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STOCK RETURNS VOLATILITY PERSISTENCE AND SPILLOVER EFFECTS: EMPIRICAL EVIDENCE FROM VIETNAM

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ABSTRACT

This study is aimed to investigate stock returns volatility of Ho Chi Minh and Ha Noi stock exchanges. The data were collected from the daily stock indexes of Vietnam stock market and nine global stock markets from the State Securities Commission of Vietnam (SSC) and Yahoo Finance website. The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model was performed to investigate the determinants of the persistence of volatility and volatility spillovers from foreign stock markets. The results indicated that there were evidences of volatility clustering and persistence of volatility in the two stock exchanges of Vietnam. This study also showed that both Ho Chi Minh and Ha Noi stock exchanges were affected by major stock markets in Asia and the rest of the world. Specifically, Vietnam stock market was mostly influenced by Singapore stock market.

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1 INTRODUCTION

Stock markets play an increasingly important role in the financial economy of many countries in the world. As the economy develops, it needs the support of a go-ahead stock market to manage its financial capital. The stock market promotes the needed capital accumulation and investment for economic growth and development. Therefore, the effectiveness of the stock market reflects the country's economic performance in the short, medium, and long terms. However, the stock market is not only responsive to various economic shocks in the economy, but is also susceptible to political and social unrest. Thus, it is often difficult to accurately predict how the future stock market will evolve. Hence, volatility modeling of the stock market prices and returns are highly useful to investors, risk-managers and policy-makers.

Vietnam stock market can be considered as a very young and small market compared to other stock markets in Asia. As an emerging market, it is characterized by high volatility, capital illiquidity, limited capitalization, imperfect legal framework and irrationality of investors as manifested by their mob mentality. However, given the present dynamic economy of Vietnam coupled with a strong legal framework, both the Ho Chi Minh Stock Exchange (HOSE) and Ha Noi Stock Exchange (HNX) stock markets have huge potentials for development in the future.

By investigating the volatility modeling of the stock market index in Vietnam, i.e., Vietnam Ho Chi Minh stock index (VN index) of Ho Chi Minh Stock Exchange and Ha Noi stock index (HNX index) of Ha Noi Stock Exchange, the study examined persistence of volatility in Vietnam stock market. It also determined whether Vietnam stock market might be affected by its neighboring stock

markets in Asia and other well-developed stock markets in the world. This phenomenon was called the meteor shower effect. The meteor shower effect says that the impact of a shock in one market is transferred to other markets. If indeed the meteor shower effect is present, then local investors can make more accurate decisions by monitoring the behavior of other stock markets in Asia and the rest of the world before investing in Vietnam.

To examine persistence of volatility in the stock market, Goyal (2000) used various GARCH models to check the ability of stock return volatility forecasts using the CRSP (Center for Research in Security Prices) daily and monthly value weighted returns. After comparing these forecasts and actual volatility, the author showed that the GARCH model is too smooth to capture the entire variation in actual volatility. However, he also affirmed the GARCH volatility frequently lies within the same confidence interval of other measures. Frimpong *et al.* (2006) studying the Ghana Stock Exchange using the stock volatility models, showed the GARCH(1,1) model outperformed the other GARCH models. He found evidence of high volatility persistence and long memory in the unique 'three days a week' Databank Stock Index (DSI) series. In 2008, Yang examined the Dow Jones stock index volatility over a period (2000-2008) using the GARCH model. He showed that the GARCH model was a good choice for volatility forecasting in the financial market, especially for describing heteroscedastic time series. Abdalla (2012) aimed to model stock return volatility in the Saudi stock market by using daily closing prices on the general market index (Tadawul All Share Index - TASI) over the period of January 2007 to November 2011. The paper employed different univariate specifications of the GARCH model. An application of the GARCH(1,1) model provided strong evidence of the persistence of volatility varying with time.

