

## Exploring the Volatility of Stock Index Futures in China by Financial Measurement

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**Keywords:** Measurements; Stock index futures; Volatility; System; Investment

**Abstract.** The objective is to accurately and comprehensively apprehend the volatility of the stock index futures (SIF) market in China. The Multiplicative Error Model is constructed to research and analyzed the major two Chinese SIF markets, i.e., the Shanghai-Shenzhen 300 Index (SHSZ300) and the China Securities Index 500 index (CSI500). Through the constructed MEM, the index changes of the two major SIF markets, i.e. SHSZ300 and CSI500, in 2015-2018 are studied, and the factors impacting the volatility of Chinese SIF are analyzed and studied. The research results show that MEM plays an essential role in the analysis of the volatility of SIF. The factors affecting the SIF market include market risk, liquidity risk, insider risk, institutional supervision, information, market manipulation, and other risks. In these factors, the insider of the market is considered to be the biggest factor in the volatility of the Chinese SIF market at present. The volatility amplitudes of the two major SIF markets, i.e., SHSZ300 and CSI500, are about 2200-5000 and 4000-12000, respectively. Currently, most investors lack trust in the current environment and system of the SIF market in China. Conclusion: By constructing the MEM, the situations of SHSZ300 and CSI500 from 2015 to 2018 are analyzed, thereby the volatility of SIF is investigated. Among various risk factors, the insider of the market is considered to be the biggest factor in the volatility of the Chinese SIF market at present. Besides, most investors lack trust in the current environment and system of the SIF market in China. The volatility of SIF is a process and result of multiple factors, which requires multiple levels of cooperation and coordination. The research results have greatly improved the comprehension of MEM and SIF volatility.

### Introduction

With the rapid progression and advancement of science and technology, vast ordinary people have involved in financial investment. Especially, the relatively small individual investors, through the financial management investment, can achieve wealth appreciations, and they will express their opinions and attitudes on the Internet platforms to actively discuss with others [1]. These ordinary individual investors use various social platforms on the Internet, such as WeChat, Sina Weibo, Facebook, Baidu Tieba, and forums, to express their opinions and attitudes. Moreover, some investors even release their emotions directly on the Internet, which will expose all of their psychological states. The stock index futures (SIF) investors often infer the possible tendency of SIF through the exchanges on the Internet to change their investment operations and do the corresponding moves [2]. Remarks on the Internet will have a significant impact on many people. When the number of people discussing and communicating stocks and SIF reaches a relatively large magnitude, there will generate a so-called herding effect. Therefore, many people will lose the ability to think independently, which will have a certain directional impact on the sentiment and attitude of other investors. Such a situation may boost the volatility of stocks and SIF, causing certain guiding traces [3]. Unlike traditional financial investment methods, the behavioral finance approach shows that the emotions, attitudes, and statuses of most investors have a significant impact on their investment operations, which is regarded as a core factor [4].

Therefore, based on the situation, an analysis model based on the Multiplicative Error Model (MEM) is proposed. The contribution of this study is the application of a relatively simple algorithm to analyze and study the volatility of financial SIF that are very complicated and difficult to control, thereby effectively understanding the factors and solutions that lead to volatility in Chinese SIF, regaining the trusts of investors, winning the market, and strengthening the financial power of China.

In summary, in this study, the situations of Shanghai-Shenzhen 300 Index (SHSZ300) and China Securities Index 500 index (CSI500) from 2015 to 2018 are analyzed, thereby the volatility of SIF is investigated. The research results show that the SIF market in China is relatively volatile, and investors lack trust in the market. The impact of stability is manifested in many aspects. The innovations of this study lie in the combination of the comprehensive factors of the stability of the SIF market and the analysis of the obtained results, which are very important for a deeper understanding of the volatility of the SIF. Nevertheless, this study has provided a reference basis for future studies. Therefore, it is valuable and significant.

