

VPIN and the China's Circuit-Breaker

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Abstract

The market microstructure theory and high-frequency trading analyze as quantitative investment's frontier and hot issue is popular in China in recent years, but China's stock index futures introduced later, so there are not much academic attention. This paper measures the probability of informed trading in China's stock index futures market by VPIN method. The empirical results show that the VPIN can not only monitor the probability of the informed trading market of IF 300, IH 50 and IC 500, but also play an early warning role before the "circuit-breaker". Tracking VPIN values allows the liquidity providers to control their position risk, and regulators can monitor the liquidity quality of the market, limit transactions in advance or tighten market controls.

Keywords: market microstructure, high-frequency trading, VPIN, circuit-breaker, liquidity

1. Introduction

1.1 Introduce the Problem

After seven years of silence, China's stock market began to recover in December 2014, followed by a rise in the index, which opened the ninth bull market in China. After that, the China Financial Futures Exchange (CFFEX) introduced the SSE 50 index futures (IH50) and the CSI 500 index futures (IC500) in April 16, 2015. It is breaking the single index futures varieties of market environment in China. On June 12, 2015, the Shanghai Composite Index hit a high of 5178.19. Three days later, on June 15, the ShenZhen Stock Exchange Component Index also hit a high of 18211.76. But not for long, two months later, the two markets continued to decline, the Shanghai Composite Index was falling from 5178 to 2,850, down nearly 45 percent. On September 2, 2015, CFFEX modified index futures trading contracts, causing the decline of the index to stabilize, but the volume of index futures fell sharply. On December 4, 2015, the Shanghai stock exchange, shenzhen stock exchange and CFFEX officially released the relevant provisions of the index, and the benchmark index was the CSI 300 index, which was adopted by the two threshold values of 5% and 7%. Since January 1, 2016, the implementation has been officially implemented, but the "help drop" effect has been kept in place for four days after the implementation, so as to maintain the smooth operation of the market. Until August 4, 2016 index futures contract modified trade restrictions in the futures market turnover fell 99% after the September 2015, so international capital began to consider ease of index futures trading are growing about the limit.

1.2 Describe Relevant Scholarship

Easley et al. (2012a) through the investigation and study of the U.S. stock flash crash, the analysis shows that VPIN can predict short-term toxic induced fluctuations, especially when it involves large price fluctuations. Easley et al. (2012b) the empirical results show that this method has strong applicability to different markets. Easley et al. (2012 c) was introduced in detail the method of derivation and use, and discusses the use Volume in high-frequency trading environment Clock (Volume) of significance and advantages, and provides the evidence to prove that in the United States on May 16, that day, before the crash of the VPIN value has become very high, a lot of the instruction stream toxicity of lead to liquidity providers out of the market; The applicability of the VPIN model is demonstrated from the side.

2. Method

Easley used the VPIN to estimate the probability of informed trading (also known as “flow toxicity”) directly under high-frequency trading environment on U.S. stocks flash crash investigation and research process of events, on May 6, 2010. The research shows that the probability of informed trading market rise, will cause the market to grasp the information advantage of liquidity traders of adverse selection, liquidity traders leave will aggravate the imbalance of market transactions, resulting in a decline in market liquidity level, leading to greater market volatility. Based on Easley’s informed trading probability method, this paper measures China index futures and discusses the measurement effect of this method on the China’s Circuit-breaker. By comparing the VPIN value of the three index futures, the paper analyzes the probability of the informed trading of different kinds of index futures markets to discuss its market effectiveness.

Based on Easley et al. (2010, 2011a, 2011b), the VPIN metric is estimated as

$$VPIN = \frac{\alpha\mu}{\alpha\mu + 2\varepsilon} = \frac{\alpha\mu}{V} \approx \frac{\sum_{\tau=1}^n |V_{\tau}^S - V_{\tau}^B|}{nV} \quad (1)$$

where $\tau=1, \dots, 50$ are the equal volume buckets, V_{τ}^S is the volume classified as traded against the bid in bucket τ and V_{τ}^B is the volume classified as traded against the offer in bucket τ .

