The effect of the opening up of China on relationships with international stock markets

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Abstract

This paper study the dynamic correlation and sensitivity between Chinese mainland stock market and five major stock markets with the DCC-GARCH model. The effects of the reforms on dynamic correlations and sensitivity are also analyzed. The analyses prove that the Chinese mainland market is more closely tied to Asian stock markets over time, followed by the United States, and with relatively lower correlations with Europe and the United Kingdom. And the implementation of reforms changes their correlation and sensitivity over time.

Keywords

DCC-GARCH, Chinese Stock Market, Dynamic Correlation, Time-varying sensitivity, Chinese reforms

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1. Introduction

By the end of 1990, with the establishment of the Shanghai and Shenzhen stock exchanges, until today, in order to adapt to the Chinese economic growth and gradual opening of China's financial market, the stock markets have experienced several very important stages of development and reforms.

Especially since China jointed WTO at the end of 2001, it has received more and more international attention. In order to gradually open the Chinese stock market, in 2002, the Chinese government has started to implement a program QFII "Qualified Foreign Institutional Investor" which allows specified licensed international investors with the right to direct access to mainland China's stock exchanges. Along with the internationalization of China 's financial market, the links between China's stock markets and other countries are also changing. Chow and Lawler (2003) found no significant correlation between shanghai and New York stock market returns from 1992 to 2002. However, Chiang and Chen (2016) highlight that the relationships between Chinese stock markets and others global stock markets have been influenced by structural changes in China financial system as QFII.

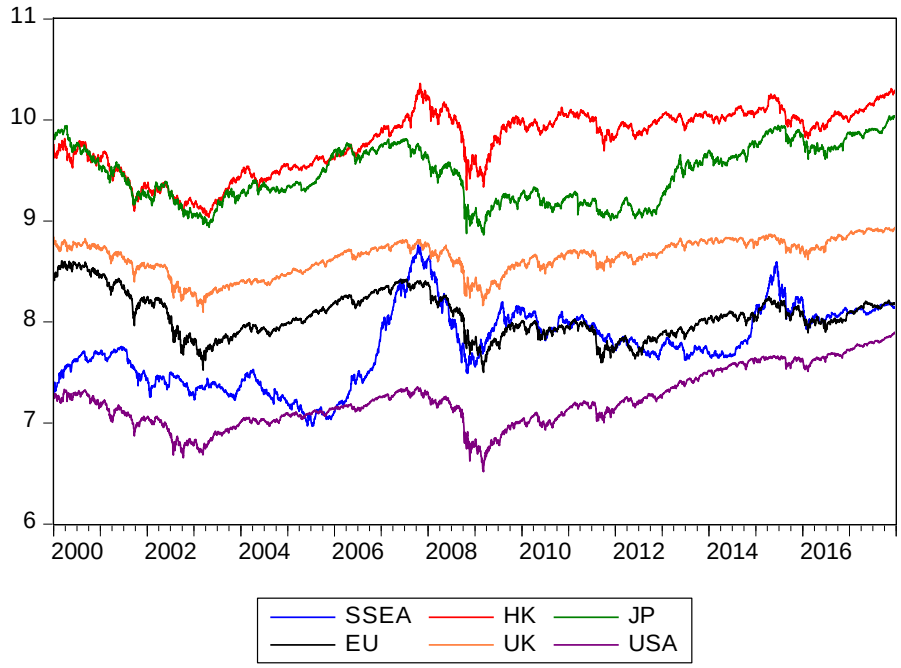
During 2001-2006, Chinese government established a plethora of reforms to continuously adjust the Chinese financial system to economic development needs. The state is undergoing reforms to reduce state-owned shares in 2000 in order to separate government functions from the enterprises. This reform has not positive effect to realize the enterprise value (Xiang and Fu, 2015). Until June 24, 2002, the State Council issued a notice to stop the reduction through the domestic stock exchange. The Shanghai Composite Index rose 9.35% on the day. However, the Chinese stock market's structure was special, which consists of Non-tradable shares (NTS) and tradable shares (TS). All B shares and H shares are TS, A shares were divided into NTS and TS (Liu and Lu, 2007). At the end of 2004, the NTS accounted for 64% of total shares. To convert Non-tradable shares into tradable shares, the Chinese government has established the Non-tradable share reform in April 2005. As of December 2006, 96% of listed companies have completed the NTS reform. The split share reform improves corporate governance and reduces the negative effect of non-tradable shares (Yu, 2013). This reform changes also the linkages between the three Chinese stock markets and improves Chinese market's structure (Mestre-Zhou and Mestre, 2018). In the meantime, another program QDII "Qualified Domestic Institutional Investor" is put into effect. Like QFII, it allows domestic investors to access foreign securities markets via an institutional investor which has certain qualifications approved by China Securities Regulatory Commission (CSRC).