## Methodology

**A Brief Introduction to the SIF Market in China.** The SIF market in China consists of investors (individuals or legal persons), futures enterprises, China Financial Futures Exchange (CFFEX), supervisory institutions, related organizations, and service agencies [5]. In addition, the CFFEX is a Stock Exchange jointly established by several financial institutions in China and approved by the authority [6]. The transactions of SIF in China are performed in CFFEX. The SHSZ300 was co-issued by the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) on April 8th, 2005 [7]. The SHSZ300 uses 300 A-shares in the SHSE and SZSE markets as sample stocks (179 in SHSE and 121 in SZSE) [8]. The SHSZ300 has the characteristics of high market value coverage, high correlation with existing market indexes, and vast high-quality stocks in sample stocks.

**Functions of SIF.** (1) Price discovery: The futures market has more liquid assets than the spot market. The price of the futures market reflects the expectations of investors for the future [9]. At the same time, due to the special delivery system of futures trading, the prices of futures and spots will eventually converge. Therefore, the price of SIF can more accurately reflect the future trend of spot prices.

(2) Hedging: When the contract will be delivered, the prices of spots and futures will tend to be identical; otherwise, there will be arbitrage opportunities. Therefore, investors can circumvent most market risks by the reverse-handling of spots and futures.

**Construction of MEM.** In the financial industry, the volatility is generally measured by the standard deviation or the variance of the return on financial assets [10]. If the time series of the rate of return meets the relevant assumptions, and the SHSZ300 futures and stocks can reach the basic standard, it can be selected as the indicator sample data variance for the calculation of overall variances, i.e.:

$$\sigma^2 = \frac{1}{T-1} \sum_{t=1}^T (R_t - \bar{R})^2 \quad (1)$$

The basic form of MEM is as follows:

$$v_t | I_{t-1} = \mu_t, \varepsilon_t, \varepsilon_t \sim \text{i.i.d.} p(\varepsilon, \pi), t=1, 2, 3, \dots, t \quad (2)$$

$$\mu_t = \omega + \sum_{i=1}^q \alpha_i v_{t-i} + \sum_{j=1}^p \alpha_j v_{t-j} \quad (3)$$

In the above equations,  $v_t$  is a non-negative variable,  $I_{t-1}$  represents the information set at the moment  $t-1$ , and the relationship between  $v_t$  and  $\mu_t$ , i.e.,  $\mu_t$  is the conditional mean of  $v_t$ .

$$\varepsilon_t \sim f(x) = \begin{cases} e^{-x}, & x \geq 0 \\ 0, & \text{others} \end{cases} \quad (4)$$

Then, the conditional distribution of  $x$  is:

$$x_t \sim f(x_t | F_{t-1}) = \frac{1}{\mu_t} e^{-\frac{x_t}{\mu_t}} (x_t \geq 0) \quad (5)$$

**Analysis of Elements Impacting the Volatility of SIF.** Market risk: Market risk refers to the risks that may be suffered by investors brought by various comprehensive elements, such as political factors, economic factors, and

changes in the prices of underlying assets [11]. It is the daily risk and meanwhile, the most common risk of SIF participants. The way to circumvent the market risk is the core for participants in the SIF market. Also, the political factors, cultural factors, supervisions of institutions and government, and the regulatory policies are the biggest factors of market risk.

**Liquidity risk:** Liquidity risk is generated since the financial assets are difficult to liquidate smoothly, including market liquidity risk and capital liquidity risk [12]. The former refers to the risk caused by insufficient market transaction volume or the inability to obtain the market price. The latter refers to the risk that the contract cannot be fulfilled at the time of expiration or the margin cannot be added in time due to insufficient funds of the investors.

**Operational risk:** Operational risk is the risk that the companies suffer in the trades of SIF due to the corporative structure, the internal management defects, or the imperfect information system [13]. The development of the SIF market, especially the market in China, is backward. Thus, the comprehension of the SIF market is critical for investors. Without a comprehensive and profound understanding of the rules and systems of the market, it may bring great losses to themselves and the companies. The financial market is an open and global market. In China, due to complex causes, both the investors and the government engage in the financial market in a later period. Therefore, it is necessary to learn the investment information, the financial system, and the situations of other countries.

