A Study on the Co-movement of Stock Markets between China and the US in Long and Short Term

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Abstract. The global integration of economics and finance has strengthened the economic ties among all countries, and the cross-border capital flows have become more frequent, magnifying the mutual influence among the global stock markets. After 30 years of development in capital market, China has opened up its stock market, significantly enhancing its connection with the world. This paper explores whether the long-term and short-term relationship of stock markets between China and the US has changed, with the implementation of China's opening-up measures. The results prove that there was no long-term co-movement of stock markets between China and the US before 2014, and the volatility spillover effect was one-way from the US to China. However, after the implementation of the opening-up measures of China, the long-term relationship began to show and the volatility spillover effect became two-way.

1. Introduction

With the pace of economic integration and financial globalization, all capital markets of countries are increasingly interconnected, thus the stock markets tend to show a common trend. As an emerging markets, China stock market has experienced continuous reforms in the past ten years, such as the approval of QFII, QDII and RQFII, the launch of Shanghai-HongKong Stock Connect and the participation in MSCI World Index. China stock market has obtained higher degree of openness and security liberalization in its market, being more closely linked to the other countries. In addition, the US stock market is highly developed and shows obvious radiating effect on the world market. Financial crises in US may infect other countries, taking subprime mortgage crisis for an example. Therefore, it is of great significance to study the stock market relationship between China and the US, to figure out the direction of the influence and whether China’s opening up measures has enhanced the connection of both markets. For the authorities, the study of the co-movement between China and the US is conducive to decreasing impacts of financial crisis and to maintaining national financial security. For international investors, it provides a new way of thinking for transnational investment and risk management.

2. Literature Review

By sorting the relevant literatures of the co-movement of stock market researches, it can be summarized in two genres. For one thing, scholars emphasize the universality of this phenomenon in different countries. Hilliard (2012) found that the correlation among stock returns in different
countries is not significant.\cite{1} However, Beirne et al.\cite{2010} maintained that the correlation has been increasing significantly since the mid-1990s.\cite{2} In the research of Kizys and Pierdzioch \cite{2009}, the mid-1990s was also mentioned as a remarkable timing node for the increase of the correlation.\cite{3} For another, some scholars believe that major financial events, such as financial crisis, will impact the correlation. Dooley and Hutchison \cite{2009} selected the stock markets indexes of China, Malaysia and South Korea as a whole to study the connection with the US stock market, and found that it disappeared temporarily after the subprime crisis in 2008, then resumed in 2009.\cite{4} Zhao Long \cite{2011} focused on the Chinese mainland and Hong Kong stock markets, with numerating the differences of the correlation before and after the subprime crisis. It is concluded that the co-movement weakened significantly after the crisis.\cite{5} As above, there is a lack of study on the co-movement between China and the US stock markets. Therefore, the previous researches mainly focus on the impact of crisis instead of financial openness. As supplementary, this paper emphatically concerned the changes of the US-China co-movement in different stages.

There are two mainstream views to explain the co-movement of stock markets. In the long run, economic fundamentals of one country may have deep and long-term influence on its stock performance.\cite{6} Under the assumption of efficient market, security prices reflect the value of enterprises. When the fundamentals of both markets improve at the same time, the stock indexes will rise also. In the short run, the behavioral factor can be the reason of the mentioned co-movement. Besides the economic fundamentals, Investors make decisions based on their feelings, instinct and other market participants, such as following the ups and downs, herd behavior and arbitrage.\cite{7} Investors' reacts may lead to similar returns in different markets in a short time. Above all, this paper studies the US-China stock market co-movement in both the long term and the short term. Co-integration will be used to test the long-term equilibrium relationship between China and the US, while GARCH model is for investigating the short-term volatility spillover effect of the two markets.

3. Empirical Analysis

3.1. Sample and Model Selection

The Dow Jones Industrial Average Index (DJIA) includes the stock price of 30 largest and most-renowned listed companies in the US, and is a comprehensive stock index to represent the US economy as a whole. In China, CSI300, an index of the 300 biggest mainland stocks, has most of the blue chip companies and can be the representative stock index. The daily trade data from January 1, 2010 to June 30, 2020 are selected as sample, and 2,350 trade data are obtained after excluding the trading days in which only one market opened. The opening and closing prices of CSI300 index are labelled as HSO and HSC, and the opening and closing prices of DJIA are labelled as DJO and DJC. The trend of HSC and DJC is shown in Figure 1. The overall trend of the two markets are approximately the same, showing the features of common fluctuation. The stock return of the two markets can be defined as \( R_{\text{HS}} = \ln(HSC_t) - \ln(HSO_t) \), \( R_{\text{DJ}} = \ln(DJC_t) - \ln(DJO_t) \). From Figure 2, the stock returns of China and the US are characterized by obvious volatility clustering, which means large volatility often follows large one, while small volatility follows small one.