In order to adapt to the needs of national economic development and foreign trade, the central bank announced, on July 2, 2005, the implementation of a managed floating rate system based on market supply and demand with reference to a basket of currencies. After the reform of Renminbi Yuan (RMB), the exchange rate has a long-run relationship with the

Chinese stock markets, particularly, it influences Shanghai A share index in the long term (Guo et *al*, 2008, Zhang, et *al*, 2008). On October 16, 2007, the Chinese stock market reached its highest level (6092.06 points). However, with the outbreak of the US subprime mortgage crisis, international stock markets plummeted. Before the crisis international, there is not a direct relationship between the mainland stock markets and US market, but a lower relationship with Hong Kong (Li, 2007). During the crisis, the correlation has been reinforced between the Asia-Pacific countries, Europe and the US (Hyde et *al*, 2007).

Graphically, we observe on the Figure 1 that there are two periods when the Chinese mainland stock market (SSEA) has not the same trend with the other markets. The first phase stretches from March 2003 to July 2005. After the dot-com bubble in 2000, the international stock markets began to show a growth trend at the end of the first half of 2003, except for the Chinese Mainland stock market. Then, the second phase stretches from May 2010 to July 2014. Until early 2009, the Chinese stock markets started to rebound after the Subprime Crisis. After the rebound, Asia's stock markets have been negatively affected by the 2010 European debt crisis and the 2011 US debt crisis. In 2013, Asian stock markets rose, ranking first in Japan. But the mainland stock market did not follow this growth. Because China's financial market is still not fully open to the outside world, and people have a negative attitude towards the stock market, investment in real estate and other low-risk wealth management products have set the stage for the 2015 China stock market crisis.

Figure 1: International market stock price indices in log-form: 01/03/2000-12/29/2017



China's financial market is undoubtedly very attractive to foreign investors, the financial development promotes Chinese economic growth (Jalil et *al*,2009). However, according to Figure 1, it is difficult for investors to judge the trend of the market. Before the period of liberalization (2003-2010), the China's stock market is isolated with the global and reginal

markets, it has not any influences on the overseas markets, but the market liberalization and reforms change the international relationships (Li, 2012).

In this paper, we study the relationship between the Chinese stock market and other markets over time considering the all the reforms made. To address these questions, we analyze the dynamic correlation between mainland stock market and five major stock markets. By comparing and analyzing these correlations, we can better appreciate the effect of China opening on its market behavior and on relationship between it and other international markets.

The remainder of this study is organized as follow. Section 2 presents the statistical data and methodology. The empirical finding and interpretation are reported in Section 3. And the conclusions are provided in Section 4.

2. Data and Methodology

2.1 Data

In this paper, we used the daily closing stock indices period from January 3, 2000 to December 29, 2017 with a total of 4695 observations. There are two Chinese stock markets indices including the Shanghai A share index, the Hang Seng Index, and some major markets indices consisting of the EU (Eurostoxx50), US (S&P500), UK (FTSE100) and Japan (Nikkei 225). In order to respect the stationary condition for DCC –GARCH model, we realize the Augmented Dickey-Fuller test (robust to the autocorrelation) and Philips-Perron (robust to the heteroskedasticity) for all series. They are both DS (Difference Stationarity) without derivate. So, after filtering by the fist differences, we obtained the stock return data.

Table 1 summarizes the characteristics of each series. The means returns of all indices are significantly equal to zero. By analyzing the standard deviation, we note that the Asian markets have the highest risk compare to the US-UK stock markets. Jarque-Bera tests indicate that all series are non-normally distributed.

Table 1: Summary statistics of stock market returns: 01/03/2000-12/29/2017

	RSSEA	RHK	RN225	REUROSTOXX50	RFTSE100	RSP500
Mean*	0.019	0.012	0.004	-0.007	0.002	0.013
Maximum*	9.400	13.407	13.235	10.438	9.384	10.957
Minimum*	-9.261	-13.582	-12.111	-9.011	-9.265	-9.470
Std. Dev.*	1.537	1.447	1.476	1.465	1.173	1.192
Skewness	-0.358	-0.097	-0.406	-0.055	-0.164	-0.208
Kurtosis	8.434	11.798	9.899	7.795	9.617	12.095
Jarque-Bera	5875	15,147	9439	4499	8584	16,214
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	4694	4694	4694	4694	4694	4694

*Note:** values multiplied by 100.

