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Research Article

Investor Sentiment and the Basis of CSI 300 Stock Index Futures: An Empirical Study Based on QVAR Model and Quantile Regression

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The asymmetrical mutual influence of investor sentiment and the basis of CSI 300 stock index futures under conditions in different market situations was investigated using the quantile vector autoregressive model (QVAR). The article also discussed asymmetrical influence of investor sentiment on the basis under conditions in different investor structures using the quantile regression method. On this basis, we obtained several important conclusions: (1) There exists a one-way causal relationship where investor sentiment has a significant impact on the CSI 300 stock index futures basis in China; the investor sentiment is likely to exert stronger influences on the basis in the chaotic period of the stock market and imposes significant asymmetrical effects. (2) The institutionalized development of investors can reduce the influences of investor sentiment on the basis when the stock market is stable, while it does not play its function in stabilizing the capital market when the stock market is in turmoil. (3) The low institutionalization level, the individualization of institutional investors, and the imperfect short-sales mechanism as a whole are still the sticking problems in the immature capital market of China.

1. Introduction

The basis of CSI 300 stock index futures is the difference between the CSI 300 spot index and futures index and plays an important role in the information transfer of the capital market. It does not only provide investors with diverse risk management strategies, but also help to improve the scale and structure of China's capital market. Its hedging effectiveness is also a direct reflection of China's capital market operation efficiency and has an important guiding significance deepening of the capital market. Generally in an efficient market, the difference between the futures and spot prices will not have a large systematical deviation. However, the abnormal phenomenon occurs to the price difference under extremely special conditions. For example, the futures index showed substantial discount relative to the stock index and the basis strengthened during the Chinese stock market crash in 2015. Such significant discount is a great problem in the operation of the capital market and needs to be deeply studied and interpreted.

For a long period to come, what the capital market and the theoretical circle both need to systemically consider are the following questions: whether there exists the interaction between the basis of stock index futures and Chinese investors' sentiment, whether the asymmetrical interaction between investor sentiment and the basis varies in different market situations, and whether the improvement of the institutionalization of the capital market in China is in favor of alleviating the abnormal effects of the investor sentiment on the basis. Studying and answering these questions can comprehensively analyze the relationship between investor sentiment and the basis and sufficiently unveil the hedging and pricing efficiencies of the stock index futures market in China. This is of great reference significance for the formation of market investment strategies and the decision adjustment of the regulatory agencies.

The paper is divided into six parts: Section 1 is the introduction, Section 2 reviews the relevant literatures, Section 3 puts forward the hypotheses to be tested and the research

design, the selected sample data and descriptive statistics are provided in Section 4, Section 5 reveals the results of the empirical analysis on the relationship between the investor sentiment and the basis, and Section 6 draws the conclusions and the inspirations.

2. Literature Review

2.1. Research on the Relationship between the Basis and Investor Sentiment. Many factors in the capital market have influences on the trend of the basis, including market liquidity and volatility, risk-free interest rate, and investor structure (Marcinkiewicz, 2014) [1]. It was pointed out by Baker and Stein (2008) [2] that the liquidity can be taken as the investor sentiment index in the market with short-sales constraints. Noise traders generally have irrational buying behaviors when they are in high spirits, and the demand shocks will improve the liquidity of the securities market. A market with high liquidity commonly presents low transaction cost and impacts cost of stock, which further drives the rise in the stock price. Roll et al. (2007) [3] studied the liquidity of the New York Stock Exchange (NYSE) and the futures-spot basis of its component index. They concluded that the two have the Granger causality. Through the impulse response analysis of the bivariate VAR model, they found that the liquidity has greater short-term influences on futures-spot arbitragers. Moreover, among the literatures on the factors affecting the basis, some scholars found the Granger causality relationship between the liquidity and the basis (Lien et al., 2013; Li and Guo, 2017) [4, 5].

As scholars across the world constantly deepen the research on the investor sentiment and the behavioral bias, some literatures begin to focus on the influences of investor sentiment on the securities market. Investor sentiment reflects the expectations of investors for the future of the market. Because investor sentiment cannot be directly measured, previous researchers basically construct investor sentiment index by using single or multiple sentiment factors. Investor sentiment is also responsible for the irrational fluctuations of the stock price. Scholars across the world have found that investor sentiment has a significant relationship with the market volatility, which indicates that the higher the investor sentiment level, the greater the volatility of the stock market (Yang and Gao, 2014; Wang et al., 2017) [6, 7]. Different from the above literatures, Zheng and Lin (2015) [8] found there is no significant relationship between the liquidity and the pricing bias of the CSI 300 stock index futures through the VAR model. Instead, the investor sentiment is the dominating influence factor of the pricing bias in China. On the whole, scholars carried out few studies on the relationship between investor sentiment and the basis. Zou and Sun (2012) [9] obtained a valuable research finding which is worth using to study the relationship between the investor sentiment and the basis. They found that the investor sentiment exerts different degrees of influences on the trade in different market situations, and the investor sentiment also has different impact on the returns and volatility of the stock market. Therefore, it is very necessary to study whether investor sentiment and the basis of stock index are mutually influential or not in different market situations, especially in the time period before and after the capital market turning from the steady operation to the unsteady one in China. If the mutual influence changes, what are the changes and what influences will they bring about?

2.2. Improvement of the Research Methods. Overseas studies on the relationship between the change of the basis and the relevant influence factors mainly use analysis methods including the VAR model and Granger causality test (Roll, 2007; Kadapakkam and Kumar, 2013; Han and Pan, 2016) [3, 10, 11], while investigations into the asymmetrical impacts of the liquidity or the investor sentiment on the basis are hardly seen. The commonly used methods are confined to setting dummy variables or using models (asymmetric GARCH model or piecewise regression model). However, these methods have shortcomings of losing samples and therefore cannot effectively measure the asymmetrical mutual influence between the basis and investor sentiment.

Based on the above literatures, the current research divided the market into the steady and chaotic situations from a new perspective, in order to explore the relationship between investor sentiment and the basis in different market situations. For the first time, we use the quantile vector autoregressive model (QVAR) method to analyze the asymmetrical mutual influence between investor sentiment and the basis. Different from the processing methods used by previous researchers, this method is superior to the VAR model as it can be used to analyze the relationship between two variables at different quantile levels. It is also superior to quantile regression that can provide more robust regression results and avoid endogeneity caused by causal relationship.

3. Hypotheses to Be Tested and Research Design

3.1. Hypotheses to Be Tested. According to the above literature review, we summarize key research issues from three aspects to further analyze the hypothesis: Firstly, the investor sentiment can influence the basis directly through the supply-demand relationship or by indirectly impacting the market liquidity and volatility. When the investor sentiment grows, investors find that the hedging and arbitrage are less attractive but tend to the unilateral speculation for the stock index futures (high-risk assets). The increasing market liquidity and volatility further lessen the basis, which is apt to cause futures premium. On the contrary, as the market sentiment reduces, investors' pessimistic judgment of index trend will be reflected by the price of the stock index futures, which is likely to propel the discount of stock index futures and strengthen the basis. Therefore, it can be seen that the investor sentiment is the factor leading to the change of the basis which declines with the growing index of the investor sentiment while it increases with the decrease of the index. Meanwhile the degree of basis discount reflects the expectations for futures market, giving the wrong information to the noise trader. Because of Chinese futures market's immaturity and

lack of arbitrage trading, insufficient liquidity in the capital market cannot be effectively reflected in investor sentiment. Compared to the impact of investor sentiment on the basis, the impact of the basis on investor sentiment may not be significant.

Secondly, investors' psychology and behavior are affected by the market environment in different market situations. Meanwhile, the interaction between basis and investor sentiment also varies in different market situations. This is because the market situation can be reflected in the characteristics of capital market prices and volatility. Whether the market is stable or not will affect investors' judgment on the capital market situation; this subjective judgment will bring about the corresponding trading behavior. It will be reflected in the premium of the stock index futures and the stock index futures basis. In summary, investors will have different trading behaviors due to the different market conditions and investors will also generate different levels of mood fluctuation based on the basis in different market situations. So the impact on the basis will also be different. The mutual influence between investor sentiment and basis changes as the market situation changes.

