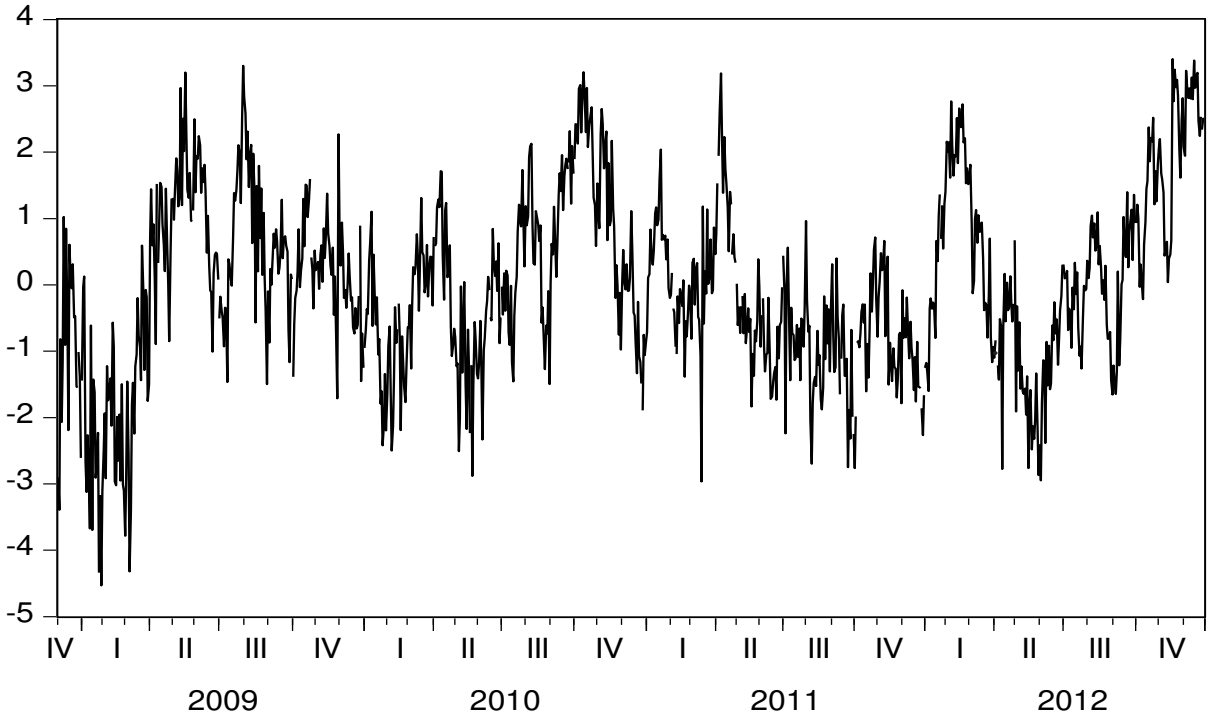
3. Estimation

The stock market sentiment index, denoted by SMT_t, is the first principal component of the eight previously stated variables. The estimation result is as follows:

$$SMT_t = -4.77 + 1.98\ TR_t - 28.57\ SST_t + 0.03\ RS_t + 0.05\ MF_t - 3.30\ HIBOR_t + 7.88\ SP_{t-1} + 19.96\ JAP_{t-1} + 11.96\ CSI_{t-1}$$

Market sentiment is positively related to stock turnover, but negatively related to the short-selling activities. The RSI and MF are both positively related to SMT, while an increase in the HIBOR rate will lower sentiment in the stock market. The performance of the U.S., Japanese, and mainland Chinese stock markets all positively affects Hong Kong's stock market sentiment. Figure 1 plots the movement of the stock market sentiment index.

Figure 1: The Sentiment Index (SMT)



The maximum and the minimum SMT values are 3.405 and -4.533, with most sentiment values occurring within the range of -4 to +4. From Figure 1, we can identify three extremely low values for the sentiment index, which all occurred in early 2009 – two occurred in January, and one in March. These coincided with the RSI also reaching its minimum value of 6.115. During these incidences, prices in the Hong Kong stock market continued to drop for several days after, resulting in a low value of the 14-day RSI.

4. Market States of Hong Kong

A number of previous studies have classified bull and bear states of the stock market (Pagan and Sossounov, 2003; Lunde and Timmermann, 2004). In this paper, we use the multivariate-threshold model (Tsay, 1998) to identify the market states. The model is as follows:

$$\begin{cases} f_1(y_{t-1}, y_{t-2}, \ldots, \epsilon_{1t}|\theta_1), & \text{if } SMT_{t-1} \leq \gamma_1 \\ \end{cases}$$

$$y_t = \begin{cases} f_2(y_{t-1}, y_{t-2}, \ldots, \epsilon_{2t}|\theta_2), & \text{if } \gamma_1 < SMT_{t-1} \leq \gamma_2 \\ f_3(y_{t-1}, y_{t-2}, \ldots, \epsilon_{3t}|\theta_3), & \text{if } \gamma_2 < SMT_{t-1} \end{cases}$$

where y_t is the stock return, defined as

$$y_t = 100 \ln\left(\frac{P_t}{P_{t-1}}\right)$$

$f_i(\cdot)$ are well-defined functions with $f_i(\cdot) \neq f_j(\cdot)$ for any $i \neq j$, θ_i is a finite-dimensional parameter for any *i*, and ϵ_{nt} is the error term.