In addition, considering the major reform practices in China stock market during 2010-2020, this paper chooses the approval of RQFII (August 17, 2011), the launch of Shanghai-HongKong Stock
Connect (November 17, 2014) and the participation in MSCI World Index (June 20, 2018) as splitting points to cut the whole period into four phases, exploring whether there is a significant change in the US-China stock co-movement in different periods.

![Figure 1. The closing price of CSI300 and DJIA (2010Q1-2020Q2).](image1)

![Figure 2. The stock return of CSI300 and DJIA (2010Q1-2020Q2).](image2)

### 3.2. Stationarity and Causality Test

The ADF test results are shown in Table 1. The lags are determined according to the information criterion. The null hypothesis are all rejected both in RHS and RDJ, no matter the whole sample or in different periods. RHS and RDJ are stationary.

|                  | Full sample | Phase I | Phase II | Phase III | Phase IV |
|------------------|-------------|---------|----------|-----------|----------|
|                  | t-Statistic | Prob.   | t-Statistic | Prob.     | t-Statistic | Prob. | t-Statistic | Prob. | t-Statistic | Prob. |
| RHS              | -49.9989    | 0.0001  | -17.39100   | 0.0000   | -28.69121  | 0.0000 | -28.96078  | 0.0000 | -23.90419  | 0.0000 |
| RDJ              | -52.9100    | 0.0001  | -9.771787   | 0.0000   | -28.17252  | 0.0000 | -22.55447  | 0.0000 | -26.06718  | 0.0000 |

Granger causality test results are shown in Table 2. The US opens its market one day later than China, so all models are set to be first-order lag. In the full sample, mutual causality is significant between the two markets. However, in Phase I and II, the US stock market only pose one-sided influence on China stock market, and the causality is no longer obvious in Phase III. In Phase IV, the causality become two-sided.
### Table 2. Causality test of RHS and RDJ.

| Null Hypothesis                      | Full sample | Phase I   | Phase II  | Phase III | Phase IV  |
|--------------------------------------|-------------|-----------|-----------|-----------|-----------|
| RHS does not Granger Cause RDJ       | 2.44777     | 0.03571   | 0.04043   | 2.35839   | 0.58654   |
|                                      | (0.0320)    | (0.8503)  | (0.8407)  | (0.1250)  | (0.0041)  |
| RDJ does not Granger Cause RHS       | 3.84242     | 8.69833   | 0.39928   | 0.30128   | 11.5711   |
|                                      | (0.0018)    | (0.0035)  | (0.0277)  | (0.5832)  | (0.0007)  |

### 3.3. The Long-Term Co-movement of the US-China Stock Market

RHS and RDJ are both stationary, so the long-term stock correlation between China and the US can be studied through the co-integration test. The Johansen test results of RHS and RDJ are list in Table 3 by using three models. The null hypothesis that there is no co-integration is accepted in Phase I, but being rejected in the other periods. It shows that the long-term co-movement is not significant before 2014. However, this long-term relationship began to emerge and lasted for two stages since Phase III, the opening of which is the Shanghai-HongKong Stock Connect.

### Table 3. Johansen Test of RHS and RDJ.

| Model | Null Hypothesis | Trace   | Eigenvalue |
|-------|-----------------|---------|------------|
| Phase I | r=0       | 178.8012 | 0.302446  |
|        | r=1         | 82.99462 | 0.268026  |
| 2      | r=0         | 178.8001 | 0.302444  |
|        | r=1         | 82.99429 | 0.268025  |
| 3      | r=0         | 183.1642 | 0.305244  |
|        | r=1         | 86.28835 | 0.277033  |
| 4      | r=0         | 491.3759 | 0.291675  |
|        | r=1         | 230.6679 | 0.262962  |
| Phase II | r=0       | 491.3704 | 0.291670  |
|        | r=1         | 230.6673 | 0.262962  |
| 2      | r=0         | 491.7182 | 0.291675  |
|        | r=1         | 231.0099 | 0.263296  |
| Phase III | r=0      | 750.9178* | 0.390858* |
|          | r=1        | 331.5520** | 0.324232* |
| 2      | r=0        | 750.9172* | 0.390858* |
|          | r=1        | 331.5517* | 0.324232* |
| 3      | r=0        | 754.0000* | 0.392176** |
|          | r=1        | 332.8022* | 0.325230* |
| Phase IV | r=0       | 401.7753* | 0.373068* |
| 2      | r=0        | 401.7753* | 0.373068* |
3.4. The Short-term Co-movement of the US-China Stock Market