Thirdly, the asymmetrical short-sales mechanism of the spot market commonly restricts the reverse cash and carry arbitrage, which is the leading cause for the asymmetric effects of the investor sentiment on the basis. In the same way, investors will also generate a different level of mood fluctuation based on the different level of the basis. Moreover, the change of the basis is the result of multiple influence factors. The psychological and behavioral biases of investors in the periods of futures premium and discount also can induce the asymmetrical change of the sensitivity of these factors to the basis.

Fourthly, irrational noise trade is likely to result in the continuous rise of the market price and the theoretical price. From the perspective of trading behavior of different types of investors, Lee et al. (2012) [12] found from empirical research that irrational behaviors of investors in different structures have different influences on the basis. Therefore, the effects of the investor sentiment on the basis can be probably impacted by different investor structures: institutional investors in the market are basically more rational in terms of the investment (Daniel et al., 1997) [13], while individual investors are more likely to behave irrationally while making their investment decisions (Odean, 1998) [14]. When the number of individual investors grows in the market, the soaring investor sentiment can amplify the irrational buying behavior and leads to the continuous increase of the basis. Based on the four aspects, the following four hypotheses (1~4) to be tested are proposed:

Hypothesis 1. Under the same market situation, there exists a two-way causal relationship or one-way causal relationship between investor sentiment and basis. The basis decreases with the enlarging index of the investor sentiment and increases with the decline of the index

Hypothesis 2. The mutual influence between investor sentiment and basis changes in different market situations

Hypothesis 3. Under the same market situation, the mutual influence between the investor sentiment and the basis presents asymmetric character

Hypothesis 4. The institutionalization level of the capital market changes the influences of the investor sentiment on the basis

3.2. Variable Construction

3.2.1. Selection of Indicators (Explanatory Variable/Endogenous Variable) of the Investor Sentiment. When selecting the direct indictors of the sentiment, CCTV BSI and some macroeconomic factors (industry prosperity index, consumer confidence index, and economist confidence index included) are generally used in the Chinese capital market. However, these indicator data present poor continuity and consistency and whether the data are compiled rationally remains to be further checked through the practice. In the academic circle, the majority of scholars in China carry out investigations using sentiment proxy variables, such as closed-end fund premium/discount rate, price-earnings ratio (PE), new trading accounts, initial public offering (IPO) shares, IPO initial return, and some indicators of market liquidity. Because the liquidity data are difficult to measure, domestic scholars (Zheng and Lin, 2015) [8] adopted the turnover and the trading volume as the proxy indicators of the liquidity, which are able to reflect the changes of the investor sentiment to some extent. The current research discriminates these sentiment variables, so as to establish the model. The reasons are as follows: Firstly, the IPO shares and the IPO initial return are influenced by many human factors and the increase in the IPO shares of enterprises is a long-term process, so they are not suitable for reflecting the investor sentiment. Secondly, China has comprehensively loosened the restriction that "one person can only have one account" in the A-share market since April of 2015, so the new trading account loses its representativeness as the indicator of investor sentiment. It, however, can be replaced by the number of investors newly participating in the trade. Thirdly, Kumar and Lee (2006) [15] used the ratio of the difference between the buying and selling volumes of stock to the total trading volume to represent the investor sentiment. Their empirical analysis reveals that the indicator more accurately represents the investor sentiment in explaining the stock price change than the closed-end fund premium/discount rate. Therefore, the ratio of the difference of the active buying amount minus the active selling amount to the total trading volume is taken as the active buying rate indicator in the spot market. As the data of active buying and selling are difficult to attain, the net inflow of funds in the CSI 300 block is regarded as the proxy variable for the difference between the active buying amount and the active selling amount. After eliminating the extreme situations such as circuit breakers of the stock market, the weekly average net inflow of funds is used as the indicator of the active buying rate in the spot market. And fourthly, the trading volume and the turnover can describe the variation of the investor sentiment and further affect the liquidity of the futures and spot markets, so

the ratio of the trading volume to the circulated stock value is taken as the turnover of the market.

Based on the above considerations, the research selects the number (num) of investors newly participating in the A-share trade in the end of a phase closed-end fund premium/discount rate (prem), market turnover (turnover), average price-earnings ratio (PE) of A shares, and the active buying rate (buyrate) in the spot market as the original indicators for the composite index of the investor sentiment.

We consider that the composite index of the investor sentiment proposed by Huang et al. (2015) [16] using the partial least squares (PLS) has higher accuracy and stronger predictive ability than those constructed using other methods. PLS can be implemented by the following two steps of OLS regressions. In the first step, for each original investor sentiment proxy x_i(x_i is the number of investors newly participating in the A-share trade in the end of a phase closed-end fund premium/discount rate, market turnover, average price-earnings ratio of A shares, and the active buying rate in the spot market), we run a time-series regression of $x_{i,t-1}$ on a constant and realized stock return R_t.

$$x_{i,t-1} = \pi_{i,0} + \pi_i R_t + u_{i,t-1} \quad \mathrm{i} = 1, 2 \cdots \mathrm{T}. \tag{1}$$

The coefficient π_i in the first-stage estimation can describe how each sentiment index depends on the true investor sentiment. π_i captures the sensitivity of each sentiment proxy $x_{i,t-1}$ to investor sentiment S_{t-1} instrumented by future stock return that expected excess stock return explained by investor sentiment as the following standard linear relation:

$$E_t\left(R_{t+1}\right) = \alpha + \beta S_t. \tag{2}$$

In the second-stage regression, we run a cross-sectional regression of $x_{i,t-1}$ on the corresponding loading $\widehat{\pi}_i$ estimated in (1),

$$x_{i,t} = c_t + \widehat{\pi}_i S_t^{PLS} + v_{i,t} \quad \mathrm{i} = 1, 2 \cdots \mathrm{T}, \tag{3}$$

where S_t^{PLS} is the estimated investor sentiment and S_t^{PLS} can be regarded as investor sentiment of the capital market in China. By using the complete-sample information, we obtain the $\mathrm{T} \times 1$ vector $\mathrm{S}^{\mathrm{PLS}} = (\mathrm{S}_1^{\mathrm{PLS}}, \mathrm{S}_2^{\mathrm{PLS}}, \cdots \mathrm{S}_{\mathrm{T}}^{\mathrm{PLS}})'$ of composite index of the investor sentiment. $\mathrm{S}^{\mathrm{PLS}}$ is the linear composition of the indicators of the investor sentiment and also the expression of the composite sentiment index using the PLS method.

$$\mathrm{S}^{\mathrm{PLS}} = \mathrm{X}\mathrm{J}_{\mathrm{N}}\mathrm{X}'\mathrm{J}_{\mathrm{T}}\mathrm{R}\left(\mathrm{R}'\mathrm{J}_{\mathrm{T}}\mathrm{X}\mathrm{J}_{\mathrm{N}}\mathrm{X}'\mathrm{J}_{\mathrm{T}}\mathrm{R}\right)^{-1}\mathrm{R}'\mathrm{J}_{\mathrm{T}}\mathrm{R}, \tag{4}$$

where R is the $\mathrm{T}\times 1$ vector of the spot return of the CSI 300 stock index and $\mathrm{X}=(x_1', \mathrm{x}_2', \cdots \mathrm{x}_{\mathrm{T}}')'$ is the $\mathrm{T} \times \mathrm{N}$ order matrix composed of single original indicator variables of the investor sentiment, in which N represents the number of the selected original indicators of the sentiment. Then, there are matrixes $\mathrm{J}_{\mathrm{T}} = \mathrm{I}_{\mathrm{T}} - (1/\mathrm{N})\tau_{\mathrm{T}}\tau_{\mathrm{T}}{}'$, $\mathrm{J}_{\mathrm{N}} = \mathrm{I}_{\mathrm{N}} - (1/\mathrm{N})\tau_{\mathrm{N}}\tau_{\mathrm{N}}{}'$, where I_{T} and I_{N} are the T- and N-dimensional identity matrix, τ_{T} and τ_{N} are the T- and N-dimensional vectors of ones.

