2007 International Conference on Convergence Information Technology

The Association of Stock Index among the market of China, US., and Japan

Meng-Long Shih, National Taitung University
sh48@ms17.hinet.net
Shu-Hua Hsiao, Leader University, Corresponding author.
mm5846@yahoo.com.tw
Fang-Sheng Chen, Industrial Bank of Taiwan
anson.chen@ibts.com.tw

Abstracts

With trend of globalization in international financial market, more intimate of capital flows was formed day by day in capital market. Thus, it is important to understand the relationship of individual country in international stock markets. The main purpose of this study is to explore the relationship of Stock Index among the China, US., and Japan. The study period was covered from March 2001 to December 2006. By using the Cointegration Test, Granger Causality, and Forecast Error Variance Decomposition to identify whether the stock market exits long-term relationship among the China, US., and Japan. Results show that six Stock Indices present severe volatility, however, there is no Cointegration relationship. Further, Shanghai B Shares ahead of other three stocks and influence each other. Finally, the US' stock ahead of Shenzhen B Shares and Japan's. China stock market is closed, that Stock Index was no influence by US. and Japan markets.

Key Words: **Cointegration Test, Granger Causality, Forecast Error Variance Decomposition**

1.Introduction

Under international finance market globalization, capital market became more closely associated due to cash flow of various countries, so that international stock market correlation rose. Correlation of international stock market became important topic of theoretical and empirical research in financial discipline. Ripley(1973), Panton, Lessig and Joy(1976) argued that in countries of free trade and free capital flow, their stock integration were higher. Eun and Shim(1989) regarded that, when economic integration got higher, stock price variation became more correlated; hypotheses on stock market interaction included what Forbes & Rigobon (2002) defined Contagion effect as shock arising out of one country (or regional countries) tends to make market co-movement significantly rise. Results showed that positive or negative impact enhances or undermines interaction between stock markets, and also influences strategy of investor, and international capital flow, resulted in multiple balances. Besides, Madura(1998) suggested that, when there was certain factor to influence global overall economy, international stock market would give rise to comovement.

Since capital market had close interaction, investor could make each asset price consistent with that in other capital market by means of carry trade. Opening the door to international capital market research, Grubel(1968) applied portfolio theory first into international capital market. He pointed out benefit of international portfolio. Campbell and Hamao (1992) pointed out that if capital market was integrated, financial assets traded in different markets, given the same risk feature, would have the same predicted return; if capital market was isolated, investor would have trouble making carry trade in different markets. In other word, although the same financial asset was traded in different market, different predicted returns would result even under the identical risk feature. Hence, investors could make full use of international market correlation characteristic to acquire benefit of carry trade and risk distribution.

Since China established "Shanghai Security Exchange" in 1990, and "Shenzhen Security Exchange" in July of next year, public shares were mainly divided into A-share and B-share, originally, A-shares were to be bought by natural persons and legal persons in territory of China; B-shares were to be bought by foreign natural persons and legal persons, but eventually, in order to increase mobility of B-share, strengthen

DOI 10.1109/ICCIT.2007.386

investment intent of foreign fund on capital market, meanwhile to pave the way towards WTO, the mainland administration lifted the restriction of persons in territory of China investing in B-share on Feb.19, 2001.

Recently China loosened its policies, gradually lifted restrictions on foreign investment, 2008 Beijing Olympic Game was driving various infrastructures, plus huge internal demand market, foreign exchange reserve hit high frequently, 2007 economic growth rate was predicted to amount to 10% for the fifth year in a row, therefore, it attracted eyesight of many international investors, and drove stock market booming as well, so that China stock market received international concentration. Further attracting influx of more international hot money, wave of investing in China stock market kept on rapid heating.

To avoid overheated industry investment and influx of speculative hot money, China government launched cooling measures one after another, including multiples measures such as macro-control related policies in April 2004. Raising bank deposit reserve ratio for several times, recollecting land VAT, implementing energy conservancy policy so as to inhibit plant investment, which resulted in not only China stock market collapse, but also international stock market weakening. On February 27, 2007, black Tuesday, China stock market plunged nearly 9%, giving rise to chain reaction of stock markets of many regions in the world such as Asia, Europe and USA., frustrated one after another. Therefore, in China stock market that is becoming more and more important, it was a key issue to study interaction and integration relationships between China stock market and international stock market, so as to find proper trade communication rule and portfolio strategy.

Most research methods of international stock market or bond market focused on vector autoregression (VAR) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) family model, e.g., Engsted & Tanggaard (2006). As USA and Japan stock markets were maximum capital markets of the world and Asia respectively, and largest trade competitor country of China, accounting for about 40% of total China export and import output, therefore, this study used cointegration relation test to investigate whether stock markets of China, USA, Japan with close economy and trade relation, have long-term close-heeled cointegration relation; and used VAR causality test to analyze whether USA and Japan markets have return leading effect on four markets in China (Shanghai A, B-shares and Shenzhen A, B-shares); finally used prediction error variance decomposition to acquire interaction and exogeneity intensity of stock indices of various stock markets, so as to provide investor useful information as important reference for fund arrangement and investment decision.