Table 2 presents the unconditional correlation coefficients and the corresponding t-statistics of markets stock returns. In the one hand, the Chinese mainland stock market has higher positive correlation with Hong Kong and Japanese stock markets. The lowest correlation is with US stock market. In the other hand, Hong Kong stock market has the highest correlation with Japan, followed by the Chinese mainland stock market. As a more open stock market, Hong Kong has a higher linear relationship with EU, UK and USA than the mainland stock market.

Table 2: Correlations of stock market returns 01/03/2000-12/29/2017.

t-Statistic	RSSEA	RHK	RN225	REUROSTOXX50	RFTSE100	RSP500
RSSEA	1					

RHK	0,367	1				
	27,017	-----				
RN225	0,206	0,552	1			
	14,423	45,291	-----			
REUROSTOXX50	0,095	0,349	0,273	1		
	6,526	25,507	19,429	-----		
RFTSE100	0,107	0,386	0,294	0,853	1	
	7,338	28,629	21,093	112,019	-----	
RSP500	0,055	0,200	0,123	0,569	0,532	1
	3,751	13,958	8,482	47,385	43,070	-----

2.2 The DCC-GARCH Model

In order to study the time-varying correlations among the China, US, Europe and Japan, we used the Engle's (2002) dynamic conditional correlation (DCC)-GARCH model which is useful for estimating of the correlations between the stock returns in bivariate case.

Let $\{y_t\}$ denote a bivariate return series$[y_{1,t} \quad y_{2,t}]$, the model can be expressed as:

$$y_t = E(y_t|\Omega_{t-1}) + r_t$$

$$r_t|\Omega_{t-1} = [r_{1,t} \quad r_{2,t}] \sim N(0, H_t)$$

$$H_t \equiv D_t R_t D_t$$

Where r_t is a random variable, and Ω_{t-1} is the information set through time t-1. The variable $y_{1,t}$ presents the series of Chinese stock return, and $y_{2,t}$ presents other series of stock returns. For all t, the conditional covariance matrix, $H_t(E_{t-1}(r_t r_t') \equiv H_t)$, is almost surely positive definite (Bollerslev,1990). $D_t = diag(\sqrt{h_{11,t}}, \sqrt{h_{22,t}})$, where the conditional variance obtained by univariate GARCH model, then D_t is the 2*2 diagonal matrix of time-varying standard deviations. For each univariate error process, $r_{i,t} = \sqrt{h_{i,t}}\varepsilon_{i,t}$, $\forall i = 1,2,$

where $\varepsilon_{i,t} \sim N(0,1)$ and the condition variance $h_{i,t} = E_{t-1}(r_{i,t}^2)$, they follow a univariate GARCH(1,1) process following:

$$h_{1,t} = c_1 + m_1 r_{1,t-1}^2 + n_1 h_{1,t-1}$$

$$h_{2,t} = c_2 + m_2 r_{2,t-1}^2 + n_2 h_{2,t-1}$$

Parameters $m_i \; and \; n_i \;\; \forall i = 1,2$ need to be positive and $(m_i + n_i) < 1$.

In the DCC-GARCH model, a correlation matrix, R_t , is allowed to be time-varying. Its conditions are defined as the following:

$$R_t = (Q_t^*)^{-1} Q_t (Q_t^*)^{-1}$$

where $Q_t^* = diag(\sqrt{q_{11,t}}, \sqrt{q_{22,t}})$

$$Q_t = (1 - a - b)S + a\varepsilon_{t-1}\varepsilon_{t-1}' + bQ_{t-1}$$

The Q_t = $(q_{ij,t})$ is positive definite as a the 2*2 time-varying covariance matrix of ε_t , S is the unconditional correlation matrix of ε_t (where $\varepsilon_t = D_t^{-1} r_t$) while a and b are nonnegative scalar parameters($a > 0, b > 0 \; and \; (a + b) < 1$).