3.2.2. Futures-Spot Basis (Explained Variable/Endogenous Variable). To study the mutual influence between the investor sentiment and the futures-spot basis of the CSI 300 stock index, the weekly basis of the CSI 300 index is used as the explained variable and the basis at the moment t is defined as $\mathrm{Basis}_t = \ln(\mathrm{S}_t) - \ln(\mathrm{F}_t)$. Therein, S_t and F_t are the CSI 300 index price at t and the futures price obtained via weighting in accordance with the positions.

3.2.3. Moderator Variable. The quarterly data in the Wind database are used as the structure data (structure) of the investors. The "structure" represents the proportion of the CSI 300 component stock held by institutional investors. The current research also assumes that the investor structure does not change in a quarter. It needs to be noted that although the assumption is likely to lead to the sequence correlation, the corresponding shareholding ratio of institutional investors is not absolutely identical due to the different weights of CSI 300 component stock every day. Moreover, the quantile regression method relaxes the restriction for the assumption of the error term, so the assumption does not impact the results of regression analysis.

3.2.4. Control Variables

(1) Market Interest Rate (Holding Cost). The market interest rate r influences the flow of the market funds, as well as the cost for investors to invest in the spot and the futures markets. When the market interest rate rises, the financing cost grows, which shrinks the futures-spot arbitrage opportunities and further influences the basis. To uniformly match with other weekly variables in real time, the weekly interest rate of bond repurchase is adopted as the risk-free interest rate.

(2) Arbitrage Cost. Arbitrage cost consists of direct cost and indirect cost. Therein, the direct cost of the stock market includes the commission and the stamp tax while that of the futures market merely involves the commission. Although the CSI 300 and the SSE 50 stock index futures contracts have risen the trade security deposit and the service charge to different extents for the nonhedging positions since the stock market disaster in 2015, the direct arbitrage cost is still fixed because the trade in the spot market follows the "T+1" trading rule. So, we need to pay more attention to the influences of the variable indirect arbitrage costs on the adjustment of the basis. Indirect transaction costs mainly include the impact cost and the waiting cost. The impact cost can not only measure the part of transaction cost with liquidity premium but also estimate the risk brought about by the development of the price to the unfavorable orientation in the waiting process. Among the overseas researches on the impact cost, Harris (1990) [17] proposed the statistical measurement index based on tick-by-tick trade, and others put forward price impact models based on the econometric model (Glosten and Harris, 1988; Hasbrouck, 1991) [18, 19]. As the high-frequency tick-by-tick trade data needed in these methods are hard to attain and need complex computation, we refer to the impact cost model put forward by Almgren (2005) [20] to calculate the impact cost. Moreover, the CSI 300 stock index futures market has different impact costs of arbitrage

with its component stock and CSI 300ETF. Therefore, it is necessary to calculate the impact costs ("impact-F," "impact-S," and "impact-ETF") of the CSI 300 stock index futures, component stock, and CSI 300 ETF, respectively. The waiting cost is represented by the volatility ("rsigma") of the return of the CSI 300 index and the volatility ("frsigma") of the return of the CSI 300 stock index futures.

Then use the following steps to calculate impact costs. Based on the nature and characteristics of the perpetual impact and the temporary impact costs, we firstly define the impact cost referring to the research (Wei and Liang, 2013) [21] conclusion as follows:

$$IC = I + J - \frac{I}{2} = g(v) + h(v) = \gamma v + \tau v, \tag{5}$$

where IC is the impact cost and I and J$-I/2$ are perpetual impact and the temporary impact costs, respectively. We assume that the impact cost function is of linear form; γ and τ are perpetual and temporary impact factors, respectively. Suppose a single transaction volume X for any stock; we choose the standardized daily market volume (N) to obtain the standardization of its trading speed (v = X/NT). Transaction speed "v" is in line with the trading direction. We use "NT" to present the average volume of transactions from time t_0 to t_N, which avoids directly estimating T. So the econometric model to calculate the impact cost is as follows:

$$\begin{aligned} IC &= I + J - \frac{I}{2} = g(v) + h(v) \\ &= \sigma \mathrm{T}\,\mathrm{sgn}(\mathrm{X})\,\gamma \left|\frac{X}{NT}\right| + \sigma T\,\mathrm{sgn}(\mathrm{X})\,\tau \left|\frac{X}{NT}\right| + \epsilon + \omega, \end{aligned} \tag{6}$$

where σ is the intraday volatility calculated by the price of stock index futures; X is the daily market trading volume calculated by the average market trading volume over the past 10 trading days, through the net capital flow of the average price, a period of time ($\overline{S}$) and the prices when corresponding impact disappears (S_p) to obtain the price perpetual impact (I) and the temporary impact costs (J$-I/2$). S_0 represents the stock at the beginning of the transaction and S_j represents the stock price at moment t. Then we can get the impact (I) and the temporary impact costs (J $- I/2$) to estimate parameters γ and τ.

$$\mathrm{I} = \frac{(S_p - S_0)}{S_0} \tag{7}$$

$$\mathrm{J} - \frac{I}{2} = \frac{(\mathrm{S} - S_0)}{S_0}. \tag{8}$$

In this paper we use the above method to compute the impact costs (impact-F, impact-S, and impact-ETF) using the estimated parameter values γ and τ.

(3) Mean-Reversion Characteristic (Reversion). The arbitrage mechanism in the market allows stock index futures to have a long-term equilibrium relation with the spot commodity. If the basis is beyond the risk-free arbitrage interval, the presence of large amounts of arbitrage activities will lead to the mean reversion. Numerous studies of Chinese scholars (Theobald and Yallup, 2001; Monoyios and Sarno, 2002; Yi et al., 2010) [22–24] have proved that the basis of the stock index futures shows the nonlinear mean-reversion characteristic. Due to the constraint of the short-sales mechanism of the stock spot market in China, the mean reversion has more significant asymmetry. In the research, suppose the basis subject to the following stochastic processes:

$$\begin{aligned} dBasis_t &= \alpha(\mu_t - Basis_{t-1})\,dt + \sigma(t)\,dW_t^1 \\ d\mu_t &= \beta(\gamma - \mu_{t-1})\,dt + \varphi dW_t^2, \end{aligned} \tag{9}$$

where $Basis_t$ is the basis of SCI 300 stock index futures and meets the condition $dW_t^1 dW_t^2 = 0$. α, β, φ are the parameters for risk neutral market. μ_t is the long-term equilibrium value of the basis. We should do mathematical expectations on both sides of the formula and get the long-term equilibrium value of the basis (μ_t) and combined with the first formula of (9),

$$\lambda = \frac{\alpha(\mu_t - Basis_t)}{\sigma(t)}. \tag{10}$$

λ can be used to interpret the mean-reversion characteristic by dividing the difference between the basis and the mean using the relative volatility between the SCI 300 stock index futures and the spot index.