**Credit risk:** For the financial market, especially for the SIF market, credit is essential. Without trust, there will be various unknown risks. Trust is the core of financial markets. Without trust, there will be no support. For investors, regulators, and various participants, mutual trust will reduce the risk of stock index investment. However, the trust in the SIF market needs to be protected by law. Without legal support, there will be no foundation and no trust.

**Legal risk:** Legal risk is the risk that the trader cannot obtain the expected income, the contract cannot be performed normally because the laws and regulations are unclear, the transaction is not protected by the law, or the transaction contract and its contents conflict with the relevant legal system [14]. Due to the relatively late establishment of the Chinese financial market, the current system is still not perfect. The supervision of the market or the establishment and implementation of laws need improving. The various loopholes in the current system, especially the unclear and incomplete legal system, will have unfavorable effects on the development of SIF in China. Without the protection and support of the legal system, investors will lack trust in Chinese financial and SIF, which may result in the stagnation of the Chinese financial industry. Therefore, perfecting the legal system is the key to enhance the vigorous advancement of the Chinese SIF markets. The protection of laws is beneficial to the healthy and smooth development of the Chinese financial industry.

**Institutional supervision:** Institutional supervision refers to the risks brought about by inadequate supervision laws and guiding regulations [15]. Currently, the laws and regulations of the Chinese stock and futures market are mainly the *Securities Law* and the *Administrative Regulations on Futures Trading*. However, there lacks more detailed, rigorous, and targeted laws and regulations. Therefore, the legal loopholes of the market will bring risks and losses to investors. **Information and market manipulation risks:** Since the establishment of the Chinese stock market in the past 20 years, the transaction volume of the market has grown by leaps and bounds. At the same time, insider trading cases have occurred from time to time, which is destructive for the stock market and seriously affects the self-confidence of investors.

Guo Shuqing and Shang Fulin, the current and then chairmen of CSRC, said on different occasions that “the insider trading and price manipulation must be eliminated”, which will be the primary task of the CSRC and other regulatory agencies to restore the market order.

**Other risks:** The SIF market in China is still in the early developmental stage [16]. Investors lack a comprehensive and profound understanding of the new things of SIF. Once they are aggressive, they are prone to risks and pay costs.

**Impact risk:** The Internet is an influential platform that most people involve and participate in. A large number of investors gather on the Internet. Most investors will express their opinions on the Internet, as well as analyzing and studying other opinions so that they can get valuable information. The discussions and the exchange of information and opinions have large impacts on the investment strategy of each individual at a certain level. Therefore, indirect merger

investment behavior will occur. The sharing mechanism of the Internet platform will promote the decision of investors with an exceptionally efficient and rapid spreading speed. The dissemination of information will have a joint effect on the behavior of other investors, which in turn will impact the volatility of SIF.

**Results and Discussion**

The analysis and investigation of elements impacting the volatility of SIF are shown in Fig. 1. As shown in the figure, the elements that impact the volatility of SIF include market risk, liquidity risk, operational risk, institutional supervision, information, market manipulation, and other risks. In these factors, market manipulation is considered to be the biggest factor affecting the volatility of the Chinese SIF market at present, followed by supervision and information factors. The factor with the least impact is other risks. Therefore, the supervision of the market, the sound laws, and the elimination of insider trading are the most important things that need to be completed in the Chinese SIF market.

