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Research Article

An Empirical Study of the Effect of Investor Sentiment on Returns of Different Industries

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Studies on investor sentiment are mostly focused on the stock market, but little attention has been paid to the effect of investor sentiment on the return of a specific industry. This paper constructs a proxy variable to examine the relationship between investor sentiment and the return of a specific industry, using the Principle Component Analysis, and finds that investor sentiment is positively correlated with the industry return of the current period and negatively correlated with that of one lag period; we classify investor sentiment as optimistic state and pessimistic state and find that optimistic investor sentiment has a positive effect on stock returns of most industries, while pessimistic investor sentiment has no effect on them; this paper further builds a two-state Markov regime switching model and finds that sentiment has different effect on different industries returns on different states of market.

1. Introduction

Classical financial theory believes that the market is efficient, all investors have perfect rationalities, and the security price has adequately reflected all the information in the market, so the asset price cannot be affected by investor sentiment. However, with the development of the financial market, many "anomalies" cannot be explained. Many scholars began to doubt the assumption of market efficiency, and behavioral finance emerged. Behavioral finance rejected the assumption of investors' perfect rationality and holds that investors tend to be affected by their own sentiment while making decisions, which leads to bias of irrationalities in investment decision. Consequently, investor sentiment may be a systematic risk factor which affects stock returns. Bradford De Long et al. [1] proved that investor sentiment is an intrinsic factor which affects the equilibrium price of the stock with a noise trader model.

Currently, many scholars try to explore the relationship between investor sentiment and the stock return in terms of investor sentiment. Lee et al. [2] proved that excess returns are contemporaneously positively correlated with shifts in sentiment, and the magnitude of bullish (bearish) changes in sentiment leads to downward (upward) revisions in volatility and higher (lower) future excess returns. Brown and Cliff [3] found that investor sentiment cannot predict future return in the short run, and it is negatively correlated with returns of the next one to three years. Baker and Wurgler [4] argue that market-wide sentiment should exert stronger impacts on stocks that are difficult to value and hard to arbitrage. Lemmon and Portniaguina [5] find that investor sentiment has a negative effect on value stocks, but has no significant effect on growth stocks. Stambaugh et al. [6] illustrate that a broad set of anomalies are stronger following high levels of sentiment, and the short leg of each strategy is more profitable following high sentiment, but sentiment exhibits no relation to returns on the long leg of the strategies. Ben-Rephael et al. [7] pointed out that investor sentiment is positively correlated with the excess return of the market in the same period and negatively correlated with the excess return of later periods. Baker et al. [8] proved that global sentiment is a contrarian predictor of country-level returns. Both global

and local sentiments are contrarian predictors of the time series of cross-sectional returns within markets. Wang and Sun [9] showed that investor sentiment does not only affect the returns of Shanghai and Shenzhen stock markets, but also reversely corrects return fluctuations of these two markets to a large extent. Study by Huang [10] finds that there is a distinct cross-sectional effect between the investor sentiment index and the expected return of the market, and the effect is reflected in return indices for different industries with the largest effect on the information industry and the least effect on the transportation industry.

Some scholars classify investor sentiment as the optimistic state and the pessimistic state in order to examine the effect of investor sentiment on the return of a specific industry. For example, Zhang and Yang [11] adopt GARCH-M Model to prove that institutional investor sentiment has a great effect on stock returns, and sentiment rise has a greater effect on stock returns than sentiment decline. Chi and Zhuang [12] demonstrated investor sentiment affects stock returns significantly, and the effect of optimistic sentiment is greater than that of pessimistic sentiment. Besides, extreme sentiment has a special predictive power in the stock market. Lu and Lai [13] showed that investor sentiment has a significant effect on the Shanghai composite index. When the market is in a rising stage, investor sentiment is more optimistic and more investors enter the market; when the market is in a declining stage, investor sentiment is relatively pessimistic and investors will wait to enter the market.

The state of the financial market (bearish or bullish) changes accordingly with the continuous change in the financial market and the adjustment of macroeconomic policy, which will lead to corresponding changes of the coefficients for the econometric model for the return of an industry. One of the models to capture this kind of coefficient change is the Markov switching regime model with state change. Hamilton [14] introduced for the first time the Markov regime switching model into a variable structure model and studied the effect of the cyclic changes of the US economy on the actual output from 1953 to 1984. Later, a large number of researchers adopted the Markov regime switching model to characterize endogenic structural changes such as Lanne et al. [15], Farmer et al. [16], and Chen et al. [17]. This paper attempts to verify the bull and bear market using the two-state Markov regime switching model. On this basis, it further examines the changes in the effect of investor sentiment on returns of different industries in different market states.

Previous studies showed that investor sentiment significantly affects stock returns. Which kinds of industry's stocks are more easily affected by investor sentiment ? Are there any differences between their effects of the optimistic and the pessimistic states on returns of an industry? What is the difference between the effects of investor sentiment on the return of an industry at different market states? Aiming at these questions, this paper will conduct close explorations. And my paper's main contribution is to set a two-state Markov regime switching model to find that sentiment has different effect on different industries returns on different states of market. The remaining part of this paper is arranged as follows: the second part is for the index construction of investor sentiment; the third part is an empirical study; and the fourth part is the conclusion.