A (time or volume) bar τ is assigned the price change $P_{\tau} - P_{\tau-1}$, where P_{τ} is the last price included in bar τ , and $P_{\tau-1}$ the last price included in bar $\tau-1$. To define the bulk volume procedure, let

$$\widehat{V}_{\tau}^B = V_{\tau} * t\left(\frac{P_{\tau} - P_{\tau-1}}{\sigma_{\Delta P}}, df\right) \quad (2)$$

$$\widehat{V}_{\tau}^S = V_{\tau} * \left[1 - t\left(\frac{P_{\tau} - P_{\tau-1}}{\sigma_{\Delta P}}, df\right)\right] \quad (3)$$

where V_{τ} is the volume traded during (time or volume) bar τ which we wish to classify in terms of buy and sell volume V_{τ}^B and V_{τ}^S , and t is the CDF of Student’s t distribution, with df degrees of freedom. $P_{\tau} - P_{\tau-1}$ is the price change between two consecutive bars and $\sigma_{\Delta P}$ is our estimate of the standard derivation of price changes between bars. Our procedure splits the volume in a bar equally between buy and sell volume if there is no price change from the beginning to the end of the bar. Alternatively, if the price increases, volume is weighted more toward buys than sells depending on how large the price change in absolute terms is relative to the distribution of price changes.

3. Sample: IF 300, IH 50 and IC 500

IF 300 is the future of the CSI 300 index, which was introduced by CFFEX on April 16, 2010. The CSI 300 index was compiled by the China Securities Index Co., Ltd and was officially released on April 8, 2005. CSI 300 index is based on 1000 points on December 31, 2004. its sample is 300 stocks in the Shanghai Stock Exchange and Shenzhen Stock Exchange stock, including 179 in Shanghai, 121 in Shenzhen. Sample’s selection criteria are large scale and good liquidity. The CSI 300 sample covers the market value of about 60% of the Shanghai and Shenzhen market and has a good market representation. It is used to observe the market trend, and it is beneficial to investors to fully grasp the market operation condition.

IH 50 is the future of the SSE 50 Index, which was introduced by CFFEX on April 16, 2015. The SSE 50 index is based on scientific and objective methods, selects 50 large scale and good liquidity stocks of Shanghai Stock Exchange, in order to comprehensively reflect the Shanghai Stock Exchange the most influential of a batch of leading enterprises of the overall situation. The SSE 50 index has been officially released since January 2, 2004. The aim is to establish an active, large, mainly derivative financial instrument based investment index.

IC 500 is the future of the CSI 500 index, which was introduced by CFFEX on April 16, 2015. It is designed to describe the overall situation of small-cap stocks in the market, which includes 500 stocks, the circulation of a-share market value proportion is only 15.5%. CSI 500 index is sampled stocks excluding the CSI 300 index sampled stocks and the most recent year average daily total market capitalization of the top 300 shares, with the CSI 300 period is refers to the large cap stock index futures as contrast, the CSI 500 index of small-cap stocks in the index. At present, the composition of the certificate is 246 in Shanghai Stock Exchange, 11 in China Growth Enterprise Market, 133 in SME Board and 110 in Shenzhen Stock Exchange. Its valuation is 47 times PE, 3.61

times PB, well above the CSI 300 valuation. However, there are too few samples in SME Board and China Growth Enterprise Market to control the trend of SME Board and China Growth Enterprise Market.

By considering the CFFEX modified index futures contracts on September 2, 2015, to decrease the index futures trading volume. In order to keep consistency before and after the sample, this article selects the data when the terms change after a week that volume tends to be stable. Therefore, this paper selects a minute trading data of the futures contracts of IF 300, IH 50 and IC 500 on May 20, 2015. The statistical analysis of sample data is shown in Table 1.

