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A Language Learning Journey through Learner Diaries — *Ikram Mahadzir, Kamalanathan M.Ramakrishnan, Normah Ismail*

Relationship between Perceived Organizational Support and Organizational Commitment among Teachers in Private Primary Schools — *Mazida Ismail, Muruga Chinniah, Nani Shuhada Sehat*

Acceptance of Open Source Software Among UiTM Students: A Case Study of Diploma Level Computer Science Students in UiTM Johor — *Yusnita binti Sokman, Ahmad Kamalrulzaman Othman*

Peranan Kompetensi Peluang dan Struktur Organisasi Terhadap Prestasi PKS di Utara Malaysia — *Azizi Hj Halipah, Syed Mazlan Syed Mat Dom*

Adolescent Instruction in the Esl Context: Situational Realism and Linguistic Realism in Material Selection — *S. Kunaratnam Sita ramam, Evelyn Sharminnie Vasuthavan*

Kesilapan Penggunaan Kata Ganti Nama (الضَّمِيْر) Dan Kata Kerja Kala Kini (الفِعْل المُضَارِع) Dalam Pembinaan Ayat Bahasa Arab — *Abd Rahman Jamaan, Farhana Idris, Munirah Azrae*

Blogs as a Pedagogical Alternative to Language Teaching and Learning — *Alice Shanthi Kasawi @ Krisnan, Xavier Thayalan*

Sensitivity on Stock Returns and Volatility: The Case Of *Shari'ah*-Compliant Securities in Bursa Malaysia — *Roslina Mohamad Shafi*

Bringing The Information To The UserThrough Library 2.0 — *Al Bakri Mohammad, Siti Nuur-Ila Mat Kama*

An Empirical Analysis of Trading Volume and Return Volatility in Using Garch Model : The Malaysia Case — *Tan Yan Ling, Tay Bee Hoong*

The Use of Kinship Terms in Language Learning: A Perspective from Language Instructors — *Soo Kum Yoke, Carolyn, Nor Haniza Hasan, Derwina Daud*

The Gröbner Package in Maple and Computer Algebra System for Solving Multivariate Polynomial Equations — *Shamsatun Nahar Ahmad*

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An Empirical Analysis of Trading Volume and Return Volatility in Using Garch Model : The Malaysia Case

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ABSTRACT

The relationship between trading volume and return volatility has long been debated either on the contemporaneous correlation as explained by the mixture distribution hypothesis (MDH) or causal (lead-lag) relation as suggested by the sequential information arrival hypothesis (SIAH).The former is proposed by Clark (1973), and the latter by Copeland (1976) and Jennings, Starks, and Fellingham (1981).The purpose of this study is empirically to test the relationship between trading volume and return volatility from 3 January 2000 to 31 July 2008 in Malaysia. In this study, GARCH model is chosen because it gives better estimates in modelling return volatility. The contemporaneous correlation is tested by employing simultaneous approach (GARCH-cum trading volume). Our results strongly support the MDH hypothesis since both variables are found to follow a contemporaneous correlation pattern in Malaysia stocks. Moreover including trading volume in the conditional variance (return volatility) equation leads in a reduction of volatility persistence. We also suggest that trading volume is a good proxy of information arrival in the GARCH model. Therefore, the changes in trading volume can be used when formulating new strategy, instead of taking into account of changes in price.

Keywords

Trading volume, return volatility, contemporaneous correlation, GARCH

1.0 INTRODUCTION

Generalized autoregressive conditional heteroscedasticity (GARCH) models have been widely used to model return volatility in most of the financial series. According to Bohl and Henke (2003), GARCH effects have some important findings in applied finance. Moreover, stock return can be characterized by the GARCH process and return volatility is always related only to information in its own history. Therefore, conditional variances have to be taken into account in order to measure return volatility efficiently.

In terms of theoretical, the relationship among two variables has been discussed since 1970. However, the empirical research on the relationship between trading volume and return volatility still remain debatable. There are several theoretical explanations discussing on these two variables, and the most widely cited hypotheses are mixture distribution hypothesis (MDH hereafter) and sequential information arrival hypothesis (SIAH hereafter). The former is proposed by Clark (1973), and the latter by Copeland (1976) and Jennings, Starks, and Fellingham (1981).

