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Effects of international gold market on stock exchange volatility: evidence from asean emerging stock markets

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Abstract

This paper examines behaviors of returns and volatility of ASEAN emerging stock markets (Indonesia, Malaysia, Philippines, Thailand and Vietnam), incorporating with the effects from the international gold market. The estimates of GARCH(1,1) and GJR(1,1) for these stock markets indicate that the GJR(1,1) model is preferred to GARCH(1,1), except Vietnam. However, under the exogenous effects from international gold market such as the 1 day lagged returns and the 1 day lagged volatility of gold, the GARCH(1,1)-X model captures better stock market volatility behavior than GJR(1,1)-X, except Indonesia. Interestingly, gold could be a substitute commodity for stocks in Vietnam and the Philippines, while it could be a complement for stocks in Indonesia, Thailand and Malaysia.

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1. Introduction

Volatility is a measure of the uncertainty of the investment rate of return. In financial markets, volatility is a central issue to the theory and practice of investment. Though, traditional econometric methods assumed volatility to be constant, it is widely recognized in financial time series by the researchers that volatility is not constant but varies over time. This recognition has initiated and innovated extensive models of stock market volatility to capture and forecast volatility behavior. A widely used class of models for conditional volatility is the autoregressive conditionally heteroskedastic introduced by Engle (1982), and extended by Bollerslev (1986), Engle et al. (1987), Nelson (1991) and Glosten et al. (1993) among others. A summary of this family of models was reviewed in Bollerslev et al. (1992).

Gold is a precious and highly liquid metal, so it is categorized as a commodity and a monetary asset. Gold has possessed similar characteristics to money in that it acts as a store of wealth, medium of exchange and a unit of value (Goodman, 1956; Solt and Swanson, 1981). Gold has also played an important role as a precious metal with significant portfolio diversification properties (Ciner, 2001). Gold is used in industrial components, and jewellery as an investment asset and reserve asset. Gold is stored in central banks and international financial institutions, accounting to 32,000 tons (Tully and Lucey, 2007). In recent years, demand for gold has been increasing rapidly, due to the world economic recession, high inflation, depreciation of the US dollar, and reduction in world gold production. These may be the reasons causing high volatility on stock exchanges, as investors tend to reconstruct their investment portfolios by replacing part of their stock shares with gold to hedge their risks. Although, many empirical works have been carried out on stock exchange volatility over the world, only few researches on gold return volatility have been done i.e., influences of macro economic variables on gold returns and volatility (Tully and Lucey, 2007), and response of gold returns and volatility to public information arrival (Kutan and Aksoy, 2004). In fact, no studies have been found that show the effects of gold price on returns and volatility of stock markets.

In the Association of Southeast Asian Nations (ASEAN), stock markets exist only in Singapore, Indonesia, Thailand, Malaysia, the Philippines and Vietnam. Among them, Singapore is considered as a developed market, while the other five countries are categorized as emerging markets, and the Vietnam stock market is the youngest. Up to now, studies on ASEAN stock markets have commonly involved the developed markets in terms of volatility, linkages, and volatility transmission between developed markets and the regional markets. However, no such studies including the Vietnam stock market have been done, though few researches on development of the Vietnam stock market (Loc, 2006) and policy impacts on the Vietnam stock market (Andre et al., 2006) were found. Regarding the studies on regional and international stock markets, it seems to be that the Vietnam stock market has not received much interest by the researchers, yet. Moreover, in recent months, ASEAN emerging stock markets and the international gold market have seen a sharp decline (see Figure 1), due to the world economy down turn and declining global stock markets.

For the above reasons, the purpose of this paper is to focus on an empirical analysis of volatility behaviors of the five emerging stock markets in ASEAN (Indonesia, Malaysia, the Philippines, Thailand and Vietnam) incorporating with the effects from the international gold market. However, volatility transmission across these markets is thought to be very crucial that is being conducted on the process. The organization of the remainder of this paper is as follows: Section 2 provides a data, basic statistics and data analysis; Section 3 presents the model specifications of volatility; Section 4 reports the empirical results of estimation; and Section 5 provides concluding remarks.

2. Data, basic statistics and analysis

A set of five national stock indexes and gold prices, namely JKSE, KLSE, PSE, SET, VNI and GOLDFIX are selected, representing the stock exchanges of Indonesia, Malaysia, Philippines, Thailand, Vietnam and the PM London Gold Fix, respectively. Since these markets are located in Southeast Asia and have the geographical proximity, there is no time difference among them. Trading time of London gold market (local time) is from 8:30 AM to 4:00 PM and the market price of gold is fixed twice daily in London at 10:30 AM and 3:00 PM. The London Gold Fix is the guidepost for the official gold trading around the world. At the 3:00 PM fixing, all ASEAN markets closed. Therefore, this is a reference for ASEAN markets in the following trading day.