In Vietnam, Hien (2008) applied different GARCH models to examine stock return volatility in the Vietnam stock market. She showed the non-normal distribution as a strong evidence of ARCH effects in the Vietnam Index return series. The results provided evidence of the superiority of GARCH(1,1) and GARCH(2,1) over the other GARCH models. However, the excess kurtosis and skewness in the residual series of Vietnam stock return were still present even with the best-performing GARCH models. Likewise, Tuyen (2011) showed that volatility was prevalent in the Vietnam stock market over the period January to October 2009. The standard GARCH(1,0) model provided the best description of stock return dynamics in the Vietnam Stock Exchange.

On the other hand, to test the stock market volatility spillovers, Peña (1992) provided empirical evidence that meteor shower effects existed between the New York Stock Exchange and Madrid Stock Exchange during 1988-1989 using the ARMA-GARCH process. He also examined the effect of trading volume on stock return where it was seen that there was no daily effect on trading volume, and the result showed that structure of the GARCH model remained the same. This result contradicted the results of Lamoureux and Lastrapes (1990). Lin and Ito (1994) extended the previous papers (i.e. King and Wadhwani, 1990; Lin *et al.,* 1993; Hamao *et al.,* 1990) regarding transmission of financial disturbances from one market to another. Price volatility and volume spillovers, between Tokyo and New York Stock Markets using a simple regression model with GARCH process, were considered. They accounted for the interactions of trading volume, returns, and volatility across markets. The results showed that there was an existence of shock transmission from the New York's to the Tokyo's. Besides, they asserted that no evidence on volume, volatility, or return spillovers for regimes except the crash period. Booth *et al.* (1997) investigated the international transmission of intraday price volatility between the United States (U.S), United Kingdom (U.K), and Japanese future markets during 1988-1994. The results showed that there were meteor showers effects on the U.S and U.K futures markets, while heat wave effects were present in the Japanese futures market. Abidin and Zhang (2011) examined price and volatility spillovers across five major Asia Pacific stock markets (New Zealand, Hong Kong, Japan, China, Australia) with a particular interest in the spillover effects between Australia and China. They used VAR model, AR/VAR model and AR/GARCH model, respectively to estimate return spillovers. They found strong spillover effects across the sampled stock markets in the region, particularly between Australia and China, with their growing economic ties.

There were more and more researches on the volatility spillover of international stock markets using different approaches in the world. However, this issue in Vietnam has just occurred in recent years. Phu (2009) examined the transmissions of volatility spillovers, during the subprime crisis of 2007 in the U.S, between Vietnam and other Asian financial markets (Japan, Korea, China, Hong Kong, and Taiwan). This author used a GARCH model to explore the level of volatility spillover effects of

other Asian markets on Vietnam stock in the period of 2006-2009. The results showed an increase in the level of volatility effect of the selected financial markets on the Vietnamese stock market's return over time. Particularly, the level of volatility transmissions and spillover effect of the two developed markets of Hong Kong and Japan onto Vietnamese market were relatively higher and more consistent than other markets. Thuan (2010) focused on the effect of the U.S stock market on Vietnam's stock market during the period of 2003-2009. He used the GARCH-ARMA model based on daily data that was divided into four sub-groups based on special political events between the two countries. The study found that the U.S. stock market, particularly the Standard & Poor's 500 Stock Index (S&P 500 Index) had a positive and strong significant influence on the VN index return in recent years. However, there was no evidence of volatility effect of the S&P 500 Index on the VN index.

In summary, most of the above studies used a GARCH model for specific stock returns, as well as for general stock market index. They concluded that a GARCH model was a good choice for volatility forecasting in the financial market, especially for describing heteroscedastic time series. Moreover, the GARCH model was also useful for checking volatility spillovers to determine the effects of other stock exchanges on a selected stock exchange.