This paper is organized as follows. In section 2, we review related literature and hypotheses. In section 3, Data and Research Method In section 4, empirical data analysis is performed. Finally, In section 5, we discuss the results of our study and suggest the direction for future research.

2. Review related literature and hypotheses

Eun and Shim(1989) used Johansen's Maximum Likelihood Cointegration and Vector Autoregressive Model (VAR) to study interaction of New York, London, Tokyo, Toronto, Frankfurt, Zurich, Sydney, Hong Kong, Paris from December of 1979 to December of 1985. Empirical result showed that the above nine stock markets have indeed highly associated characteristic. Fisher and Palasvirta (1990) studied major stock markets in Europe and USA and stock markets in some emerging countries as dynamic object, sampled stock market data from 23 countries, daily return data of stock prices from 1986-1988, empirical study found that, above countries had interdependent relation, USA market was obviously leading world stock market, but in terms of USA and Japan stock markets, though having intimate trade partnership, their interdependency was not high, indicating that their stock market behaved more independently than other countries. Chan, Gup and Pan (1992) employed two-step cointegration method, sampled from stock markets in USA, Japan, Taiwan, Singapore, Hong Kong, Korea, daily and monthly data ranging from Feb.1, 1983 to May 31, 1987, study result showed: no cointegration among stock markets, thus distributing investment to stock markets of various countries could benefit from distributing risk. Huang(2000) used Johansen Maximum Likelihood Method to analyze Japan, USA, Taiwan, Hong Kong, Mainland, resulted in that no cointegration relation existed between Japan and other stock markets, but USA stock market had strong causality with Taiwan, Hong Kong, Shanghai and Shenzhen, hence USA stock market performance could be utilized to predict stock price variation of Hong Kong and Taiwan next day. Chang, Chou, and Wu (2000) applied VAR test in stock market daily return of five Chinese regions, Taiwan, Hong Kong, Singapore, Shanghai and Shenzhen, as well as USA and Japan; empirical finding was that among 7 stock markets, USA and Japan were most influential, while Hong Kong stock market was most vulnerable to international stock market.

There were many past studies about comovement in international equity markets. For example, Berben & Jansen (2005) developed a novel bivariate GARCH model for equity returns to explore correlation patterns among international equity returns at the market level as well as the industry level among Germany, Japan, the UK and the US in the period 1980~2000. Results show that "correlations among the German, UK and US stock markets have doubled, whereas Japanese correlations have remained the same." The U.S. market is the leading market and significant impact on all markets across continents. The U.S. market exhibits strong regional transmission effects exist and demonstrate contagion influence over countries outside its own region among the US, Canada, and the U.K. A different relationship exits in Asia-Pacific markets (Hsin, 2004). Results of Morana & Beltratti (2006) revealed, particularly strong for the US and Europe, "a progressive integration of the four stock markets, leading to increasing comovements in prices, returns, volatility and correlation." In addition, Henry, Olekalns, & Suardi (2004) found that a relationship of level effect and asymmetric response exits between S&P 500 Index returns and 3-month US Treasury Bills.

Furthermore, Hsu(1995) made cointegration study of stock market weekly data of Taiwan, Japan, Singapore, Hong Kong and Korea; study result: individual market had no significant cointegration relation, but Japan, Hong Kong, Singapore markets had stronger correlation. Yang(1999) discussed and studied international stock market interaction, the subject was stock index weekly return rates of USA, Japan, Hong Kong and Taiwan, conducted cointegration modeling and Granger causality test, resulted in that USA stock index had unilateral causality to Japan, Hong Kong and Taiwan stock indices, while Japan had only causality to Taiwan, Hong Kong stock indices.

In summary, past researchers' results pointed out that: USA market was still leading world stock market, while international stock market globalization, more finance freedom, multinational investment and information response efficiency would enable higher interaction in international stock market; as to countries with more independent trades, their stock markets were not so vulnerable to stock markets of other countries. Thus, study hypothesis was established as follows:

H_1: China has long-term cointegration relation with USA and Japan stock markets.

H_2: USA stock market leads Japan and China stock markets.

H_3: China stock market is not vulnerable to USA, Japan stock markets

3. Research Method

1. Data scope and source

Empirical object of this study was stock market of China, USA and Japan, including mainland Shanghai A-share, B-share, Shenzhen A-share, B-share, USA stock market index adopted S & P 500 index, Japan stock market index adopted Nikkei 225 index. Data stemmed from data bank of Taiwan Economic Journal international index. Sampling period was from Mar.19, 2001 to Dec.14, 2006. (sampling period in this study was based on the fact that China authority opened B-share purchase by mainland people on Feb.19, 2001, as at the beginning of opening, excessive fluctuation of A-share and B-share might influence empirical result, hence delete data of one month after opening to reduce impact of extreme values on modeling parameter prediction).

