China's A-Share, B-Share, and H-Share Stock Markets and the World Financial Markets: A Cointegration and Causality Analysis

Wei Sun
Grand Valley State University

This paper investigates the degree of integration of China's different stock markets, i.e., the Shanghai A share market, Shanghai B share market, Shenzhen A share market, Shenzhen B share market, and Hong Kong Hang Seng China Enterprise market, with the world's major stock markets in America, Europe, Asia, and other emerging markets. The Johansen and Juselius (1990) cointegration and Granger-causality methods are adopted for economic analysis. Empirical results show various degrees of integration of these sub-markets in China with the rest of the world. The results would be interesting to portfolio managers in their considerations of investments in China.

INTRODUCTION

China's stock markets reopened in the early 1990s. There are two major stock markets on mainland China, the A share market and the B share market. The Shanghai Stock Exchange and the Shenzhen Stock Exchange both trade A shares and B shares. A shares and B shares are issued by companies incorporated in mainland China. A shares are priced in the local currency Renminbi yuan and B shares are quoted in the U.S. dollar. Initially, trading in A shares are restricted exclusively to domestic investors and B shares to foreign investors. Since 2001, domestic investors were allowed to trade B shares as well, but only in U.S. dollars. After reforms were implemented in December 2002, foreign investors were allowed (with limitations) to trade in A shares under the Qualified Foreign Institutional Investor (QFII) program which was officially launched in 2003. Hong Kong Chinese Enterprise Index (HKCEI) traces shares that are issued by companies incorporated in mainland China but traded in the Hong Kong Stock Exchange. Generally, domestic Chinese investors are restricted from investing abroad, including Hong Kong.

There are several differences among these stock markets. First, foreign investors that have access to the B share market and the HKCEI share market reportedly have better access to timely updates on the world economy, from the media such as Reuters and other financial services. Second, foreign investors have access to alternative financial products that are not available to domestic Chinese investors who only have access to the A shares and the B shares (with limitation) markets. Third, Chinese companies that are listed as B shares and H shares are subject to stricter disclosure requirements and they are generally more financially stable than A shares companies. Fourth, institutional investors are the major investors in B shares market whereas individual investors are the major investors in the domestic A shares market. All factors suggest that investors in the B shares and the H shares markets will be more rational than those in the A shares market. And the B shares and the H shares markets should reflect economic fundamentals better than the A shares market. Accordingly, B shares and H shares markets should be more integrated

with the world financial markets than the A shares market and is thus more sensitive to macroeconomic shocks originated from the world financial markets.

Empirical research has documented the linkages between China's stock markets and the rest of the world. Wang and Firth (2004) find that overnight returns on all the Greater China stock indices can be estimated by using information from the daytime returns of at least one of the developed markets – Japan, U.S., and the Europe, and that the contemporaneous return spillovers are in general unidirectional from the more advanced major international markets to the Chinese markets. But mainland China's two stock markets are not affected by contemporaneous nor delayed "bad news". Huyghebaert and Wang (2009) found little interactions between the mainland China stock markets and other East Asian markets, nor the U.S. market. However, both studies are based on old data up to 2001 and 2003, respectively. Updated data, especially those since 2005, may reveal more important information regarding the linkages. Johansson (2010) uses data up to 2008 and finds that China's equity market is becoming increasingly integrated with a number of the major international markets and that the trend of increasing financial integration has continued during the global financial crisis that originated in the U.S. However, none of the above research has a focus on characterizing and distinguishing the possible different performances and responses of China's three stock markets to shocks to world financial markets. Due to the different institutional setup and levels of restrictions applied to them, it will be interesting to uncover the possible differences in the process of integration.