2 METHODS

The data for VN index and HNX index that were used in this study were the daily closing indexes obtained from the databank of the SSC. The nine other indexes, namely, Dow Jones Industrial Average Index (DJI) of New York Stock Exchange, U.S; FTSE 100 Index of London Stock Exchange, U.K; GDAX Index (GDAXI) of Frankfurt Stock Exchange, Germany; CAC40 Index of Paris Stock Exchange, France; Hang Seng Index (HSI) of Hong Kong Stock Exchange, Hong Kong; Nikkei 225 Index (NIKKEI) of Tokyo Stock Exchange, Japan; KOSPI Composite Index (KOSPI) of Korea Stock Exchange, Korea; Straits Times Index (STI) of Singapore Stock Exchange, Singapore; China Shanghai Composite Index (SCI) of Shanghai Stock Exchange, China; were obtained from Yahoo Finance website. To ensure synchronicity in all of the indexes, the data of open trading days from June 2006 to June 2012 was crossed matched, and that of closed trading days due to holidays was not included in the analysis.

The daily stock returns were used instead of the daily closing indexes. The daily closing prices of stocks were converted to returns as follow:

$$R_t = \ln P_t - \ln P_{t-1} = \ln\left(\frac{P_t}{P_{t-1}}\right) \quad (1)$$

where R_t is the stock return for period t; P_t and P_{t-1} are closing price indexes on days t and t-1, respectively; and ln is the natural logarithm.

According to Asteriou and Hall (2011) the GARCH(1,1) models can be specified as follows:

$$R_t = \gamma_0 + \delta_1 R_{t-1} + \gamma_1 \varepsilon_t \qquad \varepsilon_t \approx (0, \sigma_t^2)$$
$$\sigma_t^2 = \omega + \beta \varepsilon_{t-1}^2 + \theta \sigma_{t-1}^2$$

where σ_t^2 is the conditional variance and ε_t^2 is the residual at time t, γ_0 and ω are intercepts, δ_1, β and θ are parameters

Testing for the Meteor Shower Effect (Peña, 1992)

The VN and HNX indexes might not only be affected by Vietnam stock market, but also by other stock markets in the world that is the presence of the meteor shower effect. To test the presence of the meteor shower effect on the VN index, the conditional variance of the VN index σ_{VNI}^2 was modeled as a function of its conditional variance in the previous period $\sigma_{VNI,t-j}^2$ and the squared error term ε_i^2 from the other indexes from collected countries.

The meteor shower effect of the five Asian stock exchanges on the Ho Chi Minh Stock Exchange (VN index) can be tested using the following models:

Singapore:

$$\sigma_{VNI,t}^2 = \omega_{VNI-STI} + \sum_i^p \beta_i \varepsilon_{STI,t-i}^2 + \sum_j^q \theta_j \sigma_{VNI,t-j}^2 \quad (2)$$

China:

$$\sigma_{VNI,t}^2 = \omega_{VNI-SCI} + \sum_i^p \beta_i \varepsilon_{SCI,t-i}^2 + \sum_j^q \theta_j \sigma_{VNI,t-j}^2 \quad (3)$$

Hong Kong:

$$\sigma_{VNI,t}^2 = \omega_{VNI-HSI} + \sum_i^p \beta_i \varepsilon_{HSI,t-i}^2 + \sum_j^q \theta_j \sigma_{VNI,t-j}^2 \quad (4)$$

Korea:

$$\sigma_{VNI,t}^2 = \omega_{VNI-KOSPI} + \sum_i^p \beta_i \varepsilon_{KOSPI,t-i}^2 + \sum_j^q \theta_j \sigma_{VNI,t-j}^2 \quad (5)$$

Japan:

$$\sigma^2_{VNI,t} = \omega_{VNI-NIKKEI} + \sum_i^p \beta_i \varepsilon^2_{NIKKEI,t-i} + \sum_j^q \theta_j \sigma^2_{VNI,t-j} \quad (6)$$