2. Proxy Index Construction of Investor Sentiment

2.1. The Selecting of Proxy Indicator of Investor Sentiment. At present, there are two measures for investor sentiment—the direct approach and the indirect approach. The direct approach is rather subjective and can get only a portion of investor feedbacks. Therefore, most investor sentiment measurements adopt the index in Baker and Wurgler study [4], which selects these six variables—the average closed-end fund discount (CEFD), NYSE share turnover (TURN), the number on IPOs (NIPO), average first-day returns on IPOs (RIPO), the equity share in new issues, and the dividend premium to form an investor sentiment variable based on the Principal Component Analysis. Considering the characteristics of the Chinese stock market and the availability of data, this paper selects CEFD, NIPO, RNIPO, the number of new investor accounts for A shares (NIA), and Shanghai share turnover (TURN) to form a proxy variable for investor sentiment based on the Principal Component Analysis. The samples are monthly data from the Resset database during January 2005 to January 2013 (http://www.resset.cn).

(1) CEFD. CEFD is the ratio of the difference between the net asset value (NAV) and unit price of the closed-end fund to NAV. Lee et al. [18] find that investor sentiment can be measured by CEFD, and it also gives a comprehensive explanation to the closed-end fund discount puzzle; Wu and Han [19] show that CEFD can be a proxy variable for investor sentiment. When there is a high CEFD, stock market investors lack confidence, and their sentiment is low.

The calculation formula is

$$\mathrm{CEFD}_t = \frac{\sum_{i=1}^{n} \left(\left(P_{it} - \mathrm{NAV}_{it} \right) / \left(\mathrm{NAV}_{it} \right) \right)}{n}, \tag{1}$$

where P_{it} is the closing price of fund i in month t, NAV_{it} is the last NAV published in month t, and n represents the number of the selected funds.

(2) NIPO. Initial public offering (IPO) is the process for the enterprise to firstly issue stocks to investors in the stock exchange for the first time to raise funds for its development. When the market sentiment runs high, the stock price will grow, and the pace of IPOs will speed up, leading to more IPOs during such high market sentiment period. On the contrary, when the market is in low sentiment, the stock market will slow down or even suspend the issuing of new stocks. Empirical evidence presented by Baker and Wurgler [4] finds that the number of IPOs (NIPO) is a good proxy variable for investor sentiment.

(3) RIPO. RIPO denotes the return on the IPO in the first trading day, namely, the percentage of the closing price to the offering price. When the market sentiment is high, investors will have a greater interest in the new stock, thus resulting in higher return on the IPO (RIPO). Otherwise, low investor

Table 1: Descriptive statistics of each index.

	Mean	Standard deviation	Kurtosis	Skewness	JB statistics
CEFD	0.241111	0.121486	0.380086	1.908905	7.147080**
NIPO	13.22271	9.999192	0.688533	2.208237	10.19792***
RIPO	0.921679	0.876651	2.985041	16.61689	893.4568***
TURN	0.376856	0.233725	1.287418	4.410218	34.83308***
NIA	1080212	1063835	1.897781	7.143569	127.6175***
			The correlation of indexes		
	CEFD	NIPO	RIPO	TURN	NIA
CEFD	1				
NIPO	−0.667911***	1			
RIPO	0.220840**	−0.368060***	1		
TURN	0.418940***	−0.279498***	0.291517***	1	
NIA	−0.138380	0.122912	0.343842***	0.610424***	1

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%, similar hereinafter.

Table 2: Correlation between investor sentiment and ten variables.

	$CEFD_t$	$NIPO_t$	$RIPO_t$	$TURN_t$	NIA_t	$CEFD_{t-1}$	$NIPO_{t-1}$	$RIPO_{t-1}$	$TURN_{t-1}$	NIA_{t-1}
$Sent_t^{RAW}$	0.761	−0.700	0.565	0.745	0.378	0.766	−0.723	0.559	0.740	0.333

sentiment will produce a low interest in the IPOs, leading to a decrease in RIPO. Baker and Wurgler [4] find that RIPO is a good proxy variable for investor sentiment. Chinese researchers Wu and Han [19] find that the discount and the premium of IPO can be used to explain investor sentiment.

(4) NIA. The number of new investment accounts (NIA) reflects investors' market demand in the stock market. When investor sentiment is high, the enthusiasm to enter the market will rise, and the number of investment accounts will increase accordingly; otherwise, the number of investment accounts will decrease. Wu and Han [19], and Zhang and Yang [11] all suggest that NIA can be used as a good proxy variable for investor sentiment.

(5) TURN. The turnover rate (TURN) of a stock is the fraction sold within a certain period of time. When investor sentiment is high, they actively participate in trades, resulting in high TURN; otherwise, the decrease in market participation will lead to low TURN. Wu and Han [19] and Zhang and Yang [11] believe that TURN can be a proxy variable for investor sentiment. TURN data in this paper is the weighted monthly average turnover of A shares.

According to the correlation analysis of each index in Table 1, each index is correlated to one another in a rather complicated manner. For example, a negative correlation exists between all these pairs of proxy variables—CEFD and NIPO, CEFD and NIA, NIPO and RIPO, and NIPO and TURN.

2.2. The Constructing of Investor Sentiment Index. This paper adopts Baker and Wurgler's [4] approach to forming an investor sentiment proxy index. We start by estimating the first principal component of the five proxies and their lags. This gives us a first-stage index with ten loadings, one for each of the current and lagged proxies. The synthesized sentiment indexes are presented as follows (the cumulative contribution rate of the first five components is 87.06%):

$$\begin{aligned} Sent_t^{RAW} &= 0.372646CEFD_t - 0.342926NIPO_t \\ &\quad + 0.276802RIPO_t + 0.364866TURN_t \\ &\quad + 0.185272NIA_t + 0.375499CEFD_{t-1} \\ &\quad - 0.354266NIPO_{t-1} + 0.273913RIPO_{t-1} \\ &\quad + 0.362383TURN_{t-1} + 0.163127NIA_{t-1}. \end{aligned} \tag{2}$$

We then compute the correlation between the first-stage index and the current and lagged values of each of the proxies. Finally, we construct $Sent_t$ as the first principal component of the correlation matrix of five variables of each proxy's lead or lag, whichever has the higher correlation with the first-stage index.