Since every country had varied sabbatical leaves, according to empirical result of Hama(1990), if no country had transaction in the same empirical model, then transaction data of other country on the same day should be deleted, which did not affect correctness of empirical result. Therefore this study would employ Hama approach to deal with asynchronous transaction day problem. There were totally 1,278 daily data.

2. Research method

(1) Unit root test

This paper employed Dicker and Fuller (Augmented Dickey-Fuller or ADF proposed in 1981) test to check whether stock index had unit root feature, this test had three types:

1. No drift term and no trend term, as shown below:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{m} \delta_t \Delta Y_{t-1} + \varepsilon_t \quad (3\text{-}1)$$

2. Random walk mode with drift term but without trend term, as shown below:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{m} \delta_t \Delta Y_{t-1} + \varepsilon_t \quad (3\text{-}2)$$

3. Random walk mode with drift term and trend term, as shown below:

$$\Delta Y_t = \alpha_0 + \beta T + \gamma Y_{t-1} + \sum_{i=1}^{m} \delta_t \Delta Y_{t-1} + \varepsilon_t \quad (3\text{-}3)$$

Where: $\Delta Y_t = Y_t - Y_{t-1}$, α_0 was intercept term, T was time trend term, m was lag period, ε_t was residual term. Null hypothesis proposed was:

$$H_0: \gamma = 0 \quad (3\text{-}4)$$

When we failed to reject H_0: γ=0 null hypothesis, indicating this series has unit root, being non-constant series; if reject null hypothesis, then it indicated the serial had no unit root, it was a constant series.

(2) Cointegration

To solve spurious regression problem, while making nonstationary time series analysis, was to make regressive analysis of differentiated stationary series, but differentiation would lose long-term characteristic of series, leaving only short-term information, in other words, if variables were nonstationary series, during differentiation to reach stationary state, some implicit important long-term information of data itself would be lost, leading to wrong setting of dynamic relation between variables, so it failed to decide whether there was steady long-term balance among variables.

Cointegration was statistic model developed by Engle and Granger (1987), in order to use cointegration vector to study long-term relation of nonstationary series, if two series were nonstationary and had the same unit root, yet their linear mix was stationary, then these two series had cointegration relation, or there was long-term balance between them. Engle and Granger pointed out: two or multiple nonstationary series with same integration order, might have one or multiple long-term common trends, so that linear mix among variables could form a stationary series.

Most common measurement methods of cointegration included: (l)Engle and Granger (Two-step Estimation) and (2)Johansen and Juselius(1990) trace statistic and maximum characteristic root statistics. Although two-step estimation method is easy to run, it needs larger samples, and is susceptible to generate estimation error, therefore this study employed Johansen cointegration method.

Johansen maximum likelihood method supposes that, among variables to test cointegration, there is at most r cointegration relation (r is called Cointegration Rank), take this as null hypothesis, use maximum likelihood ratio method to test H_0: there is at most r cointegration vectors. The procedure was to use maximum likelihood estimation method to construct cointegration model:

$$\Delta Y_t = u + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-1} + \Pi Y_{t-k} + \varepsilon_t \quad (3\text{-}5)$$

where, Yt is (p×1) dimensional endogenous variable matrix; Γ is (p×p) dimensional coefficient matrix to estimate; k is intervening term conforming to fittest delay period in white noise process; ΠY_{t-k} is error correction term; ε_t is (p×1) dimensional matrix. To test cointegration number in maximum likelihood ratio method, we could employ maximum characteristic value, start test from no any cointegration relation among variables, or r= 0(H_0: r = 0), then gradually increase cointegration number to test, till unable to reject, then it indicates variables have long-term stable relation.

H_0: at most r cointegration vectors (3-6)

H_1: at least r+1 cointegration vectors (3-7)

Special attention must be taken when data test has cointegration relation, long-term correction term has to be added into vector autoregressive model, converting model to vector error corrected model, in case statistic error occurs.