The objective of this paper is to investigate the degree of integration of China's different stock markets, namely, the Shanghai A shares and B shares, the Shenzhen A shares and B shares, and the Hong Kong Chinese Enterprise stock markets, with major stock markets in the US, Europe, Asia, and other BRICs countries. We conducted a cointegration and Granger-causality analysis to show the relationships between China's stock markets and major stock markets in the world. For major world financial markets, we considered S&P500 and Dow Jones Industrial Average Index of the US, French CAC40, German DAX, British FTSE, Spanish IBEX, Italian FTSE MIB, and STOXX600 of the European area, Japanese Nikkei225 and Singapore STI of Asia, Russian RTS, Brazilian IBOV, and Indian Sensex for the emerging markets, and Crude Oil Brent Active contract index. Our results show that few of China's stock markets seem to share any long-run co-movement with stock markets in the world. Granger causality shows richer short run interactions between China and the other parts of the world. All four domestic markets – Shanghai A and B markets and Shenzhen A and B markets are found to respond to major stock markets in Europe, America, and Japan, and they are also found to Granger cause other markets in Europe, Japan, and emerging markets. Hong Kong Chinese Enterprise index seems to share the closest ties with financial markets in the world. Granger causality runs both ways – from HKCEI to other markets and from other markets to HKCEI – for the majority of others, both advanced and emerging markets. This result seems to suggest Hong Kong's special position as China's financial frontier in the world financial market.

The rest of the paper is organized as follows. Section 2 provides a literature review. Section 3 describes the empirical methodology. Section 4 discusses data and preliminary analysis. Section 5 presents the empirical results. Section 6 concludes.

LITERATURE REVIEW

Studies on China's stock markets' integration with the rest of the world is burgeoning in recent years as China's stock markets are attracting more and more investors from the rest of the world. The findings are mixed. Earlier studies usually found that China's stock markets are insulated from the world.

Lai and Tseng (2009) studied the role of the Chinese stock market in global stock markets. In particular, they investigated the relationship, as they defined them, the extreme and regular dependences between the Chinese and G7 stock markets. "Regular dependence" is defined as "co-movement on average" in regular market condition. If the Chinese stock market serves as a hedge, it should have low and insignificant regular dependence. "Extreme dependence" is defined as "probability of joint crash", that is, a market provides safety against crises and prevents itself from large shocks from another market. If the Chinese stock market serves as safe haven, it should have low probability of joint crash with other

markets. The authors found that the Chinese market has been not only a hedge but also a safe haven for the G7 stock markets using daily data of 1993-2008.

Implementing the Capital Asset Pricing Model framework, Wang and Iorio (2007) investigated the integration of three Chinese stock markets, A-, B- and H-share markets, with both Hong Kong stock market (Hong Kong Hang Seng Index) and the world market (MSCI Index). Using the market segmentation versus integration analysis a.k.a. Jorion and Schwartz (1986), the authors found that the A-share market was a segmented market during the period 1995-2004. However, a higher level of integration between the A- and B-share markets, and the A-share and the Hong Kong markets is found in the sub-period tests. They also documented that the hypothesis that the B-share and the H-share markets are becoming increasingly integrated with the world stock market is not supported.

Using daily stock market data from 1992 to 2003, Huyghebaert and Wang (2009) examined the integration and causality of interdependences among seven major East Asian stock markets. They found that after the 1997-1998 financial crisis, shocks in Hong Kong and Singapore largely affect other East Asian markets, except for those in Mainland China. They also found that the USA stock market strongly influences stock returns in East Asia – except for Mainland China.

Qiao, Chiang, and Wong (2008) examined the bilateral relationships among China's A-share and B-share stock markets and the Hong Kong stock market. They found that these stock markets are fractionally cointegrated and that analyses of the spillover effects across these markets indicated that the A-share market is most influential. They further documented that the relaxation of government restrictions on the purchase of B shares by domestic residents accelerated the market integration process of A-share with the B-share and the Hong Kong markets. Qiao, Li, and Wong (2008) also found that the new policy allowing domestic citizens to invest in B-share markets is found to be associated with the stronger lead relationship from A-share to B-share, and from B-share to H-share markets.

Johansson (2010) analyses China's integration with major financial markets in the US (SP500), Japan (Nikkei), Hong Kong (Hang Seng Index), Asia (MSCI Asia excluding Japan), Europe (MSCI Europe), and the world (MSCI world) during the last decade (1999-2009) using the conditional copulas approach. He found that China has experienced an increasing level of integration with several major markets during the last decade albeit at a slow pace and from very low levels.