Table 2 shows that each proxy's lead or lag with higher correlation coefficient is $CEFD_{t-1}$, $NIPO_{t-1}$, $RIPO_t$, $TURN_t$, and NIA_t. We analyze these five indexes with the Principle Component Analysis, we choose the first principle component (the cumulative contribution rate of the first three components reaches 90.17%), and we get the following sentiment composite index $Sent_t$:

$$\begin{aligned} Sent_t &= 0.477612CEFD_{t-1} - 0.474077NIPO_{t-1} \\ &\quad + 0.436559RIPO_t + 0.522063TURN_t \\ &\quad + 0.289835NIA_t. \end{aligned} \tag{3}$$

Figure 1 shows that investor sentiment began to rise with more enthusiasm in market participation in April 2005 when pilot separation reform projects started in China. From 2006

Table 3: Return statistics of each industry.

Industry	Mean	Standard deviation	Kurtosis	Skewness	JB statistics	ADF-t
Farming, forestry, animal husbandry, and fishery	0.006894	0.097631	−0.214655	3.532165	1.889504	−7.737645***
Extractive industry	0.003295	0.111691	0.305372	3.557856	2.765355	−6.799325***
Chemical industry	0.003431	0.085623	0.094045	3.258920	0.413938	−6.474173***
Ferrous metals	−0.002846	0.104951	0.281164	3.749400	3.547828	−2.596785***
Nonferrous metals	0.006204	0.126077	−0.060071	3.507858	1.100764	−6.442558***
Construction materials	0.002747	0.096980	0.356129	3.747072	4.306106	−6.566892***
Mechanical installation	0.002188	0.096631	−0.139295	2.820706	0.443606	−6.725198***
Electronics	−0.000460	0.103672	−0.260335	3.074738	1.118260	−6.993854***
Transportation equipment	0.006274	0.103173	−0.127551	3.037118	0.268588	−5.715664***
Information equipment	0.000262	0.099586	−0.222712	2.953698	0.810538	−6.880790***
Household appliances	0.004821	0.095675	−0.193469	3.177335	0.732221	−6.330048***
Food and beverage	0.013467	0.085772	−0.040146	3.970131	3.829889	−7.478488***
Textile and garment	0.003287	0.100715	0.469081	4.824239	17.00731***	−6.417958***
Light manufacturing	0.000639	0.099941	−0.258313	3.807337	3.713056	−6.610410***
Biopharmaceuticals	0.009660	0.086362	0.170174	3.313894	0.866395	−7.461154***
Public utility	−0.000795	0.079753	0.362636	4.353036	9.525104***	−6.586849***
Transportation	−0.004077	0.081682	0.085057	3.716854	2.193894	−6.268708***
Real estate	0.004154	0.098869	−0.118194	3.631311	1.836662	−5.748892***
Financial service	0.000202	0.090827	0.024149	4.098793	4.889115*	−3.433203**
Business and trade	0.003520	0.091366	0.036296	3.540816	1.203414	−6.418831***
Catering and tourism	0.007037	0.100273	−0.376900	3.413545	2.987743	−6.964831***
Information service	0.003905	0.083502	−0.207364	3.681743	2.573628	−7.372482***
General industry	0.002546	0.104683	0.200064	3.862630	3.654610	−6.265502***

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%.

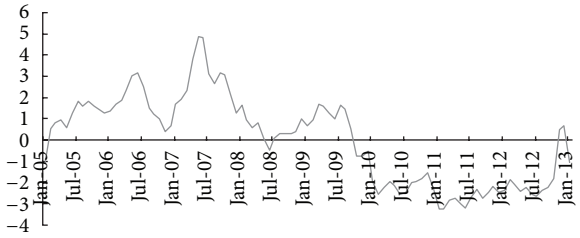

Figure 1: Investor sentiment.

to the end of 2007, investor sentiment was pushed to a summit with a lot of good news such as continuous improvement in corporate performance and the abolition of constrictions on foreign investment, and a big bull market emerged in Chinese stock markets. However, negative influence of subprime crisis in the United States spreads to domestic investors, leading to market index slump and pessimistic attitude toward stock markets. By way of selecting proxy index of investor sentiment and synthesizing new proxy index with principal components, investor behavior in the stock market can be better characterized. Thus, the new proxy index is more reasonable to a certain extent.

3. Empirical Study

This paper adopts Wind Information monthly data from January 2005 to January 2013 and divides industries into 23 categories. The monthly return of a specific industry is $r_{i,t} = \ln p_{i,t} - \ln p_{i,t-1}$, where p is the closing price of industry i in month t. The descriptive statistics of each industry are presented in Table 3.

Table 3 shows that biopharmaceuticals, farming, forestry, animal husbandry, fishery, nonferrous metals, catering and tourism, and transportation equipment have high monthly average returns with mean value of each above 0.006, among which the highest one is that of biopharmaceuticals; and the monthly average returns of transportation, ferrous metal, electronics, public utility, and general industry are relatively low with each mean value less than zero, among which the lowest one is the stocks of transportation. In terms of industry fluctuations, nonferrous metal presents the widest range, because it is closely related to industries of large metal demand such as real estate, autoindustry, and shipbuilding industry. These industries presented a cycle from prosperity to depression during the period from 2005 to 2013, thus leading to a wide range of fluctuations of nonferrous industry.

