

Comovements of the Korean, Chinese, Japanese and US Stock Markets.

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The paper examines Comovements of the Korean, Chinese, Japanese and US stock markets. Korea, Japan, and China are located in the far east Asia sharing the similar time zone and trading hours of the stock markets. The US influences the world market including the Asian countries. The paper examines the comovements of the three Asian countries and the comovements between the Asian countries and the US. In addition, the paper tries to find the change of influences after the 2008 financial crisis started from th US. The paper uses the VAR methodology and the data from 2000 to 2011 to investigate the situation.

1. Introduction

Asian stock markets open a day with the news from the wall street of New York. New York stock exchange ends its trading at 5:00 AM Korean time. Thus, the market participants in Asian countries receive trading information from the Wall Street of the previous day.

Korean stock market opens at 9:00 AM (henceforth Korean time) and closes at 3:00 PM. Japanese stock market opens at 9:00 AM and closes at 3:00 PM. Japanese stock market has break time during the lunch hour, however, Korean stock market dose not have any break time during the opening period of the day. Chinese stock market opens at 10:30 AM and closes at 4:00 PM, having an interim break. Overall the Far Eastern Asian markets trade during the similar hours of a day.

There are papers reporting the US influence on worldwide stock markets,(Lee and Jeon(1995), Eun and Shim(1989), Ng(2000), Bekaert and Harvey(1997), Arshanapalli (1995)). They report the US stock market affects other countries' stock market including Asian countries. They also report the US influence has increased along with the globalization trend.

Eun and Shin(1989) analysed 9 major country stock markets for the period of 1980-1985 using VAR model. Nine countries include US, HongKong, and other developed countries. They reported that the US influence on other countries, however, they didn't find the effects of other countries on the US market. In other words, they reported one way influence from the US market to other markets.

There are papers reporting the comovements of stock markets between the US and the other Asian countries(Kim I.M. and Kim C.W(2001), Gil (2003), Yoo and Kim C.H(1997), Moon and Hong(2003),Cho and Bauer(2002)). They report the US influence on the Asian countries including Korea. They also report that the level of influence seem to be upgraded since the Asian financial crisis of 1997.

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Korea and other South East Asian countries suffered from the financial crisis of 1997. The Asian financial crisis was a limited phenomenon within the region. However, the current economic turmoil is a global phenomenon started from the US in 2008.

The global economy seemed to rebound from its turmoil of 2008 in a couple of years. However, the global economy did not recover fully from its turmoil and turned into recession again. One of the issue of this paper is to look at the situation before and after the 2008 turmoil. In other words, we try to figure out if the US influence on Asian countries is the same as before.

The other issue of this paper is to look at the comovements among the three Asian country stock markets, including Korea, Japan, and China. Those three stock markets are open during similar hours. We want to see the pattern of information transformation among those three stock markets. We want to see the comovements of the three markets especially because the relative importance of those three markets has been increasing in the global market lately.

Next section describes data and methodology of the paper. The next section reports the results and analysis. Finally the paper summarizes and comments on the results.

2. Data and Methodology

2.1 Data

The data includes KOSPI of Korea, S&P 500 of the US, NIKKEI 225 of Japan, and SSEC of China. These indexes are major indexes representing each stock market. The total period of analysis is from 2000. 1. 1. to 2011. 6. 30. We also divide the period into two. The previous period is set at 2001.1.1. to 2007.12.31. The later period is set at 2009.1.1. to 2011.6.30. We divide the total period into two periods to see if there exists a possible structural change before and after 2008 turmoil.

We exclude the year 2008 when we divide the periods into two because we want to see the effects before and after 2008. Of course, we may lose observations excluding 2008, however, the data of the turmoil might lead us to biased understanding. That's why we exclude the 2008 in the before and after data.