EMPIRICAL METHODOLOGY

The empirical methodologies used for this paper are cointegration and Granger causality. Cointegration can identify the long-run co-movements between the stock markets and Granger causality the short-run lead-lag interactions.

Cointegration

If the stock indices are I(1), we can test for cointegration. We denote the bivariate cointegration between any two stock indices as $S = (s_i, s_j)'$, where $i \neq j$.[1] Following the Johansen and Juselius (1990) maximum likelihood method, we first estimate the following vector autoregressive model:

$$S_t = A_0 + A_1 S_{t-1} + A_2 S_{t-2} + \ldots + A_p S_{t-p} + \varepsilon_t \quad (1)$$

where S_t is the vector of the two stock indices; A_0 is the 2x1 vector of constants; $A_k, k = 1,\ldots, p$, is the 2x2 coefficient matrix of S_t lagged by *k* periods; and ε_t, the 2x1 vector of residuals, is assumed to be bivariate normal with mean vector zero and covariance matrix Σ, and independent across time periods. We then rewrite the VAR(*p*) in (1) in the following vector error-correction form when all series are I(1):

$$\Delta S_t = A_0 + \sum_{k=1}^{p-1} \pi_k \Delta S_{t-k} + \Delta S_{t-p} + \varepsilon_t \quad (2)$$

where $\pi = -\left(I - \sum_{k=1}^{p} A_k \right)$ and $\pi_k = -\left(I - \sum_{l=1}^{k} A_l \right)$ are 2x2 matrices of coefficients. Two likelihood ratio test statistics developed to test the rank of the π matrix are the trace test statistic, *λ-trace*, and the maximum eigenvalue test statistic, *λ-max*:

$$\lambda_{trace} = -T \sum_{i=c+1}^{2} \log(1 - \lambda_i) \quad (3)$$

$$\lambda_{\max} = -T \log(1 - \lambda_{c+1}) \quad (4)$$

where *T* denotes the length of the time series, and λ_i is the eigenvalue obtained from the reduced rank regression problem. If $Rank(\pi) \geq 1$, the two stock indices are cointegrated and thus share long-run common trends.

Granger Causality

Granger causality analysis (Granger, 1980; Engle and Granger, 1987) examines whether lagged values of one stock index enter the equation for that of the other in our bivariate systems. When the stock index *A* is found to Granger cause stock index *B* (i.e., past values of the stock index *A* help explain the current value of the stock index *B*), it is likely that stock market *B* takes the value of stock index *A* into account when forming its own value. This may happen when the two markets are closely integrated. It is also likely that Granger causality runs in both directions, from *A* to *B* and from *B* to *A*. In either case, it reveals a close interdependence between the two markets.

Consider the model of $S = (s_i, s_j)'$. If the pair of stock indices are found to be I(1) and non-cointegrated, we estimate the following vector autoregressive model (VAR):

$$\Delta s_{i,t} = \alpha_{0,i} + \sum_{k=1}^{p} \alpha_{11,k} \Delta s_{i,t-k} + \sum_{k=1}^{p} \alpha_{12,k} \Delta s_{j,t-k} + \varepsilon_{i,t} \quad (5a)$$

$$\Delta s_{j,t} = \alpha_{0,j} + \sum_{k=1}^{p} \alpha_{21,k} \Delta s_{i,t-k} + \sum_{k=1}^{p} \alpha_{22,k} \Delta s_{j,t-k} + \varepsilon_{j,t} \quad (5b)$$

$\alpha_{lm,k}$ is the coefficient of the k^{th} lag of variable *m* on equation *l*; $\alpha_0's$ are the intercept terms; and $\varepsilon_t's$ are the white noise residuals. Using equation (5b), the equation of the stock index of market *j*, we test whether the value of stock index *i* Granger causes the value of stock index *j*. The null hypothesis $H_0 : \alpha_{21}(k) = 0$, $\forall$ *k, k = 1, 2, … p*, states that *i* does not Granger cause *j*. If an estimated F-test statistic is greater than the critical value, the null hypothesis is rejected, indicating the existence of Granger causality from *i* to *j*.