3.1. The Relationship between Market Sentiment and Return of a Specific Industry. For the concurrent effect of sentiment on industry return with OLS, the equation is

$$R_{i,t} = \alpha_0 + \alpha_1 \text{Sent}_t + \varepsilon_t. \quad (4)$$

Table 4 presents the estimates of coefficients and significance levels for 23 industries regarding the effect of market

Table 4: Effect of sentiment on industry return.

Industry	Parameter estimate	adj $-R^2$	Industry	Parameter estimate of	adj $-R^2$
Farming, forestry, animal husbandry, and fishery	0.010572**	0.0494	Textile and garment	0.012170**	0.0615
Extractive industry	0.017801**	0.1069	Light manufacturing	0.011457***	0.0553
Chemical industry	0.013608***	0.1063	Biopharmaceuticals	0.009759**	0.0538
Ferrous metal	0.012803***	0.0626	Public utility	0.010123***	0.0678
Nonferrous industry	0.018426***	0.0899	Transportation	0.011796***	0.0878
Construction materials	0.014664***	0.0962	Real estate	0.015494***	0.1034
Mechanical installation	0.014671**	0.0970	Financial service	0.010219**	0.0533
Electronics	0.009823*	0.0378	Trade and business	0.014061***	0.0997
Transportation equipment	0.016164***	0.1033	Catering and tourism	0.008872*	0.0330
Information equipment	0.009669*	0.0397	Information service	0.008983***	0.0487
Household appliance	0.013644***	0.0856	General industry	0.008103	0.0252
Food and beverage	0.010993***	0.0684			

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%.

Table 5: Effect of investor sentiments of the current period and one period lagged.

Industry	Parameter estimate β_1	Parameter estimate β_2	Industry	Parameter estimate β_1	Parameter estimate β_2
Farming, forestry, animal husbandry, and fishery	0.037385**	−0.028318*	Textile and garment	0.048461***	−0.038231**
Extractive industry	0.056997***	−0.041332**	Light manufacturing	0.040493**	−0.030612*
Chemical industry	0.044125***	−0.032238**	Biopharmaceuticals	0.030392**	−0.021772
Ferrous metal	0.053247***	−0.042409**	Public utility	0.041732***	−0.033375***
Nonferrous metal	0.065028***	−0.049041**	Transportation	0.046340***	−0.036269***
Construction material	0.061296***	−0.049067***	Real estate	0.042135***	−0.027891*
Mechanical installation	0.039774***	−0.026484*	Financial service	0.042135**	−0.010572**
Electronics	0.037814**	−0.029529*	Business and trade	0.030454**	−0.021355
Transportation equipment	0.057564***	−0.043570***	Catering and tourism	0.041507***	−0.028868**
Information equipment	0.028910*	−0.020259	Information service	0.023528*	−0.015257
Household appliances	0.038257**	−0.026050*	Integration	0.004006	0.0004154
Food and beverage	0.038429***	−0.028924**			

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%.

sentiment on the returns of specific industries. It shows that market sentiment is significantly and positively correlated with the current return of a specific industry. More optimistic market sentiment of the current period leads to a larger number of stock demand and in turn greater stock return, among which the greatest effect of investor sentiment appears in nonferrous material industry with the parameter estimate of 0.018426. This may be probably attributed to industries closely connected to financial industry of nonferrous materials; when the financial industry of nonferrous materials goes well, the stock trading of nonferrous materials will increase greatly; when the financial industry of nonferrous materials goes bad, the demand for nonferrous material stock becomes much smaller. And at the same time overinvestment causes serious excess of production capacity. The impact of market sentiment on the financial industry of nonferrous materials couples with the impact on the industry of nonferrous material, leading to low expectations with the consequences of sharper decrease in nonferrous material stock trading. Therefore, this may be the reason for the relatively greater effect of investor sentiment on the nonferrous metal industry.

3.2. Investor Sentiment Effect of Different Periods on the Returns of Specific Industries. In the study of investor sentiment effect on the returns of specific industries, we should consider that investor sentiment at different period will have different impacts on industry return because people's inherent mind sets and habits often lag behind the change in economic decisions. Thronging autocorrelation test, it can be found that the level of investor sentiment is one-period lag, so we introduce the market sentiment level of the one period lagged in (4) to verify the effect of sentiment levels of different periods on the returns of specific industries:

$$R_{i,t} = \beta_0 + \beta_1 \mathrm{Sent}_t + \beta_2 \mathrm{Sent}_{t-1} + \varepsilon_t. \quad (5)$$

The results in Table 5 show that the goodness of fit has been appreciably improved after investor sentiment at lag

one is introduced into the regression: the coefficients of investor sentiment for the current period are all significantly positive while those for the one period lagged are all negative with six coefficients insignificant. This fact indicates that the stock return is positively correlated with investor sentiment at the current period and negatively correlated with investor sentiment at one-period lag. Meanwhile, the phenomenon that coefficients for investor sentiment at the current period are all greater than those coefficients for lag one implies that there exists price overcorrection for lag one in the Chinese stock market.

3.3. The Effect of Different States Investor Sentiment on Industry Returns. In order to clearly understand the effect of different investor sentiment levels on the industry returns, investor sentiment is divided into two kinds: optimism and pessimism. The division of optimism and pessimism is when investor sentiment index is greater than zero, it is defined as the optimistic month, while it is defined as the pessimistic month if it is smaller than zero. The statistical results are shown in Table 6.

Table 6 shows that the industry return of the optimistic period is greater than that of the pessimistic period. In the sampling period, there are 57 months when investors are optimistic, of which the market average returns are 0.395745, and there are 40 months when investors are pessimistic, of which the average market income is −0.36907. The difference between the two is 0.764818.