MDH hypothesis is basically stated that price changes and trading volume relations are due to mixture of distribution. It is actually another explanation of the relationship between trading volume and return volatility or to be known as contemporaneous correlation. According to Clark (1973), trading volume and return volatility are positively correlated because of their joint dependence on a common mixing variable, which could be interpreted as the rate of information flow into the market. Therefore, this implies that trading volume and return volatility change simultaneously in response to new information flow into the market and it produces a contemporaneous correlation between trading volume and return volatility. On the basis of the MDH hypothesis, Lamoureux and Lastrapes (LL) (1990) extend their analysis by using data on 20 UK companies. They argue that GARCH effects in the stock returns can be generated by the serially correlated new arrival process where new arrival is proxied by the trading volume. In other word, stock returns can be characterized by the GARCH model and return volatility is not only explained by its own history, but also explained by the rate of information. Their model shows that autoregressive conditional heteroskedasticity (ARCH) phenomena or persistence in return volatility becomes small when trading volume is included in the conditional variance equation. Trading volume is also found to be a good proxy for information arrivals in the UK stock market. In contrary, most of the emerging markets fail to include trading volume into the analysis.

Besides, using the same GARCH-cum-volume model, Bohl and Henke (2003) conduct a study to investigate the contemporaneous correlation among two variables for 20 Polish stocks. The empirical results show that in the majority cases, the inclusion of trading volume as an explanatory variable in the conditional variance results in a substantial reduction of volatility persistence in returns. Their results are strongly support of the implications of MDH hypothesis, and also consistent with the findings of LL (1990) and Omran and Mckenzie (2000). Hence, serially correlated new arrival processes are a source of GARCH effects in the Polish stock market and the implications of the MDH provide to a large extent a valid theoretical explanation for Polish stock market volatility.

Alternatively, Arago and Nieto (2005) re-examine the results of LL (1990) by analyzing the persistence of GARCH effects on the return of nine international stock exchange indices. Interestingly, the outcomes show that the inclusion of trading volume does not substantially reduce the volatility persistence in all markets. Their study suggests that trading volume is unable to eliminate the GARCH effect on the market returns. It may be interpreted in many ways includes trading volume is not a suitable proxy for the arrival information in the market or volatility persistency is not only due to time dependence in the rate of arrival of new information. Subsequently, the study suggests that unexpected trading volume as alternative proxy variable to try to reflect the effect of the information flow on the market volatility. It has a greater effect on the conditional volatility than the trading volume.

On the other hand, SIAH hypothesis as proposed by Copeland (1976) and extended by Jennings et al. (1981) postulate that there exists a positive bidirectional causal relation (lead-lag) among trading volume and return volatility. It could be explained that the new information that reaches the market is not distributed to all traders and market participants simultaneously, but in a sequential process. The final information equilibrium is only achieved after a sequence of intermediate has occurred. Therefore, this implies that trading volume and return volatility change in a sequential, not simultaneously in response to new information flow into the market. This process produces a causal (lead-lag) relation between trading volume and return volatility.

Darrat, Rahman and Zhong (2003) investigate the contemporaneous correlation and causal relationship between trading volume and return volatility in all stocks comprising the Dow Jones Industrial average (DJIA) using Exponential GARCH-in-Mean (EGARCH-M) and Granger causality test. Overall, the results show no contemporaneous correlation between trading volume and return volatility. However, these results are strongly support SIAH hypothesis of significant causal relation between two variables examined. In addition, Darrat, Zhong and Louis (2007) re-examine the dynamic relation between trading volume and return volatility in two cases: with and without identifiable public news in NYSE stocks by employing the same EGARCH and Granger causality test. Their empirical analysis offers three main findings. First, investors trade more aggressively in the no-news period than in the news period. Second, return volatility is more pronounced in the period with public news than in the no-news period. Third, there exists a bi-directional causality between trading volume and return volatility in the period with public news and in line with SIAH hypothesis. As a conclusion, most of the studies show mixed results in supporting MDH hypothesis and SIAH hypothesis.

The objective of this study is to empirically test the relationship between trading volume and return volatility in Malaysia from 3 January 2000 to 31 July 2008. In this study, return volatility is measured by using GARCH model. The simultaneous approach (GARCH-cum trading volume) is adopted to test the contemporaneous correlation between there variables. The rest of paper is organized as follows. In Section 2, the data is discussed. Section 3 presents an overview on the methodology. Section 4 contains the empirical results and finally, section 5 provides the conclusion.