If the system is cointegrated we follow the Dolado and Lutkepohl (1996) method which leads to Wald tests with asymptotic $\chi^2 -$ distributions. This approach avoids possible pre-test biases associated with the usual procedure of estimating a first order differenced VAR if variables are known to be I(1) with no cointegration, and an error correction model if they are known to be cointegrated. Using this method we can directly apply Wald tests to the least squares estimators of the coefficients of the VAR specified in levels of the variables.[2]

Applying the Dolado and Lutkepohl (1996) method, we first estimate the system in (1) and find the appropriate *p* using Wald tests. We then refit the data with a VAR(*p*+1) as shown in system (6):

$$s_{i,t} = \alpha_{0,i} + \sum_{k=1}^{p+1} \alpha_{11,k} s_{i,t-k} + \sum_{k=1}^{p+1} \alpha_{12,k} s_{j,t-k} + \varepsilon_{i,t} \quad (6a)$$

$$s_{j,t} = \alpha_{0,j} + \sum_{k=1}^{p+1} \alpha_{21,k} s_{i,t-k} + \sum_{k=1}^{p+1} \alpha_{22,k} s_{j,t-k} + \varepsilon_{j,t} \quad (6b)$$

Since all equations have the same lag length, the least squares estimators of the coefficients are consistent and asymptotically efficient (Enders, 2010). To test Granger causality, we use equation (6b) and apply Wald tests on the first *p* coefficients for each variable. For example, to see if s_i Granger causes s_j, test $H_0 : \alpha_{21,k} = 0, \ \forall \text{k}, \ k = 1 \ldots p.$

DATA AND PRELIMINARY ANALYSIS

We use daily observations for the period 1998 to 2012 for the following stock market indices. The subject indices for the Chinese sub-markets are the following five indices: Shanghai A share (SHA), Shanghai B share (SHB), Shenzhen A share (SZA), Shenzhen B share (SZB), and Hong Kong Chinese Enterprise Index (HKCEI). For the advanced stock markets we use the following eight indices: S&P 500 (SP500) of the U.S., DAX of Germany (DAX), CAC40 of France (CAC), FTSE100 of Great Britain (FTSE), FTSEMIB of Italy (FTSEMIB), Nikkei 225 of Japan (NIK), Hang Seng Index of Hong Kong (HKH), and STOXX600 pan-European stock index (STX). The three stock indices for the emerging markets are: Sensex of India (SEN), RTS of Russia (RTS), and IBOV of Brazil (IBOV). We have also included the crude oil Brent active index to check the relationship between China's stock markets and the oil market. Finally, we have a total of 18 time series. The data are obtained from Bloomberg database.

We take the natural logarithms for estimation. We first check the stationarity of the stock indices. For both the Augmented Dickey-Fuller (1979) test and the Phillips and Perron (1988) test, the null hypothesis of a unit root cannot be rejected for all series in levels but can be rejected for all in their first differences at the 1% level of significance. Thus, these stock indices series are integrated of order 1, or I(1).[3]

EMPIRICAL RESULTS

Cointegration

In this section, we present the results for the cointegration tests. We have five stock indices for China, and 15 foreign stock indices, among which the stoxx600 is for European region and Brent is the crude oil price. Thus, we have a total of 75 pairs of bivariate cointegration results between China and the advanced markets, the three emerging markets, the European market, and world oil market. Lag lengths are chosen using the AIC and the SCB tests for each pair case. Various financial crises in East Asia, Russia, America, and Worldwide may show up as structural breaks in the data and may lead toward cointegration biases. To account for these possibilities, we include impulse dummies in our VAR estimation for these cases whenever applicable following the Doornik, Hendry and Nielsen (1998) method. Table 1 reports Engle-Granger Cointegration test results and Table 2 reports likelihood ratio test, the λ-trace and the λ-max test results.