(3) Vector autoregressive model

Vector autoregressive model was a kind of time series analysis dynamic model, comprising of groups of vector regressive equations of multiple variables. Vector autoregressive model needs neither transcendent theory basis nor variable endogeneity and exogeneity and causality, regard all variables as endogenous variables, take lag term of this variable with other variable as descriptive variable, use a group of regressive equations to represent variable interaction, for time series nitty-gritty lies on that lag term already reflects all related information. Vector autoregressive model format was as follows:

$$Z_t = \alpha + \sum_{i=1}^{m} \beta_i Z_{t-1} + u_t \quad (3\text{-}8)$$

where, $E(u_t) = 0, E(u_t Z'_{t-1}) = 0$, Z_t is linear random process composed of (m×1) vector with joint covariance stationary feature, Z_t is the very variable in model, m is the number of variables to discuss in model, β_t is (m×m) coefficient matrix, Z_{t-1} is (m×1) vector composed of t-i period lag term variables, u_t is (m×1) t period prediction error, u_t can be deemed as random shock term, $E(u_t) = 0$ represents that error term expectation value of every regressive formula in model is 0, $E(u_t Y'_{t-i}) = 0$ represents that each formula is independent series, and error term and every lag term are independent of each other.

Vector autoregressive model could be aided by analysis tools to determine variable relation, including shock response function and prediction error variance decomposition.

(4) Causality test

Granger put forward causality definition in 1969, defining causality between variables from perspective of “prediction ability”. Suppose two time series X, Y, when predicting X, if adding past value of Y to information set would get more accurate prediction result of X, then it indicates “Y is the cause of X”, alternatively, X might be the cause of Y, too. When above two relations coexist, then we call X and Y have Feedback relation. And so-called causality here was not completely notation of “X leads to Y”, but also “lead-lag” relationship.

Causality test in VAR model is to take account of simultaneous system of all formulae, test with F statistic. Hereafter describe causality test with a binomial (Y_{1t},Y_{2t}) VAR(p)model:

$$\begin{bmatrix} Y_{1t} \\ Y_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} \\ \beta_{21,1} & \beta_{22,1} \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ Y_{2,t-1} \end{bmatrix} + ... + \begin{bmatrix} \beta_{11,p} & \beta_{12,p} \\ \beta_{21,p} & \beta_{22,p} \end{bmatrix} \begin{bmatrix} Y_{1,t-p} \\ Y_{2,t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \quad (3\text{-}9)$$

To test if Y_{1t} and Y_{2t} have cause-effect (lead-lag) relation, then their null hypotheses were respectively:

$$H_0 : B_{12,1} = B_{12,2} = ... = B_{12,p} = 0 \quad (3\text{-}10)$$

$$H_0' : B_{22,1} = B_{22,2} = ... = B_{22,p} = 0 \quad (3\text{-}11)$$

If test result fails to reject null hypotheses H_0 and H_0' at the same time, then it indicates that there is no causality between Y_{1t} and Y_{2t}, they are independent of each other; if rejecting null hypothesis H_0' but not rejecting null hypothesis H_0, it means Y_{1t} leads Y_{2t}; if rejecting null hypothesis H_0 but not rejecting null hypothesis H_0', it means Y_{2t} leads Y_{1t}, and if rejecting two null hypothesis at the same time, then it indicates Y_{1t} and Y_{2t} have cause-effect feedback relation.

(5) Prediction error variance decomposition

Prediction error variable decomposition primarily studies exogeneity ordering of economic variables.

$$Z_t - E_{t-k}(Z_t) = D_0\varepsilon_t + D_1\varepsilon_{t-1} + ... + D_{k-1}\varepsilon_{t-k+1} \quad (3\text{-}12)$$

In equation (3-12), $E_{t-k}(Z_t)$ denotes prediction value obtained by using all known information to predict Z_t at t-k period, and error possibly derived, from k order prediction error, obtain corresponding prediction error covariance matrix:

$$\begin{aligned} & E(Z_t - E_{t-k}(Z_t))(Z_t - E_{t-k}(Z_t))' \\ & = D_0 E(\varepsilon_t \varepsilon_t') D_0' + D_1 E(\varepsilon_t \varepsilon_t') D_1' + ... + D_{k-1} E(\varepsilon_t \varepsilon_t') D_{k-1}' \end{aligned} \quad (3\text{-}13)$$

It could be seen from equation (3-13) that variance of every variable could be expressed as weighted sum of all variable variances, or values on diagonal of each period, and these values were dependent on elements of D_k matrix; thus, by means of coefficient matrix D_i in moving range expression of vector autoregressive model, we could decompose k order error variance of predicting each variable, and from D_i calculate percentage of prediction error decomposition of each variable, so as to judge variable exogeneity intensity, error variance vulnerability of other variable, and interaction maybe existed among variables.

4. Empirical Analysis

(1) Basic statistic analysis

In regard to descriptive statistic of Table 1 stock indices, in study period, six stock markets exhibited strong fluctuation, stock index difference was above 2 times, in particular Shanghai B-share was as high as 4.67 times; it is known from skewness coefficients of all stock indices that, except that USA S&P 500 index was leftward distribution (skewness coefficient<0), all other stock indices were rightward distribution (skewness coefficient>0). As to kurtosis, except USA S&P 500, Nikkei 225 indices were less than 3, belonging to low flat peak distribution; kurtosis coefficients of all stock indices were greater than 3, belonging to high narrow peak distribution.