3.3. Quantile Regression Model and Quantile Vector Autoregressive Model. Before we test the influence of the investor sentiment on the basis, the endogenous problems caused by mutual causality between sentiment and basis should be considered. In addition to the simple Granger causality test, the quantile vector autoregressive model (QVAR) [25] can measure the causal relationships. We can first investigate the asymmetrical mutual influence of investor sentiment and the basis of CSI 300 stock index futures under conditions in different market situations using the quantile vector autoregressive model. The quantile vector autoregressive model of order p is shown as follows:

$$\begin{aligned} \begin{pmatrix} Basis_t \\ S_t^{PLS} \end{pmatrix} &= \begin{pmatrix} c_1(\tau_1) \\ c_2(\tau_2) \end{pmatrix} \\ &+ \sum_{i=1}^{p} \begin{pmatrix} \beta_{i,11}(\tau_1) & \beta_{i,12}(\tau_1) \\ \beta_{i,21}(\tau_2) & \beta_{i,22}(\tau_2) \end{pmatrix} \begin{pmatrix} Basis_{t-1} \\ S_{t-1}^{PLS} \end{pmatrix} \\ &+ \begin{pmatrix} e_{1t}(\tau_1) \\ e_{2t}(\tau_2) \end{pmatrix} \quad t = 1 \cdots T, \end{aligned} \tag{11}$$

where $\mathrm{Basis_t}$ is the basis of the CSI 300 stock index futures in the tth week and $\mathrm{S^{PLS}}$ is the composite index of the investor sentiment in the tth week. $\mathrm{Basis_t}$ and $\mathrm{S^{PLS}}$ are endogenous variables and $c(\tau)$ is the N-dimensional intercept term vector at the level of division $\tau = (\tau_1, \tau_2)$. The lag coefficient matrix $\beta_i(\tau)$ with n × n dimension size and $e_i(\tau)$ represents the error term vector with n × 1 dimension size. This model can consider the interrelationships between the endogenous variables at different quantile levels, simultaneously.

Then the influence of investor sentiment on basis under different investor structures is discussed using the quantile regression method. The quantile regression model is applied to test the influences of the investor sentiment on the basis, and the model is shown as follows:

$$\text{Basis}_t = \alpha + \beta_1 S_t^{PLS} + \sum_{j=2}^{n} \beta_j \text{Control}_{t-1} + \varepsilon_t. \quad (12)$$

Lagging the control variable Control_{t-1} by one order can avert the occurrence of the endogeneity in the regression model. To more favorably compare the influences of different factors on the basis, all variables except for the explained variable are standardized. This way, the influences of per-unit change of each factor on the basis can be more easily compared.

In the robustness test, the control function method is used to establish the semiparameter quantile regression model, which is shown as follows:

$$\text{Basis}_t = \alpha + \beta_1 S_t^{PLS} + \beta_2 X_t + \sum_{j=3}^{n} \beta_j \text{Control}_{t-1} + \varepsilon_t \quad (13)$$

$$X_t = \rho_t + \theta_1 S_t^{PLS} + \theta_2 Z_t + \sum_{j=3}^{n} \theta_j \text{Control}_{t-1} + \delta_t, \quad (14)$$

where Basis_t and S^{PLS} represent the basis of the CSI 300 stock index futures and the composite index of the investor sentiment in the tth week, respectively. X_t is an endogenous explanatory variable while Z_t is the instrumental variable of X_t. Lagging the control variable Control_{t-1} by one order can avoid the endogeneity in the regression model and Control_{t-1} can be regarded as an exogenous explanatory variable. ε_t and δ_t are unobservable real-valued random variables. In the regression, formula (14) is subjected to the quantile regression at first, and then the obtained residue term is substituted in formula (13) to carry out the quantile regression to attain the estimates of the parameters.

4. Sample Data and Descriptive Statistics

4.1. Sample Data. The sample data used in the research were the daily trading data of the CSI 300 stock index futures from July 26, 2013, to July 15, 2016. Because the majority of the proxy variables for the investor sentiment are weekly data, data of 155 weeks were used for the research. Based on the distinguishing method for the bull market and the bear market proposed by Pagan and Sossounov (2003) [26], the volatility three months before and after the tth week was calculated to differentiate the market situations. It is regarded that the stock market becomes chaotic when the volatility of the tth week and in the subsequent period (lasts no less than 4 months) keeps exceeding 20% of the volatility before the tth week. In this way, the market is divided into a steady period (July 26, 2013~March 27, 2015) and a chaotic period (April 3, 2015~July 15, 2016). The explained variable, explanatory variables, control variables, and moderator variable were all calculated by the original data which were collected from the Wind database and underwent quantile regression analysis using R3.3.0.

4.2. Descriptive Statistics and Variance Analysis. Table 1 lists the detailed descriptions of each variable and the descriptive statistics in different market situations. The descriptive statistics and variance analysis unveil that the growth rate (num) of investors newly participating in the trade, closed-end fund premium rate (prem), market turnover ratio (turnover), average price-earnings ratio (PE) of the A share, and the active buying rate (buyrate) in the spot market are taken as the original indicators for the composite index of the investor sentiment. Except for the number of investors newly participating in the trade and the active buying rate (buyrate), other indicators have significant differences in the two market situations. It can be seen from the results of the variance analysis that the composite sentiment index presents significant difference in the two market situations. The basis also has significant difference in the two market situations (significant at the 1% level), which indicates that the premium/discount degree of the stock index futures varies in the two market situations and has a mean value of 0.2 in the chaotic stock market, implying an apparent premium phenomenon. The moderator variable and the control variables present different significant levels in the two market situations, which suggests that the above division of the two time periods truthfully reflects different market situations.

5. Results of Empirical Research

5.1. Relationship between the Investor Sentiment and the Basis of CSI 300 Stock Index Futures. Limited by the length of the paper, Table 2 merely lists the quantile vector autoregressive regression model results at representative quantiles (25%, 50%, and 75%, p=3). Table 2 shows the result of the QVAR (quantile vector autoregressive) model. It can be seen from the regression results that the influences of the investor sentiment on the basis are significant, whereas the influences of the basis on the sentiment are not significant. Generally speaking, the quantile 25% represents the premium of the futures market, 50% means that the basis is close to 0, and 75% indicates the discount of the futures market. On this basis, we observed the overall influences of the investor sentiment on the basis. The coefficient of the composite index of the investor sentiment is always negative at all of the quantiles in the two market situations and is the most significant at the chaotic period of the market with the largest absolute value of the coefficient. This indicates that the same range of sentiment change has stronger influences on the basis in the market where the stock price sharply rises and falls when other control variables are unchanged. This also proves hypotheses 1 and 2.

An observation of the regression coefficient reveals that asymmetrical influences of the investor sentiment on the basis present different effects in different market situations: when the stock market runs normally, the investor sentiment has similar influences on the premium and discount of the futures, while, in the chaotic market, the investor sentiment has greater influences and more apparent actions on the basis and the influences exhibit asymmetrical effects, thus proving hypothesis 3. The basis is more likely to be influenced by

Table 1: Variables descriptive statistics and variance analysis.

variables	unit	Stable market		Turbulent market		variance analysis	
		mean	Std.	mean	Std.	F	Pr
Explained variable/Endogenous variable							
Basis	300 yuan/point	-0.03	0.08	0.2	0.21	84.144	2.95E-16∗ ∗ ∗
Explanatory variable/Endogenous variable							
S^{PLS}	%	2.54	0.44	3.56	0.54	166.84	2.20E-16∗ ∗ ∗
Moderator variable							
structure	%	53.1%	1.45	54.3%	2.34	13.904	2.70E-04∗ ∗ ∗
Control variables							
r	%	5.3	3.57	2.27	1.05	45.431	3.03E-10∗ ∗ ∗
impact-F	300 yuan/point	5.35	3.9	3.2	2.92	14.188	0.000236∗ ∗ ∗
impact-S	300 yuan/point	1.44	2.98	23.93	32.66	41.334	1.55E-09∗ ∗ ∗
impact-ETF	300 yuan/point	4.39	3.56	6.92	9.56	5.2287	0.02359∗
rsigma	%	0.01	0.01	0.02	0.01	29.168	2.49E-07∗ ∗ ∗
frsigma	%	0.01	0.01	0.02	0.02	29.168	2.49E-07∗ ∗ ∗
psigma	%	26.71	22.33	62.43	55.21	30.359	1.49E-07∗ ∗ ∗
fpsigma	%	29.04	27.85	72.26	62.77	33.197	4.44E-08∗ ∗ ∗
reversion	300 yuan/point	0.03	0.61	-0.84	7.22	1.2798	0.2597
Original indicators for the composite index of the investor sentiment							
num	%	0.01	0.28	-0.01	0.15	0.3452	0.5577
prem	%	-0.15	0.03	-0.12	0.06	18.638	2.83E-05∗ ∗ ∗
turnover	%	0.04	0.03	0.06	0.04	16.534	7.62E-05∗ ∗ ∗
PE	%	9.55	1.67	13.41	2.04	167.06	2.20E-16∗ ∗ ∗
buyrate	%	0.11	0.95	0.06	0.04	2.1311	0.1464