Cointegration tests show that cointegration is not the norm between any of the Chinese stock markets and other foreign stock markets nor the world oil market. That is, we do not find a long-run co-movement between stocks in China (in all five related markets) and stocks in others major financial markets. However, we do find a few exceptions. According to different test methods, we find that the Hong Kong Chinese Enterprise Index is cointegrated with the Indian Sensex Index and Brazilian IBOV Index. Both the Shanghai A share index and the Shenzhen A share index are found to be cointegrated with the French CAC40 index, Italian FTSEMIB index, and Spanish IBEX35 index. Shanghai B share index is

cointegrated with the French CAC40 index. Our results seem to suggest that among the sub-stock markets in China, the A-share markets – both Shanghai and Shenzhen – have closer ties with major stock markets in Europe, while the Hong Kong Chinese Enterprise market seems to be tied more closely with other emerging markets.

Next, we will examine the Granger causality relationships between the China sub-markets and foreign markets.

TABLE 1
COINTEGRATION: ENGLE-GRANGER TEST

F-Test	Shanghai A Share	Shanghai B Share	Shenzhen A Share	Shenzhen B Share	Hong Kong CEI Share
DAX	-2.23	-1.54	-2.16	-1.69	-2.08
CAC40	-1.71	-1.66	-1.70	-1.71	-1.67
FTSE	-2.07	-2.11	-2.02	-1.91	-2.04
FTSEMIB	-2.19	-2.34	-2.28	-2.16	-2.16
IBEX35	-2.26	-2.00	-2.16	-1.94	-2.48
NIKKEI	-1.82	-2.27	-1.89	-2.14	-1.88
SP500	-2.23	-2.23	-2.22	-2.15	-2.21
DJIA	-2.68	-2.43	-2.65	-2.41	-2.73
HKHS	-3.01	-2.22	-2.69	-1.98	-2.12
SING	-1.92	-1.24	-1.76	-1.16	-2.01
SENSEX	-1.98	-1.54	-1.51	-2.04	-3.34**
RUS	-0.93	-1.61	-0.21	-2.19	-0.48
BRAZ	-2.03	-1.79	-1.58	-2.24	-3.18*
BRENT	-2.05	-1.84	-1.86	-1.94	-2.48
STOXX600	-1.46	-1.64	-1.47	-1.59	-1.48

Note: Critical values at 1%, 5%, and 10% level of significance are -3.90, -3.34, and -3.05, respectively. ***, **, and * represent significance at the 1%, 5%, and 10%, respectively. The null hypothesis is the stock indices are not cointegrated, and the alternative hypothesis is they are cointegrated. Rejection of the null indicates cointegration.

Granger Causality

In this section, we will further explore the short run interactions between China's five stock markets with foreign financial markets. Granger causality analysis is conducted between a Chinese stock market and a foreign stock market. We test to see whether lagged values of one stock index Granger cause the current value of another. If stock index A is found to Granger cause stock index B, it may suggest that investors in the B market may adjust their expectations and thus behavior based on the observations in the closing prices in market A; and second, market B may have encountered similar shocks as market A, which lead to similar investor reactions, so that changes in stock prices in the two markets are similar. Table 3 and 4 report the results.

Table 3 presents the results for causality that runs from a foreign market to a Chinese stock market. Table 4 reports results that have causality run from a Chinese stock market to a foreign market. Interestingly, Table 3 and Table 4 show richer interactions between China's stock markets and foreign markets. The German DAX index is found to Granger cause four of the five Chinese stock markets – Shanghai A share, Shanghai B share, Shenzhen A share, and Hong Kong Chinese Enterprise index. The European market index – Stoxx600 – Granger causes three of China's five markets - Shanghai A share, Shenzhen A share, and Shenzhen B share. Nikkei Granger causes four of the five Chinese markets – Shanghai A share and B share, Shenzhen B share, and Hong Kong CEI share market. S&P and DJIA are both found to Granger cause three of the five markets – Shanghai A share, Shanghai B share, and

Shenzhen A share markets. The Hong Kong Chinese Enterprise index is Granger caused by most foreign markets, among them are German DAX, British FTSE, Japanese Nikkei, Hong Kong Hang Seng, Singapore Strait, Indian Sensex, Russian RTS, Brazilian IBOV, even crude oil Brent.

