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Spillover Effects of Chinese Stock Markets

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Abstract

This study utilized the cross-sectional independence test established by Pesaran (2004) to identify the existence of common factors in stock markets functioning in Chinese regions. The volatility spillover test of Hafner and Herwartz (2006) based on the Lagrange multiplier (LM) principle was also adapted to test for non-causality in the variance of stock indexes of Chinese stock markets. Our results show that cross-sectional interdependence is apparent in Chinese stock markets; however, only stock markets with higher market values, such as those in Shanghai and Hong Kong, have influence on the Taiwan stock market.

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1. Introduction

Tests of Granger causality (Granger, 1969, 1988) have become a standard procedure in the analysis of linear systems associated with macroeconomic and microeconomic time series. However, causal relationships in stock markets are often defined according to forecasting principles motivated by causation in conditional variance across financial market price comovements. Recently, growing studies on causality have employed financial data to address the issue of nonlinearity or causality in variance (Comte and Lieberman, 2000). Even though linear and nonlinear causality methods are capable of capturing predictive power from one variable to another, they are unable to detect volatility spillover between two variables, because volatility corresponds to fluctuations in the variance of data. Thus, it would also be useful to conduct causality in variance tests to gain a better understanding of the price transmission mechanism in stock markets. Engle *et al*. (1990), Hamao *et al*. (1990), and King and Wadhwani (1990) have proved the existence of causality in conditional variance across the returns of financial assets. Furthermore, Cheung and Ng (1996), Kanas and Kouretas (2002), and Constantinou et al. (2005) have applied cross-correlation functions (CCF) approach to study causality in variance between different stock markets.

Since the economic reform of China in 1990s, there has been a growing interest among portfolio managers for the Chinese emerging capital markets as they provide opportunities for greater asset returns compared to those of the developed markets. This paper re-examined whether the properties of volatility spillover held for the emerging stock markets of China, Hong Kong, and Taiwan during the period of 1995Q4 to 2012Q1 and presented the summary statistics in Table 1.

Table 1: Summary statistics of Chinese Stock markets

	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	J-B
TSEC (Taiwan)	6860.75	9854.95	3636.94	1477.00	-0.076	2.146	2.071
HIS (HK)	15370.74	27812.65	7883.46	4802.69	0.600	2.546	4.531
SSE (China)	1933.12	5552.30	554.04	961.07	1.571	6.252	56.243***

Note: 1. The sample period is quarterly from 1995Q4 to 2012Q1.
2. J-B denotes the Jarque-Bera test for normality. *** indicate significance at the 1% level. H_0: SK=0, K=3 (normality).

In the evaluation of the development of a stock market, the market capitalization of listed companies presents a major indicator. As presented in Table 2, in 1990, the market capitalization of the listed companies in both Hong Kong's and mainland China's exchanges fell behind that of Taiwan. Yet in the wake of economic reform in China, large Chinese firms rushed to go public in Hong Kong. This, coupled with new policy regarding capital liberation and internationalization in Hong Kong, caused the HK stock market in 1999 to surge well above that of Taiwan, while China too experienced considerable positive growth with the market capitalization of Chinese listed companies outnumbering Taiwan's by 2000. In 2011, the market capitalization of China's stock market was 3.8 times than that of Hong Kong, and 5.33 times that of Taiwan; i.e. Hong Kong's stock market surpassed Taiwan's by 1.4 times. This paper explores the effect of volatility spillover in Chinese regions under the aforementioned context, and determines whether a market with higher market capitalization affects a market with lower market capitalization in the one-way fashion of volatility spillover effects or in a reciprocal two-way relationship.

Table 2: Market capitalization of the equity markets of the Chinese, 1990, 1999, 2009 and 2011

Market	Market capitalization ($US million)			
	1990	1999	2009	2011
China	2,028	330,703	5,007,646,	3,389,098
Hong Kong	83,397	609,090	915,825	889,597
Taiwan	100,710	375,991	651,619	634,784

2. CD and LM tests

Table 3: The Pesaran (2004) cross section dependence test (CD test)

	Pesaran (2004) CD statistic is distributed as a two-tailed standard normal	
Null Hypothesis:	CD statistic	*p*-value
Cross section independence	5.752	0.000

The long-run variance (PANKPSS) was estimated according to the Kurozumi (2002) proposal with Bartlett kernel critical values with: 5000 replication and the Bootstrap technique

It is possible that our panel suffers from cross-section dependence and presence of cross-section dependence might bias our analysis and result in conclusion in favor of the stationary of the panel data. We first used the Pesaran (2004) CD test to examine cross-sectional interdependence issues in Chinese stock markets. The CD test statistic is normally distributed under the null hypothesis that there would be no cross-sectional dependence. The results in Table 3 demonstrate that structural issues already exist in three Chinese markets and that regional comovement is present among the interdependent Chinese markets. Cross-sectional interdependence indicates the existence of potential common factors influencing the stock markets in Chinese regions. There are two possible causes of cross section dependence: first, these Chinese countries and regions are geographically interdependent and have similar backgrounds in economic, cultural, and historical development; second, the continuing reform and opening up of finance in Asian countries has led to more frequent volatility transmission among Chinese stock markets.

