Evolution of Correlations among Stock Markets in Hong Kong, Shanghai and the U.S.

WEI ZHOU
School of Finance
Renmin University of China
Beijing, 100872,
P.R. CHINA
zhouw@ruc.edu.cn

Abstract: - The paper examines weekly earnings data between January 2000 and August 2008 of Hong Kong’s Hang Seng index, Shanghai Composite Index and the U.S. S & P 500 index, adopting the method of moving correlation coefficient series analysis and finding that the correlation between Hong Kong market and Shanghai market is in a trend of steadily increasing; Shanghai market and the U.S. market is of very low correlation, basically can be recognized as independent fluctuations; although Hong Kong market has been closely associated with the United States market, from 2007, with the stable increase in correlation with Shanghai market, the impact of the United States market on Hong Kong market is rapidly weakening, Hong Kong market is getting more influenced by Shanghai market.

Key-Words: - Stock Market, Moving Correlation Coefficient, the Hang Seng Index, the Shanghai Composite Index, S&P 500 Index

Hong Kong's stock market is associated closely with international markets, especially with the U.S. market due to its free financial environment and amounts of international institutions’ participation. In addition, Hong Kong market is the main financing channel for many Chinese mainland enterprises who want to get listed overseas. If these two points are taken as the basis for further inference, Hong Kong’s stock market will be double impacted by both the international capital markets and the Mainland market. This article is to explore the extent to which Hong Kong market is under the impact of the Mainland market, and the extent to which it follows the lead of the U.S. market’s fluctuations.

This paper collects data of the markets in Hong Kong, Shanghai and the U.S. during the period of January 2000 to August 2008, hoping to take advantage of simple and practical data analysis methods, provides a quantitative description of the linkage among the three markets’ relations, and further analyzes the deep-seated reasons promoting the relations’ evolution.

1 Literature Review

There are a series of important documents on the research of different stock markets’ relationships. Before early 90’s, a substantial amount of research focused on different mature capital markets’ relationship.

As the Asian capital market develops, since the 90's, a growing body of research has begun to pay attention to the relationship of co-movements between Asian markets and other mature capital markets. With regard to the Choice of research methods, cointegration relationship model has gradually taken the place of correlation coefficient which dominated previous 90’s. Kwan et al (1995) studied the stock markets of Australia, Hong Kong, Singapore, South Korea, Taiwan, Britain, the United States and Germany. They thought these markets have not reached weak effective condition, because they didn’t find an obvious leader-lag relationship among these markets. However, Chan et al (1992) studied markets of Hong Kong, Singapore, South Korea, Taiwan, Japan and the United States, finding that these markets are weak-form effectiveness, but do not meet each other cointegration. Cheung and Ho (1993) found the relationship between mature markets and the Asian emerging markets is instable. Huang and Cheung (1995)’s study took the exchange rate factors into account finding some evidence of cointegration existence among Asian markets. Corhay et al (1995) studied the long-term relationships among Pacific Rim's main stock markets, believing they showed cointegration relationship. Ghosh et al (1999)’s study found that long-run equilibrium relationship exists between some Asian stock markets and the world's leading markets, but some other markets had not shown
similar phenomenon. Tuluca and Zwick (2001) studied indices’ change of 13 Asian markets and non-Asian markets before and after 1997 Southeast Asian financial crisis applying Granger inspection techniques, and adopted factor analysis methods to study its index rate of return. Their study concluded that after the financial crisis in Southeast Asia, these markets showed stronger synchronization.

Relationship change between different markets also attracted the attention of scholars who study Chinese capital market. GARCH family model and cointegration model are widely used in their study. Sun et al (2000) believe that, due to the same macro-economic factors and environmental constraints, there is a positive connection between red chips, H shares and the Mainland stock market; Poon et al (2000)’s study also shows that there is stable intrinsic link among red chips, H shares and the mainland stock market. Wu Shinong and Pan Yue (2005) discussed system’s changes’ impact on the stock market and found that during this period red chips was always ahead of the mainland market, and they did not find obvious correlation between H shares and the Mainland stock market; the 1997 Asian financial crisis changed the red chips’ guiding role on H shares.