TABLE 2
COINTEGRATION: LIKELIHOOD RATIO TEST

λ-Trace	Test-Statistics	Shanghai A Share	Shanghai B Share	Shenzhen A Share	Shenzhen B Share	Hong Kong CEI Share
DAX	*λ-trace*	14.20	8.19	13.51	4.10	5.61
	λ-max	11.16	4.94	10.12	3.83	4.58
CAC40	*λ-trace*	18.32*	16.41*	15.98*	6.94	4.98
	λ-max	10.51	10.23	9.51	5.16	3.38
FTSE	*λ-trace*	11.38	10.29	9.87	4.57	5.12
	λ-max	8.21	7.97	7.29	4.50	4.21
FTSEMIB	*λ-trace*	16.98*	14.18	15.68*	8.37	7.81
	λ-max	10.06	9.15	10.42	6.28	5.67
IBEX35	*λ-trace*	20.82**	10.62	18.54*	6.22	8.73
	λ-max	15.66**	7.84	12.64	5.93	7.48
NIKKEI	*λ-trace*	13.21	12.43	11.81	6.24	4.82
	λ-max	9.28	10.40	8.09	6.01	3.99
SP500	*λ-trace*	9.68	8.05	8.60	5.56	6.28
	λ-max	7.28	6.61	6.62	5.41	5.39
DJIA	*λ-trace*	10.66	8.89	10.37	7.05	9.76
	λ-max	8.79	7.50	8.44	6.93	8.72
HKHS	*λ-trace*	11.84	10.75	11.25	6.46	5.83
	λ-max	10.96	9.45	9.47	6.44	4.86
SING	*λ-trace*	8.98	3.95	8.74	2.76	5.24
	λ-max	7.28	3.93	6.75	2.72	4.92
SENSEX	*λ-trace*	8.59	4.88	9.00	5.11	12.90
	λ-max	8.27	4.63	7.70	5.10	12.40*
RUS	*λ-trace*	5.42	7.48	4.86	8.28	5.45
	λ-max	5.18	7.44	4.86	6.58	4.45
BRAZ	*λ-trace*	6.02	6.39	6.09	6.92	10.72
	λ-max	5.86	6.10	5.21	6.73	10.23
BRENT	*λ-trace*	10.88	10.85	10.70	8.08	10.83
	λ-max	9.54	9.20	9.90	6.80	10.30
STOXX600	*λ-trace*	15.04	11.39	13.01	4.92	3.50
	λ-max	9.08	8.37	8.13	4.82	2.93

Note: The estimation follows the Johansen and Juselius (1990) method. The test statistics are for the test of H_0: $r \leq 0$ vs. the alternative. Critical values are: for *λ-max*: at 1% 18.63, at 5% 14.07, and at 10% 12.07; for *λ-trace*: at 1% 20.04, at 5% 15.41, and at 10% 13.33 (see Osterwald-Lenum, 1992). *, **, *** refer to significance at 10%, 5% and 1%, respectively.

TABLE 3
GRANGER CAUSALITY: FROM FOREIGN TO CHINA'S INDICES

	Shanghai A Share	Shanghai B Share	Shenzhen A Share	Shenzhen B Share	Hong Kong CEI Share
DAX	1.67*	1.54*	1.61*	1.10	1.51*
CAC40	1.09	0.29	0.76	1.21	1.31
FTSE	0.98	1.01	0.91	1.41	1.70*
FTSEMIB	0.77	0.55	0.80	0.55	1.44
IBEX35	0.98	0.37	1.10	0.48	1.33
NIKKEI	1.66*	1.97*	1.15	1.56*	5.38*
SP500	2.10*	1.81*	1.87*	1.30	1.40
DJIA	1.83*	1.70*	1.74*	1.44	1.22
HKHS	1.28	1.42	1.29	0.94	3.77*
SING	0.50	1.38	0.89	0.84	1.86*
SENSEX	1.24	1.08	1.10	1.00	3.89*
RUS	1.13	1.26	0.64	0.76	1.54*
BRAZ	1.98*	0.86	1.28	0.94	4.03*
BRENT	1.29	0.97	1.27	0.97	1.70*
STOXX600	2.06*	1.33	1.87*	1.49*	0.42

Note: a) The table reports the F-statistics for non-cointegrated systems and χ^2-statistics for the cointegrated systems.
b) * indicates that the test statistic is at least significant at the 10% level, implying causality.