We use SMT_{t-1} as the threshold variable and estimate the following threshold model with two thresholds:

$$y_t = \begin{cases} \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \alpha_m y_{t-p} + \epsilon_{1t}, & \text{if } SMT_{t-1} \leq \gamma_1 \\ \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_m y_{t-p} + \epsilon_{2t}, & \text{if } \gamma_1 < SMT_{t-1} \leq \gamma_2 \\ \varphi_0 + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots + \varphi_m y_{t-p} + \epsilon_{3t}, & \text{if } \gamma_2 < SMT_{t-1} \end{cases}$$

The two threshold values of our estimation are -1.238 and 1.390, respectively. These two values can be used to identify three regimes in the state of the market. The result of the estimation is

$$y_t = \begin{cases} -0.028 + 0.392 y_{t-1} + 0.136 y_{t-2} + 0.326 y_{t-3} + \epsilon_{1t} & \text{if } SMT_{t-1} \leq -1.238 \\ -0.045 + -0.583 y_{t-1} + 0.191 y_{t-2} + 0.194 y_{t-3} - 0.012 y_{t-4} + 0.017 y_{t-5} + \epsilon_{2t} \end{cases}$$

$$\text{if } -1.238 < SMT_{t-1} \leq 1.390$$

$$0.129 + 0.526y_{t-1} + 0.309y_{t-2} + 0.050y_{t-3} + \epsilon_{3t} \qquad \text{if } 1.390 < SMT_{t-1}$$

We conducted the Hansen (2000) likelihood ratio test to test for threshold effects, with the results shown in Table 1.

Table 1: The Likelihood Ratio Test Result

Threshold value	-1.238	1.390
Observed test value**	29.898	33.042
Bootstrap critical value	12.771	21.899

** at the 5% significance level

The observed test values are greater than their corresponding bootstrap critical values, indicating that both thresholds are significant at the 5% level. We also compare the sentiment index (SMT) with daily Hang Seng Index (HSI) from 1 December 2008 to 31 December 2012, with the result is plotted in Figure 2.

Figure 2: The Sentiment Index and Hang Seng Index (HSI) from 2008 to 2012

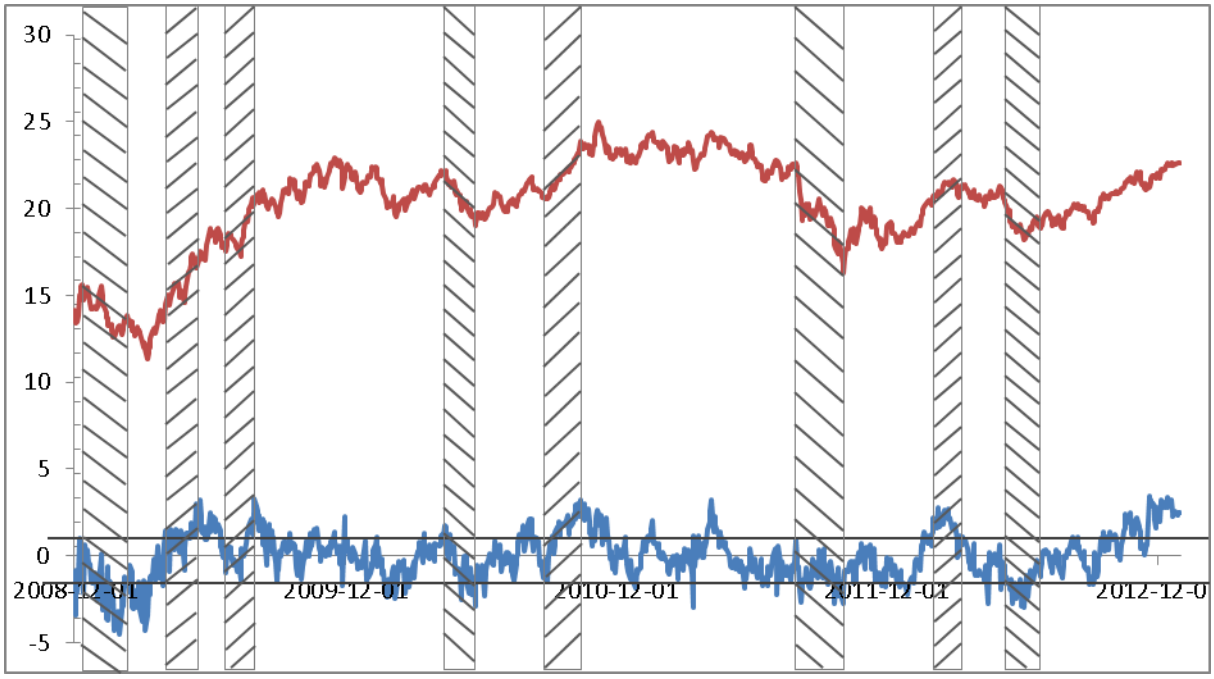


Figure 2 shows that the investor sentiment has a significant positive impact on the return of stock index futures. Periods when the sentiment index is below (above) the lower (upper) threshold value for a significant length of time are shaded. Note that when the value of the SMT is larger than the upper threshold of 1.390, the HSI displays an upward trend. If the value SMT is smaller than lower threshold of -1.238, the HSI faces downward pressure. This suggests that our sentiment index can be used to predict the market performance.

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