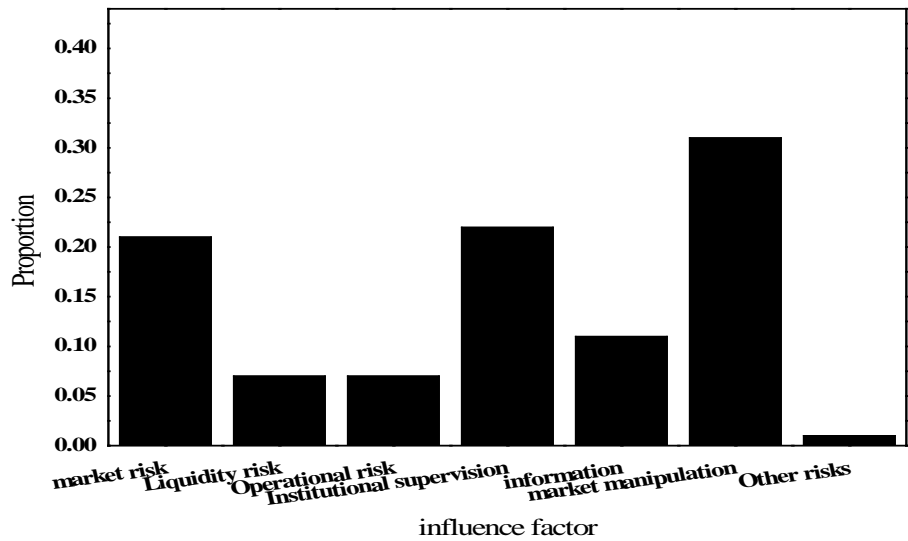


Figure 1. Analysis of factors affecting the volatility of SIF

The tendency of SIF SHSZ300 is as shown in Fig. 2. As shown in the figure, from about the beginning of 2015 to April 2018, the SIF SHSZ300 fluctuated sharply, the lowest reached about 2200 while the highest reached nearly 5000, the volatility was very large. Therefore, the stability of the Chinese SIF market is relatively poor. However, SIF bring positive effects on the Chinese financial market. The core is to balance the risks brought by the stock market. It is specifically due to the positive role of the SIF market that makes it urgent to improve the laws and supervisions, thereby avoiding the turbulence caused by volatility in our economy.

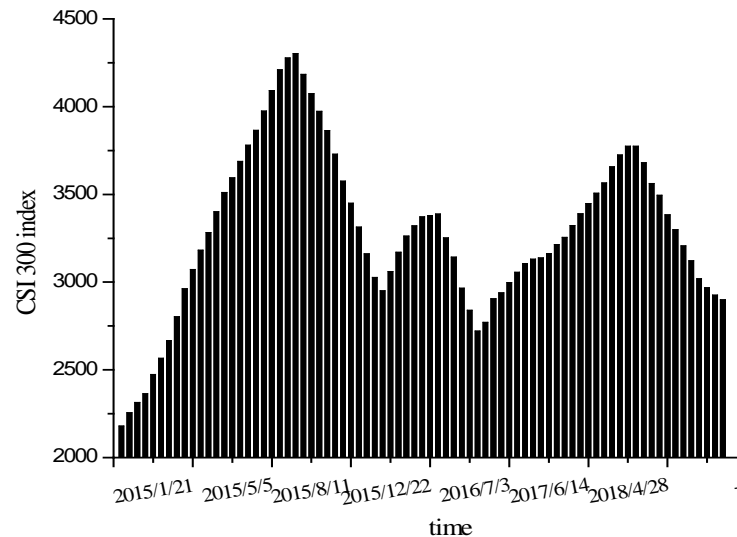


Figure 2. The tendency of SIF SHSZ300

The tendency of SIF CSI500 is as shown in Fig. 3. As shown in the figure, from January 2015 to April 2018, the SIF CSI500 fluctuated sharply, the lowest reached about 4000 while the highest reached nearly 12000, which was obvious difference volatility. Therefore, the volatility of the Chinese SIF market is still quite obvious. However, SIF has brought a lot of help to the stability and progression of the financial market in China, circumventing many traps and risks in the market. It is particularly due to the positive role of the SIF market that makes it urgent to improve the laws and supervisions, thereby reducing the unnecessary market risks.