The meteor shower effects of the stock markets from the rest of the world on the VN index of Vietnam are specified as follows:

U.S:

$$\sigma^2_{VNI,t} = \omega_{VNI-DJI} + \sum_i^p \beta_i \varepsilon^2_{DJI,t-i} + \sum_j^q \theta_j \sigma^2_{VNI,t-j} \quad (7)$$

U.K:

$$\sigma^2_{VNI,t} = \omega_{VNI-FTSE} + \sum_i^p \beta_i \varepsilon^2_{FTSE,t-i} + \sum_j^q \theta_j \sigma^2_{VNI,t-j} \quad (8)$$

Germany:

$$\sigma^2_{VNI,t} = \omega_{VNI-GDAXI} + \sum_i^p \beta_i \varepsilon^2_{GDAXI,t-i} + \sum_j^q \theta_j \sigma^2_{VNI,t-j} \quad (9)$$

France:

$$\sigma^2_{VNI,t} = \omega_{VNI-CAC40} + \sum_i^p \beta_i \varepsilon^2_{CAC40,t-i} + \sum_j^q \theta_j \sigma^2_{VNI,t-j} \quad (10)$$

where $\sigma^2_{VNI,t}$ is the conditional variance of the VN index at time t, $\varepsilon^2_{i,t-i}$ is the squared error term of the i[th] stock market index at time t-i. Based on the significance of parameter β_i in each equation, the meteor shower effect was determined. If the joint effects of β are statistically significant, i.e., $\sum \beta_i \neq 0$ in each equation, then it can be concluded that the meteor shower effect is present in the VN index coming from the stock markets.

Similarly, the meteor shower effect of Asian stock exchanges and global stock exchanges to the Ha Noi Stock Exchange (HNX index) will also be determined using the same analysis.

3 RESULTS AND DISCUSSION

Descriptive Statistic

For all stock returns, the study showed that their distribution was not normal based on the result of the Shapiro-Wilk test in Table 1.

The Augmented Dickey-Fuller (ADF) test was used for checking the unit root. Table 1 presents the results of the ADF test without trend and lags. The results implied that the null hypothesis of a unit root was rejected for all the stock returns at the 5% level. Consequently, all daily stock returns were stationary.

For testing cluster volatility, this study used the Lagrange Multiplier test (with only one lag) to test for autoregressive conditional heteroscedasticity effect or ARCH effect. It can be seen in Table 1 that the null hypothesis of "no ARCH effect" was strongly rejected in case of all the concerned variables. Thus, there were ARCH effect in the VN and HNX stock returns series.

Table 1: Testing for normality, stationary and ARCH effect in daily stock returns

Stock Return	Shapiro-Wilk test for Normality	Augmented Dickey-Fuller test for Stationary	LM test for ARCH effect[a]
VNI	0.9935**	-28.925**	164.902**
HNX	0.9624**	-32.535**	38.026**
STI	0.9383**	-39.245**	51.169**
HIS	0.9258**	-40.693**	217.294**
SCI	0.9569**	-38.980**	26.266**
NIKKEI	0.9131**	-40.096**	159.604**
KOSPI	0.9265**	-38.097**	61.344**
DJI	0.8977**	-44.017**	50.256**
FTSE	0.9279**	-40.880**	73.380**
GDAXI	0.9304**	-39.200**	34.592**
CAC40	0.9346**	-41.162**	49.887**

NS Indicates non-significance

*** Indicates significance at a 5% level*

[a] Lagrange Multiplier test for ARCH(1) disturbance, or one lag.

Testing for Volatility Persistence

Actually, the GARCH(p,q) model is the ARMA(p,q) model of variances, where p related the number of autoregressive lags imposed on the equation and q relates the number of moving average lags specified. Thus, this study used partial autocorrelation and autocorrelation to determine autoregressive order the AR(p) and moving average order MA(q), respectively.