Table 1. Sample statistics for index futures contracts

Future contract	IF300	IH50	IC500
Sample size (minute)	41755	42146	41647
Sample trading day	165	167	165
Total volume (hand)	2680047	1005491	1852482
Total number of interval	3300	3340	3300
Unit interval volume (hand)	812.14	301.05	561.36

Index futures trading contracts is that month, next month, the following season two months, so every day there are four futures contracts in the same index, this paper without the use of simple contracts that month data as the sample of the probability of informed trading, but the use of daily trading volume data to calculate the probability of informed trading contract, because it can response more market information distribution and market conditions.

4. Estimation Results of VPIN

4.1 Descriptive Statistics

Programming and calculating by MATLAB: 3281 VPIN value of IF 300, 3321 VPIN value of IH 50, 3281 VPIN value of IC 500, the descriptive statistics result as shown in table 2.

Table 2. Descriptive statistics of VPIN

Stats	IF300	IH50	IC500
Mean	0.2669	0.2718	0.2827
Max	0.6348	0.5106	0.5679
Min	0.1631	0.1326	0.1377
StDev	0.0528	0.0535	0.0640
Skew	1.4280	0.5256	0.5365
Kurt	8.3029	3.4955	3.4255
AR(1)	0.9987	0.9987	0.9986
J-B	4959.44	186.90	182.13
Observations	3281	3321	3281

In terms of mean, the VPIN of the IF 300 is slightly smaller, and IH 50 is center, IC 500 is slightly larger. This indicates that the average probability of the informed trading market of the IC 300 is the smallest, because the contract has been listed for the longest time, the investor market is stable and the maneuverability is weak. The IH 50 and IC 500 have been listed for just over a year, and the investment market is not stable with the IF 300. Compared the two contracts, the average probability of informed trading market of the IC 500 is larger. Because the SSE 50 index is in view of the leading enterprises with large scale and active trading, the CSI 500 index is in view of the small and medium-sized enterprises with smaller scale and less active trading. So the CSI 500 index futures contracts can be relatively strong maneuverability, the probability of informed trading market is the largest.

The maximum value of VPIN of IF 300 is slightly larger, IC 500 is center, IH 50 is smaller. The minimum value of VPIN of IF 300 is slightly larger, IC 500 is center, IH 50 is smaller. This indicates that the VPIN value of the IF 300 is the most sensitive to market manipulation, especially in the extreme market conditions.

The standard deviation of the IF 300 is slightly smaller, IH 50 is center, IC 500 is larger. It shows that the VPIN of the IC 300 is the most stable in the sample period, which is related to the most long-listed characteristics of

the market and the most extensive characteristics of the investor market. The IC 500 is the most unstable, which has a great correlation with the shorter time of the market and the smaller coverage of the market.

The skewness of the three future contracts is greater than 0, indicating that these sequences are right-biased. In the IF 300, the skewness of the VPIN is the largest, and the IH 50 is center, the IC 500 is smallest. The kurtosis of the three future contracts is greater than 3 (normal distribution kurtosis is 3). Therefore, the kurtosis of these sequences is greater than the kurtosis of the normal distribution, indicating that these sequences have a thick tail. The kurtosis of the VPIN of the IF 300 is the largest, the IH 50 is center, the IC 500 is smallest.

The first-order autocorrelation coefficient of the three futures contracts is close to 0.999, indicating that the self-correlation of these sequences is very strong, which is because the statistical method of the VPIN value is based on the smooth estimation of time. The JB statistics of VPIN of IF 300 is 4959.44, IH 500 is 186.9, the IC 500 is 182.13, indicating that these sequences are not subject to the standard normal distribution, relatively speaking, the IH 50 and IC 500 is more approximate to normal distribution than the IF 300.

4.2 The Analysis of Frequency Distribution and Cumulative Experience Distribution

The VPIN of the IF 300, IH 50 and IC 500 are distributed and calculated, and the frequency distribution graph and cumulative experience distribution map are obtained, as shown in FIG. 1, FIG. 2 and FIG. 3. The logarithmic normal distribution is well fitted to the frequency distribution of VPIN, which is consistent with the findings of Easley et al. (2011b).