2.0 THE DATA

The data set are obtained from the Bursa Malaysia Security Exchange (BMSE) consisting of the daily stock price indices for the Kuala Lumpur Composite Index (KLCI) and trading volume from 3 January 2000 to 31 July 2008, a total of 2,239 observations. The daily stock price indices and trading volume are collected based on the data availability. In this study, the variables considered are R_t and LTV_t. Returns (R_t) are calculated as the natural logarithm difference of daily stock returns index times 100, ($R_t = log\left(\frac{P_t}{P_{t-1}}\right) * 100$) where P_t and P_{t-1} are the closing daily stock price indices for KLCI at t and $t - 1$, respectively. Trading volume (LTV_t) is defined as the natural logarithm of the trading volume at time t.

3.0 METHODOLOGY

Engle (1982) and Bollerslev (1986) provide the evidence concerning on characteristics of return volatility by using ARCH and GARCH models, respectively. In order to capture the return volatility in financial time series, several models of conditional variance have been introduced. Following Bohl and Henke (2003) and Omran and Mckenzie (2000), GARCH model is used to measure return volatility. The AR(1,3)-GARCH(1,3) model can be written as :

$$R_t = \theta_0 + \theta_1 R_{t-1} + \theta_3 R_{t-3} + \varepsilon_t \quad (1)$$

$$\varepsilon_t \sim N(0, \sigma_t^2) \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon^2{}_{t-1} + \alpha_2 \varepsilon^2{}_{t-2} + \beta_1 \sigma_{t-1}^2 \quad (3)$$

Where R_t denotes stock returns, $\theta_0, \theta_1, \theta_3, \alpha_0, \alpha_1, \alpha_2$ and β_1 are the parameter estimates and σ_t^2 is the conditional variance. Eq. (1) includes only autoregressive term in the mean equation of return, while Eq. (3) describes conditional variance equation of return (return volatility). If the parameter estimates of α_1, α_2 and β_l are positive, it means return volatility persist over time. The degree of persistence is determined by the sum of these parameter estimates ($\alpha_1 + \alpha_2 + \beta_1$). The greater of the sum of $\alpha_1 + \alpha_2 + \beta_1$, the greater persistence of return volatility.

Following LL (1990), we investigate contemporaneous correlation among trading volume and return volatility by estimating simultaneous approach (GARCH-cum trading volume). GARCH-cum trading volume, AR(1,3)-GARCH(1,3)-level model is estimated by adding trading volume in the conditional variance equation, Eq. (3) and the model can be written as :

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \beta_1 \sigma_{t-1}^2 + \lambda LTV_t \tag{4}$$

The null hypothesis of trading volume does not influence return volatility is tested. In addition, if trading volume is considered a proxy of the arrival of new information, it is expected that $\lambda > 0$. Thus, the sum of parameter estimates $(\alpha_1 + \alpha_2 + \beta_1)$ will be smaller when trading volume is included. It can be said that volatility persistence tends to vanish or disappear. However, Omran and Mckenzie (2000) postulate that a drawback of the LL (1990) methodology is that they did not apply any diagnostic tests on the residuals from their model to check whether they are free of GARCH effects. To account for possible residual problems, we use Ljung-Box Q-statistics on standardized residuals ($\hat{s}_t = \hat{\varepsilon}_t / \hat{\sigma}_t$) and Q^2-statistics on standardized squared residuals ($\hat{s}_t^2$) to check for serial correlations and conditional heteroskedasticity, respectively. Moreover, the best fitted GARCH model can be selected by using the most commonly used model selection criteria or information criteria such as the Akaike Information Criterion (AIC), Schwartz Criterion (SC) and Log Likelihood (Log LL). For example, a model is to be said that the best fitted model when it has a smaller value of AIC (or SC) and a higher value of Log LL compare to other models.

4.0 EMPIRICAL RESULTS

It is necessary to check the order of integration of return and trading volume series before we continue to estimate the GARCH model. The stationary properties of return and trading volume data could be tested by using ADF test. Table 1 show the results of unit root test. The ADF test postulates that the null hypothesis of a unit root is rejected at the 0.05 significance level and we conclude that return and trading volume are stationary at I(0) or level over the 2000-2008 period. Thus, these series will be used for the remaining estimation.

Table 1

Unit root test (ADF test)

	Return	Trading Volume
Test Statistic	-22.2372	-5.8592
Critical Value 1%	-3.4331	-3.4331
Critical Value 5%	-2.8626	-2.8626
Critical Value 10%	-2.5674	-2.5674
Log likelihood	-3398.912	-491.9222
AIC	3.046	0.4447
SC	3.0588	0.4575
Lag	3	3

Note. The ADF test contains a constant term and lags are determined according to AIC.