The log-likelihood function consists of a volatility part and a correlation part:

$$L(\theta, \emptyset) = L_V(\theta) + L_c(\theta, \emptyset)$$

The part of volatility:

$$L_V(\theta) = -\frac{1}{2}\sum_t (nlog(2\pi) + log|D_t|^2 + r_t' D_t^{-2} r_t)$$

The part of correlation:

$$L_c(\theta, \emptyset) = -\frac{1}{2}\sum_t (log|R_t| + \varepsilon_t' R_t^{-1} \varepsilon_t + \varepsilon_t' \varepsilon_t)$$

The correlation estimator of R_t will be positive definite:

$$\rho_{12,t} = \frac{q_{12,t}}{\sqrt{q_{11,t} q_{22,t}}}$$

To improve the result analysis, we can compute the time-varying sensitivity from the dynamic covariance by the following equation:

$$\beta_{12,t} = \frac{q_{12,t}}{q_{22,t}} \quad \text{and} \quad \beta_{21,t} = \frac{q_{12,t}}{q_{11,t}}$$

3. Empirical Finding and Interpretation

In order to analyze the dynamic correlation between the Chinese mainland stock return (SSEA) and the other markets, we estimate the DCC-GARCH model for each pairwise variable. The parameters estimators of the DCC-GARCH model are presented in Table 3. It shows that the conditional correlation parameters are positive, and their sum is less than 1.

Table 3: Results of bivariate DCC-GARCH (1, 1) model for the Chinese mainland stock returns

Parameters	SSEA_HK	SSEA_JP	SSEA_EU	SSEA_UK	SSEA_US
a	0.006***	0.004***	0.003**	0.002***	0.006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)
b	0.994***	0.994***	0.996***	0.997***	0.957***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.049)

Note: *denote reject null hypothesis at the 10% critical value, ** 5% critical value, ***1% critical value. The values in the parenthesis are the standard deviations.

Table 4 shows that the value of average conditional correlation with Hong Kong is the highest, and with the highest standard deviation, followed by the Japanese stock market. On the contrary, the lowest conditional correlation is between SSEA and US, with the less volatility, followed by the UK stock market and EU stock market. This result corresponds to the unconditional correlations presented in Table 2. However, the result of the correlation between SSEA and US is strange. In addition, their coefficient of the parameters is not significant.

Table 4: Summary statistics of dynamic correlations between Chinese mainland stock market and others markets

	SSEA_HK	SSEA_JP	SSEA_EU	SSEA_UK	SSEA_US
Mean	0.341	0.186	0.081	0.095	0.051
Median	0.434	0.174	0.073	0.119	0.050
Maximum	0.596	0.361	0.182	0.210	0.218
Minimum	-0.026	0.015	-0.020	-0.043	-0.025
Std. Dev.	0.187	0.092	0.053	0.072	0.024
Observations	4694	4694	4694	4694	4694

The time difference between China and USA is 12-13 hours. Therefore, the opening and closing times of the Chinese and US stock markets have one day lagged. With the same methodology previous, we estimated the dynamic conditional correlation among $SSEA_t$ and US_{t+1}, and $US_{t-1,}$ the results reported in Table 5. We notice that the US_{t-1} is correlated significantly with China. The mean value of the conditional correlation between SSEA and US_{t-1} is 0.113 instead of 0.051. It' means that the stock market quotes of the previous day in USA will affect China's stock market that day.

Tables 5: Results of the time varying conditional correlation: SSEA-US $_{t-1}$ and SSEA-US_{t+1}

Tables 5.1: DCC-GARCH parameters

Parameters	$SSEA\_US_{t-1}$	$SSEA\_US_{t+1}$
a	0.015**	0.000
	(0.007)	(0.005)
b	0.921***	0.930***
	(0.041)	(0.243)

Note: *denote reject null hypothesis at the 10% critical value, ** 5% critical value, ***1% critical value. The values in the parenthesis are the standard deviations.

Table 5.2: Summary statistics of dynamic correlations: SSEA-US $_{t-1}$ and SSEA-US_{t+1}

	$SSEA\_US_{t-1}$	$SSEA\_US_{t+1}$
Mean	0.113	0.004
Median	0.113	0.004
Maximum	0.313	0.004
Minimum	-0.060	0.004
Std. Dev.	0.044	0.000
Observations	4694	4694

We compute the time-varying sensibilities in order to improve the analysis of correlation. Table 6 summarizes the results.

Tables 6: Summary statistics of time-varying sensitivity

6.1: Summary statistics of time-varying sensitivity of SSEA to other countries.