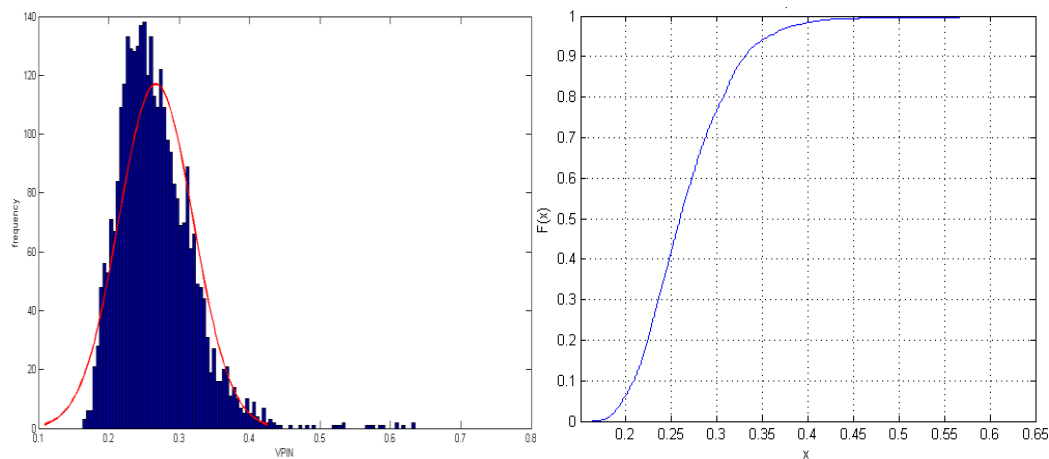


Figure 1. The frequency distribution and experience accumulation map of the VPIN of the IF 300

FIG. 1 shows that, during the sample period, 80 percent VPIN of the IF 300 is less than 0.32, while the probability of the VPIN greater than 0.4 is only about 1%. This indicates that most of the time the VPIN of IF 300 is at relatively low levels, and the market operation is generally normal and order.

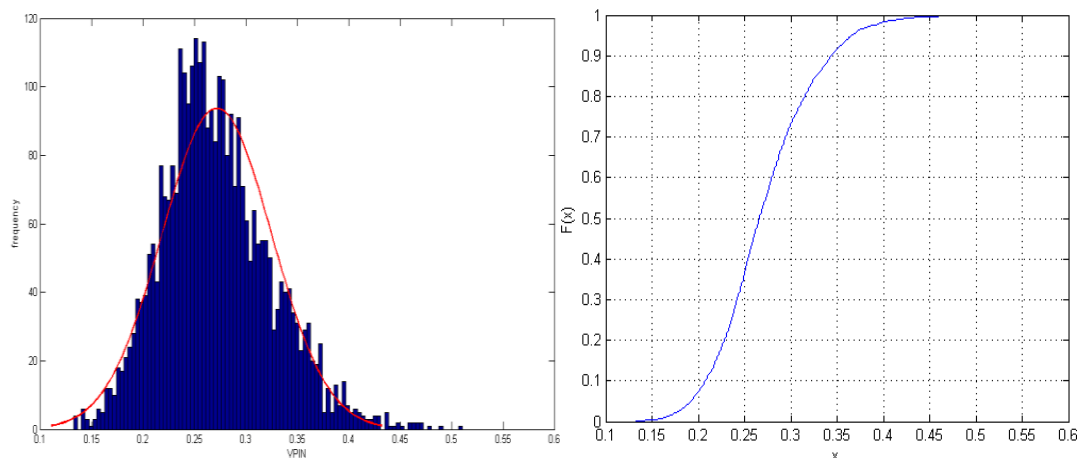


Figure 2. The frequency distribution and experience accumulation map of the VPIN of the IH 50

FIG. 2 shows that, during the sample period, 80 percent VPIN of the IH 50 is less than 0.33, while the probability of the VPIN greater than 0.4 is also only about 1%. This indicates that most of the time the VPIN of IC 50 is also at relatively low levels, and the market operation is also generally normal and order.