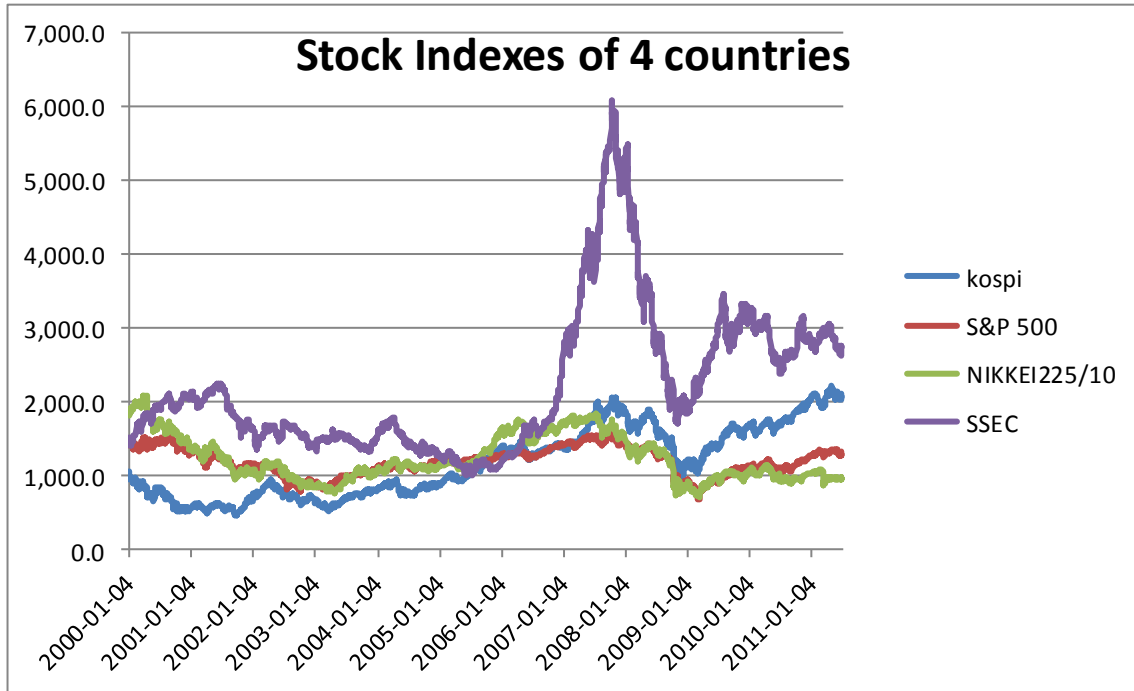
Figure 1 shows the stock index movements of the four countries during the period of 2001 ~ 2011. 6.30. Korean, Chinese, Japanese and the US indexes started the year of 2001 at the level of 1,028 , 1,368, 18,937, and 1,446 respectively. In the figure, the Japanese index numbers are divided by 10 to adjust the scale with other index numbers.

Since the turmoil of 2008, every country has suffered some loss in the stock market. The US and Japan were most severely damaged, The US experienced the lowest at the 9th of march of 2009 and the lowest of the Japan was at the 10th of march of 2009. In the figure, the lowest of Korea was at 2001 and the lowest of China was at 2005.

The highest point in the stock market appeared at different periods. The US and China revealed the highest point at 2007, before the 2008 economic turmoil. Japan showed the highest point at 2000 representing a long run slow down of the economy. Korea showed the highest point at 2011.

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Figure 1: Stock Indexes of 4 Countries



Overall, Japan has experienced the decade of long recession period and other three countries have experienced a bull trend up to the year of 2007. Every country experienced a severe damage in 2008 and it lasted up to the 1st quarter of 2009. After that each country showed a general trend of overall recovery. Korean recovery was relatively faster than other countries.

We use log rate of return in the paper. In the paper R_k , R_{us} , R_{jp} , and R_{ch} represent the stock index returns of Korea, the US, Japan, and China respectively.

$$R_{j,t} = (\log P_{j,t} - \log P_{j,t-1}) \times 100 \quad (1)$$

Table 1 shows the descriptive statistics of index returns of each country. On average, China shows the highest average return during the period. Korea, the US, and Japan follows China on average returns. In case of China, the previous period experienced higher returns than the later period. In other countries, the later period experienced higher returns than the previous period. The countries suffered a serious loss from the financial turmoil and rebounded later, except China. China was less damaged from the financial turmoil, thus, the recovery was less rapid relative to other countries.