	BETASSEAHK	BETASSEAJP	BETASSEAEU	BETASSEAUK	$BETASSEAUS_{t-1}$
Mean	0.399	0.206	0.095	0.142	0.170
Median	0.364	0.179	0.088	0.138	0.156
Maximum	1.562	0.690	0.431	0.615	0.731
Minimum	-0.022	0.009	-0.018	-0.058	-0.106
Std. Dev.	0.264	0.131	0.070	0.116	0.095
Observations	4694	4694	4694	4694	4694

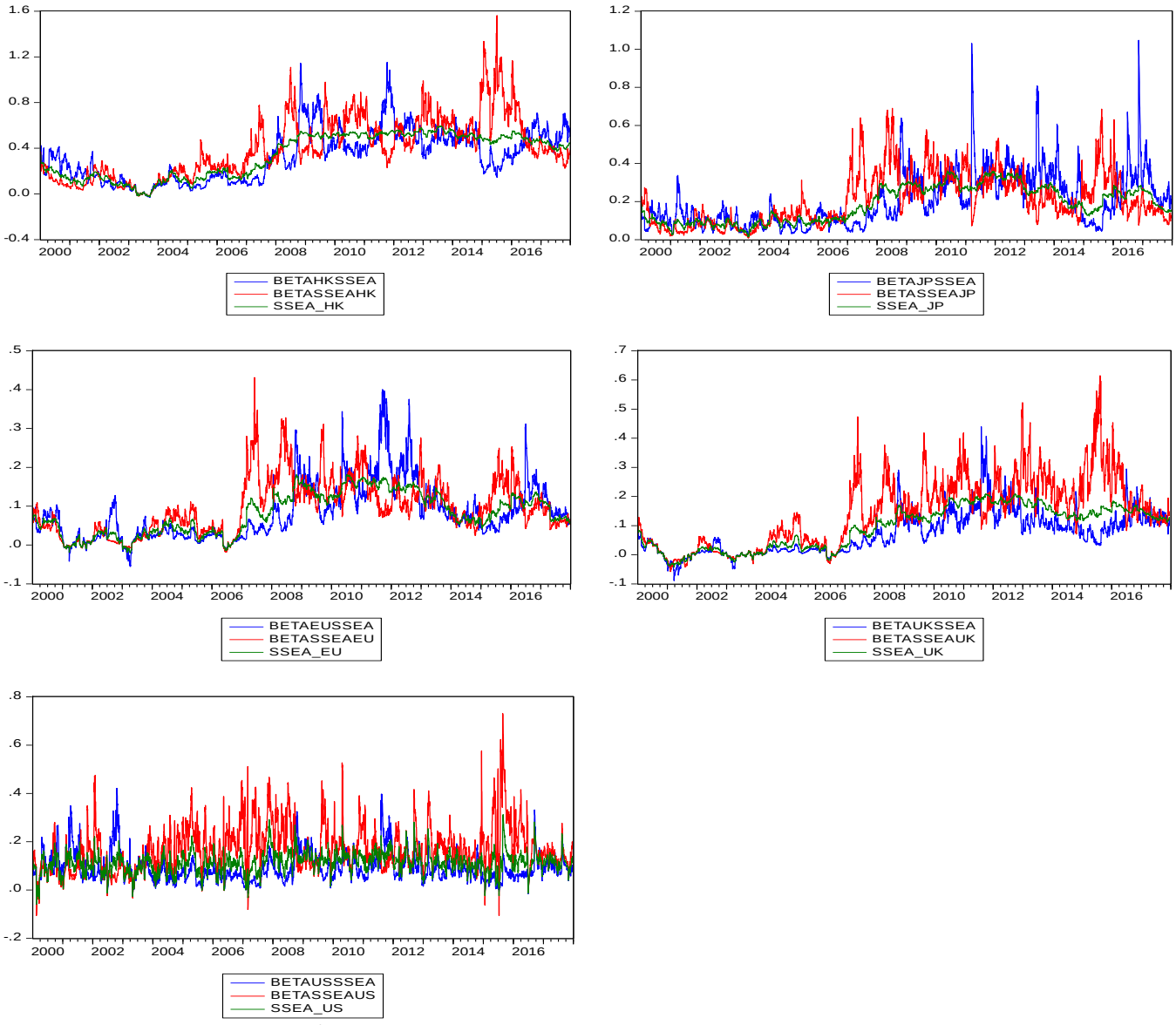
6.2 Summary statistics of time-varying sensitivity of other countries to SSEA.