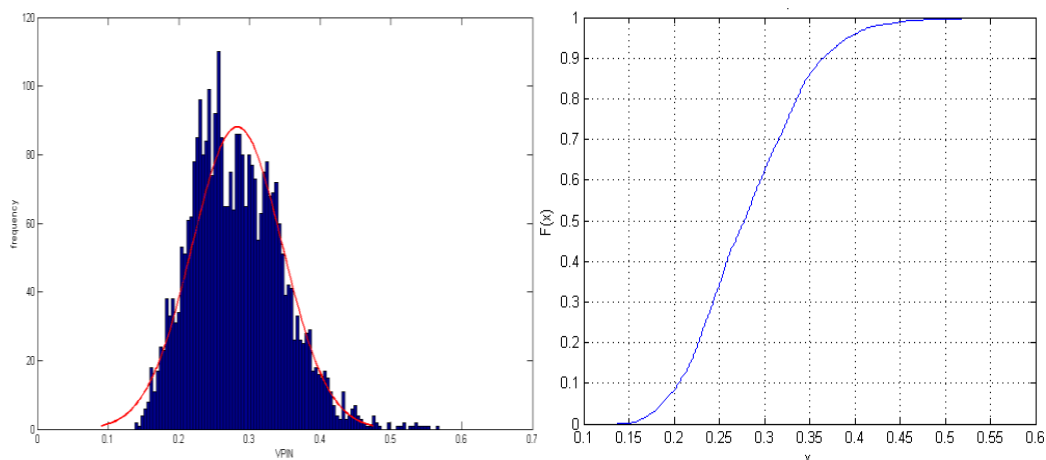


Figure 3. The frequency distribution and experience accumulation map of the VPIN of the IC 500

FIG. 3 shows that, during the sample period, 80 percent VPIN of the IC 500 is less than 0.33, while the probability of the VPIN greater than 0.45 is also only about 1%. This indicates that most of the time the VPIN of IC 500 is also at relatively low levels, and the market operation is also generally normal and order.

The comparison of three futures contracts: the IF 300 runs longest and its market position is the strongest, so the market has the highest order. The IH 50 has a short running time, but the sample stock is the leading enterprise, so the market share is high, so the market also is in order. The IC 500 has a short running time, and the sample is small and medium-sized enterprises, and the market share is low, therefore the market has a weak order.

4.3 The VPIN and Price Trend of the Sample

Drawing the relationship of the “flash crash” and the VPIN of futures by MATLAB, get the VPIN and main contract price distribution of IF 300, IH 50 and IC 500, as shown in FIG. 4, FIG. 5 and FIG.6. The diagrams show that the VPIN is relatively stable in most of the time, but strong volatility in early 2016. When the VPIN is high, the market index point appear sharply lower and the trend is more extreme.