Daily closing data of the stock market indexes and the PM London Gold Fix were downloaded from Reuter and www.kitco.com in the period from July 28, 2000 (the first trading day of the Vietnam stock market) to October 31, 2008. The plots of 5 stock indexes and gold prices are given in Figure 1.

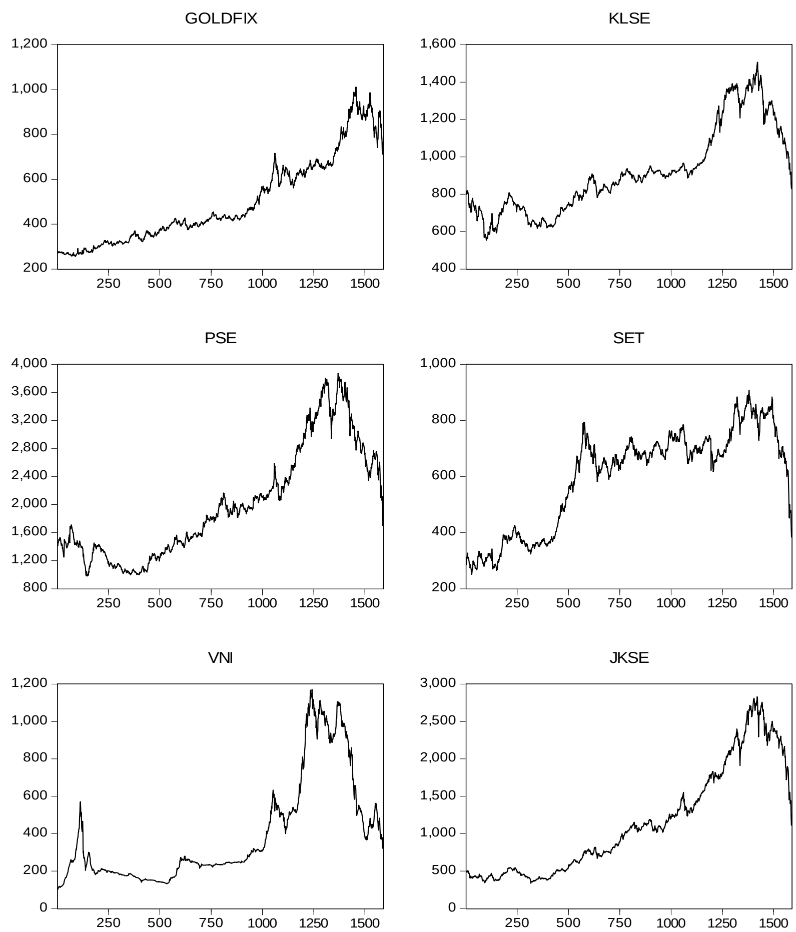

Figure 1: Daily data plots of the six level series (July 28, 2000 to October 31, 2008)

Following the conventional approach, daily returns ($R_{i,t}$) of stock and gold markets were calculated as the percentage of logarithmic difference in their daily prices ($p_{i,t}$) i.e., $R_{i,t} = 100*(\log p_{i,t} - \log p_{i,t-1})$. To provide a general understanding of the nature of each stock market and gold returns, a descriptive statistics of the daily returns is presented in Table 1. The statistics include returns of the gold and five selected stock indexes for mean, standard deviation, annualized volatility, skewness, excess kurtosis, Jarque-Bera test, etc. It indicates that all the means of six returns series are positive. Usually, it is assumed that the higher returns of a financial asset imply a higher risk, so the mean and variance tend to go in the same direction.

Table 1: Descriptive statistics of daily stock market and gold returns

	GOLD_R	JKSE_R	KLSE_R	PSE_R	SET_R	VNI_R
Mean (μ)	0.046	0.046	0.004	0.015	0.018	0.065
Maximum	6.471	11.707	4.503	16.178	10.577	6.656
Minimum	-7.972	-10.954	-9.978	-13.089	-16.063	-7.656
Std. Dev. (σ)	1.133	1.528	0.936	1.455	1.474	1.749
Annualized volatility	17.986	24.259	14.854	23.093	23.403	27.770
Skewness (S)	-0.407	-0.797	-1.115	0.673	-0.975	-0.292
Kurtosis (κ)	8.042	11.004	13.525	21.946	15.137	5.841
Jarque-Bera test	2272.26	5525.10	9819.32	30606.25	12763.13	665.84
P-value	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
No. observations	2091	1991	2036	2036	2027	1900

Note: JKSE_R, KLSE_R, PSE_R, SET_R, VNI_R and GOLD_R denote for daily returns of the Indonesia, Malaysia, Philippines, Thailand, Vietnam stock markets and the P.M London Gold Fix, respectively. Differences in the number of observations in each series are due to a lack of data availability.