	BETAHKSSEA	BETAJPSSEA	BETAEUSSEA	BETAUKSSEA	$BETAUS_{t-1}SSEA$
Mean	0.331	0.200	0.082	0.072	0.090
Median	0.332	0.163	0.067	0.065	0.076
Maximum	1.152	1.048	0.401	0.440	0.422
Minimum	-0.031	0.024	-0.056	-0.089	-0.034
Observations	4694	4694	4694	4694	4694

By comparing the sensitivities means reported, we notice that the Chinese mainland stock market is more sensitive to UK and US than they are sensitive to china. Compared to Hong

Kong, they are highly sensitive each other. The sensitivity of China to Japan is similar in average to those of Japan to China. The figures 2 illustrate the time-varying correlation and sensitivities, they improve the previous results.

Figures 2: Dynamic conditional correlation and Sensitivity between SSE A shares index and other indices.



Note: we use US to present the series USt-1

First, we observe that the correlation SSEA-US has not the same trajectory than others. Compared with others graphs, we don't clearly observe a trend in the correlation between China and the Unites States.

Second, for the others countries, we observe that the trend changed around 2002 with a great growth around 2006, so after each reform, the sensitivity of China's financial market to other financial markets will be enhanced. This strong rise in correlation coincides with the

reforms previously presented. This result confirms the objective of the reforms packet to progressively open Chine Financial System. During international crisis, the Chinese stock market has a stronger correlation with others markets because it was more opened and subjected to international risk sources. After the crisis, around 2012, the global economy slowly recovered but we note that the correlation between mainland China and other countries has attenuated (except Hong-Kong). On December 4, 2012, the Shanghai stock exchange index reached the lowest level (1949.46 points) of the year because of the rise of investment in foreign stock markets and the China's real estate market led to a decrease in funds invested in the stock market. The correlation with the Hong Kong stock market, at the opposite, still remains at the same level. Because at the end of 2011, the program RQFII "RMB Qualified Foreign Institutional Investor" was launched in Hong Kong market and was limited to only Hong Kong subsidiaries of Chinese financial institutional. On April 10, 2014, the program Shanghai-Hong Kong stock Connect was announced. Investors in each market are now able to trade securities in each other's markets through their exchange trading and clearing facilities.

Since 2013, CSRC announced to expand the RQFII scheme to other countries. The United Kingdom is the first country outside of Asia to be given a license of this type. Consequently, we notice that SSEA correlation with others countries increases in 2014 and reach a pick in the second part of 2015 during a bubble period in China's Stock Market. The Table 7 summarizes the means of sensitivities and dynamic correlation by periods.

Table 7: summarizes the results by providing a synthesis of dynamic correlations and sensitivities for each period.

	Mean	2000-2002	2003-2006	2007-2009	2010-2014	2015-2017
SSEA-HK	Betahkssea	0.189	0.088	0.404	0.513	0.421
	Betasseahk	0.126	0.164	0.481	0.577	0.605
	ρ_t	0.143(0.052)	0.117(0.066)	0.407(0.123)	0.528(0.025)	0.465(0.040)
SSEA-JP	Betajpssea	0.115	0.089	0.193	0.323	0.235
	Betasseajp	0.082	0.102	0.342	0.266	0.234
	ρ_t	0.088(0.023)	0.089(0.025)	0.235(0.057)	0.280(0.053)	0.208(0.047)
SSEA-EU	Betaeussea	0.037	0.019	0.091	0.147	0.092
	Betasseaeu	0.026	0.039	0.177	0.124	0.108
	ρ_t	0.028(0.025)	0.026(0.020)	0.115(0.032)	0.129(0.037)	0.093(0.025)
SSEA-UK	Betaukssea	0.007	0.007	0.075	0.140	0.109
	Betasseauk	0.014	0.034	0.183	0.228	0.229
	ρ_t	0.009(0.028)	0.016(0.020)	0.107(0.031)	0.171(0.027)	0.145(0.017)
$SSEA\text{-}Us_{t-1}$	$Betaus_{(t-1)}ssea$	0.120	0.065	0.089	0.103	0.076
	$Betasseaus_{(t-1)}$	0.105	0.165	0.210	0.171	0.198
	ρ_t	0.100(0.041)	0.098(0.040)	0.122(0.048)	0.125(0.037)	0.114(0.047)

Note: The values in the parenthesis are the standard deviations.