Looking the other way around, that is, whether a Chinese stock market Granger causes a foreign stock market, we find similar interactions. Shanghai A share is found to Granger cause Spanish IBEX35, Japanese Nikkei, Indian Sensex, and European Stoxx600. Shanghai B share Granger causes German DAX, British FTSE, Japanese Nikkei, Hong Kong Hang Seng, and Indian Sensex. Shenzhen A share is found to Granger cause Spanish Ibex35, Japanese Nikkei, Singaporean Strait, Indian Sensex, and European Stoxx600. Shenzhen B share is found to Granger cause Spanish Ibex35, Japanese Nikkei, Indian Sensex, and Brazilian Ibov. Again, we find that the Hong Kong Chinese Enterprise index is found to Granger cause the largest number of foreign stock markets, among them are British FTSE, Japanese Nikkei, American S&P500 and DJIA, Hong Kong Hang Seng, Singaporean Strait, Indian Sensex, Russian RTS, Brazilian Ibov, and European Stoxx600.

TABLE 4
GRANGER CAUSALITY: FROM CHINA TO FOREIGN INDICES

	Shanghai A Share	Shanghai B Share	Shenzhen A Share	Shenzhen B Share	Hong Kong CEI Share
DAX	1.24	1.61*	1.16	1.10	1.24
CAC40	1.14	0.98	0.95	1.09	0.93
FTSE	1.36	1.81*	1.34	1.05	1.70*
FTSEMIB	1.19	0.96	0.83	0.67	1.48
IBEX35	1.58*	1.30	1.98*	1.78*	0.87
NIKKEI	2.60*	2.38*	2.17*	2.50*	4.00*
SP500	0.74	0.95	0.76	0.38	3.58*
DJIA	0.65	0.84	0.72	0.35	3.02*
HKHS	1.12	2.30*	0.85	1.07	1.98*
SING	1.44	1.17	1.51*	1.27	4.14*
SENSEX	1.59*	1.76*	1.73*	1.97*	2.71*
RUS	0.58	0.51	0.66	1.21	7.74*
BRAZ	1.21	1.31	1.33	1.51*	5.26*
BRENT	0.85	0.77	1.11	0.67	1.44
STOXX600	1.66*	1.24	1.97*	0.99	1.70*

Note: a) The table reports the F-statistics for non-cointegrated systems and χ^2-statistics for the cointegrated systems, which are underlined. b) * indicates that the test statistic is at least significant at the 10% level, implying causality.

CONCLUDING REMARKS

This paper investigates whether the five Chinese stock markets – the Shanghai A share, Shanghai B share, Shenzhen A share, Shenzhen B share, and Hong Kong Chinese Enterprise index – show different degree of integration with major stock markets worldwide, for which, both advanced stock markets and emerging markets are examined. We use the Johansen and Juselius (1990) cointegration analysis and Granger causality (1980) analysis for estimation. We find the following results. First, none of the five Chinese stock markets seem to share long-run co-movements with other markets except in a few occasions. Second, short-run interactions reveal a richer relationship between the Chinese markets and the rest of the world. All four domestic markets – Shanghai A and B markets and Shenzhen A and B markets are found to respond to major stock markets in Europe, America, and Japan, and they are also found to Granger cause other markets in Europe, Japan, and emerging markets. Hong Kong Chinese Enterprise index seems to share the closest ties with financial markets in the world. Granger causality runs both ways – from HKCEI to other markets and from other markets to HKCEI – for the majority of others, both advanced and emerging markets. The results seem to suggest the followings: 1) China's domestic markets are experiencing an increasing level of integration with major world financial markets; 2) between A share and B share markets, A share markets seem to dominate in the sense that foreign investors seem to take the A share market more as the investment barometer in China; and 3) Hong Kong continues to play a special role as China's financial frontier in the world financial market. The results shed light on the diversification benefits of investing in China for portfolio managers and policy makers in China.