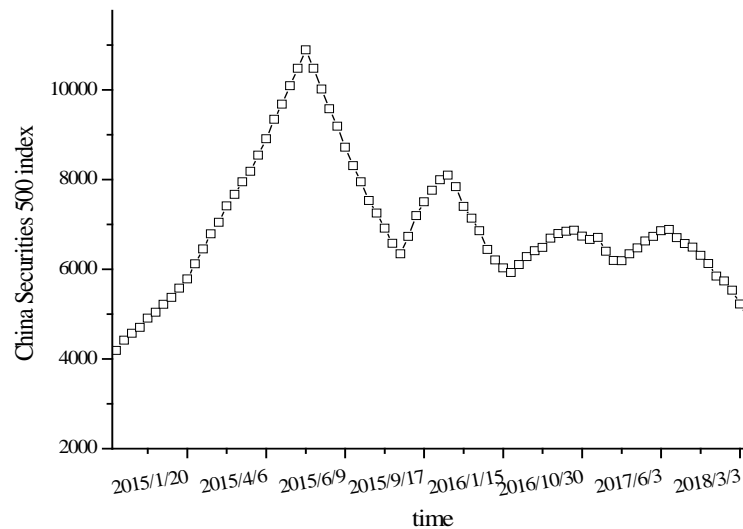


Figure 3. The tendency of SIF CSI500

The satisfaction research of the Chinese SIF market is as shown in Fig. 4. As shown in the figure, most investors are very dissatisfied with the overall environment and system of Chinese SIF market. The SIF market is an important section of the financial market in China, especially its evasive effect on the risks of the stock market. Therefore, the order and supervision of the SIF market should be improved. Without a perfect system, the enthusiasm of investors will be reduced. Because of the distrust of the Chinese futures market, the investors may withdraw, which will have a very obvious impact on the Chinese financial industry and economy. Therefore, it is the most important thing to appease the market sentiment as soon as possible to win the trust of investors.

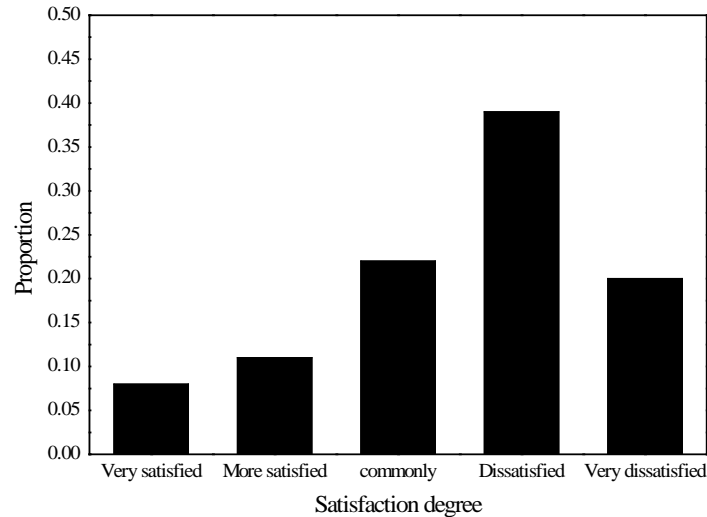


Figure 4. Satisfaction research of Chinese SIF market

## Conclusion

Through the construction of MEM, the index changes of the two major SIF markets, i.e. SHSZ300 and CSI500, in 2015-2018 are studied, and the elements impacting the volatility of Chinese SIF are analyzed. The research results show that the MEM is effective in the analysis of the volatility of SIF. The factors affecting the SIF market include market risk, liquidity risk, insider risk, institutional supervision, information, market manipulation, and other risks. Besides, the insider of the market is considered to be the biggest factor in the volatility of the Chinese SIF market at present. The volatility amplitudes of the two major SIF markets, i.e., SHSZ300 and CSI500, are extremely apparent. Also, most investors lack trust in the current environment and system of the SIF market in China. The MEM proposed in this study has significant reference value for the subsequent research on SIF. The research in this study is also subject to certain restrictions. For example, the research and analysis of the SIF volatility are very complicated. The volatility is subject to many influential factors. The analysis and evaluation of it require the comprehensive application of multiple indicators to obtain comprehensive results. In the analysis of algorithm performance, only several factors are analyzed, while the uncontrollable factors in the financial market are not considered, thereby the obtained results are slightly unpersuasive. Therefore, the subsequent research could be more comprehensive and detailed to reduce the interferences caused by other factors. In summary, the study has provided an important reference for later researchers.