Some research set broader vision, exploring the relationships among China's stock market, the Asia-Pacific and international stock markets. Yu Shidian et al (2001) study the relationships among Dow Jones index, Hang Seng Index, NASDAQ index, Nikkei Index, Shanghai Composite Index, with the method of Granger causality test, finding that foreign stock markets granger cause China's stock market, although the impact of this causal relationship is very small, but China's stock market doesn’t granger cause foreign stock markets, which means the causal relationship does not hold inversely. Gu Yao and Lu Lina (2006) built a DCC-(BV) EGARCH-VAR model, systematically measuring the earnings and fluctuations’ impact and dynamic condition relevance between Shanghai, Shenzhen, and Hong Kong’s stock markets, finding the Hong Kong stock market’s impact on Mainland has been growing, and the impact was non-symmetrical on Shanghai and Shenzhen’s markets.

This article does not apply popular Granger causality analysis methods and GARCH family model, but adopt intuitive and useful moving correlation coefficient series analysis method, in order to provide a new perspective for exploring the evolution course of different markets’ relationship.

2 Data Analysis

2.1 Data

Our aim is to study the evolutionary characteristics of the U.S. market, Hong Kong market and mainland markets’ relationship linkage between each other. Therefore, it is necessary to use three market indices which are fully representative. S & P 500 Index is selected for the U.S. market, Hang Seng Index is selected for the Hong Kong market, and Shanghai Composite Index is selected for mainland market.

Because we took corresponding index to represent changes in a single stock market, to some extent the calculation methods for the index affect the final result. The calculation methods of S & P 500 and Shanghai Composite Index do not change much in the observation period, the biggest change happens to the Hong Kong's Hang Seng Index. In May 2006, the Hang Seng Index Limited announced to change the method of compilation of the Hang Seng Index, replacing the original total market value weighted method by the new circulation market value weighted method, and set ceilings for several individual constituent stocks. The change was progressively implemented throughout September 2006 to September 2007 gradually, and was eventually completed by September 7th, 2007, and after the close of market at that day, the full implementation of the circulation market value adjustment is taken place. Since September 11th, 2006, Hang Seng Index took the first eligible H share into its constituent stocks. In 2007, there were 7 companies in total being incorporated into the new constituent stocks. H shares became an important part of the Hang Seng Index which account 10 in the 43 constituent stocks, in addition to that, red chips accounted 8 among these 43 stocks. Whether HS index’s change in method of calculating has become a major factor changing the markets’ relationship will also be an element of this article’s follow-up analysis.

We have collected from Bloomberg database the weekly return data of Hang Seng index, Shanghai Composite Index and the U.S. S & P 500 index between January 2000 and August 2008. Because there are market holidays and time difference in the three markets, the data were adjusted accordingly by deleting relevant data records which is inadequate in any of the three markets, so that the weekly data can reach period unanimous. After the adjustment, we have got three sets of time series whose respective capacity is 428
samples. After an initial calculation of the data, three indexes formed three indexes yield time series, the follow-up study will start from focusing on the relationship among the three yield time series.

2.2 Method of Analysis
Correlation coefficient is a simple and practical statistical indicator for examining associated relationship of two time series’ fluctuations, but it can’t reflect the evolution of different markets’ relationship in a certain period. In order to better analyze the process of different markets’ relationship changes in the entire time span; we carry out our research here with moving correlation coefficient series method.

Moving correlation coefficient series is developed from moving average method, forming fixed spans’ data window of a specific period of time series data to calculate the correlation coefficient of these two data window’s data, and then move back the data window to get a series of window and accordingly calculate a series of correlation coefficients, forming a correlation coefficient time series.

The time window for A series can be expressed by formula (1), said:
\[ \text{Win}_A (T, n) = \{A (T + n-1), A (T + n-2 ),..., A (T + nT)\} \]  
\[ n \text{ is the series number of the time window, } 1 \leq n \leq N-T +1, \text{N is the total sample size of the series, } T \leq N; \text{ T is the length of the time window, which is the data sample size of window time series; } \]

Similarly, time window for A series can be described as follows:
\[ \text{Win}_B (T, n) = \{B (T + n-1), B (T + n-2 ),..., B (T + nT)\} \]  

The correlation coefficient of A, B time series’ single window time series is as follows:
\[ \text{MC}_{A,B}(T, t) = \text{Cor} [\text{Win}_A (T, t), \text{Win}_B (T, t)] \]  

Series generated by the movement of the correlation coefficient time series is as follows:
\[ \text{MC}_{A,B}(T) = \{\text{MC}_{A,B}(T, 1), \text{MC}_{A,B}(T, 2), ..., \} \]  

Fig. 1: MC\_HS\_HS(40),MC\_HS\_SP(40) and MC\_SH\_SP (40)

From Figure 1, we can get some intuitive judgments on the relationship among the three stock markets.