ENDNOTES

1. Bivariate models are chosen over the multivariate models for two reasons. First, bivariate models provide straightforward evidence for whether one stock index shares co-moves with another. Second, although the bivariate approach investigates an index-to-index correlation, this approach is useful when it is hard to specify possible cointegration relationship in a mutivariate model. As Enders (2010) points out, as a practical matter, if multiple cointegrating vectors are found in a multivariate setting it may not be possible to identify the behavioral relationships from what may be reduced-form relationships.
2. The argument for the Dolado and Lutkepohl (1996) method is that the non-standard asymptotic properties of the Wald test on the coefficients of cointegrated VAR systems are due to the singularity of the asymptotic distribution of the least square estimators. This method gets rid of the singularity by fitting a VAR process whose order exceeds the true order. They show that this device leads to a non-singular distribution of the relevant coefficients.
3. The unit root test results are not reported to save space but are available upon request.

REFERENCES

Chan, M.W. (2010). Financial markets of China: Issues and perspectives. *The Chinese Economy*, 43 (6), 4-7.

Chiang, T., Nelling, E., & L. Tan (2008). The speed of adjustment to information: evidence from the Chinese stock market. *International Review of Economics and Finance*, 17, 216-229.

Chittedi, K. (2010). Global stock markets development and integration: with special reference to BRIC countries. *International Review of Applied Financial Issues and Economics*, 2(1), 18-36.

Dickey, D. & Fuller, W. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, 427-431.

Dolado, J. & Lutkepohl, H. (1996). Making Wald tests work for cointegrated VAR systems. *Econometric Reviews*, 15, 369-386.

Domowitz, I., Glen, J., & Madhavan, A. (1997). Market segmentation and stock prices: evidence from an emerging market. *Journal of Finance, 52*, 1059–1085.

Enders, W. (2010). *Applied Econometric Time Series*, New York: John Wiley and Sons, Inc.

Engle, R. & Granger, C. (1987). Cointegration and error correction: representation, estimation, and testing. *Econometrica*, 55, 251-276.

Granger, C. (1980). Testing for causality. *Journal of Economic Dynamics and Control*, 2, 329-352.

Huyghebaert, N. & Wang, L. (2009). The co-movement of stock markets in East Asia - Did the 1997–1998 Asian financial crisis really strengthen stock market integration? *China Economic Review*, 21, 98-112.

Johansen, S. & K. Juselius (1990). Maximum likelihood estimation and inference on cointegration – with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Johansson, A. (2010). China's financial market integration with the world. *Journal of Chinese Economic and Business Studies*, 8(3), 293-314.

Jorion, P. & E. Schwartz (1986). Integration vs. segmentation in the Canadian stock market. *Journal of Finance*, 41(3), 603-614.

Li, Y., Yan, D., & J. Greco (2006). Market segmentation and price differentials between A shares and H shares in the Chinese stock markets. *Journal of Multinational Financial Management*, *16*(3), 232-248.

Phillips, P. & P. Perron (1988). Testing for a unit root in time series regression. *Biometrika*, 75, 335-346.

Qiao, Z., Chiang, T., & W. Wong (2008). Long-run equilibrium, short-term adjustment, and spillover effects across Chinese segmented stock markets and the Hong Kong stock market. *Journal of International Financial Markets, Institutions, and Money*, 18, 425-437.

Qiao, Z., Li, Y., & W. Wong (2008). Policy change and lead–lag relations among China's segmented stock markets. *Journal of Multinational Financial Management*, *18*(3), 276-289.

Schuppli, M., & M. Bohl (2010). Do foreign institutional investors destabilize China's A-share markets? *Journal of International Financial Market, Institutions & Money* 20, 36-50.

Sun, Q. & W. Tong (2000). The effect of market segmentation on stock prices: the China syndrome. *Journal of Banking and Finance, 24*, 1875–1902.

Wang, S. & M. Firth (2004). Do bears and bulls swim across oceans? Market information transmission between greater China and the rest of the world. *Journal of International Financial Markets, Institutions, and Money, 14,* 235–254.