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Table 1: Descriptive Statistics of Indexes

	Rk				Rus			
	Total	Previous	Later	2008	Total	Previous	Later	2008
Average	0.0083	0.0099	0.0482	-0.1028	-0.0027	-0.0009	0.0326	-0.1041
Median	0.0502	0.0519	0.0735	-0.0197	0.0270	0.0203	0.0550	0.0000
Max	4.9007	4.3685	2.2494	4.9007	4.5269	2.4204	2.6804	4.5269
Min	-6.9988	-6.9988	-2.7020	-4.8519	-5.9835	-3.4041	-2.3566	-5.9835
Std.Dev	0.8261	0.8356	0.5867	1.1762	0.6268	0.5086	0.6195	1.2071
Skewness	-0.5911	-0.6476	-0.3805	-0.1763	-0.4124	-0.0515	-0.1532	-0.3838
Kurtosis	9.5340	9.2948	5.5601	6.7787	12.418	6.3778	5.6188	7.5412
Jarque-Bera	4574.4	2968.6	161.7	132.63	9272.7	820.8	157.6	195.33
Probability	0	0	0	0	0	0	0	0
N	2490	1725	544	221	2490	1725	544	221

	Rk				Rus			
	Total	Previous	Later	2008	Total	Previous	Later	2008
Average	0.0083	0.0099	0.0482	-0.1028	-0.0027	-0.0009	0.0326	-0.1041
Median	0.0502	0.0519	0.0735	-0.0197	0.0270	0.0203	0.0550	0.0000
Max	4.9007	4.3685	2.2494	4.9007	4.5269	2.4204	2.6804	4.5269
Min	-6.9988	-6.9988	-2.7020	-4.8519	-5.9835	-3.4041	-2.3566	-5.9835
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Skewness	-0.5911	-0.6476	-0.3805	-0.1763	-0.4124	-0.0515	-0.1532	-0.3838
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Probability	0	0	0	0	0	0	0	0
N	2490	1725	544	221	2490	1725	544	221

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The standard deviation of the US was the lowest during the total period. However, the standard deviation of Korea is even lower than the US during the later period. It means that the volatility of the US has increased since the economic turmoil of 2008.

We can easily notice that the year of 2008 was a turmoil period. The rate of return of each index has experienced a serious loss and the volatility of standard deviation has increased abruptly. That's one of the reason we eliminate the 2008 year when we divide the data into two.

We employed the unit root test to use the time series data. When the serial data is non-stationary, the data has a unit root and the analysis may not be useful. We also may not get economic meanings with the non-stationary data. We used ADF(Augmented Dickey Fuller)test and PP(Phillips-Perron)test to check the existence of the unit root.

Table 2 reports the unit root test of the index returns. The data of returns rejects the null hypothesis of the unit root with both ADF and PP test. We conclude the data is stationary and can be used when we employ VAR(Vector Auto Regression) model for analysis. In addition to the unit root test, we tried the cointegration test, and found that the error correction term is not necessary.

Table 2: Unit Root Test

	Rk	Rus	Rjp	Rch
ADF - Fisher	18.4207	87.723	18.4207	18.4207
prob.	0.0001	0	0.0001	0.0001
PP - Fisher	18.4207	18.4207	18.4207	18.4207
prob.	0.0001	0.0001	0.0001	0.0001

2.2 The Methodology

The paper uses the VAR(Vector Auto Regressive model) to analyze the relationship among the indexes. The VAR model is useful to analyze a time series data and is also useful for the Granger causality analysis, and impulse response functional relation analysis. The VAR model does not depend upon a prior theory or structural equation, rather, it generates internal relation using the historical internal data. The 12th VAR(p) is expressed in equation(2)

$$y_t = A_0 + A_1 y_{t-1} + \dots + A_p y_{t-p} + \epsilon_t \quad (2)$$

The VAR model use the SC information criterion and HQ information criterion to find the appropriate fitness, the level of lag, and the inclusion of the constant term. we use the model of lag one without the constant term.