The plots of six daily return series are shown in Figure 2. It shows that the mean returns are constant but the variances change over time, with large or small changes tending to be followed by large or small changes in either sign.

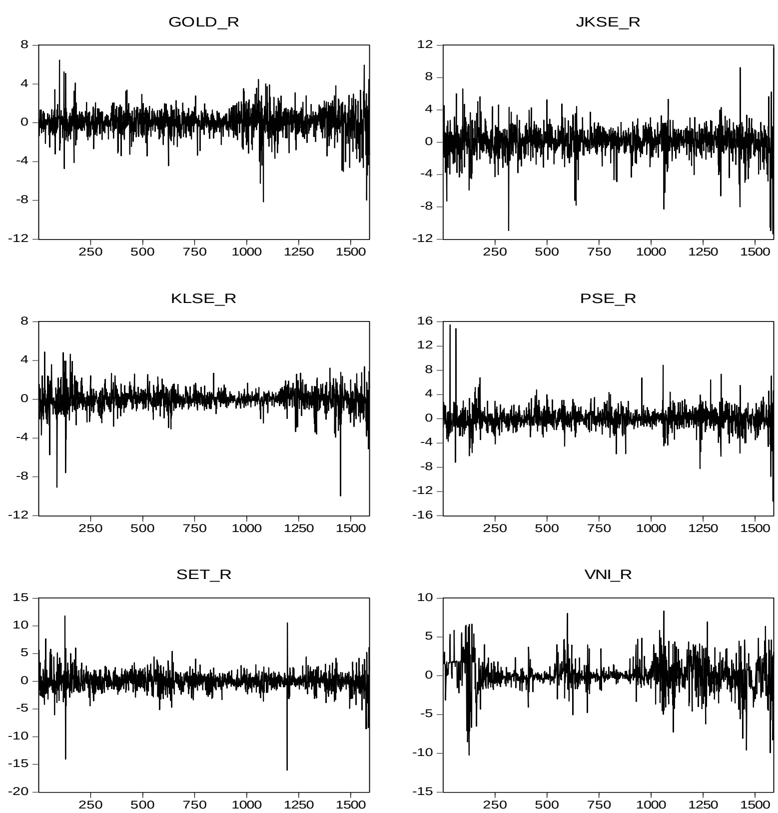

Figure 2: Daily returns of the six series

The basic statistics in Table 1 reveals that the Vietnam stock market provides the highest mean return (0.065) along with the highest risk (1.749). Meanwhile, the Malaysia stock market appears to show the lowest mean return (0.004) and the lowest risk (0.936). The returns and standard deviations of the Philippines and Thailand stock markets seem to be similar. However, return of the gold market seems to be relatively high (0.046), but less risky (1.133) as compared to those of the stock markets. The highest annualized volatility is found in Vietnam (27.77), followed by those in Indonesia (24.26), Thailand (23.09), the Philippines (23.09), the London Gold Fix (17.99) and Malaysia (14.85).

Another characteristic of the stock and gold return series is that they all exhibit the standard property of asset return data such fat-tailed distributions, as indicated by the positive coefficients of excess kurtosis. This characteristic is also shown by the highly significant Jarque–Bera normality test, a joint test for the absence of skewness and kurtosis. This suggests that, for these markets, the stock-return series may not be normally distributed, so the null hypothesis of normality can be rejected. As the normal distribution, the theoretical value of the skewness is zero, however negative skewness appears in all the cases, except in the Philippines, and the most heavily skewed is found in Malaysia.

In order to form a statistically adequate model, the time series data should first be checked to see whether or not they can be considered stationary. Results of applying the augmented Dickey–Fuller (ADF) and Perron-Phillips (PP) tests are reported in Table 2. It implies that the null hypothesis of a unit root in the six level series cannot be rejected, implying that nonstationarity exists in the five stock indexes and gold prices. However, the null hypothesis of a unit root in the first difference of the six level series is clearly rejected, so all the six daily return series are stationary.