For the effect of optimistic and pessimistic investor sentiment on industry return with OLS, the equation is

$$R_{i,t} = c(0) + c(1)\,\text{optimisticSent}_t + c(2)\,\text{pessimisticSent}_t + \varepsilon_t. \tag{6}$$

From the results shown in Table 7, we can see that when investor sentiment index value is positive, optimistic investor sentiment has a positive effect on the returns of most industries, because fundamentals continue to be better, and investors' investment and speculative motives are strengthened to cause the market to rise all the way. However, when investor sentiment index value is negative, the effect of the pessimistic investor sentiment on the stock returns is not significant, because investors will weaken their motivation to participate in the market when the market sentiment is pessimistic, and they will be wary of entering the market and even hold the stocks refusing to sell them because of the heavy loss they have already suffered. To some extent, this also prevents the stock price from falling sharply. At the same time, the proportion of the irrational investors will go down in this period and rational investors will occupy a dominant position. Therefore, the effect that the sentiment of the pessimistic investors impacts on industry returns will become insignificant.

3.4. Studies on Effect of Investor Sentiment on Industry Return Based on Markov Regime Switching. With the development of the financial markets and adjustment of macroeconomic policy, the market state has changed, which changes coefficients of estimated industry returns within the model accordingly. To capture this kind of change, the paper employs the Markov regime switching model.

Table 6: Statistics of market returns for optimistic and pessimistic periods.

	Sent >0	Sent <0	Total sampling period
Mean	0.395745	−0.36907	0.080357
Median	0	0	0.052068
Standard deviation	1.843508	1.055102	2.140861
Skewness	0.142774	−1.819949	−0.048180
Kurtosis	4.541919	12.84935	3.416804
Observations	57	40	97

After adopting the Markov regime switching model, the paper compares the monthly stock index of the current period with the indexes three months before and after the current period in order to further verify the bearish or the bullish state. If the index of the current period is at the highest position, it means a peak, and it is called the bull market; if it is at the lowest position, it means a trough, and it is considered to be the bear market.

3.4.1. General Model. In order to investigate the effect of investor sentiment on industry returns, this paper proposes the following regression model:

$$R_{it} = a_i + b_i \times \text{Sent}_t + \varepsilon_{it}, \tag{7}$$

where R_{it} is the industry return at time t and Sent_t denotes the investor sentiment.

3.4.2. Markov Regime Switching Models. This paper employs the *E-M* algorithm proposed by Hamilton. There is M time-varying regression equation between the returns of industry i and investor sentiment, and it represents effects of investor sentiment on industry returns in different states, where state variable S_t denotes homogenous unobservable stochastic variable of t and has the first-order Markov process in the state space; its transition matrix $P = (p_{ij})$, where $p_{ij} = \Pr(s_t = j \mid s_t = i)$ and $\sum_{j=1}^{M} p_{ij} = 1$, for any t; the current state is only correlated with the state of one-period lag, while other past states do not have any effect. The stochastic state variable is set to be one or two, and the switching of investor sentiment is not a continuous change. At this time, (8) is

$$\begin{aligned} R_{it} &= a_i + b_i \times \text{sent} + \varepsilon_{it}, \\ \varepsilon_{it} &\sim \left(0, \sigma_{ist}^2\right), \\ p_{ij} &= \Pr\left(s_t = j \mid s_t = i\right), \\ \sum_{j=1}^{M} p_{ij} &= 1. \end{aligned} \tag{8}$$

Table 7: Effects of optimistic and pessimistic sentiment on industry returns.

Industry	Parameter estimate $c(1)$	Parameter estimate $c(2)$	Industry	Parameter estimate $c(1)$	Parameter estimate $c(2)$
Farming, forestry, animal husbandry, and fishery	0.019735	0.001824	Textile and garment	0.037789^{**}	−0.012290
Extractive industry	0.050252^{***}	−0.013182	Light manufacturing	0.027157^{*}	−0.003533
Chemical industry	0.034506^{***}	−0.006345	Biopharmaceuticals	0.019993	0.000000
Ferrous metal	0.030332^{**}	−0.003394	Public utility	0.027694^{**}	−0.006654
Construction material	0.033261^{**}	−0.003092	Real estate	0.039997^{***}	−0.007899
Mechanical equipment	0.029462^{**}	−0.000549	Financial service	0.031956^{***}	−0.010535
Electronics	0.023487	−0.003223	Business and trade	0.033691^{**}	−0.004681
Transportation equipment	0.038812^{**}	−0.005461	Catering and tourism	0.024919^{*}	−0.006449
Information equipment	0.016593	0.003059	Information service	0.021967^{*}	−0.003415
Household appliances	0.027274^{*}	0.000631	Integration	0.018913	−0.002284
Food and beverage	0.028954^{***}	−0.006273			

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%.