In regard to descriptive statistic analysis of Table 2 return rate, in terms of average return rate, except Shenzhen B-share among four China stock markets had average return rate greater than USA, Japan; all the remaining markets were less than USA, Japan, and Shenzhen A-share was the only market with negative average return rate among six stock markets in sampling period. Result showed that China stock market performed worse than expectation during sampling period. besides, using standard deviation as alternate variable of risk, and observing return obtained for investor to withstand a unit risk (or average return/standard deviation), the result indicated: Japan, Shenzhen B-share have highest return rates, this means recent Japan economy resurrection tends to be stable, while in China, except Shenzhen B-share, other three capital markets have lower return, reflecting “high risk, low return” feature of China stock market during sampling period. In terms of skewness, kurtosis coefficients, six capital market except Shenzhen B-share were rightward high narrow peak distribution; Jarque-Bera values indicated that return rates of six capital markets did not follow normal distribution, corresponding to viewpoint of Engle (l982): most finance commodity time series data do not conform to normal distribution.

Table 1 Descriptive statistic analysis of China, USA, Japan stock indices

	Shanghai A-share	Shanghai B-share	Shenzhen A-share	Shenzhen B-share	S&P 500	Nikkei 225
Mean	1594.823	113.5932	429.1727	254.4553	1126.530	11833.87
Maximum	2364.380	239.7300	697.6800	435.5700	1425.490	17563.37
Minimum	1062.450	51.34000	245.9300	185.5200	776.7600	7607.880
Standard deviation	286.2688	36.55373	102.9368	47.09569	136.8847	2379.807
Skewness coefficient	0.608075	0.776121	0.615762	1.208774	-0.409539	0.659092
Kurtosis coefficient	3.228226	3.387676	3.283438	4.439165	2.557014	2.606670
Jarque-Bera	81.53155	136.3065	85.03969	421.5130	46.17449	100.7659

Note: period 2001/3/19-2006/12/14

Table 2 Descriptive statistic of China, USA, Japan stock return rates

	Shanghai A-share	Shanghai B-share	Shenzhen A-share	Shenzhen B-share	S&P 500	Nikkei 225
Mean	0.017879	0.012471	-0.004210	0.044903	0.021677	0.032966
Maximum	9.855780	9.917987	9.680701	11.32940	5.732732	7.488904
Minimum	-6.298188	-15.29349	-6.523427	-18.09314	-4.921559	-7.457113
Standard deviation	1.421363	2.038973	1.516560	2.094179	1.120783	1.471127
Mean/standard deviation	0.012579	0.006116	-0.00278	0.021442	0.019341	0.022409
Skewness coefficient	0.735156	0.019695	0.473303	-0.322526	0.288554	0.083128
Kurtosis coefficient	8.408048	10.59796	7.554492	11.22716	6.362999	4.983176
Jarque-Bera	1671.210	3071.745	1151.399	3623.605	619.4947	210.7384
Probability	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Observation	1277	1277	1277	1277	1277	1277

Note: period 2001/3/19-2006/12/14

(2) Unit root test

This paper used ADF to validate whether sample data were stationary. Result of Table 3 showed, data of three variable levels used in this study, unit root test of index variables of Shanghai A-share, Shanghai B-share, Shenzhen A-share, Shenzhen B-share, S&P 500, Nikkei 225, were not constant series; after first order differentiation, all series became stationary, amounting to 1% significant level. This was consistent with conclusion of Nelson and Plosser (1982), or, generally speaking, every economic variable has unit root and stable feature after first order differentiation. Besides, six index variables in this study belonged to I (1) series, satisfying cointegration condition.

(3) Cointegration

Before Johansen maximum likelihood estimation, lag period of VAR model must be chosen, this study preferred SBC selection of fittest lag period, as shown in Table 4, the fittest lag period was period 1, and Johansen cointegration was performed accordingly.

Table 5, Table 6 showed cointegration result of China and USA, Japan stock indices, at 1% significant level, both trace test and maximum characteristic root test statistics rejected cointegration relation. In other words, stock indices of all stock markets had no cointegration vectors, that is, Shanghai A, B-shares, Shenzhen A, B-shares had no long-term comovement relation with USA, Japan markets, it is impossible to use error correction model to analyze interference of error term on long-term balance relation. This empirical result indicated: H_1 hypothesis does not hold, probably because China stock markets are vulnerable to government policy, so that stock price fails to respond in time and transmit all information each other, as a result, stock market has no long-term cointegration relation during sampling period.