Table 2: Unit root test for the time series data of stock markets and gold

	Level		1st Difference	
	ADF	PP	ADF	PP
JKSE	-1.0454	-1.0064	-39.1648	-39.0226
KLSE	-1.1077	-1.1060	-22.7367	-39.4575
PSE	-1.1241	-1.0944	-41.3383	-41.2684
SET	-1.3791	-1.4097	-44.4619	-44.5109
VNI	-1.3015	-1.3836	-18.0035	-32.6934
GOLDFIX	-0.7712	-0.8256	-38.8707	-38.8580

Note: Critical values at the 1%, 5% and 10% levels of significance are -3.343, -2.863 and -2.567, respectively.

All of the pairwise correlations of the five stock indexes and gold price, presented in Table 3, are positive and quite high. For instance, almost all the pairs are over 0.8, and the lowest one is 0.578. In view of the presence of unit roots, this is not particularly surprising.

Table 3: Pair correlation between the five daily stock indexes and gold price

	JKSE	KLSE	PSE	SET	VNI	GOLDFIX
JKSE	1.0000					
KLSE	0.9659	1.0000				
PSE	0.9506	0.9622	1.0000			
SET	0.8029	0.8090	0.7713	1.0000		
VNI	0.8251	0.8578	0.9179	0.5780	1.0000	
GOLDFIX	0.9494	0.8735	0.8459	0.7542	0.7066	1.0000

However, the pairwise correlations in their first differences given in Table 4 are much lower than those of the pairs in their level series. They are found to be positive, except for the pair of the VNI_R and GOLD_R. The pairwise correlations between VNI_R and the rest market returns are generally slacker as compared to those of any other markets. Perhaps, Vietnam is a new emerging market, so its co-integration in the regional market appears weaker than the others.

Table 4: Pair correlation between the six daily return series

	GOLD_R	JKSE_R	KLSE_R	PSE_R	SET_R	VNI_R
GOLD_R	1.0000					
JKSE_R	0.1153	1.0000				
KLSE_R	0.0478	0.3848	1.0000			
PSE_R	0.0599	0.3914	0.3423	1.0000		
SET_R	0.0264	0.4232	0.4198	0.3227	1.0000	
VNI_R	-0.0018	0.0798	0.0086	0.1527	0.0320	1.0000

3. Model specifications

The generalized autoregressive conditional heteroscedastic model of order p and q, GARCH(p, q) is $h_t = \varpi + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}$ (1)

$$\varepsilon_t = \eta_t \sqrt{h_t} \text{ and } \eta_t \sim \text{iid}(0,1)$$

where, $\omega > 0$, $\alpha_i \geq 0$ for $i = 1,\ldots, p$ and $\beta_j \geq 0$ for $j = 1,\ldots, q$ are sufficient conditions to ensure that the conditional variance $h_t > 0$, and $\sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j \prec 1$ for the existence of the second moment (Bollerslev, 1986). The simplest and often most useful GARCH is the GARCH(1,1) model, given by $\varepsilon_t | F_{t-1} \sim$ N(0; h_t), with $h_t = \varpi + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$, where $\omega > 0$, $\alpha_1 \geq 0$, $\beta_1 \geq 0$ and $\alpha_1 + \beta_1 \prec 1$.

Equation (1) assumes that a positive shock ($\varepsilon_t > 0$) has the same impact on the conditional variance, h_t, as a negative shock ($\varepsilon_t < 0$). In order to accommodate differential impacts on the conditional variance of positive and negative shocks, Glosten et al. (1992) proposed the GJR specification for h_t, which is a special case of (1), as follows

$$h_t = \varpi + \sum_{i=1}^{p} (\alpha_i + \gamma_i I(\varepsilon_{t-i} < 0)) \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}. \quad (2)$$

For the case $p = q = 1$ or GJR(1,1), $\omega > 0$, $\alpha_1 \geq 0$, $\alpha_1 + \gamma_1 \geq 0$ and $\beta_1 \geq 0$ are sufficient conditions to ensure that the conditional variance $h_t > 0$. And, I_t is an indicator function, taking the values of 1 if $\varepsilon_{t-1} < 0$ (bad news) and zero, otherwise. Therefore, the impact of ε_t^2 on the conditional variance h_t in this model is different when ε_t is positive or negative. The negative innovations have a higher impact than positive ones. The GJR(1,1) model is asymmetric as long as γ is significant different from zero. Ling and McAleer (2002) established the regularity condition for the existence of the second moment of the GJR(1,1) model, which is $\alpha + \gamma/2 + \beta \prec 1$. When the conditional shocks (η_t) follow a symmetric distribution, the expected short-run persistence is $\alpha_1 + \gamma_1/2$, and the contribution of shocks to expected long-run persistence is $\alpha_1 + \gamma_1/2 + \beta_1$.