Table 1 reports the summary descriptive statistics of price series. The explained variable (basis) is the basis of CSI 300 index futures. The regulated variable (structure) is the percentage of stock held by institutional investors. Market interest rate, arbitrage cost, and mean-reversion characteristic are the control variables. We use the weekly interest rate of bond repurchase as the risk-free interest rate. "Impact-F,", "impact-S," and "impact-ETF" are adopted as the impact costs and "rsigma," "frsigma," "psigma," and "fpsigma" represent the waiting cost, and reversion is used to interpret the mean-reversion characteristic. The "PE" is the average price-earnings ratio of the A share, "num" is the number of investors newly participating in the trade, "prem" means closed-end fund premium rate, turnover represents market turnover, and "buyrate" is the active buying rate in the spot market. The index above is taken as the original indicators for the composite index of the investor sentiment. S^{PLS} is the composite index of the investor sentiment in the tth week calculated using the sentiment original index by the PLS model.

the investor sentiment during the discount. This is because investors commonly have high sentiment when the price booms in the market, thereby attracting large numbers of speculators to trade frequently. When the market liquidity improves, the price expectation is further elevated, causing greater premium. When the market sees steep fall in price, the short-sales constraint of the spot market makes investors panic and the pessimistic emotion will enlarge the irrational behaviors of investors, such that the sentiment exerts more significant influences on the adjustment of the basis. Because of the imperfect short-sales mechanism, the stock index futures market, as one of the few risk management tools of the Chinese capital markets, is overused by pessimistic investors and bears huge selling pressure coming from the spot market when the price falls abnormally in the market. The issue of the market mechanism is also one of the critical reasons for the continuous and great discount during the abnormal volatility of the stock market.

Consistent with the Granger causality test, investor sentiment is the Granger cause of the basis but the basis is not the Granger cause of the investor sentiment. As investor sentiment fluctuates, it will attract large numbers of speculators to trade frequently affecting the basis. However, the fluctuation of the basis does not lead to arbitrage trading effectively as the speculative trading dominates the market and makes arbitrage traders not able to correct the basis to a reasonable level. The Granger causality test verified the result of the quantile vector autoregressive model again.

As the investor sentiment cannot affect the basis significantly, the endogenous issue caused by the interrelated factor of basis and investor sentiment can be avoided. Then we can further discuss the impacts of sentiment on the basis in different investor structures using the quantile regression model.

5.2. Impacts of Irrational Behaviors of Investors on the Basis in Different Structures. To verify hypothesis 4, the cross term of the investor sentiment and the investor structure is added in the quantile regression model. The detailed verification results are displayed in Table 3. By observing the coefficient of the cross term in the regression results, it can be found that the coefficient of the investor sentiment

Table 2: Regression results of the quantile vector autoregressive models.

Panel A: Quantile vector autoregressive models						
	First stage (Stable market)			Second stage (Turbulent market)		
Endogenous variable	25%	50%	75%	25%	50%	75%
$\beta_{i,Basis,Basis}$	0.6273**	0.7841***	0.7482***	0.7432***	0.7329***	0.7380***
$\beta_{i,Basis,S^{PLS}}$	-0.0557	-0.0622	-0.0804*	-0.2804**	-0.2056**	-0.3802***
$\beta_{i,S^{PLS},Basis}$	-0.0566	-0.0319*	-0.0068	0.0296	-0.0001	-0.0048
$\beta_{i,S^{PLS},S^{PLS}}$	0.7306***	0.7130**	0.8242***	1.1527**	0.6769***	0.6117**
Panel B: Quantile vector autoregressive models						
H_0		F-value			P value	
Investor sentiment is not the Granger cause of the basis		5.4546			0.000***	
Basis is not the Granger cause of the investor sentiment		1.7076			0.1368	

Table 2 reports the result of the quantile vector autoregressive estimation (QVAR). ***, **, and * stand for statistical significance at the 1%, 5%, and 10% level, respectively.

Table 3: Result of the regression estimation considering investors' structure.

	First stage (Stable market)			Second stage (Turbulent market)		
Explanatory variable	25%	50%	75%	25%	50%	75%
S^{PLS}	-0.08743***	-0.04192***	-0.05550***	-0.08393**	-0.10100*	-0.10155**
	(-4.23043)	(-4.38351)	(-3.86572)	(-2.21789)	(-1.78345)	(-2.35179)
r	-0.01342	-0.00432	-0.00485	-0.04817	0.10072	0.09509
	(-0.93107)	(-0.40926)	(-0.59169)	(-0.27588)	(1.21478)	(1.25509)
Impact-F	-0.64312**	-0.35835	-0.30577	-0.00956	-0.01519	-0.05584
	(-0.75737)	(-0.43484)	(-0.46250)	(-0.17924)	(-0.37509)	(-1.34429)
Impact-S	-0.02083	-0.01507	-0.00397	0.02021	-0.02122	-0.03463
	(-1.39984)	(-0.79281)	(-0.23122)	(0.28662)	(-0.36004)	(-0.62744)
Impact-ETF	0.07377***	0.06707***	0.03344	0.01376	0.03331	0.06455
	(2.67012)	(2.21958)	(1.35567)	(0.33060)	(0.76813)	(1.32247)
frsigma	0.03401	0.03057	0.04518	0.03208	0.06545	0.12111
	(0.69870)	(0.73495)	(1.03438)	(0.38646)	(0.69189)	(1.17760)
rsigma	-0.04960	-0.03862	-0.03177	0.01714	0.01722	-0.00237
	(-1.25115)	(-1.03519)	(-0.78892)	(0.21168)	(0.23797)	(-0.03858)
reversion	0.00121	0.00326	0.00554	-0.00298	-0.00022	0.00093
	(0.10323)	(0.22396)	(0.39898)	(-0.87293)	(-0.07527)	(0.37368)
structure	0.05964**	0.08180***	0.03544	-0.01597	-0.04100	-0.05175
	(2.26087)	(2.72718)	(1.24361)	(-0.23068)	(-0.82039)	(-1.29275)
Structure* S^{PLS}	0.09101***	0.11225***	0.04722	0.00673	0.05757	0.07131
	(2.79851)	(3.20395)	(1.59309)	(0.09844)	(1.15699)	(1.61321)
Intercept	-0.42035	-0.27074	-0.18529	0.14605	0.32032***	0.42930***
	(-1.11143)	(-0.73668)	(-0.61618)	(1.08549)	(3.53903)	(5.43184)

Table 3 reports the result of the regression estimation considering investors' structure. The values in parentheses are t statistics value. ***, **, and * stand for statistical significance at the 1%, 5%, and 10% level, respectively.

and the investor structure is positive in the steady period of the stock market, which is apposite to the effects of the sentiment on the basis and significant at the 10% confidence level. This proves the hypothesis and suggests that the higher the institutionalization level of the futures market in the steady period of the stock market, the smaller the impacts of the investor sentiment on the basis. The positive effects are more significant in the premium of the futures. However, the important conclusion also needs to be noticed: in the chaotic stock market, the coefficient ahead of the cross term of the investor sentiment and the investor structure is not significant and the improvement of the institutionalization level actually does not lower the influences of the investor sentiment on the basis. It indicates that the rising institutionalization level is in favor of stabilizing the market when the stock market runs normally, while when the stock market is chaotic the institutional investors play an insignificant role.