Table 3 ADF unit root test result of China, USA, Japan stock indices

Variable	No intercept term and no trend term		With intercept term		With intercept term and trend term	
	Initial	First differentiation	Initial	First differentiation	Initial	First differentiation
Shanghai A-share	0.141833	-35.625***	-0.761444	-35.613***	0.714086	-35.836***
Shanghai B-share	-0.563058	-16.563***	-1.394297	-16.559***	-1.624448	-16.577***
Shenzhen A-share	-0.951720	-35.366***	-1.951731	-35.360***	-0.239989	-35.525***
Shenzhen B-share	0.259637	-36.437***	-1.225813	-36.425***	-1.233741	-36.506***
S&P 500	0.520969	-35.526***	-0.741760	-35.527***	-1.910789	-35.555***
Nikkei 225	0.561292	-36.534***	-0.480260	-36.535***	-1.892061	-36.589***

Note 1: *, **, *** denote rejecting unit root null hypothesis at 10%, 5% and 1% significant level respectively.

Table 4 Selection of VAR model fittest lag period of China, USA, Japan stock indices

Lag period	SBC	Lag period	SBC
1	43.44966	5	44.03462
2	43.56992	6	44.18757
3	43.70568	7	44.35513
4	43.86269	8	44.53473

Table 5 Cointegration vector test result of China and USA stock indices

Market	Null hypothesis	Track pitch test	1% critical value	Maximum characteristic root test	1% critical value
Shanghai A-share	None	9.773363	20.04	7.847036	18.63
	At most 1	1.926328	6.65	1.926328	6.65
Shanghai B-share	None	7.581108	20.04	3.895558	18.63
	At most 1	3.685550	6.65	3.685550	6.65
Shenzhen A-share	None	9.773363	20.04	7.847036	18.63
	At most 1	1.926328	6.65	1.926328	6.65
Shenzhen B-share	None	7.932121	20.04	7.610358	18.63
	At most 1	0.321763	6.65	0.321763	6.65

Note 1: * denotes reject of null hypothesis at 1% significant level.

Table 6 Cointegration vector test result of China and Japan stock indices

Market	Null hypothesis	Track pitch test	1% critical value	Maximum characteristic root test	1% critical value
Shanghai A-share	None	13.88981	20.04	11.06763	18.63
	At most 1	2.822179	6.65	2.822179	6.65
Shanghai B-share	None	10.51366	20.04	6.161953	18.63
	At most 1	4.351710	6.65	4.351710	6.65
Shenzhen A-share	None	13.54392	20.04	10.23184	18.63
	At most 1	3.312079	6.65	3.312079	6.65
Shenzhen B-share	None	10.13780	20.04	9.124339	18.63
	At most 1	1.013456	6.65	1.013456	6.65

Note 1: * denotes reject of null hypothesis at 1% significant level.

(4) Causality test

This study also employed Granger causality test result to analyze whether China, USA and Japan stock markets have bilateral feedback relation, or just unilateral causality, or even independent relation. It is known from analysis of Table 7 that: 1) Shanghai B-share has unilateral causality of leading Shanghai A-share, Shenzhen A-share, Shenzhen B-share. 2) Shenzhen B-share has unilateral causality of leading Shenzhen A-share and Japan. 3) USA has unilateral causality of leading Shenzhen

B-share and Japan. 4) There is no significant causality between other bilateral stock markets. Therefore it proved that H_2 hypothesis holds: USA stock market indeed leads Japan and China stock markets.

Table 7 Granger causality test statistic of China, USA, Japan stock indices

Null hypothesis	F test statistic	P-Value
SHB does not Granger-cause SHA	10.2433	0.00141*
SHA does not Granger-cause SHB	0.01995	0.88771
SZA does not Granger-cause SHA	0.72389	0.39503
SHA does not Granger-cause SZA	0.02465	0.87527
SZB does not Granger-cause SHA	3.29631	0.06967
SHA does not Granger-cause SZB	1.80995	0.17875
US does not Granger-cause SHA	1.50229	0.22055
SHA does not Granger-cause US	0.16356	0.68596
JP does not Granger-cause SHA	0.52120	0.47046
SHA does not Granger-cause JP	0.05550	0.81379
SZA does not Granger-cause HB	0.02941	0.86387
SHB does not Granger-cause SZA	9.90723	0.00168*
SZB does not Granger-cause SHB	2.94443	0.08642
SHB does not Granger-cause SZB	8.26728	0.00410*
US does not Granger-cause SHB	3.41039	0.06502
SHB does not Granger-cause US	0.16354	0.68599
JP does not Granger-cause SHB	3.03742	0.08161
SHB does not Granger-cause JP	0.35941	0.54894
SZB does not Granger-cause SZA	5.12118	0.02380*
SZA does not Granger-cause SZB	2.45673	0.11727
US does not Granger-cause SZA	1.41927	0.23375
SZA does not Granger-cause US	0.13814	0.71019
JP does not Granger-cause SZA	0.69077	0.40606
SZA does not Granger-cause JP	0.06287	0.80206
US does not Granger-cause SZB	9.57220	0.00202*
SZB does not Granger-cause US	0.95677	0.32819
JP does not Granger-cause SZB	1.87481	0.17117
SZB does not Granger-cause JP	5.78782	0.01628*
JP does not Granger-cause US	0.12506	0.72367
US does not Granger-cause JP	58.2202	4.6E-14*

Note 1: SHA, SHB, SZA, SZB, US, JP represent Shanghai A-share, Shanghai B-share, Shenzhen A-share, Shenzhen B-share, S&P 500 and Nikkei 225 stock indices respectively.