An alternative specification that accommodates asymmetries between positive and negative shocks, which models the logarithm of conditional volatility, is called the EGARCH model (Nelson, 1991). The model is specified as

$$\log h_t = \omega + \sum_{i=1}^{p} \alpha_i |\eta_{t-i}| + \sum_{i=1}^{p} \gamma_i \eta_{t-i} + \sum_{j=1}^{q} \beta_j \log h_{t-j} \quad (3)$$

where, α, β and γ are constant parameters to be estimated.

It is expected that γ<0 and γ<α <-γ, reflecting the leverage effect, so "good news" generates less volatility than "bad news". The EGARCH model is asymmetric if γ≠0. In (3), $|\eta_{t-i}|$ and η_{t-i} capture the size and sign effects of the standardized shocks, respectively. Unlike GARCH and GJR, EGARCH uses the standardized residuals, $\eta_t = \varepsilon_t / \sqrt{h_t}$**,** rather than the unconditional shocks. Since EGARCH uses the logarithm of conditional volatility, there are no restrictions on the parameters in (3). As the standardized shocks have finite moments, the moment conditions of (3) are straightforward.

GARCH and GJR models including exogenous variables (X) in the mean and volatility equations may also be of interest to measure the impact of exogenous variables on the volatility. Such models can be written as GARCH-X or GJR-X model. The mean and variance equation can generally be specified as

$R_t = \mu + \theta_1 R_{t-1} + \delta\sigma_{t-1} + \lambda X_{t-1} + \varepsilon_t$, with $\varepsilon_t \sim N(0, \sigma_t^2)$

$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} + \rho X_{t-1}$ for GARCH(1,1)-X, or

$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \gamma I(\varepsilon_{t-1} < 0)\varepsilon_{t-1}^2 + \beta h_{t-1} + \rho X_{t-1}$ for GJR(1,1)-X.

In order to check the structural properties of the first and second moments, the second moment and log-moment conditions are evaluated for the GARCH(1,1) and GJR(1,1) models. Jeantheau (1998) showed that the log-moment condition given by

$$E(\log(\alpha_1 \eta_t^2 + \beta_1)) < 0 \quad (4)$$

Equation (4) is sufficient for the QMLE to be consistent for the GARCH(1,1) model of conditional volatility. It is crucial to note that the log-moment condition is a weaker regularity condition than the second moment condition, namely $\alpha_1 + \beta_1 \prec 1$. Empirically, it is more straightforward to verify the second moment condition than the log-moment condition, as it involves a function of unknown random parameters and the mean of the logarithmic transformation of a random variable. For instance, the parameters in (4) are replaced by their QMLE, the standardized residual squares, $\eta_t^2 = \varepsilon_t^2 / h_t$, are derived from the GARCH model estimation, for t = 1,..., n, and the expected value is calculated by their sample mean. Ling and McAleer (2002) established the log-moment condition for GJR(1,1) as

$$E(\log((\alpha_1 + \gamma_1 I(\eta_t))\eta_t^2 + \beta_1)) < 0, \quad (5)$$

which is sufficient for consistency and asymmetric normality of the QMLE for GJR(1,1). Moreover, the second moment regularity condition, $\alpha_1 + \gamma/2 + \beta_1 < 1$, is also sufficient for consistency and asymmetric normality of the QMLE for GJR(1,1).

Mathematically, E(log(1+z_t)) ≤ E(z_t), setting $z_t = \alpha_1\eta_1^2 + \beta_1 - 1$ shows that the log-moment condition in (4) can be satisfied even when $\alpha_1 + \beta_1 > 1$. Similarly, setting $(\alpha_1 + \gamma_1 I(\eta_t))\eta_t^2 + \beta_1 - 1$ shows that the log-moment condition in (5) can be satisfied even when $\alpha_1 + \gamma/2 + \beta_1 > 1$. Empirically, the parameters in (5) are replaced by their QMLE. The standardized residual squares, $\eta_t^2 = \varepsilon_t^2 / h_t$, are derived from the GJR model estimation, for t = 1,..., n, and the expected value is calculated by their sample mean. Departing from the GARCH(1,1), $h_t = \varpi + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}$, with $\varepsilon_t = \eta_t\sqrt{h_t}$, or $\varepsilon_{t-1}^2 = \eta_{t-1}^2 h_{t-1}$**,** $\eta_t \sim iid(0,1)$ the GARCH(1,1) can be rewritten and reduced to as $h_t = \varpi + \alpha\eta_{t-1}^2 h_{t-1} + \beta h_{t-1}$, *or* $h_t = \varpi + (\alpha\eta_{t-1}^2 + \beta)h_{t-1}$. When $0 < \alpha\eta_{t-1}^2 + \beta < 1$ and $\varpi > 0$, we ensure that h_t is positive and finite, or equivalent to the $E(\log(\alpha_1\eta_t^2 + \beta_1)) < 0$. Moreover, the $E(\log(\alpha_1\eta_t^2 + \beta_1))$ can be rewritten as