Tables 2 and 3 present the autocorrelation and partial autocorrelation of the VN and HNX stock returns. The results support to the GARCH(1,1) model in both cases.

Table 2: Autocorrelations and partial autocorrelations of VN stock return

LAG	AC	PAC	Q	Prob>Q	[-1 0 1] Autocorrelation	[-1 0 1] Partial Autocorrelation
1	0.2845	0.2845	122.03	0.0000	|---	|---
2	0.0232	-0.0628	122.85	0.0000	|	|
3	0.0240	0.0381	123.71	0.0000	|	|
4	0.1172	0.1103	144.46	0.0000	|	|
5	0.0913	0.0289	157.05	0.0000	|	|
6	0.0343	0.0046	158.83	0.0000	|	|
7	0.0121	0.0031	159.05	0.0000	|	|
8	0.0081	-0.0082	159.15	0.0000	|	|
9	-0.0037	-0.0179	159.17	0.0000	|	|
10	-0.0101	-0.0112	159.32	0.0000	|	|
11	0.0092	0.0136	159.45	0.0000	|	|
12	0.0313	0.0260	160.94	0.0000	|	|

Table 3: Autocorrelations and partial autocorrelations of HNX stock return

LAG	AC	PAC	Q	Prob>Q	[-1 0 1] Autocorrelation	[-1 0 1] Partial Autocorrelation
1	0.1719	0.1719	44.42	0.0000	|---	|---
2	0.0055	-0.0247	44.46	0.0000	|	|
3	0.0191	0.0230	45.01	0.0000	|	|
4	0.0860	0.0814	56.15	0.0000	|	|
5	0.0773	0.0507	65.16	0.0000	|	|
6	-0.0047	-0.0259	65.19	0.0000	|	|
7	-0.0237	-0.0198	66.04	0.0000	|	|
8	0.0031	0.0027	66.05	0.0000	|	|
9	0.0323	0.0222	67.63	0.0000	|	|
10	-0.0213	-0.0332	68.31	0.0000	|	|
11	-0.0056	0.0102	68.36	0.0000	|	|
12	0.0180	0.0202	68.85	0.0000	|	|

In short, the GARCH(1,1) model was applied for both VN and HNX return volatility models with Generalized Error Distribution (GED) since both of them had non-normal distribution. This was consistent with the declaration of Palm (1996) that in the empirical analysis of financial data, GARCH(1,1) or GARCH(1,2) models had often been found to appropriately account for conditional heteroskedasticity. By using Maximum Likelihood Estimation (MLE), the result of GARCH(1,1) models was showed in Table 4.

Table 4: GARCH models estimation for VN and HNX Indexes

Coefficients	VN index	HNX index
Mean	-0.0004^{NS} (0.372)	-0.0012** (0.003)
Constant (ω)	14.2E-06** (0.0000)	11.9E-06** (0.0020)
ARCH term (β_1)	0.1996** (0.0000)	0.2902** (0.0000)
GARCH term (θ_1)	0.7614** (0.0000)	0.7402** (0.0000)

^{NS} *Indicates non-significance*

** *Indicates significance at 5% level*

P-value is noted in parentheses

For the VN stock return volatility model, all parameters were greater than zero. This satisfied that the conditional variances were strictly positive in GARCH model. The GARCH model of the VN index return was determined as follow:

$$R_{VNI} = -0.0004 + \varepsilon_t$$

$$\sigma_t^2 = 14.2E-06^{**} + 0.1996^{**}\varepsilon_{t-1}^2 + 0.7614^{**}\sigma_{t-1}^2$$

Both the ARCH term and GARCH term were significant at the 5% level. These were evidences of clustering volatility and persistence of volatility in the VN stock return. The VN stock return volatility was influenced by 76.14% from own previous period volatility and by 19.96% from news of the prior period.