Vector denotes the state of the system (industry subscripts omitted):

$$\xi_t = \begin{bmatrix} I(s_t = 1) \\ \vdots \\ I(s_t = j) \\ \vdots \\ I(s_t = m) \end{bmatrix}, \tag{9}$$

where

$$I(s_t = 1) = \begin{cases} 1, & \text{if } s_t = j, \\ 0, & \text{else.} \end{cases} \tag{10}$$

Then the parameters to be estimated in (6) can be expressed in (9):

$$\begin{aligned} a_{st} &= [a_1, \ldots, a_M] \times \xi_t, \\ b_{st} &= [b_1, \ldots, b_M] \times \xi_t. \end{aligned} \tag{11}$$

The conditional density in different states is

$$\eta_t = \begin{cases} f(r_t \mid S_t = 1, I_{t-1}; \theta) \\ \quad = \dfrac{1}{\sqrt{2\pi\sigma_1^2}} \left\{ \dfrac{-(r_t - a_{1t} - b_{1t} \times \mathrm{Sent}_t)^2}{2\sigma_1^2} \right\}, \\ f(r_t \mid S_t = 2, I_{t-1}; \theta) \\ \quad = \dfrac{1}{\sqrt{2\pi\sigma_2^2}} \left\{ \dfrac{-(r_t - a_{2t} - b_{2t} \times \mathrm{Sent}_t)^2}{2\sigma_2^2} \right\}, \\ \vdots \\ f(r_t \mid S_t = M, I_{t-1}; \theta) \\ \quad = \dfrac{1}{\sqrt{2\pi\sigma_M^2}} \left\{ \dfrac{-(r_t - a_{Mt} - b_{Mt} \times \mathrm{Sent}_t)^2}{2\sigma_M^2} \right\}, \end{cases} \tag{12}$$

where I_{t-1} denotes the information set at time $t-1$, and θ is the parameter set of the parameters to be estimated, that is, $a_1 \cdots a_M$, $b_1 \cdots b_M$, and $\sigma_1^2 \cdots \sigma_M^2$, and of the components of the transition matrix, that is, $p_{11} \cdots p_{MM}$, and in the state ζ_{t-1} with the information set at time $t-1$, that is, I_{t-1}, the marginal density function of r_t follows a mixed normal distribution, with its probability density

$$\begin{aligned} &f(r_t \mid R_t, \xi_{t-1}, I_{t-1}; \theta) \\ &\quad = \sum_{m=1}^{M} f(r_t \mid \xi_{t-1}, R_t, I_{t-1}; \theta) \Pr(\xi_{t-1}) \\ &\quad = 1' (\eta_t \otimes \xi_{t|t-1}), \end{aligned} \tag{13}$$

where $\otimes$ denotes the multiplication of two vectors and 1 represents $(M \times 1)$ vectors with all the component to be 1. Formula (7) shows that there are M industries and the impacts of investor sentiment in different states on the market returns of the M industries are different. The optimal inference and prediction of $\xi_{t|t}$ based on the information set at time $t-1$ can be obtained from iteration of (14). At last, all the parameter can be estimated through maximizing the likelihood function. Probabilities obtained from all the observations are called smoothed probabilities. The Markov regime switching models can separate the data automatically to identify different state intervals and thus avoid the bias caused by subjective segmentation:

$$\begin{aligned} \xi_{t|t} &= \frac{\xi_{t|t-1} \otimes \eta_t}{1' (\xi_{t|t} \otimes \eta_t)}, \\ \xi_{t|t+1} &= P \otimes \xi_{t|t}. \end{aligned} \tag{14}$$

3.4.3. Empirical Analysis. Comparing the AIC value or the BIC value, we can find that the two-state Markov process is more useful. Moreover, the goodness of fit has been greatly

improved when adopting the Markov process. We estimate the parameters of (7) on R software, which are shown in Table 8.

At first, comparing the stock index of an industry in the current period with those indexes three months before and after the current period, we can find that the split share structure reform started in May 2005; the issuing of a large number of open-end funds and the expectation of RMB appreciation led to excess liquidity in the securities market, and return indexes of all industries went up all the way. If we select the data for all industries around January 2007, we can see that the data at this sentiment level are relatively highs (which makes a crest), that is, all the industries are in a bull market. So all industries are at state one—a bull market. But starting from 2007, with the influence of a series of bad news such as the soaring of inflation, the suspension of the issuing of funds, and the US subprime crises, the Chinese stock market fell into a long bearish period, and all indexes for various industries plummeted. We choose the data for all industries around January 2010 and see that the indexes at this sentiment level are at a relatively low level, which makes a trough. We can believe that all the industries are in a bearish market; that is, for all the industries the state is two, a bearish market.

Secondly, with the state being set, we test whether the switching of the state significantly affects the coefficients for investor sentiment index. In Table 8, we can see that the effects of investor sentiment on the stock returns of industries are quite different in the bull market and in the bear market. For agriculture, forestry, animal husbandry and fishery, mining, ferrous metals, textiles and services, and business and trade sectors, effects of investor sentiment on stock returns of these industries are significant in the bull market, while in the case of a bear market, effects are not significant. Animal husbandry and fishery and extractive industries belong to the foundational industries in national economies and are closely related to economic trends. When the market is bullish, it will promote the development of those industries, and investors will have greater interest in stocks of these industries and choose to buy more of these stocks for an optimal investment portfolio; therefore, the effect of investor sentiment at this state is significant on these industries. When the market is bearish, investors may choose to avoid this type of stocks, and effect of investor sentiment on stock returns of these foundational industries becomes less significant. For chemical industry, nonferrous metals, building materials and construction, biopharmaceuticals, financial service, and general industries, the effect of investor sentiment on returns of these industries is not significant when it is a bull market, while in the case of a bear market, the effects of investor sentiment on the stock are significant. This may be because nonferrous metals and petrochemical category belong to resource-based industry, and investors will increase the investment in resources stocks to avoid risks, which makes these stocks more resistant to risks. Therefore the effect of investor sentiment on these stocks is more significant in a bear market, while in a bull market it becomes insignificant. For industries such as mechanical equipment, electronics, transportation equipment, household appliances, food and beverage, light manufacturing, public utilities, transportation, real estate, catering and tourism, and information services, the effect of investor sentiment on returns of the industry is significant whether it is in a bull market or in a bear market. Investor sentiment to the stocks of these industries is generally stable. This may be due to the fact that industries of household appliances, food and beverage, and other consumer goods are generally stable and thus will not change dramatically with economic conditions. For information equipment industry, whether it is in a bull market or a bear market, the effect of investor sentiment is not significant, because information equipment industry is a high-tech industry; China's information industry is relatively backward and cannot play a role in leading the stocks of the information industry. Consequently, the effect of investor sentiment on the return of the information equipment industry in China is relatively small either in a bull market or in a bear market.