$E[\log(1 + (\alpha_1\eta_t^2 + \beta_1 - 1))] \leq E(\alpha_1\eta_t^2 + \beta_1 - 1)$, so

$E(\log(\alpha_1\eta_t^2 + \beta_1)) \leq \alpha_1.E(\eta_t^2) + \beta_1 - 1$, or $E(\log(\alpha_1\eta_t^2 + \beta_1)) \leq \alpha_1.1 + \beta_1 - 1$. (6)

It can be seen from (6) that two possibilities may occur: (i) If $\alpha_1 + \beta_1 \prec 1$, or $\alpha_1 + \beta_1 - 1 \prec 0$, then $E(\log(\alpha_1\eta_t^2 + \beta_1)) < 0$ is always satisfied. Thus, the second moment exists and the log-moment exists; (ii) If $\alpha_1 + \beta_1 \succ 1$, then the second moment does not exist. However, if $E(\log(\alpha_1\eta_t^2 + \beta_1))$ is negative, then the log moment exists, or if it is positive, then the log-moment condition is violated.

4. Empirical results

In the section, we first provide the estimates for both the GARCH(1,1) and GJR(1,1) conditional volatility models of the five stock markets. For the mean equations, it was assumed that all the conditional mean returns of the selected stock markets follow the AR(1) process. Results of the estimation are shown in Table 5 and Table 6. All the estimates of the parameters are obtained using the Marquardt optimization algorithm in the Eviews 6 econometric software package.

Table 5: AR(1)-GARCH(1,1) estimation for the five stock markets

	θ_0	θ_1	ω	α	β	Log-moment	2nd moment
JKSE_R	0.1522*	0.1346*	0.1487*	0.1315*	0.8249*	-0.0707	0.9564
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)		
KLSE_R	0.0460**	0.1305*	0.0048*	0.0870*	0.9175*	-0.0075	1.0045
	(0.0360)	(<0.001)	(<0.001)	(<0.001)	(<0.001)		
PSE_R	0.0352	0.0953*	0.2873*	0.2498*	0.6776*	-0.1585	0.9274
	(0.3542)	(<0.001)	(<0.001)	(<0.001)	(<0.001)		
SET_R	0.1045**	0.1191*	0.3588*	0.1630*	0.7082*	-0.1882	0.8712
	(0.0193)	(<0.001)	(<0.001)	(<0.001)	(<0.001)		
VNI_R	-0.0164	0.2999*	0.0428*	0.3509*	0.7006*	-0.0551	1.0515
	(0.5585)	(<0.001)	(<0.001)	(<0.001)	(<0.001)		

Note: The numbers in parentheses are p-values.
*, ** and *** stand for statistical significance at the 1%, 5%, and 10% levels, respectively

The estimates for AR(1)-GARCH(1,1) models, presented in Table 5, indicate that effects of the lagged returns (θ_1) in the mean equations are significant in all the five stock markets. And, the estimates for unconditional mean returns (θ_0) in these markets are positive, except Vietnam, but they are insignificant in the Philippines and Vietnam. All the coefficients in the variance equations i.e., the unconditional volatility (ω), the ARCH effects (α) and the GARCH effects (β) are positive and highly significant, indicating that volatility in ASEAN emerging stock markets is characterized by a heteroscedastic process. The short-run persistence effect in Vietnam is high at 0.3509, and is also quite high at 0.2498 in the Philippines. The log-moment conditions are negative and satisfied with all the five cases. Therefore, even though the second moment conditions are not satisfied in Malaysia and Vietnam, the QMLE for all the five stock markets are consistent and asymptotically normal.

In finance, volatility tends to increase more as the stock market index was decreasing than as it was increasing by the same magnitude. Therefore, the GJR(1,1) model are estimated to check for any asymmetry between the positive and negative shocks to the volatility. Results from the GJR(1,1) estimation are presented in Table 6.