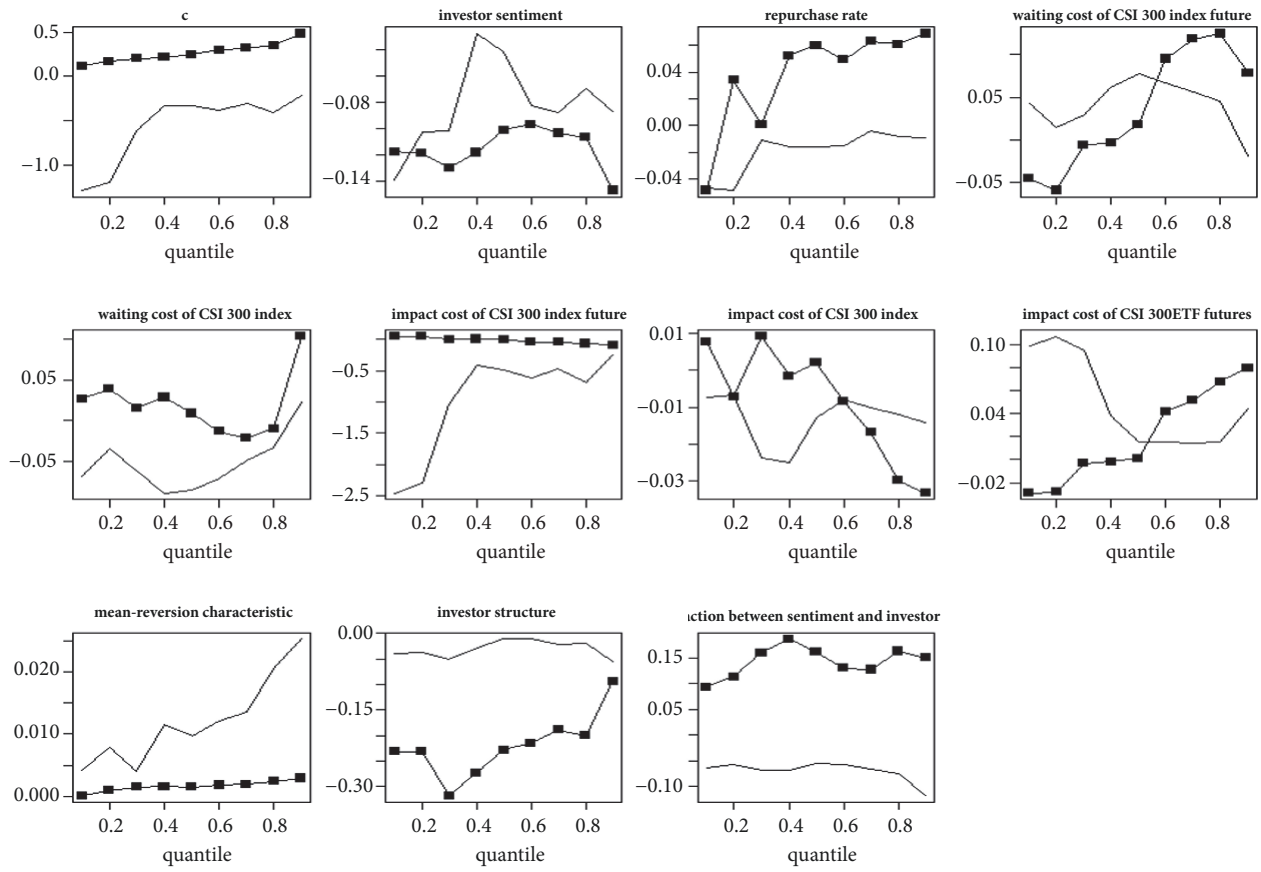

Figure 1: Changes of the quantile regression coefficients of the influence factors of the basis. Note: the solid line with square dots represents the quantile regression results in the chaotic stock market, and the solid line without dots shows the quantile regression results in the steady market. The abscissa axis and the ordinate axes represent the different quantiles of the basis and the regression coefficients of various variables, respectively.

To more intuitively observe the overall influences of the sentiment index on the basis at different quantiles, Figure 1 displays the changes of the quantile regression coefficients of the influence factors of the basis. As can be seen from the figure, the basis reduces (increases) with the rising (declining) investor sentiment index, and the coefficients at different quantiles in the chaotic market are also smaller than those in the steady market. This indicates that the investor sentiment shows greater influences on the basis when the market is under a chaotic condition. No matter whether the market runs steadily or the market is chaotic, the influences of the investor sentiment on the basis are displayed as a curve indicating that the impacts of the investor sentiment on the basis have asymmetrical effects. According to the significance of the quantile regression results, the arbitrage cost is also among the factors significantly influencing the basis, while the basis does not have an obvious mean-reversion characteristic. It can be seen from the figure that the repo rate has significantly different influences on the basis in the two market situations despite the insignificant influences on the basis in terms of the statistics, which can be explained using the theory of the holding cost. When the stock market runs steadily, the repo rate is negatively correlated with the basis. Under the condition, the market sentiment is stable and improvement in the financing cost will lead to the strengthening of the basis, while the opposite situation can be found in the chaotic period of the stock market; that is, the increasing financing cost is more likely to take some of the steam out of the market and decline the return expectation, thus leading to the further weakening of the basis. The results suggest that the holding cost also exerts certain influences on the basis, but the influences are less significant than the investor sentiment.

Moreover, this section discusses focus on the influence of sentiment and investor structure on the basis at different quantiles. The basis is more likely to be influenced by the interaction between investor sentiment and structure. The effect of institutionalization level on investor sentiment is different because the regression coefficients show different symbols. It indicates that the rising institutionalization level is in favor of stabilizing the market when the stock market is stable. Institutional investors can reflect their rational behavior when the stock market is stable but show more irrational behavior when the stock market is in turmoil.

5.3. Robustness Analysis

5.3.1. Robustness Analysis of the Indicators of the Investor Sentiment. By testing the relationship between the market liquidity and the basis of the CSI 300 stock index futures, it avoids the negation of the influences of the investor sentiment on the basis which may rise because the index system of the investor sentiment contains the liquidity indicator. Based on the previous research of Li and Wu (2006) [27], Li et al. (2012) [28], and Zheng and Lin (2015) [8], trading volume, as the indicator of market liquidity, comprises two parts: the liquidity (expected trading volume) and the information trading volume. Therein, the information trading volume reflects the investor sentiment. Therefore, the first-order autoregression method of Amihud (2002) [29] can be used to decompose the trading volume of the CSI 300 stock index futures and the spot trading volume, so as to represent the market liquidity indicator using the expected trading volume. Moreover, the robustness test method of Li Fengyu (2014) [30] can be adopted to represent the investor sentiment index using five single indicators of the investor sentiment. Meanwhile, the refitting can be conducted using the QVAR model to more clearly reveal the leading function of the investor sentiment on the basis and the influence degrees of various original indicators on the basis. The final regression results demonstrate that (this article omits the robustness analysis of investor sentiment indicators and the relevant forms remain to be retained), in the futures market, the regression coefficient of the expected trading volume is not significant while that of the information trading volume is significant at multiple quantiles; the regression coefficients of both the expected trading volume and the information trading volume are significant in the spot market. The results are opposite to those obtained by foreign researchers, which indicates that the investor sentiment exerts the predominant impacts on the basis in China. In addition, except that the regression coefficients of the new trading accounts and the closed-end fund premium/discount rate are not significant, the other original indicators of the investor sentiment have significant regression coefficients at various quantiles. This suggests that the liquidity proxy indicators (turnover and active buying rate) and the price-earnings ratio that are able to explain the changes of the investor sentiment can more favorably explain the change of the basis than the new trading accounts (the number of investors newly participating in the A-share trade) and the closed-end fund premium rate. In other words, they can more effectively describe the change of investor sentiment in China (the robustness analysis of the investor sentiment index is given in the appendix).

5.3.2. Robustness Analysis of the Endogeneity Caused by the Missing Variables or Measurement Errors. We use the quantile regression method to investigate the irrational behaviors of investors on the basis in different structures. Although the model built in the research carries out regression analysis considering many key control variables, the endogenous issue caused by the missing variables and measurement errors will lead to biased and inconsistent estimated results of the model. To overcome the issue, most scholars in China use the two-phase regression model based on the instrumental variables while using the quantile regression. However, the obtained results are not always consistent (Terza et al., 2008) [31]. We believe that the basis value lagging by two phases can be introduced in the right side of the regression model (12) to serve as the instrumental variable. The quantile regression based on the instrumental variable can relatively effectively reduce the endogeneity of the model. It can be seen from the robust regression results that the regression coefficients of the investor sentiment are still significantly negative at various quantiles, and the value and significance of the coefficient of the investor sentiment are similar to those in Table 3. This indicates that the endogenous issue caused by the missing variables and the measurement errors does not influence the conclusions obtained above.