## References

- [1] G. Jiang, H. He and J. Yan, et al. Multiscale convolutional neural networks for fault diagnosis of wind turbine gearbox, *IEEE Transactions on Industrial Electronics*. 66 (2018) 3196-3207.
- [2] C. Peeters, P. Guillaume and J. Helsen. Vibration-based bearing fault detection for operations and maintenance cost reduction in wind energy, *Renewable Energy*. 116 (2018) 74-87.
- [3] P. B. Dao, W. J. Staszewski and T. Barszcz, et al. Condition monitoring and fault detection in wind turbines based on cointegration analysis of SCADA data, *Renewable Energy*. 106 (2018) 107-122.
- [4] A. Ziaja, I. Antoniadou and T. Barszcz, et al. Fault detection in rolling element bearings using wavelet-based variance analysis and novelty detection, *Journal of Vibration and Control*. 22 (2016) 396-411.
- [5] Z. Feng, S. Qin and M. Liang. Time-frequency analysis based on Vold-Kalman filter and higher order energy separation for fault diagnosis of wind turbine planetary gearbox under nonstationary conditions, *Renewable Energy*. 85 (2016) 45-46.
- [6] J. Chen, J. Pan and Z. Li, et al. Generator bearing fault diagnosis for wind turbine via empirical wavelet transform using measured vibration signals, *Renewable Energy*. 89 (2016) 80-92.

- [7] M. Cao, Y. Qiu and Y. Feng, et al. Study of wind turbine fault diagnosis based on unscented Kalman filter and SCADA data, *Energies*. 9 (2016) 847.
- [8] T. Wang, Q. Han and F. Chu, et al. Vibration based condition monitoring and fault diagnosis of wind turbine planetary gearbox: A review, *Mechanical Systems and Signal Processing*. 127 (2019) 662-685.
- [9] R. U. Maheswari, R. Umamaheswari. Trends in non-stationary signal processing techniques applied to vibration analysis of wind turbine drive train—A contemporary survey, *Mechanical Systems and Signal Processing*. 85 (2017) 296-311.
- [10] D. Astolfi, L. Scappaticci and L. Terzi. Fault diagnosis of wind turbine gearboxes through temperature and vibration data, *International Journal of Renewable Energy Research (IJRER)*. 7 (2017) 965-976.
- [11] H. Zhao, H. Liu and W. Hu, et al. Anomaly detection and fault analysis of wind turbine components based on deep learning network, *Renewable energy*. 127 (2018) 825-834.
- [12] T. Waqar, M. Demetgul. Thermal analysis MLP neural network based fault diagnosis on worm gears, *Measurement*. 86 (2016) 56-66.
- [13] Y. Qiu, Y. Feng and J. Sun, et al. Applying thermophysics for wind turbine drivetrain fault diagnosis using SCADA data, *IET Renewable Power Generation*. 10 (2016) 661-668.
- [14] M. Bach-Andersen, B. Rømer-Odgaard and O. Winther. Deep learning for automated drivetrain fault detection, *Wind Energy*. 21 (2018) 29-41.
- [15] A. Romero, S. Soua and T. H. Gan, et al. Condition monitoring of a wind turbine drive train based on its power dependent vibrations, *Renewable energy*. 123 (2018) 817-827.
- [16] H. D. M. de Azevedo, A. M. Araújo and N. Bouchonneau. A review of wind turbine bearing condition monitoring: State of the art and challenges, *Renewable and Sustainable Energy Reviews*. 56 (2016) 368-379.