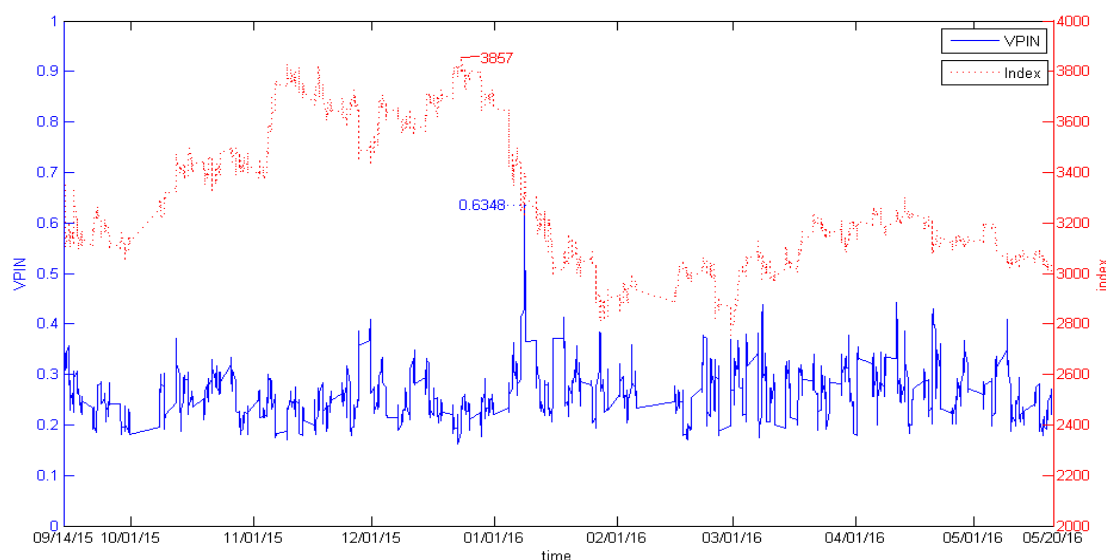


Figure 4. The distribution of the VPIN and the main contract price of the IF 300

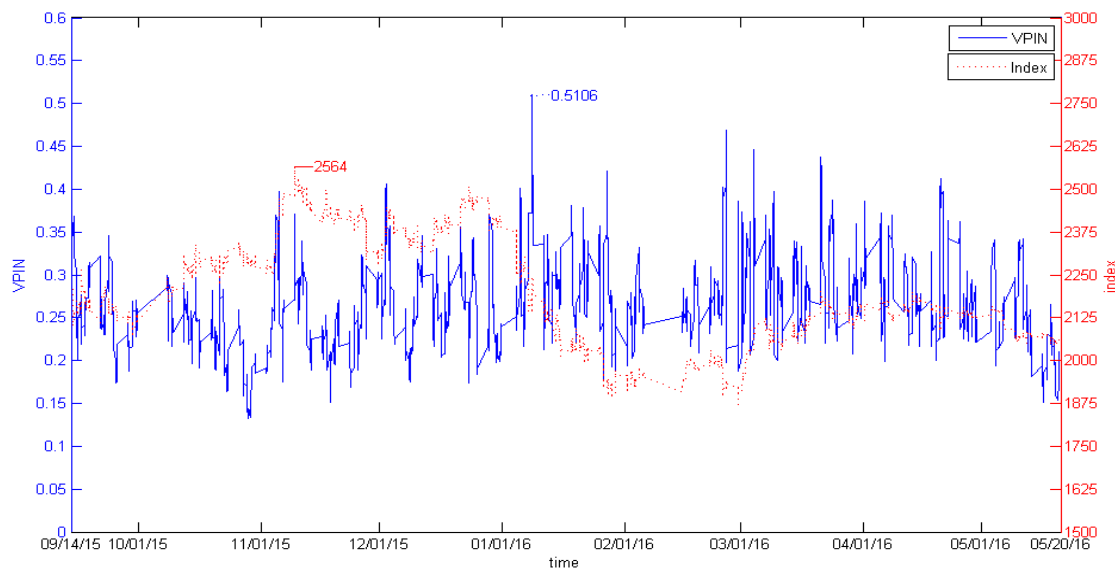


Figure 5. The distribution of the VPIN and the main contract price of the IH 50

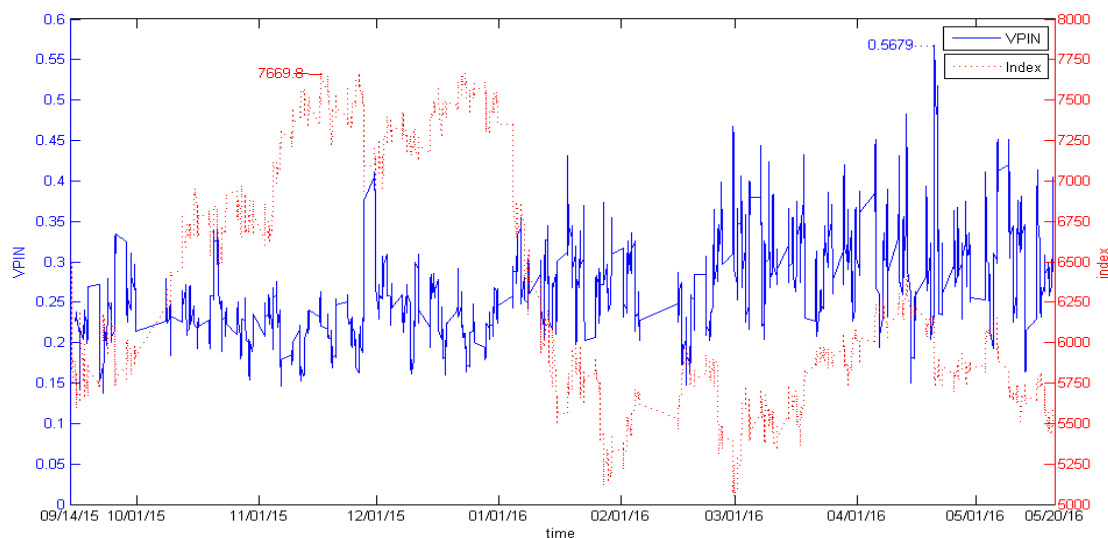


Figure 6. The distribution of the VPIN and the main contract price of the IC 500

Based on the comprehensive comparison and analysis, the stability of the VPIN the IC 300 is better, the IH 50 is center, the IC 500 is worse. In addition, on the general trend, the warning fluctuation of the VPIN of the IF 300 is more obvious, the IH 50 is center, and the IC 500 is less obvious.

5. VPIN and the Price Trend of the “China’s Circuit-Breaker”