5.3.3. Robustness Analysis of the Endogeneity Caused by Causal Relationship. The endogenous issue caused by the interrelated factor of basis and investor sentiment can be avoided through the QVAR model and Granger causality test. Moreover, considering that the shareholding ratio of institutional investors is closely related to the situation of the stock market, the change of the basis of stock index futures will influence the investment decision of institutional investors and further impacts the shareholding ratio of institutional investors. The basis of the stock index futures probably has a causal relationship with the investor structure, therefore generating endogeneity and causing biased or inconsistent quantile regression results. In reference to Lee (2007) [32] and Chernozhukov (2015) [33], we overcome the endogeneity using the control function method by introducing the proxy variable of the investor structure in the right side of the model as the institutional variable. Referring to the measurement method of Zhang et al. (2010) [34] for the investor structure, the selected proxy variable is measured using the ratio of the trading volume to the positions. The investor structure refers to the relativity of the speculative behaviors to the hedging behaviors, so the ratio of the trading volume to the positions reflects the comparison between the speculative behaviors and the hedging behaviors. Table 4 shows the quantile regression results considering the investor structure, which are very close to the conclusions in Table 3. This proves that the selected institutional variable is appropriate.

In the quantile regression results based on the control function, although the coefficient ahead of the cross term of the investor sentiment and the investor structure has low significance in the chaotic stock market, the investor structure is negatively correlated with the basis and the absolute value of the coefficient ahead of the investor structure is larger than that of the cross term. This indicates that when considering the interaction effect between the investor sentiment and the investor structure on the basis, the trading behaviors of institutional investors do not stabilize the market although the behaviors of these investors are more irrational. Under the effect of the sentiment, their behaviors can even drive the sharp rise and fall of price of stock index futures. In the steady growth of the market, the coefficient of the investor structure and that ahead of the cross term are positive, and the growing

Table 4: Result of the regression estimation based on the control function.

	First stage (Stable market)			Second stage (Turbulent market)		
Explanatory variable	25%	50%	75%	25%	50%	75%
S^{PLS}	-0.16557∗∗	-0.11369	-0.06448∗∗∗	-0.16217∗∗	-0.10287∗∗	-0.13471∗∗
	(-2.27769)	(-1.27907)	(-2.69299)	(-2.27290)	(-2.45963)	(-2.15698)
r	-0.01112	-0.00385	-0.00193	0.00340	0.06320	0.12280
	(-0.83031)	(-0.36070)	(-0.23227)	(0.02250)	(0.92401)	(1.53992)
Impact-F	-0.15937	-0.42612	-0.51004	-0.00584	0.08853∗	0.04291
	(-0.15427)	(-0.49928)	(-0.88732)	(-0.09762)	(1.71316)	(0.48510)
Impact-S	-0.02997∗	-0.01418	-0.00387	0.01871	0.01134	0.00223
	(-1.82102)	(-0.73461)	(-0.23216)	(0.26946)	(0.24403)	(0.03874)
Impact-ETF	0.09271∗∗∗	0.07069∗	0.01602	0.01965	-0.05050	-0.01540
	(2.87755)	(1.86775)	(0.63691)	(0.45562)	(-1.16406)	(-0.19722)
frsigma	0.02915	0.02646	0.06791	0.02114	0.07014	0.15580∗
	(0.55109)	(0.63738)	(1.52442)	(0.26064)	(1.19412)	(1.78095)
rsigma	-0.05966	-0.03489	-0.06694	0.01102	-0.08675	-0.09587
	(-1.44361)	(-0.96732)	(-1.52094)	(0.13923)	(-1.16397)	(-0.92189)
reversion	0.00117	0.00261	0.01200	-0.00343	0.00162	0.00295
	(0.09298)	(0.18037)	(0.80610)	(-1.04246)	(0.68540)	(0.35990)
structure	0.17619∗	0.09032∗	-0.00286	-0.13268∗	-0.19102∗∗	-0.10445∗
	(1.81114)	(1.80714)	(-0.08643)	(-1.77757)	(-2.19664)	(-1.87666)
Structure∗ S^{PLS}	0.07950∗∗	0.10961∗∗∗	0.05691∗	0.07628	0.09819∗	0.09208∗
	(2.42821)	(3.09761)	(1.81072)	(1.11018)	(1.95420)	(1.91860)
Intercept	-0.17200	-0.29884	-0.26534	0.30836∗∗	0.66830∗∗∗	0.46606∗∗∗
	(-0.36064)	(-0.78357)	(-1.01895)	(3.18539)	(4.62874)	(4.87156)

Table 4 reports the result of the regression estimation based on the control function. The values in parentheses are t statistics value. ∗∗∗, ∗∗, and ∗ stand for statistical significance at the 1%, 5%, and 10% level, respectively.

institutionalization level plays an extremely significant role in the stabilization of the market. In general, the investor structure is indeed a critical factor influencing the basis: in the steady stock market, the increase in the institutionalization level can decline the influences of the investor sentiment on the basis, while, in the chaotic period of the stock market, the trading behaviors of institutional investors do not stabilize the steady operation of the stock market.

6. Conclusions and Inspirations

Based on the quantile vector autoregressive model, the research systematically investigates the relationship between the investor sentiment and the basis. It also further discusses the influence of investor structure and investor sentiment on the basis of stock index futures, broadens the existing research boundary, and enriches the research methods. We obtain the following results: investor sentiment exerts asymmetrical impacts on the basis of the CSI 300 stock index futures and the capital market in China has the following three problems in the operation: firstly, there is a one-way causal relationship between the basis and investor sentiment. The basis has no significant impact on investor sentiment, but the investor sentiment presents negative influences on the basis. The basis declines with the growing index of the investor sentiment and increases with the enlarging index, and the influences have asymmetry. The asymmetry is shown in the following two aspects. (1) In different market situations, the investor sentiment has different negative influence degrees on the basis. The results of both the quantile vector autoregressive model and quantile regression model can illustrate this point of view. (2) The negative influences of the investor sentiment on the basis are at different degrees when the stock market witnesses premium or discount in the chaotic situation. When the stock index futures market has discount, the basis is more likely to be influenced by the investor sentiment factors. Secondly, among the indicators of the investor sentiment, the price-earnings ratio, the turnover, and the active buying rate can more effectively explain the changes of the basis. Compared with the market liquidity, the investor sentiment is the leading influence factor of the adjustment of basis in China. Thirdly, the improvement of the institutionalization level of the market does not always reduce the abnormal effects of the investor sentiment on the basis. When the stock market is in the steady state, the influences of the investor sentiment on the basis decrease with the rising institutionalization level of the capital market. However, institutional investors' irrational trading behaviors induced by the sentiment even drive the sharp rise and fall of the price of stock index futures in China in the chaotic period of the stock market. Similarly, the institutionalized development does not play the anticipated role in stabilizing the market in the stock market slump.