The fluctuations of one market will be transferred to the other in the short term, which is the so-called spillover effect. For the reason of international capital flow, when a certain capital market has experienced large fluctuations, the behavior of investors in another market will be influenced. Besides, investors panic should be taken into consideration. As mentioned, the stock markets of China and the US are characterized by volatility cluster. Therefore, GARCH model is used to simulate the two stock returns with GARCH term representing the variance. The causality of GARCH term will show whether there is spillover effect and determine which country is affected. The volatility spillover effects are tested in four stages, as China’s capital market opens up, the effect may also change. According to the information criterion and the results of four successive lag orders, GARCH (1,1) is chosen to simulate stock returns with mean equation to be AR (1).

The results of Granger causality test between the GARCH term of RHS and RDJ in different phases is listed in Table 4. In Phase I, the spillover effect is not significant, which means volatility of one market will not affect another. In Phase II and IV, the US market has significant one-way spillover effect on China, while the spillover effect is being discovered mutual in Phase III. Nevertheless, the spillover effect in Phase IV is not as expected to be mutual. By analyzing the potential issues, the one-sided spillover effect in Phase IV may be the result of the fierce fluctuations of the US stock prices during 2020. Under this assumption, by ignoring the sample in 2020, the outcome turns to be mutual.

Table 4. Causality test of RHS GARCH term and RDJ GARCH term.

| Null Hypothesis                  | Lag | Phase I F-Statistic | Phase II F-Statistic | Phase III F-Statistic | Phase IV F-Statistic | Phase IV (Without 2020) F-Statistic |
|----------------------------------|-----|---------------------|----------------------|-----------------------|----------------------|------------------------------------|
| GARCH(RHS) does not Granger Cause GARCH(RDJ) | 1   | 2.44711             | 0.07302              | 5.36457*              | 0.00731              | 0.65893                            |
|                                  | 2   | 1.38270             | 0.92034              | 3.20641*              | 0.81032              | 1.11237                            |
|                                  | 3   | 0.71106             | 1.27079              | 2.91856*              | 1.34417              | 0.74360                            |
|                                  | 4   | 0.89737             | 0.75348              | 3.26241*              | 1.32558              | 0.58731                            |
| GARCH(RDJ) does not Granger Cause GARCH(RHS) | 1   | 0.53248             | 3.14667              | 0.00028               | 4.15175*             | 0.56618                            |
|                                  | 2   | 0.71657             | 1.77638              | 6.55285**             | 5.79918**            | 0.79940                            |
|                                  | 3   | 1.17584             | 2.98298*             | 4.32867**             | 4.22724**            | 1.38614**                          |
4. Conclusion

In conclusion, this paper explores the long-term and short-term stock co-movement between China and the US from 2010 to 2020, which is divided into four stages for horizontal comparison. Firstly, according to the Granger causality test, the US stock market caused the changes in China instead of the other way around in the early stage, but after the launch of RQFII, the causality gradually becomes two-way. Secondly, the Johansen co-integration test examines the long-term equilibrium relationship. The results reveal that there was no co-integration between the two markets before the Shanghai-Hong Kong Stock Connect, but this relationship has built up gradually with the implementation of opening-up measures. Finally, GARCH model is used to investigate the short-term volatility spillover effect. The spillover effect is significant and one-way (from the US to China) before 2011. Then the spillover effect tends to be mutual after 2011, which means stock volatility of China has a correlative impact on the US. However, under the extreme situation such as the drastic fluctuations, the spillover effect could become less significant.

Thus, as the continuous opening up of China stock market, the stock co-movement between China and the US has become increasingly apparent, both in long and short term. With the development of global capital flow etc., China stock market will be a qualified option for the international investors, consequently, it could urge China stock market to deepen its system reform to be more standardized. In addition, the authorities of China and the US should take the increasing spillover effects into consideration, safeguarding the financial safety of nations.

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