The change of SH\_HS was the most apparent, and 2005 was a watershed. Since then, the number of SH\_HS went up rapidly, and in the follow-up period, remaining at the level of 0.4 most of the time with minor fluctuations, and only in 2007 it produced a larger decrease, but soon recovered. This indicates that new change happened on the linkage relations between Shanghai market and the Hong Kong market, and their correlation upgraded obviously.

In the observation period of 2000-2008, HS\_SP showed larger fluctuations. But the absolute value of correlation is clearly much higher than that of the SH\_HS and SH\_SP. In about three years before 2005, HS\_SP showed obvious gradual downward trend with larger fluctuations, and reached the lowest point of the observation period in 2005, after which began a rapid climb, and showed a more drastic fluctuations before 2005, and dropped to lows again in 2008. While it is difficult to determine the stability of HS\_SP’ downward trend just from the graphics of Figure 1, the fluctuations’ downward scope is a clear phenomenon. This shows that while the U.S. market maintains a high degree level of correlation with the Hong Kong market, the relationship is also facing pressure of gradual declining.

SH\_SP fluctuated at a relatively low level, basically remained at the level of no more than 0.2 before early in 2007. The entire 2007-2008 period
is a very special period within the entire observation period, in 2007, the correlation maintained a value around 0.2-0.4, but in the early of 2008, a sudden and drastic reduction happened, and the correlation turned negative. It can be seen that under the background of long-term low correlation between the U.S. market and the Shanghai market, although the correlation improved significantly in 2007, in 2008 it showed a high negative correlation again meaning a stable trend of higher correlation has not been formed.

2.4 Statistical Features
Statistical distribution characteristics of SH_HS, HS_SP and SH_SP can be seen from Figure 2, Figures 3 and 4. As can be seen from the distribution graphs, characteristics of these three pairs of relations are very different. SH_HS shows clear bimodal distribution; the skewness of HS_SP is the highest, and its average and median is much larger than those of SH_HS and SH_SP; the skewness of SH_SP is close to 0, kurtosis is 3.15, Normality Jarque-Bera test value is approximately 0.6, and can be recognized as a normal distribution.

In order to determine whether the relationships three pairs of time series are stationary series, we carried out unit root tests. Stationary series revolve around a mean and move closer to its trend, non-stationary series do not have this nature. ADF (Augmented Dickey-Fuller Test) test is a widely used method for testing single-integration currently. In order to study the characteristics of the three time series, we carried out ADF tests, whose results are shown in Table 1. The test results indicate that SH_HS accept the null hypothesis with unit root and is non-stationary series; HS_SP accepts the null hypothesis and is non-stationary series at 1% significant level, but at 5% significant level, it denies the null hypothesis; and there is no unit root in SH_SP.

| Test critical values: | 1% level | -3.447125 |
| Test critical values: | 5% level | -2.868829 |
| Test critical values: | 10% level | -2.570719 |

* Automatic based on AIC, MAXLAG=16

3 Evolutionary characteristics
Although the evolution of the volatility relationship between United States, Hong Kong and Shanghai’s capital markets is complex, some valuable information can be got through market data’s relationship between different indices. Based on the preliminary results of data analysis above, the evolutionary characteristics can be summed up as following aspects:
3.1 The correlation between Shanghai and Hong Kong markets have shown a steady growth.

Such growth did not appear until 2005, and after that it has become more obvious. From SH_HS’ bimodal distribution characteristics, combined with analysis of Figure 2, Bimodal peaks distribution basically reflected of two distribution characteristics before and after 2005, which is the results of two distributions’ superposition.

It might be thought that it is the Hang Seng Index’s incorporating H shares into its calculation system who leads to the two markets’ increasing correlation. However, judging from the data and period relationship, this view is not accurate. Hong Kong's Hang Seng Index formally incorporated H shares into its Hang Seng Index’s calculation system in September 2006, but correlation between Hong Kong market and Shanghai market has started steadily increasing in 2005, reaching a high-point (correlation coefficient: 0.46) in April 2006. although H shares’ number and proportion in Hang Seng Index has been rising after formally being incorporated into the calculation system of Hang Seng Index, the correlation between the two markets has remained stable around 0.4 level without greater improvement, even once fallen to around 0.2. This shows that the change of Hang Seng Index’s calculation is not the main factor causing their correlation relationship’s change.