To measure volatility spillover, previous research adopted the causality in variance test developed by Cheung and Ng (1996) and Hong (2001) to examine volatility spillover between two series, which is based on cross-correlation functions of standardized residuals obtained from univariate general autoregressive conditional heteroscedasticity (GARCH) estimations. This has been utilized in relevant literature to deal with commodity prices. However, the CCF based Portmanteau test is susceptible to significant over-sizing in small and medium samples when the volatility process is leptokurtic (Hafner and Herwartz, 2006). In addition to this drawback resulting from the method of Cheung and Ng (1996), the results from CCF based volatility spillover testing are sensitive to the order of leads and lags, which also call into question the robustness of the findings.

The volatility spillover test of Hafner and Herwartz (2006) based on the Lagrange multiplier (LM) principle in univariate GARCH models is introduced by Lundbergh and Teräsvirta (2002). The LM test resolves the shortcomings of Cheung and Ng's method and is very practical for empirical illustrations. Furthermore, the Monte Carlo experiment performed by Hafner and Herwartz (2006) indicates that the LM approach is more robust against leptokurtic innovations in small samples or fat-tailed asset return distributions, and the gain from carrying the LM test increases with sample size.

In the following, we briefly explain the details of Hafner and Herwartz (2006) test of causality in variance. In this approach, we want to test the null hypothesis as follows:

$$H_0 : Var\left(\varepsilon_{i,t} \middle| F_{t-1}^{(j)}\right) = Var\left(\varepsilon_{i,t} \middle| F_{t-1}\right), \quad (1)$$

where $\varepsilon_{i,t}$ is a stationary stochastic process of the GARCH(1,1) model and $F_{t-1}^{(j)} = F_{t-1} \setminus \sigma\left(\varepsilon_{j,\tau}, \tau \le t\right)$. The test for causality in variance is based on estimating univariate GARCH models as follows:

$$\varepsilon_{i,t} = \xi_{i,t}\sqrt{\sigma_{i,t}^2 g_t} \quad (2)$$

$$g_t = 1 + z_{j,t}'\theta, \quad \mathrm{z}_{j,t} = \left(\varepsilon_{j,t-1}^2, \sigma_{j,t-1}^2\right) \quad (3)$$

$$\sigma_{i,t}^2 = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i \sigma_{i,t-1}^2 . \quad (4)$$

where $\xi_{i,t}$ is the standardized residuals from the GARCH(1,1) model. The null hypothesis of non-causality in variance between two return series is described as follows: H_0:θ=0, H_1:θ≠0.

An LM statistic can be constructed using estimated univariate GARCH processes, as follows:

$$\lambda_{LM} = \frac{1}{4T}\left(\sum_{t=1}^{T}\left(\xi_{i,t}^2 - 1\right)z'_{j,t}\right)V(\theta_i)^{-1}\left(\sum_{t=1}^{T}\left(\xi_{i,t}^2 - 1\right)z'_{j,t}\right) \xrightarrow{d} \chi^2(2),, \tag{5}$$

where

$$V(\theta_i) = \frac{k}{4T}\left(\sum_{t=1}^{T} z_{j,t}z'_{j,t} - \sum_{t=1}^{T} z_{j,t}x'_{j,t}\left(\sum_{t=1}^{T} z_{j,t}x'_{j,t}\right)^{-1}\sum_{t=1}^{T} x_{j,t}z'_{j,t}\right), \tag{6}$$

$$\kappa = \frac{1}{T}\sum_{t=1}^{T}\left(\xi_{i,t}^2 - 1\right)^2. \tag{7}$$

The asymptotic distribution of LM statistic (λ_{LM}) in the equation (5) will depend on the number of misspecification indicators in $z_{j,t}$.

3. Results

Table 4: Causality-in-variance

causality-in-variance	LM statistic	*p*-value
TSEC does not cause HIS	2.686	0.261
HIS does not cause TSEC	5.133	**0.077**
HIS does not cause SSE	2.396	0.302
SSE does not cause HIS	3.091	0.213
SSE does not cause TSEC	5.349	**0.069**
TSEC does not cause SSE	2.400	0.301

Note: Non-causality tests are from the first market to the second market.

For robustness, we then apply the LM test developed by Hafner and Herwartz (2006) for the causality in variance across the three equity markets. These empirical results of LM test are reported in Table 4. We discovered that the SSE Composite Index and Hong Kong's Hang Seng Index exert influence on the TSEC Weighted Index. However, no feedback relationship is present in the reverse, and no interaction is apparent with other markets. This demonstrates that markets with higher values have a greater influence on the momentum of other markets. For this reason, the higher-ranking Shanghai market and Hong Kong market produce volatility spillover effects on the Taiwan market. Shanghai and Hong Kong, however, play even more crucial roles in the transmission of volatility to the Taiwan market. From this conclusion, we can formulate a market value-momentum hypothesis in which markets with higher market value have more momentum and exert greater volatility spillover effects than markets with lower market value. However, this hypothesis requires further verification.

4. Conclusions

Many researchers have investigated the interaction between the stock markets of China, Hong Kong, and Taiwan. Conventional research approaches examine linear or nonlinear causal relationships. In contrast, we employed causality in variance to investigate volatility spillover effects. Furthermore, we performed a cross-sectional independence test to establish the presence of cross-sectional interdependence; that is, we investigated whether or not potential common factors influencing the Chinese stock markets exist. Our results indicate that the Shanghai and Hong Kong markets exert volatility spillover effects on the Taiwan market. This supports the market value-momentum hypothesis and rejects cross-sectional interdependence, thereby proving the existence of structural connections among Chinese stock markets.

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