Table 6: AR(1)-GJR(1,1) estimation for the five stock markets

	θ_0	θ_1	ω	α	γ	β	$\alpha + \gamma/2$	Log-moment	2nd moment
JKSE_R	0.105**	0.146*	0.286*	0.029**	0.196*	0.767*	0.127	-0.145	0.895
	(0.018)	(<0.001)	(<0.001)	(0.046)	(<0.001)	(<0.001)			
KLSE_R	0.033	0.123*	0.008*	0.073*	0.059*	0.901*	0.102	-0.013	1.003
	(0.151)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)			
PSE_R	0.010	0.092*	0.255*	0.143*	0.148*	0.717*	0.217	-0.139	0.933
	(0.811)	(<0.01)	(<0.001)	(<0.001)	(<0.001)	(<0.001)			
SET_R	0.064	0.134*	0.403*	0.080***	0.250*	0.659*	0.205	-0.225	0.864
	(0.154)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)			
VNI_R	-0.013	0.300*	0.043*	0.357*	-0.015	0.701*	0.350	-0.055	1.051
	(0.703)	(<0.001)	(<0.001)	(<0.001)	(0.696)	(<0.001)			

Note: The numbers in parentheses are p-values.
*, ** and *** stand for statistical significance at the 1%, 5%, and 10% levels, respectively

We note that the coefficients of asymmetry (that is, γ or the GJR effect) are significant in all five markets, except Vietnam. For the significant asymmetric effects, the GJR(1,1) model is being more preferred to the GARCH(1,1), implying that volatility of theses markets is characterized by an asymmetric heteroscedastic process. Estimation of the mean equations shows that coefficients of the lagged returns (θ_1) are significant in all the cases. However, the estimates of unconditional mean returns (θ_0) are insignificant, except the case of Indonesia. The log-moment conditions are negative and satisfied with all the cases. Therefore, even though the second moment conditions are not satisfied with Malaysia and Vietnam, the QMLE for all five series are consistent and asymptotically normal. This confirms a positive empirical finding regarding the empirical usefulness of the estimates.

In recent years, gold production in the world has been declining (Table 7), while demand for gold has been increasing over time. This might be the reason causing the high volatility on the stock exchanges.

Table 7: World gold production

Year	Metric tons (Mt)	Growth (%)
1970	1,477.40	*n.a*
1975	1,234.80	-16.42
1980	1,219.30	-1.26
1985	1,533.40	25.76
1990	2,308.46	50.55
1995	2,248.78	-2.59
2000	2,573.00	14.42
2005	2,518.00	-2.14
2006	2,469.00	-1.95
2007	2,444.00	-1.01

Source: synthesized by the author from http://www.goldsheetlinks.com/production.htm.

To see how gold can explain behavior of ASEAN emerging stock markets, first we introduce the 1 and 1-2 day lagged gold returns as the exogenous explanatory variables of the stock market returns, and then the standard Granger bi-directional causality tests are employed. The Granger causal relations are inferred through the generalized F statistic, which measures if the lagged terms of an exogenous variable significantly improve the autoregression of another. The results of the tests are shown in Tables 8.

It reveals that three of the five stock markets are influenced by the gold markets. Specifically, the Vietnam, Thailand and Indonesia stock market returns are found to be significantly affected by the 1 and 1-2 day lagged gold returns. In the reverse direction, the 1 and 1-2 day lagged returns of the stock markets have mostly insignificant effects on the gold returns, except the case of Vietnam. Thus, the gold and stock market have a bi-directional effect in Vietnam, while some others have a unidirectional effect. This may not be so surprising since Vietnam is a new emerging market and has a high demand of gold import. In recent years, the country has imported about 60-70 tons of gold annually, equivalent to 90% of its total demand.

Table 8: Pairwise Granger causality tests for the five stock market and gold returns

Causal direction	Lag 1 F-test	p-value	Lag 1-2 F-test	p-value
GOLD_R →JKSE_R	2.4730	0.1160	5.0173	0.0067
GOLD_R →KLSE_R	1.4165	0.2342	0.9150	0.4007
GOLD_R →PSE_R	0.2054	0.6505	0.8007	0.4492
GOLD_R →SET_R	4.3356	0.0375	2.6272	0.0726
GOLD_R →VNI_R	14.2977	0.0002	7.9281	0.0004
JKSE_R →GOLD_R	0.0017	0.9675	0.1710	0.8428
KLSE_R→GOLD_R	1.5528	0.2129	0.8836	0.4135
PSE_R →GOLD_R	2.5996	0.1071	1.3684	0.2548
SET_R →GOLD_R	0.2112	0.6459	0.1897	0.8273
VNI_R →GOLD_R	8.4274	0.0037	3.7866	0.0229