Similarly, for the HNX stock return volatility model, all parameters were greater than zero, or the conditional variances were strictly positive in GARCH model. The GARCH model of HNX index return was specified below.

$$R_{HNX} = -0.0012 + \varepsilon_t$$
$$\sigma_t^2 = 11.9E-06^{**} + 0.2902^{**}\varepsilon_{t-1}^2$$
$$+0.7402^{**}\sigma_{t-1}^2$$

As the VN stock returns, there are evidences of clustering volatility and persistence of volatility in the HNX stock return since both the ARCH and GARCH parameters are significant at the 5% level. In comparison with the VN index, the HNX index volatility was more sensitive to past news than the VN index.

Besides, Table 6 showed the existence of the heat wave effect in both Ho Chi Minh and Ha Noi Stock Exchanges. This result indicated that Vietnam stock market was affected by previous domestic news. In comparison with Ho Chi Minh stock exchange, the heat wave effect in Ha Noi stock exchange is stronger. This meant that Ha Noi stock exchange was more sensitive to domestic news than Ho Chi Minh stock exchange.

Testing for the Meteor Shower Effect.

In the meteor shower model, the domestic shocks were replaced by the shocks from foreign stock exchanges. The current period volatility in Ho Chi Minh and Ha Noi stock exchanges was examined under the impact of the previous period events or shocks from the other stock markets because the trading opening time in Ho Chi Minh and Ha Noi Stock Exchanges was earlier than trading closing time in the other stock exchanges (Figure 1).

The result of the meteor shower effect from Asian stock markets to the Vietnam stock market was presented in Table 5.

Table 5 showed the significance of all $\beta_{1,i}$ parameters at the 5% level in volatility spillovers model of both VN and HNX indexes. Therefore, these are evidences of the meteor shower effects from Asian stock markets to Vietnam stock market. The results showed clearly that among Asian markets, Singapore market has the most powerful effects on both Vietnam stock exchanges. It is understandable because Singapore is a member of Association of Southeast Asian Nations (ASEAN). Moreover, in both of Ho Chi Minh and Ha Noi stock exchanges, there are many listed Singapore companies. In contrast, the weakest influence on Vietnam stock market comes from Japan.

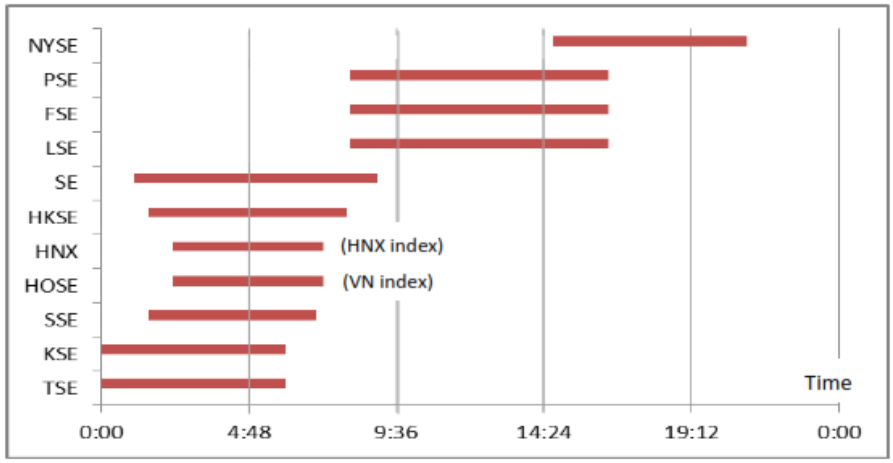

Fig. 1: Trading time of Vietnam and other stock markets

Table 5: The meteor shower effect of the Asian zone on the Vietnam Stock Market

Stock Index	Coefficient	Singapore	Hong Kong	Shanghai (China)	Korea	Tokyo (Japan)
VN Index	$\beta_{1,i}$	0.2218** (0.0000)	0.1880** (0.0000)	0.2013** (0.0000)	0.1929** (0.0000)	0.1723** (0.0000)
	$\theta_{1,j}$	0.7433** (0.0000)	0.7763** (0.0000)	0.7634** (0.0000)	0.7595** (0.0000)	0.8039** (0.0000)
HNX Index	$\beta_{1,i}$	0.3146** (0.0000)	0.2935** (0.0000)	0.2833** (0.0000)	0.2872** (0.0000)	0.2600** (0.0000)
	$\theta_{1,j}$	0.7307** (0.0000)	0.7434** (0.0000)	0.7488** (0.0000)	0.7385** (0.0000)	0.7577** (0.0000)