The one-way causal relationship between the basis and investor sentiment shows that the basis does not significantly affect investor sentiment. The changes in basis cannot effectively affect arbitrage trading behavior, reflecting changes in investor sentiment, while the change of the futures-spot basis in China is induced mainly by investor sentiment. This result implies that the Chinese capital market is now in a situation of apparent speculative circumstance and low market efficiency. This provides three inspirations for learning the operation of the capital market and the adjustment of the policies relating the capital market: Firstly, the basis cannot influence the investor sentiment indicator through trading behavior; it shows that China's financial market is still immature. The speculative trading dominates the market and arbitrage traders cannot effectively reduce the impact of such noise traders' actions on the market. Secondly, the high arbitrage cost in the futures and spot markets inhibits the realization of the arbitrage and hedging, which makes the basis more likely to be influenced by the investor sentiment and not beneficial to the rational regression of the basis. Thirdly, the asymmetrical impacts of the investor sentiment on the basis are mainly attributed to the asymmetry of the long- and short-sales mechanism of the spot market and the few types of the risk management tools including financial futures. This suggests that the short-sales mechanism of the capital market in China remains to be consummated and more types of risk management tools need to be developed. Finally, individual investors account for a large proportion in the Chinese capital market and the institutional investors present an individualization tendency. Once overall investors have irrational behaviors, the formulation and effects of trading strategies (hedging) will be seriously impacted, thus further enlarging the systematic risk of the capital market.

Data Availability

The data or variables in this paper were all directly from the Wind database or indirectly calculated by the original data which were collected from the Wind database.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

[1] E. Marcinkiewicz, "Determinants of the Index Futures Basis: an Empirical Study of Warsaw stock exchange," in *Proceedings of the 14th International Conference on Finance and Banking*, pp. 242–251, 2014.

[2] M. Baker and J. C. Stein, "Market liquidity as a sentiment indicator," *Journal of Financial Markets*, vol. 7, no. 3, pp. 271–299, 2004.

[3] R. Roll, E. Schwartz, and A. Subrahmanyam, "Liquidity and the law of one price: The case of the futures-cash basis," *Journal of Finance*, vol. 62, no. 5, pp. 2201–2234, 2007.

[4] D. Lien, G. Lim, L. Yang, and C. Zhou, "Dynamic Dependence Between Liquidity and the S&P 500 Index Futures-Cash Basis," *Journal of Futures Markets*, vol. 33, no. 4, pp. 327–342, 2013.

[5] P. J. Li and Y. Guo, "Futures-cash Basis and Liquidity in Security Market," *Journal of Management Science*, vol. 30, no. 4, pp. 151–160, 2017.

[6] C. Yang and B. Gao, "The term structure of sentiment effect in stock index futures market," *The North American Journal of Economics and Finance*, vol. 30, pp. 171–182, 2014.

[7] Z. X. Wang and H. L. Wang, "Investor sentiment, subjective belief adjustment and market volatility," *Journal of Financial Research*, no. 4, pp. 142–155, 2013.

[8] A. L. Zheng and J. Lin, "The price bias of CSI 300 Index Futures and Investor Sentiment," *Journal of Applied Statistics and Management*, no. 6, pp. 1129–1140, 2015.

[9] H. Zou and L. Sun, "The Influence of Investor Sentiment on Stock Return and its Volatility under Different Market States," in *Proceedings of the 2012 Fifth International Conference on Business Intelligence and Financial Engineering (BIFE)*, pp. 337–341, Lanzhou, Gansu, China, August 2012.

[10] P.-R. Kadapakkam and U. Kumar, "Impact of Liquidity on the Futures-Cash Basis: Evidence from the Indian Market," *Journal of Futures Markets*, vol. 33, no. 3, pp. 266–298, 2013.

[11] J. Han and Z. Pan, "On the relation between liquidity and the futures-cash basis: Evidence from a natural experiment," *Journal of Financial Markets*, vol. 36, pp. 115–131, 2017.

[12] H.-C. Lee, C.-Y. Chien, and T.-H. Liao, "Commonality in trading activity and futures-cash basis: Evidence from the Taiwan futures and stock markets," *Journal of Futures Markets*, vol. 32, no. 10, pp. 964–994, 2012.

[13] K. Daniel, M. Grinblatt, S. Titman, and R. Wermers, "Measuring mutual fund performance with characteristic-based benchmarks," *Journal of Finance*, vol. 52, no. 3, pp. 1035–1058, 1997.

[14] T. Odean, "Are investors reluctant to realize their losses?" *Journal of Finance*, vol. 53, no. 5, pp. 1775–1798, 1998.

[15] A. Kumar and C. M. C. Lee, "Retail investor sentiment and return comovements," *Journal of Finance*, vol. 61, no. 5, pp. 2451–2486, 2006.

[16] D. Huang, F. Jiang, J. Tu, and G. Zhou, "Investor sentiment aligned: a powerful predictor of stock returns," *Review of Financial Studies* , vol. 28, no. 3, pp. 791–837, 2015.

[17] E. Harris L and Liquidity., "Trading Rules and Electronic Trading Systems," *Monograph Series in France and Economics*, vol. 47, pp. 455–468, 1990.

[18] L. R. Glosten and L. E. Harris, "Estimating the components of the bid/ask spread," *Journal of Financial Economics*, vol. 21, no. 1, pp. 123–142, 1988.

[19] J. Hasbrouck, "Measuring the Information Content of Stock Traders," *Journal of Finance*, vol. 46, no. 1, pp. 178–208, 1991.

[20] R. F. Almgren, "Optimal execution with nonlinear impact functions and trading-enhanced risk," *Applied Mathematical Finance*, vol. 10, no. 1, pp. 1–18, 2003.

[21] P. Wei and C. Liang, "Stock Index Futures Impact Cost Estimation and Empirical Research," *Journal and Applied Statistics and Management*, vol. 32, no. 4, pp. 727–739, 2013.

[22] M. Theobald and P. Yallup, "Mean reversion and basis dynamics," *Journal of Futures Markets*, vol. 21, no. 9, pp. 797–818, 2001.

[23] M. Monoyios and L. Sarno, "Mean Reversion in Stock Index Futures Markets: A Nonlinear Analysis," *Journal of Futures Markets*, vol. 22, no. 4, pp. 285–314, 2002.

[24] R. Yi, W. Zhang, C. Chen, and S. Y. Wang, "Agriculture futures basis behaviors basing on expectations theory," *Systems Engineering - Theory & Practice*, vol. 11, pp. 1954–1959, 2010.

[25] H. Chuliá, R. Gupta, J. M. Uribe, and M. E. Wohar, "Impact of US uncertainties on emerging and mature markets: Evidence from a quantile-vector autoregressive approach," *Journal of International Financial Markets, Institutions & Money*, vol. 48, pp. 178–191, 2017.

[26] A. R. Pagan and K. A. Sossounov, "A simple framework for analysing bull and bear markets," *Journal of Applied Econometrics*, vol. 18, no. 1, pp. 23–46, 2003.

[27] J. Li and C. Wu, "Daily return volatility, bid-ask spreads, and information flow: Analyzing the information content of volume," *Journal of Business*, vol. 79, no. 5, pp. 2697–2739, 2006.

[28] J. L. Li, Y. Lei, and S. J. Li, "Market depth, liquidity and volatility-The Impact of Starting Stock Index Futures of Shanghai and Shenzhen Stock Exchange on Stock Market," *The Journal of Finance*, vol. 06, pp. 124–138, 2012.

[29] Y. Amihud, "Illiquidity and stock returns: cross-section and time-series effects," *Journal of Financial Markets*, vol. 5, no. 1, pp. 31–56, 2002.

[30] F. Y. Li, "Does investor sentiment explain the ETF's premium?Evidence from the A-share market [J]," *The Journal of Finance*, no. 2, pp. 180–192, 2014.

[31] J. V. Terza, A. Basu, and P. J. Rathouz, "Two-stage residual inclusion estimation: addressing endogeneity in health econometric modeling," *Journal of Health Economics*, vol. 27, no. 3, pp. 531–543, 2008.

[32] S. Lee, "Endogeneity in quantile regression models: a control function approach," *Journal of Econometrics*, vol. 141, no. 2, pp. 1131–1158, 2007.

[33] V. Chernozhukov, I. Fernandez-Val, and A. E. Kowalski, "Quantile regression with censoring and endogeneity," *Journal of Econometrics*, vol. 186, no. 1, pp. 201–221, 2015.

[34] X. Zhang, D. Wan, and G. Yang, "Research on the Impact of Investor Structure and Term Structure on the Efficiency of Futures Markets," *Securities Market Herald*, no. 04, pp. 35–40, 2010.