By comparing the different kinds of sensitivities reported in table 7, we observe that the SSEA sensitivities to other markets became stronger as of 2006 and sharply increase whereas the foreign markets sensitivities to China began increase during the crisis period. This observation indicates that mainland china stock market immediately reacts to system reforms.

In 2011 during the RQFII announcement, the Hong Kong stock market sensitivity to China is higher that Shanghai sensitivity to Hang Seng Index. Similar results for Eurostoxx 50 Index sensitivity are observed during the Debt Crisis period. During the Speculative Period of 2014-2015 in China, the SSE A shares index became more and more sensitive to the other markets.

Since joining WTO at the end of 2001 to the end of 2006, Chinese government has implemented many different reforms in order to gradually open up the Chinese financial market. We refer to the period from the QFII that began in 2002 to the NTS reform that was basically completed at the end of 2006, called the reform period. In order to analyze the effect of reforms on dynamic correlations between mainland China and other markets, it is estimated with a dichotomous variable I_t. The equation is as follows:

$$\hat{\rho}_{ssea,i,t} = c + \varphi I_t + \varepsilon_t$$

where $\hat{\rho}_{ssea,i,t}$ is the dynamic conditional correlation of stock returns between SSEA and i (other markets), parameters c is the constant and φ the slope. We cut the period in two, so I_t=0 for the period from January 04, 2000 to the end of the reform period in December 31, 2006 because 96% of listed companies have completed NTS reforms, and I_t=1 for the period after the reforms. Table 8 presents the result of the regression estimated by the OLS (Ordinary Least Squares) model for the effects of the reforms.

Table 8: Estimates of the effect of the reforms on time-varying conditional correlation of stock returns.

	c	φ	R^2
$\hat{\rho}_{ssea.hk.t}$	0.128***	0.350***	0.8293
	(70.40)	(150.95)	
$\hat{\rho}_{ssea.jp.t}$	0.089***	0.159***	0.7065
	(75.71)	(106.28)	
$\hat{\rho}_{ssea.eu.t}$	0.027***	0.088***	0.6582
	(37.31)	(95.05)	
$\hat{\rho}_{ssea.uk.t}$	0.013***	0.133***	0.8064
	(17.86)	(139.80)	
$\hat{\rho}_{ssea.us(t-1).t}$	0.099***	0.022***	0.0624
	(100.26)	(17.67)	

Note: *denote reject null hypothesis at the 10% critical value, ** 5% critical value, ***1% critical value. The values in the parenthesis are the t-stats.

The R-squared vary between 0.0626 and 0.8293, and the parameter for the dichotomous variable, φ, are positive and vary between 0.022 and 0.35. We observe that the parameter is the highest (0.35) for the Hong Kong-Shanghai correlation, followed by Japan (0.159). For the European stock markets, the effect of reforms for UK is more obvious than European Union. The lowest parameter is for the SSEA-US correlation but it is significant, however the R^2 is very low.

We observe that, the value of parameter $\hat{c}$, represents the estimated average correlation before the reforms. For the period after the reforms, the estimated average value of correlation is provided by $(\hat{c} + \hat{\varphi})$. We note that the correlation before the reforms period is lower than the correlation after reforms. These results are consistent with those presented in table 7. All the reforms support the gradually opening of Chinese financial market. They have strengthened the correlation between mainland China and other international markets.

4. Conclusion

This paper analyzed the dynamic correlations and their sensitivities between Chinese mainland stock market and other major stock markets with the DCC-GARCH model. Based on these correlations, we investigate the effect of Chinese policy reforms.

First, the Chinese mainland stock market has a higher dynamic correlation with one-day lagged US stocks market than US stock market at the moment t due to the time-difference between the two countries.

Second, the Chinese mainland stock market has the highest time varying correlation with Hong Kong stock market, followed by Japan. Geographically, the Chinese mainland market is more closely tied to Asian stock markets over time, followed by the United States, and with relatively lower correlations with Europe and the United Kingdom.

Third, after deciding to open China's mainland stock market and implement a series of reforms, the level of correlation between China’s mainland stock market and other major markets has become stronger. Therefore, the mainland stock market is more sensitive to other markets, and also more sensitive to financial crises. Other stock markets also showed higher sensitivity to the Chinese mainland market during the financial crisis.

The China’s Opening with the reforms packets changes the relationships with liberalized stock market and internationalizes the mainland stock market.

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