Observing the window time before and after the “China’s Circuit-breaker” (December 30, 2015 to January 11, 2016), examining whether or not VPIN method have a certain warning role to measure the probability of the informed trading market about the China’s stock index futures market. Analyzing the VPIN, the CDF(VPIN) and the time distribution of the main contract price of the IF 300, the IH 50 and the IC 500 before and after the “China’s Circuit-breaker” by MATLAB, as shown in FIG. 7, FIG. 8 and FIG.9. Before the major contract price drops sharply, the CDF(VPIN) was fluctuating violently. In the process of falling price of the main contract, the CDF(VPIN) rises to a maximum value of 1.

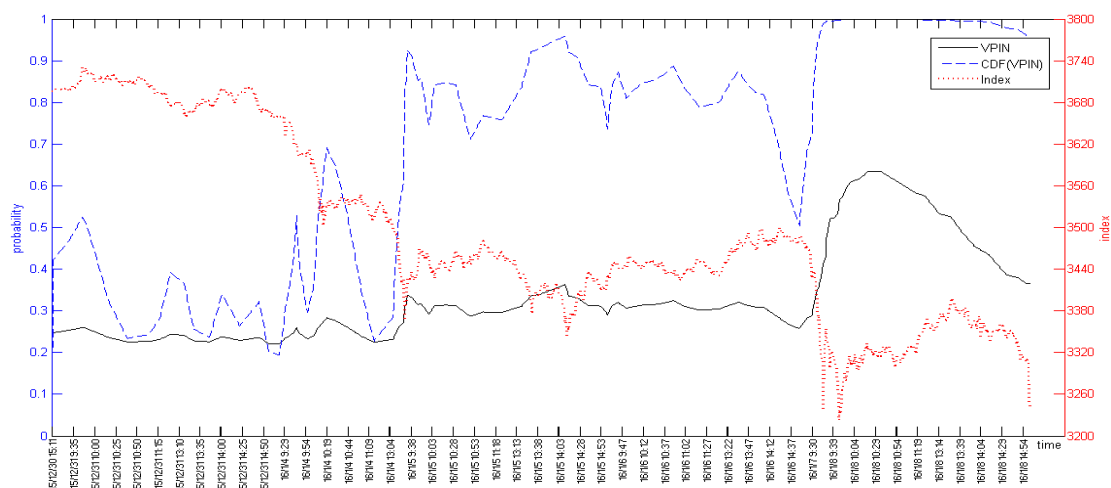


Figure 7. VPIN, CDF(VPIN) and main contract price distribution map of IF 300 on December 30, 2015 to January 11, 2016