We may find part of the answers in the overseas listing of Chinese enterprises and the launch of QDII program for searching for the core determining factors in the relationship between Shanghai market and Hong Kong market. Hong Kong is the main destination for overseas listing of China’s enterprises. Starting in 2005, China’s super-large state-owned enterprises set off a round craze of getting listed overseas. Following Air China listed in Hong Kong by the end of 2004, Bank of Communications, and China Construction Bank have been individually listed in Hong Kong in June and October, 2005. While in 2006 this trend has continued. In 2006, a total of 86 Chinese companies went to overseas capital markets, financing a total amount of 43.998 billion U.S. dollars, higher than the 20.441 billion U.S. dollars totally financed through overseas IPO in 2005 by 53.5 percent.

Large state-owned enterprises going to get listed overseas impact different investment and transaction participants of the market from two aspects. First, it makes a large number of international capitals participate in the investment of Chinese enterprises, and further attract them invest into mainland stock market. Second, a large number of domestic investment funds began to seek investment opportunities in the international market, especially in the Hong Kong market which is led by the large state-owned enterprises getting listed overseas. Third, QDII’s formal launch in 2006 helped the process of more internal capital entering into the international market. Taking the barriers international capital face when entering Chinese market into account, the domestic funds’ pouring into the Hong Kong market to carry out transactions may be the key factor causing Shanghai and the Hong Kong markets’ enhancing stable correlation.

3.2 The linkage between Shanghai market and the U.S. market is very low, and furthermore after 2007 the relationship is very unstable.

The very low correlation between Shanghai market and U.S. market reflects the two markets’ separating state, and it is easy to understand the low correlation taking into account China's not freely convertible capital account, relatively small QFII quotas. This low correlation has been in a very stable state until 2007. It is noteworthy that between 2007 and 2008, the two markets’ associated relations appeared large volatility. I believe this is associated with the market’s instability, in the meantime, the Shanghai market has experienced dramatic declines, and the United States market has also been tortured by continuous wave of sub-prime and financial crisis. The unit root test results show there is no unit root between SH_SP, and thus it is a stable time series without containing intrinsic trend factors. Therefore, such fluctuations in 2007 and 2008 can be regarded as accidental phenomenon.

3.3 "Hong Kong market is gradually breaking away from the U.S. market, speeding up to move closer to the mainland", this trend is more obvious.

As a free international financial market, it is obviously reasonable that the Hong Kong stock market change simultaneously with the U.S. market. One Problem worth exploring is that whether the relationship between U.S. market and Hong Kong market is reducing or not in the condition that the
correlation between Hong Kong market and Shanghai market is rising, Shanghai and the U.S. market move independently?

From Figure 1, it can be seen that between late 2007 and August 2008, the correlation between Hong Kong market and the United States market showed rapid decline. Of course, in 2005-06, the same situation occurred in Hong Kong market, but during that period correlation between Shanghai market and the United States market rose meaning shanghai market is not the factor of dropped correlation between Hong Kong market and the United States market. In 2007 and 2008, correlation between Hong Kong market and the U.S. market declined rapidly, basically synchronized with the dramatically dropped correlation between Hong Kong market and Shanghai market. However, correlation between Hong Kong and Shanghai showed very stable. Thus, we can get a viewpoint arising out of the phenomenon, the U.S. market’s impact on the Hong Kong market is gradually weakening, and mainland market’s impact is getting stronger. Of course, a certain period’s data is not sufficient to provide adequate evidence for this point of view, but time will give a more accurate answer.

4 Conclusions

In order to understand the three markets’ correlation changes’ continuous-time evolution process, we have adopted a moving correlation coefficient series analysis method. By simple analysis of the moving correlation coefficient time series, we found the correlation between Hong Kong market and Shanghai market remains stable and improves stably; correlation between Shanghai market and U.S. market is very low, and can be basically recognized as independent fluctuations of each other; the U.S. market’s impact on the Hong Kong market is gradually weakening, and shanghai market’s impact is getting stronger.

It can be said that the relationship change among the three markets reflects deeper relationship change happening in Sino-US economic and financial development pattern. One of The main factors leading to the three markets’ relationship change is the process of China's large enterprises getting listed overseas, and hence stimulating domestic capital’s participation in Hong Kong market.

In future development, we may be able to observe more evidence showing U.S. market’s impact on Hong Kong market is gradually getting weaker, and Hong Kong market is more and more closely related to the Shanghai market which represents volatility of Mainland stock market.

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