Note 2: * denotes not accepting null hypothesis at 5% significant level.

(5) Prediction error variance decomposition analysis

Finally, this study employed prediction error variance decomposition to make inter-interpretability analysis of China, USA, Japan stock market fluctuation variance. As there's no definite criteria in literatures on sorting variables, during prediction error variance decomposition analysis of each variable, this paper took market value as sorting criterion. Stock market ranking order was: S&P 500, Nikkei 225, Shanghai A-share, Shenzhen A-share, Shanghai B-share, Shenzhen B-share.

Four results could be observed from Table 8: 1) rank in descending order of self-interpretability (or exogeneity) was USA stock market (99.871%), Shanghai A-share (98.438 %), Japan stock market (96.776%), and Shanghai B-share(47.823%), and Shenzhen B-share(28.941%), Shenzhen A-share (7.046%). 2) Shenzhen B-share, Shenzhen A-share had lower self-interpretability of their variances, indicating that Shenzhen stock market was vulnerable to other stock markets, and Shanghai A-share influences Shenzhen stock market deeply; 3) variation of Shanghai A-share interprets high ratio of variation of other three mainland stock markets, indicating that Shanghai A-share has very intense impact on other three mainland stock markets. 4) four capital markets in China impact each other, in particular Shanghai A-share is most influential, while USA, Japan variation have low impact on four China capital markets, indicating that mainland stock markets are vulnerable to other domestic stock markets, rather than other countries, they are of occult capital market. Empirical result showed: USA, Japan stock markets have strong exogeneity, and are not vulnerable to other stock markets, on the other hand, though invulnerable to USA, Japan, China stock market is vulnerable to other domestic stock markets. Therefore H_3 hypothesis was proved to hold water.

Table 8 Prediction error variance decomposition result of China, USA, Japan stock indices

	Period	S&P 500	Nikkei 225	Shanghai A-share	Shenzhen A-share	Shanghai B-share	Shenzhen B-share
S&P 500	1	100.000	0.000	0.000	0.000	0.000	0.000
	4	99.983	0.004	0.004	0.002	0.000	0.007
	7	99.940	0.013	0.014	0.008	0.001	0.023
	10	99.871	0.029	0.030	0.019	0.001	0.050
Nikkei 225	1	0.329	99.671	0.000	0.000	0.000	0.000
	4	0.887	99.044	0.007	0.000	0.053	0.009
	7	1.708	98.058	0.023	0.002	0.178	0.031
	10	2.756	96.776	0.046	0.007	0.353	0.062
Shanghai A-share	1	0.069	0.817	99.114	0.000	0.000	0.000
	4	0.058	0.997	98.929	0.012	0.000	0.004
	7	0.050	1.192	98.702	0.042	0.000	0.013
	10	0.044	1.400	98.438	0.091	0.000	0.028
Shenzhen A-share	1	0.067	0.718	90.738	8.478	0.000	0.000
	4	0.067	0.864	91.075	7.980	0.001	0.012
	7	0.068	1.024	91.360	7.503	0.003	0.042
	10	0.070	1.196	91.594	7.046	0.005	0.087
Shanghai B-share	1	0.467	0.127	41.664	3.222	54.519	0.000
	4	0.554	0.156	43.147	3.898	52.243	0.001
	7	0.648	0.189	44.550	4.606	50.005	0.002
	10	0.750	0.226	45.870	5.329	47.823	0.003
Shenzhen B-share	1	0.636	0.631	42.507	3.821	23.775	28.630
	4	0.806	0.697	44.562	4.032	21.001	28.902
	7	0.989	0.769	46.525	4.177	18.538	29.001
	10	1.183	0.849	48.388	4.255	16.385	28.941

5. Discussion and Conclusions

This study took six stock markets as research subject, that is, Shanghai A-share, Shanghai B-share, Shenzhen A-share, Shenzhen B-share, S&P 500, Nikkei 225 indices. The study period regarded one month after mainland administration opened domestic purchase of B-share as reference point, 1278 closing price daily data were sampled from each of six markets from Mar.19, 2001 to Dec.14, 2006. This paper investigated whether there were long-term stable balance relation and short-term index interaction among China, USA, Japan stock markets, and further explored price discovery and information transmission process, in the wish of serving as reference index and basis for investor to invest.