At last, the effect of investor sentiment on returns of stocks of different industries is different in duration. For agriculture, forestry, animal husbandry and fishery, mining, ferrous metals, textiles and services, and commercial trade industries, the expected duration of the effect in state one is 2.86, 6.41, 4.81, 5.81, and 3.62 months, respectively. For industries such as processing of agricultural products, chemicals, nonferrous metals, building materials, construction, biopharmaceuticals, financial services, and general industry, the expected durations are 3.34, 3.51, 13.02, 15.27, 4.56, 36.90, and 5.05 months, respectively; for industries such as mechanical equipment, electronics, transportation equipment, household appliances, food and beverage, light manufacturing, public utilities, transportation, real estate, catering and tourism, and information services industry, the expected duration of the effect in state one is 10.17, 25.06, 27.25, 5.75, 3.88, 33.44, 21.93, 26.81, 5.24, 30.58, and 29.67 months, respectively; the expected duration of the effect in state 2 is 2.56, 30.58, 34.72, 8.19, 1.37, 27.32, 63.29, 22.27, 19.69, 26.18, and 29.33 months, respectively.

In short, each industry has its own characteristics. For resource-based industries such as nonferrous metals and petrochemicals, the effect of investor sentiment on stock returns of these industries is relatively significant in a bearish market condition, while the effect is insignificant when the stock market is bullish. As for household appliances, food and beverage, and other consumer goods industries, the effect of investor sentiment on stock returns of these industries is generally stable. There is no significant effect of investor sentiment on stock returns of the information equipment industry, whether it is in a bull market or bear market.

3.4.4. Smoothed Probability Analysis. In order to further understand the duration of each state and the maximum probability for which state may appear in each period, we can further investigate the effect of investor sentiment on each industry through the smoothed probability in Figure 2. Here, it is regarded as the bull market when $\Pr(s_t = 1 \mid I_{t-1} = i) > 0.5$ and as the bear market when $\Pr(s_t = 2 \mid I_{t-1} = i) > 0.5$. Due to space limitations, this paper only presents

Table 8: Effects of investor sentiment on industry returns based on Markov regime switching.

Industry	Farming, forestry, animal husbandry, and fishery	Extractive industry	Chemical industry	Ferrous metal	Nonferrous metal	Construction materials
a_1	0.0704***	0.0677***	−0.0436	0.0737***	−0.0701*	−0.0584*
b_1	0.0324***	0.0372***	0.0009	0.0372***	−0.0255	0.0263
Root MSE	0.0458	0.0499	0.0699	0.0638	0.1430	0.0889
R Square	0.7065	0.7299	0.0006	0.6059	0.0751	0.1176
a_2	−0.0213	−0.0335	0.0494**	−0.0455***	0.0360***	0.0679***
b_2	−0.0003	0.0081	0.0247***	0.0000	0.0282***	0.0373***
Root MSE	0.0921	0.1096	0.0516	0.0818	0.0822	0.0589
R Square	0.8693	0.01704	0.5171	0.4835	0.3572	0.5914
AIC	−190.2188	−178.0989	−222.4067	180.6269	−146.7789	−202.075
BIC	−161.6211	−149.5012	−193.8090	−152.0292	−118.1812	−173.4773
LL	99.1094	93.0495	115.2033	94.3135	77.3895	105.0375
P_{11}	0.6506	0.8439	0.7096	0.6944	0.7721	0.9454
P_{12}	0.1876	0.1089	0.2848	0.2075	0.0768	0.0655
P_{21}	0.3494	0.1561	0.2904	0.3056	0.2279	0.0546
P_{22}	0.8124	0.8911	0.7152	0.7925	0.9232	0.9345
Industry	Mechanical equipment	Electronics	Transportation equipment	Information equipment	Household appliances	Catering and tourism
a_1	−0.0251 **	0.0523***	0.0594***	−0.0649**	0.0734***	0.0120
b_1	0.0114**	0.0273***	0.0324***	0.0234	0.0245***	0.0119**
Residual	0.0814	0.0719	0.0639	0.1070	0.0576	0.0950
R Square	0.0739	0.3362	0.4699	0.0705	0.4206	0.05774
a_2	0.1029***	−0.0799***	−0.1003***	0.0487	−0.0472**	0.0169***
b_2	0.0229***	0.0310**	0.0513***	0.0269	0.0181**	0.0090***
Root MSE	0.0344	0.1047	0.0959	0.0662	0.0788	0.0235
R Square	0.6622	0.1226	0.3003	0.3695	0.1683	0.4361
AIC	−193.7313	−178.0449	−198.2534	−186.0705	−197.6915	−209.8202
BIC	−165.1336	−149.4472	−169.6557	−157.4728	−169.0938	−181.2225
LL	100.8657	93.0225	103.1267	97.0352	102.8457	108.9101
P_{11}	0.9017	0.9601	0.9633	0.9658	0.8262	0.7425
P_{12}	0.3909	0.0327	0.0288	0.0389	0.1221	0.7326
P_{21}	0.0983	0.0399	0.0367	0.0342	0.1738	0.2575
P_{22}	0.6091	0.9673	0.9712	0.9611	0.8779	0.2674
Industry	Textile and garment	Light manufacturing	Pharmaceuticals	Public utilities	Transportation	Real estate
a_1	0.0834***	−0.0876***	-0.0088	−0.0552	−0.0742***	−0.1506***
b_1	0.0375***	0.0361**	0.0049	0.0390**	0.0330***	0.0567***
Root MSE	0.0593	0.1037	0.0800	0.1159	0.0813	0.0611
R Square	0.6511	0.1545	0.01349	0.1976	0.1959	0.5145
a_2	−0.0317**	0.0517***	0.0758***	−0.0013	0.039***	0.0362***
b_2	0.0039	0.0285***	0.0302***	0.0053*	0.0260***	0.0205***
Root MSE	0.0849	0.0617	0.0514	0.0498	0.0496	0.0692
R Square	0.0067	0.4282	0.6222	0.03928	0.4871	0.2897
AIC	−192.6297	−196.2553	−208.9941	−245.056	−238.2588	−206.4154
BIC	−164.0321	−167.6577	−180.3964	−216.4583	−209.6611	−177.8177
LL	100.3149	102.1277	108.4970	126.5280	123.1294	107.2077