To examine the effects of gold market on returns and volatility behaviors in ASEAN emerging stock markets, the 1 day lagged returns and the 1 day lagged return volatility in the PM London Gold Fix are employed as the exogenous variables (X) in the mean and volatility equations. In Table 9, only the estimates of the appropriate models are introduced i.e., the GARCH(1,1)-X and GJR(1,1)-X. The results show that the symmetric GARCH(1,1)-X models can capture better volatility behaviors of the stock markets in Malaysia, Philippines, Thailand and Vietnam than the GJR(1,1)-X, except Indonesia. The estimated parameters in the variance equations of the five stock markets are positive and significant, ensuring that the estimated volatilities (h_t) are positive, except a negative effect of the 1 day lagged gold returns in the Philippines market. However, its absolute value is smaller than the ARCH and the GARCH effects on volatility in the Philippines stock market. The effect of the 1 day lagged volatility of gold returns (ρ) is also found to be significant on volatility in the Philippines and Malaysia stock markets.

The estimates for the mean equations given in Table 9 are all significant with an exception of the unconditional mean return (θ_0) of the Philippines stock market. The effect of the 1 day lagged gold returns (λ_1) is found to be positive and significant on returns of the Thailand, Indonesia and Malaysia stock markets, while this effect is negative and significant for the Philippines stock market. However, the effect of the 1 day lagged volatility of gold returns (λ_2) is significant on returns of the Vietnam stock market. And, the leverage effect (the GARCH in mean) is found in Vietnam with a positive and significant risk premium term (δ), so we would expect that investors in Vietnam are compensated with higher returns for taking the higher risk. It is assumed that the London gold market drives all ASEAN gold markets. This leads to an interested interpretation, in terms of portfolio diversity, gold could be a substitute commodity for the stock exchanges of Vietnam and the Philippines, but could be a supplement for the stock exchanges of Indonesia, Malaysia and Thailand.

Table 9: Estimates of GARCH-X(1,1) and GJR-X(1,1) models for the five stock markets

	Parameters in the mean equations					Parameters in the variance equations				
	θ_0	θ_1	δ	λ_1	λ_2	ω	α	β	γ	ρ
VNI_R	0.113**	0.278*	0.147*		-0.160*	0.044*	0.351*	0.699*		
	(0.025)	(<0.001)	(<0.01)		(<0.001)	(<0.001)	(<0.001)	(<0.001)		
SET_R	0.097**	0.120*		0.053***		0.361*	0.161*	0.708*		
	(0.031)	(<0.001)		(0.085)		(<0.001)	(<0.001)	(<0.001)		
JKSE_R	0.102**	0.144*		0.053***		0.274*	0.029**	0.772*	0.197*	
	(0.020)	(<0.001)		(0.068)		(<0.001)	(0.041)	(<0.001)	(<0.001)	
PSE_R	0.028	0.095*		-0.041**		0.320*	0.255*	0.663*		-0.111*
	(0.474)	(<0.01)		(0.071)		(<0.001)	(<0.001)	(<0.001)		(<0.001)
KLSE_R	0.046**	0.128*		0.023***		0.003**	0.077*	0.927*		0.009*
	(0.041)	(<0.001)		(0.083)		(0.020)	(<0.001)	(<0.001)		(0.006)

Note: The numbers in parentheses are p-values.
*, ** and *** stand for statistical significance at the 1%, 5%, and 10% levels, respectively.
θ_0, θ_1, δ, λ_1, λ_2, ω, α, β, γ and ρ denote the coefficients of the unconditional mean return, lagged returns AR(1), GARCH in mean, 1 day lagged gold returns, 1 day lagged volatility of gold returns, unconditional volatility, ARCH effect, GARCH effect, GJR effect and 1 day lagged gold returns, respectively.

5. Concluding remarks

The paper contributes to a broader view on model estimation of volatility behavior for stock markets incorporating the effects of gold market. The estimates of the GARCH(1,1) and GJR(1,1) models without the effects of the exogenous variables such as the lagged returns and the lagged volatility of the London Gold Fix indicate that the GJR(1,1) model is preferred to the GARCH(1,1) in ASEAN emerging stock markets, except Vietnam. However, as the exogenous variables were introduced, the GARCH(1,1)-X is the appropriate model for most of these stock markets, except Indonesia.

Examining stock market returns and volatility under the effects of the international gold market provides the insights on trading behaviors in ASEAN emerging stock markets. In terms of stock and gold investment behaviors, keeping gold and stocks or selling them together might be of interest in Indonesia, Malaysia and Thailand. However, in Vietnam as the international gold market becomes more volatile, investors could be interested in changing their trading behaviors from stock exchanges to trading volatility in the gold market. In the Philippines, an increase in the international gold market return might cause a decrease in its stock market return, so part of capital in its stock market might be transferred to the gold market.

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