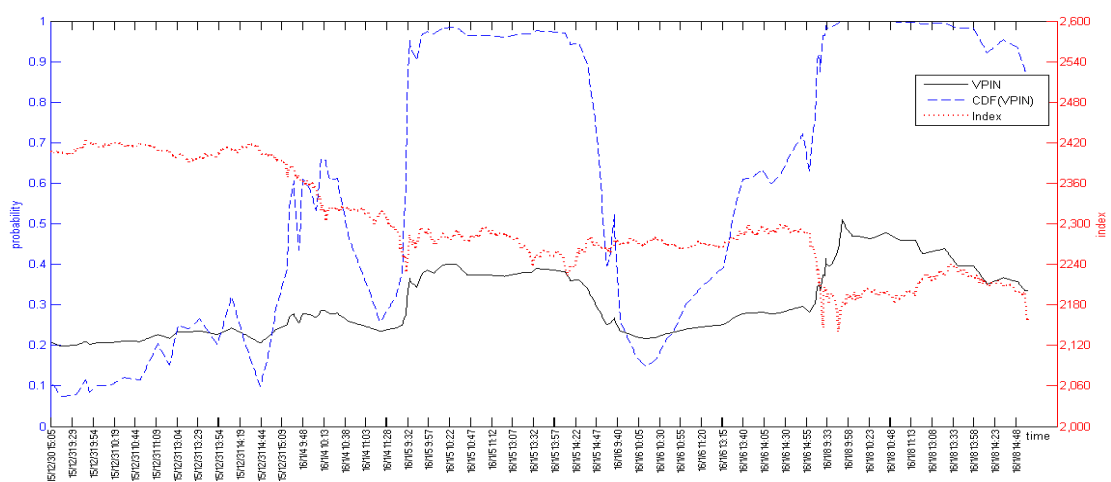


Figure 8. VPIN, CDF(VPIN) and main contract price distribution map of IH 50 on December 30, 2015 to January 11, 2016

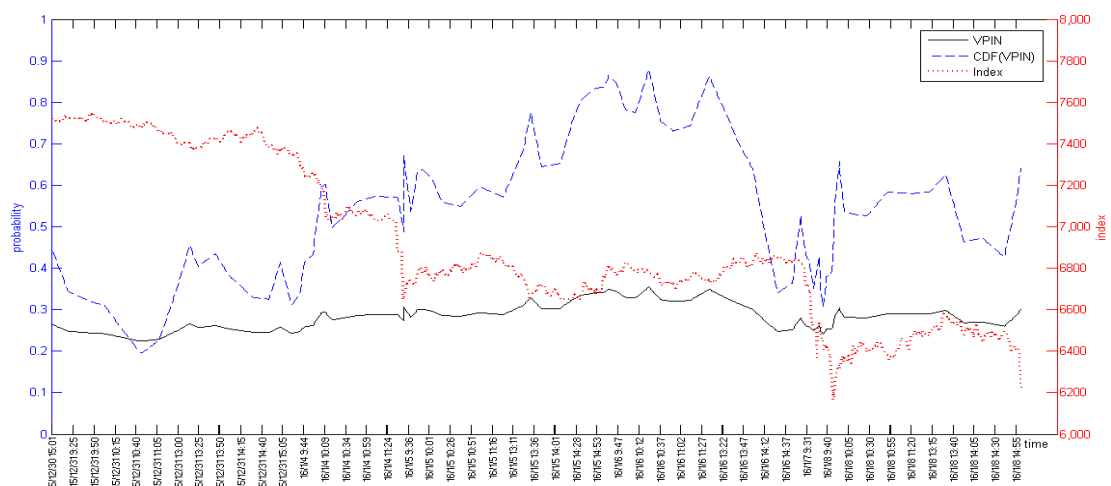


Figure 9. VPIN, CDF(VPIN) and main contract price distribution map of IC 500 on December 30, 2015 to January 11, 2016

6. Conclusion

From the comprehensive analysis of the IF300, the IH 50 and the IC500, we find that CDF(VPIN) can predict the trend of abnormal decline of the main contract price of China index futures. In addition, the trigger of the circuit breaker will lead to a significant drop in the value of the VPIN and the CDF(VPIN), and at the opening of the second day it will hit a higher high.

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