Table 8: Continued.

P_{11}	0.8276	0.9701	0.9177	0.9544	0.9627	0.8090
P_{12}	0.1068	0.0366	0.2194	0.0158	0.0449	0.0508
P_{21}	0.1724	0.0299	0.0823	0.0456	0.0373	0.1910
P_{22}	0.8932	0.9634	0.7806	0.9842	0.9551	0.9492
Industry	Financial service	Business and trade	Catering and tourism	Information service	General	
a_1	−0.0014	0.0563***	0.0388***	−0.0437	−0.0252	
b_1	0.0040	0.0281***	0.0168***	0.0305**	−0.0005	
Root MSE	0.0496	0.0580	0.0689	0.1078	0.0926	
R Square	0.0196	0.5279	0.1992	0.1329	0.0001	
a_2	−0.0483*	−0.0338	−0.0820**	0.0132	0.0790***	
b_2	0.0380**	0.0038	0.0333*	0.0085**	0.0401***	
Root MSE	0.1141	0.0779	0.1169	0.0540	0.0682	
R Square	0.1492	0.00874	0.1153	0.08257	0.5604	
AIC	−218.3481	−204.8813	−188.721	−221.7585	−175.087	
BIC	−189.7504	−176.2837	−160.1233	−193.1609	−146.4893	
LL	113.1741	106.4407	98.36051	114.8793	91.54349	
P_{11}	0.9797	0.7239	0.9673	0.9663	0.9142	
P_{12}	0.0271	0.2086	0.0382	0.0341	0.1980	
P_{21}	0.0203	0.2761	0.0327	0.0337	0.0858	
P_{22}	0.9729	0.7914	0.9618	0.9659	0.8020	

Notes: ***, **, and * denote, respectively, significance at the significance level of 1%, 5%, and 10%.

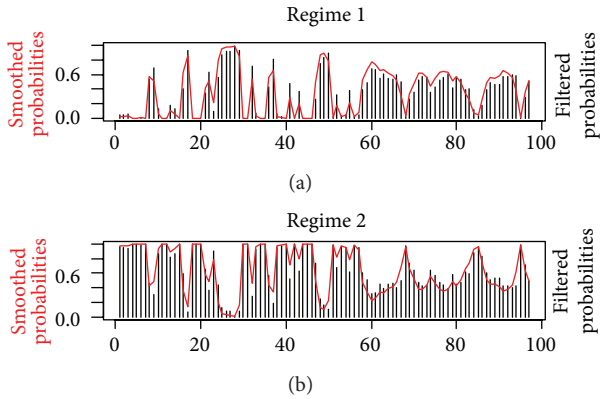

Figure 2: Smoothed probability of animal husbandry and fishery industry.

the smoothed probability plots of the animal husbandry and fishery industry.

4. Conclusion

This paper constructs a proxy variable for investor sentiment to examine the relationship between investor sentiment and the return of a specific industry, using the Principal Component Analysis, and finds that investor sentiment is positively correlated with the current period industry return and negatively correlated with that for one period lagged, and investor sentiment coefficients for the current level are greater than coefficients for one period lagged, which demonstrates there exists a one-period price overcorrection in China's stock market; according to a standard, investor sentiment is classified into two kinds: the optimistic and the pessimistic, and optimism shows positive effects on stock returns on most industries while the pessimistic yields no significant effects on the majority of industries' stocks.

In this paper, we establish a two-state Markov model to identify the shifting between the bull market and the bear market, which helps to study the effect of investor sentiment on the industry returns in the bear market and in the bull market. It finds that the animal husbandry and fishery industry and the extractive industry belong to the foundational industry of the national economy and are closely related to economic trends. When the stock market is bullish, the market condition will promote the development of these foundational industries. When the stock market is bearish, investors may choose to avoid stocks of these industries and thus the effect of investor sentiment on stock returns of these foundational industries will become less significant. For resource-based industries such as nonferrous metals and petrochemicals, the effect of investor sentiment on stock returns of these industries is relatively significant in a bearish market condition, while the effect is insignificant when the stock market is bullish. As for household appliances, food and beverage, and other consumer goods industries, the effect of investor sentiment on stock returns of these industries is generally stable. There is no significant effect of investor sentiment on stock returns of the information equipment industry, whether it is in a bull market or bear market. Each

industry has its own characteristics. To construct investment portfolios with a consideration of the differences in the effect of investor sentiment on returns of different industries in different market states is of important reference value to large institutional investors in allocating their funds among different industries in the securities market.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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