Empirical result analysis was as follows:

(1) Basic descriptive statistic showed that, during study period, all stock markets exhibited intense fluctuation, stock index differences were above two times, in particular Shanghai B-share was as high as 4.67 times. In terms of average return rate, China stock markets performed worse than expectation during sampling period; besides, Japan economy resurrection tended to be stable recently. Among China markets, except Shenzhen B-share, three other stock markets had low return rates, indicating that China stock markets had "high risk, low return" feature during study period, which could be reference for investor to invest in mainland stock market.

(2) Based on cointegration result: Shanghai A, B-shares, Shenzhen A, B-shares did not form long-term comovement relations with USA, Japan as expected, probably because government policy leads to insufficient transmission of information, investors were difficult to make carry trade among stock markets, but could gain return of dispersing risk by means of international portfolio.

(3) Based on causality test: (1) Shanghai B-share had unilateral causality with Shanghai A-share, Shenzhen A-share, Shenzhen B-share. (2) Shenzhen B-share had unilateral causality with Shenzhen A-share and Japan. (3)USA had unilateral causality with Shenzhen B-share and Japan. (4) No causality between other stock markets. Investors shall take account of causality information between stock markets in investment decision, so as to acquire extra profit.

(4) Prediction error variance decomposition analysis result: (1) descending order of

self-interpretability (or exogeneity) was firstly USA stock market, Shanghai A-share, Japan stock market, secondly Shanghai B-share, and the least, Shenzhen B-share and Shenzhen A-share. (2) Shenzhen B-share, Shenzhen A-share had low self-interpretability of stock market variation, indicating that Shenzhen stock market was vulnerable to other stock markets, and Shanghai A-share influenced Shenzhen stock markets most. (3) Variation of Shanghai A-share could interpret high ratio of variation from three other mainland stock markets, indicating that Shanghai A-share had very strong impact on three other mainland stock markets. (4) Four China stock markets had interaction relation, in particular Shanghai A-share was the most influential, while USA, Japan variation had low impact on four China stock markets, indicating that mainland stock markets were vulnerable to other domestic stock markets, rather than other countries, it was an occult capital market.

References

Berben R.P. & Jansen W. J. (2005). Co-movement in international equity markets: A sectoral view. Journal of International Money and Finance.

Chan, K.C., B.C. Gup, and M.S. Pan(1992),"An empirical analysis stock price in major Asian Markets and the United States, " The Financial Review, Vol.27, pp.289-307.

Chang, A. K. H., S. L. Chou, and C. S. Wu (2000). "International transmission of stock market movements within the great China economic area." PanPacific Management Review, Vol.3,pp 283-298.

Engsted, T. & Tanggaard, C. (2006). The comovement of US and German bond markets. International Review of Financial Analysis 16, 172–182.

Eun, C. S. and Shim S.,(1989),"International Transmission of Stock Market Movements,." Journal of Financial and Quantitative Analysis, Vol.24, pp.241-256.

Forbes, K. & Rigobon, R. (2002). No Contagion Only Interdepenence:Measuring Stock Market Comovements. Journal of Finance, (5), 2223-2261.

Gruble, H. G. (1968). "Internationally diversified portfolios: Welfare gains and capital flows." American Economic Review, pp1299-1314.

Henry, O.T., Olekalns, N. & Suardi, S. (2004). Modelling Comovements in Equity Returns and Short-Term Interest Rates: Level Effects and Asymmetric Volatility Dynamics. Department of Economics, The University of Melbourne.

Hsin, C.W. (2004). A multilateral approach to examining the comovements among major world equities. International Review of Financial Analysis. 13, 433-462.

Hsu, S.D.(1995), "Empirical Study of Asia stock market cointegration", Security Market Development Quarterly, Vol 7, Issue 4, pp.33-57.

Huang, B.N., C.W.Yang, and John W.S. Hu(2000), "Causality and Cointegration of Stock Market among the United States, Japan, and the south China Growth Triangle," International Review of Financial Analysis, Vol.9(3), pp.281-297.

Morana, C. & Beltratti, A. (2006). Comovements in International Stock Markets. Journal of International Financial Markets Institutions and Money, Forthcoming.

Yang, C.W.(1999), "A study of stock indices co-movement-the case of U.S., Japan, Hong Kong, and Taiwan", Asia Pacific Management Review, Vol 4, Issue 2, pp.97-107.

Yang Jian-wei & Lai Yi-xun (1998), "Study of interaction relation of stock indices of USA, Japan, Hong Kong and Taiwan", Journal of the Land Bank of Taiwan, Vol 35, Issue 2, pp.1-15.

Yang, Y.N.(2004), Time Series Analysis, Taipei: Yeh Yeh Book Gallery Co., Ltd.