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Table 3: SC and HQ information

차수	상수항포함		상수항 없음	
	SC	HQ	SC	HQ
1	8.104841*	8.074992*	8.093872*	8.069993*
2	8.13219	8.078461	8.121293	8.073535
3	8.158894	8.081287	8.148066	8.076429
4	8.196331	8.094844	8.185374	8.089857
5	8.224504	8.099138	8.213574	8.094178
6	8.262458	8.113213	8.251588	8.108312
7	8.302796	8.129671	8.291808	8.124653
8	8.346451	8.149447	8.335552	8.144518

3. The Results

3.1 VAR Results

Table 4 reports the VAR estimation results. The US shows a small negative serial correlation with its own historical data. The US lag data show significant positive influence on China, Korea, and Japan. The Chinese lag data shows negative influence on Korea and Japan. The Japanese lag data shows negative influence on Korea and Japan.

Table 4: VAR Results (total period)

	Rus	Rch	Rk	Rjp
Rus(-1)	-0.05305	0.162331	0.446301	0.548598
	[-2.56822]	[6.37630]	[17.3664]	[25.1326]
Rch(-1)	-0.00352	-0.0119	-0.04362	-0.05582
	[-0.21198]	[-0.58191]	[-2.11315]	[-3.18405]
Rk(-1)	0.009965	0.015067	-0.03003	-0.00203
	[0.51099]	[0.62687]	[-1.23756]	[-0.09866]
Rjp(-1)	-0.03499	-0.03786	-0.07675	-0.11492
	[-1.60722]	[-1.41096]	[-2.83328]	[-4.99509]

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Table 4.1: VAR Results

	Previous				Later			
	Rus	Rch	Rk	Rjp	Rus	Rch	Rk	Rjp
Rus(-1)	-0.0064	0.0784	0.5963	0.4718	-0.0937	0.2494	0.3646	0.6453
	[-0.262]	[2.341]	[15.85]	[16.84]	[-2.108]	[4.795]	[9.277]	[14.86]
Rch(-1)	0.0030	-0.0130	-0.0186	-0.0251	0.0354	0.0278	-0.0339	-0.0770
	[0.169]	[-0.536]	[-0.683]	[-1.236]	[0.900]	[0.602]	[-0.975]	[-2.003]
Rk(-1)	-0.0233	0.0248	-0.0455	-0.0036	0.0865	-0.1083	-0.1073	-0.1823
	[-1.309]	[1.017]	[-1.660]	[-0.177]	[1.375]	[-1.470]	[-1.929]	[-2.968]
Rjp(-1)	-0.0163	-0.0015	-0.0165	-0.0594	-0.0134	-0.0010	-0.0591	-0.0335
	[-0.688]	[-0.046]	[-0.453]	[-2.187]	[-0.271]	[-0.017]	[-1.353]	[-0.696]

The results of the VAR model change a little when divide the periods into two. In the previous period, the US lag data influences on other countries' market. However, in the later period, Japan is influenced by the US, China, and Korea's lag data.

3.2 Granger Causality Results

The VAR results show how the lag data of the countries affect the current status of return. However, the results do not report the causality of the relationship. The Granger causality analysis reports which country affects the return of the other country's index movement. The Granger analysis uses the block exogeneity test when we use the VAR model.

Table 5 reports the Granger causality results. When we look at the results of the total period, the US influences three Asian countries on one direction. Korea and Japan are affected by the US and China. Korea is also affected by Japan.

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Table 5: Granger causality

Rus(total)			Previous		Later	
	Chi-sq	Prob.	Chi-sq	Prob.	Chi-sq	Prob.
Rch	0.044936	0.8321	0.028716	0.8654	0.810324	0.368
Rk	0.261114	0.6094	1.714212	0.1904	1.892439	0.1689
Rjp	2.583171	0.108	0.474135	0.4911	0.073645	0.7861
All	3.156868	0.3681	4.565325	0.2065	4.820674	0.1854
Rch(total)			Previous		Later	
Rus	40.65717	0	5.480261	0.0192	22.99386	0
Rk	0.39297	0.5307	1.035017	0.309	2.163527	0.1413
Rjp	1.990795	0.1583	0.002191	0.9627	0.000312	0.9859
All	42.8979	0	8.136771	0.0433	23.48011	0
Rk(total)			Previous		Later	
Rus	301.592	0	251.3553	0	86.07265	0
Rch	4.46541	0.0346	0.467172	0.4943	0.951216	0.3294
Rjp	8.027462	0.0046	0.206068	0.6499	1.832129	0.1759
All	309.3806	0	252.1067	0	87.74412	0
Rjp(total)			Previous		Later	
Rus	631.646	0	283.6842	0	221.0154	0
Rch	10.13818	0.0015	1.5293	0.2162	4.01314	0.0451
Rk	0.009734	0.9214	0.031521	0.8591	8.810239	0.003
All	652.5792	0	289.0072	0	222.9445	0

The US influence on the three Asian countries still exist even after 2008 financial turmoil of the US. The difference between the previous period and the later period is the mutual causality among the three Asian countries. In the previous period the three countries did not show any causality among them. In the later period, Japan was influenced by Korea and China in addition to the US.