NS Indicates non-significance

*** Indicates significance at 5% level*

Table 6: Meteor shower effect of rest of the world on the Vietnam Stock Market

Stock Index	Coefficient	New York (U.S)	London (U.K)	Frankfurt (Germany)	Paris (France)
VN Index	$\beta_{1,i}$	0.2209** (0.0000)	0.2008** (0.0000)	0.2148** (0.0000)	0.2189** (0.0000)
	$\theta_{1,j}$	0.7477** (0.0000)	0.7750** (0.0000)	0.7562** (0.0000)	0.7530** (0.0000)
HNX Index	$\beta_{1,i}$	0.3104** (0.0000)	0.3005 ** (0.0000)	0.3065** (0.0000)	0.3159** (0.0000)
	$\theta_{1,j}$	0.7225** (0.0000)	0.7396** (0.0000)	0.7318** (0.0000)	0.7282** (0.0000)

NS Indicates non-significance

*** Indicates significance at 5% level*

The coefficients $\theta_{1,j}$ are significant in the two models. This implies that persistence of Vietnam stock market volatility exists under impacts of events or shocks from foreign stock exchanges.

Table 6 presented the meteor shower effects from the rest of the world as major international stock markets. Based on the significance of the parameters $\beta_{1,i}$, both Ho Chi Minh and Ha Noi stock exchanges were influenced by major stock markets of the rest of the world (New York, London, Frankfurt and Paris). Interestingly, the influence level of international major stock markets on Vietnam stock market almost has the same magnitude. On the other hand, the stock markets from the rest of the world are more important than the Asian stock markets since their effects on Vietnam stock market are stronger than Asian stock market's effects. Moreover, the results also showed that the meteor shower effect from international stock exchanges to Ha Noi stock exchange was stronger than Ho Chi Minh's.

4 CONCLUSIONS

Like most stock markets in the world, Vietnam stock market exhibits basic financial market characteristics such as stock market prices being integrated of order one series, the existence of clustering volatility and persistence of volatility in stock returns, and non-normal distribution in stock return.

There was evidence of persistence of volatility in Ho Chi Minh stock exchange, as well as Ha Noi one. Therefore, when risk-managers and policy-makers build stock market volatility forecast models, they must pay attention to the persistence of volatility of VN and HNX indexes. For investors, they anticipate the shock effects not only in the short run, but also in the long run.

The results of the study asserted that Vietnam stock market is still young and volatile since it is affected by both domestic news and shocks from global stock markets. Based on the results of the meteor shower effects, the stock markets from the rest of the world have more strongly affected the Vietnam stock market than those from Asian stock markets. On the other hand, the study also showed that among the Asian markets, Singapore exhibited the strongest meteor shower effect to Vietnam. Therefore, investors and risk managers should monitor news and shocks from both the Asian and global stock markets. Between the Asian and global markets, investors should pay more attention to the later stock markets since the meteor shower effects were found to be larger from these markets.

This study examined the volatility of Vietnam stock markets during the more volatile period between 2006 and 2012. It is expected that the behavior of Vietnam stock markets may show different patterns of volatility during non-crisis periods which is characterized by more stability. Despite the "newness" of the future contracts and transactions in the future financial markets in Vietnam, it has already gained popularity. Therefore, volatility assessment in futures market was an interesting off shoot of the present study.

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