3.3 Impulse - Response Results

The impulse - response analysis reports the lag of response time when a market affects the other. The impulse is a unit standard deviation of the error term of a market index return, the response is the change of the returns of the other.

The impulse - response function can be influenced by the sequence of the variables. Thus, we need to decide the sequence of the variables. Usually the most exogenous variable enters first in the analysis. The sequence of the variables was determined by

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the pairwise Granger causality. In this paper, the US is selected as the first entrance. China, Korea, and Japan appeared in sequence. Table 6 reports the impulse - response estimation results. The first part reports the US response from the impulse of each country. The US responds from its own impulse. The second part shows the Chinese response. China responds from its own impulse and the US impulse.

Korea responds from its own impulse and also from the US and China. Japan tends to respond from other impulses. We also checked the two separate periods. In the later period, the level of responses in Korea has increased. The situation seems to be shared with Japan.

Table 6: Impulse-Response estimation results

Rus reponse				
Term	Rus	Rch	Rk	Rjp
1	0.6249	0.0000	0.0000	0.0000
	(0.0089)	0.0000	0.0000	0.0000
2	(0.0373)	(0.0056)	(0.0038)	(0.0189)
	(0.0125)	(0.0125)	(0.0119)	(0.0118)
3	(0.0070)	0.0019	0.0011	0.0028
	(0.0060)	(0.0014)	(0.0015)	(0.0017)
Rch response				
Term	Rus	Rch	Rk	Rjp
1	0.0426	0.7690	0.0000	0.0000
	(0.0154)	(0.0109)	0.0000	0.0000
2	0.0975	(0.0118)	(0.0010)	(0.0204)
	(0.0155)	(0.0154)	(0.0146)	(0.0145)
3	(0.0155)	0.0007	0.0001	(0.0011)
	(0.0075)	(0.0023)	(0.0022)	(0.0024)
Rk response				
Term	Rus	Rch	Rk	Rjp
1	0.2058	0.1079	0.7419	0.0000
	(0.0153)	(0.0150)	(0.0105)	0.0000
2	0.2577	(0.0455)	(0.0469)	(0.0414)
	(0.0161)	(0.0156)	(0.0148)	(0.0146)
3	(0.0532)	0.0037	0.0027	(0.0015)
	(0.0090)	(0.0055)	(0.0051)	(0.0052)

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Rjp response				
Term	Rus	Rch	Rk	Rjp
1	0.1720	0.1141	0.3203	0.5393
	(0.0130)	(0.0127)	(0.0117)	(0.0076)
2	0.3203	(0.0563)	(0.0383)	(0.0620)
	(0.0141)	(0.0133)	(0.0126)	(0.0124)
3	(0.0632)	0.0041	0.0025	(0.0020)
	(0.0091)	(0.0067)	(0.0064)	(0.0064)

4. Summary and Conclusion

We studied the comovements of stock markets using KOSPI, SSEC, NIKKEI 225, and S&P 500 indexes. The period of analysis covers from 2001 to 2011. We experienced two conspicuous phenomena during the period. One is the wide spread globalization and the other is the economic turmoil at the global level. The turmoil has started from the US.

The dynamic comovement was analyzed using the VAR model, Granger causality, and impulse-response functions. As were the previous research results, the one way influence of the US on other countries was still in effect. In case of China, the country was only influenced by the US. Korea was Granger caused by the US, China, and Japan. Japan was granger caused by the US and China. Japan was influenced by not only the US but also China and Korea in the later period.

The paper empirically tested if the 2008 economic turmoil changed the relationship among the US and far eastern Asian countries. The US influence has been dominating before and after the turmoil. However, the influence of the Chinese market seemed to increase in recent years.

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