Table 2 shows the robust ordinary least square (OLS) results that include two lags (first lag and third lag) of return. Ljung Box Q-statistics indicate that the residuals are serially uncorrelated and insignificant at lag 8 and lag 16. But, Ljung Box Q^2-statistics show that the null hypothesis of squared residuals (no GARCH effects) is rejected at the 0.01 significance level. In addition, Lagrangian Multiplier (LM) test (Table 3) also shows that null hypothesis of no GARCH effects is statistically significant at 0.01 level for lag 2, 4, 6, 8, 10, and 12. Hence, the results are suggesting the existence of GARCH effects in stock returns.

Table 2

OLS estimates

Variable		**Coefficient**	***p* value**
Constant	Θ_0	0.0158	'0.5059
$\mathbf{R}_{t-1}$	Θ_1	-0.0410	0.0523*
$\mathbf{R}_{t-3}$	Θ_3	0.0556	0.0084***
Log LL		-3401.1290	
AIC		3.0448	
SC		3.0525	
Q(8)		10.234	0.1760
Q(16)		18.912	0.2180
$\mathbf{Q^2(8)}$		443.58	0.0000***
$\mathbf{Q^2(16)}$		444.27	0.0000***

Note. *** and * indicate significant at the 0.01and 0.10 levels respectively

Table 3

LM Test

Lag	$\mathbf{nR^2}$	***p* value**
2	533.1509	0.0000***
4	576.9098	0.0000***
6	581.3541	0.0000***
8	581.0934	0.0000***
10	581.1229	0.0000***
12	580.7113	0.0000***

Note. *** indicates significant at the 0.01 level

AR(1,3)-GARCH(1,2) model (Table 4) is chosen in modelling return volatility . This is because it gives better estimates compared to other GARCH models. The parameter estimates are highly significant at the 0.01 level, and the sum of these parameter estimates ($\alpha_1 + \alpha_2 + \beta_1$ = 0.8285) are generally high. It indicates that stock returns have high persistence conditional variances. This result is similar to the findings of Omran and Mckenzie (2000) and LL (1990). Moreover, the Ljung-Box Q-statistics and Q^2-statistics on standardized residuals and standardized squared residuals are free from serial correlations and conditional heteroskedasticity (GARCH effects). Thus, the AR(1,3)-GARCH(1,2) model seems adequate in estimating both mean and conditional variance of return.

Table 4

AR(1,3)-GARCH(1,2)

Variable		Coefficient	*p* value
Constant	Θ_0	-0.0009	0.9681
$\mathbf{R}_{t-1}$	Θ_1	0.1498	0.0000***
$\mathbf{R}_{t-3}$	Θ_3	0.0554	0.0068***
Constant	α_0	0.2607	0.0000***
ε^2_{t-1}	α_1	0.1545	0.0000***
ε^2_{t-2}	α_2	0.2539	0.0000***
σ^2_{t-1}	β_1	0.4201	0.0000***
Log LL		-3006.3050	
AIC		2.6953	
SC		2.7131	
Q(8)		2.5798	0.8590
Q(16)		12.0120	0.6050
$\mathbf{Q^2(8)}$		2.8258	0.8300
$\mathbf{Q^2(16)}$		2.9783	0.9990

Note. *** indicates significant at the 0.01 level

Having measured the return volatility, we proceed in testing the relationship between trading volume and return volatility. Table 5 gives the contemporaneous correlation between trading volume and return volatility by employing GARCH-cum trading volume model which includes trading volume as a proxy of the arrival of new information. The coefficient of trading volume (λ) is significantly positive at 0.01 level. It means that there is a significantly positive contemporaneous correlation between trading volume and return volatility. This would indicate the increase of new information, as proxied by trading volume, is always associated with an increase in return volatility. This inference is consistent with results of Clark (1973) and LL (1990). The sum of parameter estimates ($\alpha_1 + \alpha_2 + \beta_1$ = 0.6944) are generally lower than the sums of parameter estimates of the GARCH model without trading volume variable, implying that including trading volume variable in conditional variance equation leads in a reduction of volatility persistence. The analysis is continued by checking the standardized residuals for serial correlations and standardized squared residuals for GARCH effects. The Ljung-Box *Q*-statistics and Q^2-statistics at lag 8 and lag 16 indicate that the standardized residuals and standardized squared residuals do not show any significant serial correlations and GARCH effects. Thus, the results are strongly suggests that trading volume is a good proxy of information arrival in explaining the persistence of stock returns.

Table 5

AR(1,3)-GARCH(1,2)-L

Variable		**Coefficient**	***p* value**
Constant	Θ_0	-0.0254	0.2382
R_{t-1}	Θ_1	0.1173	0.0000***
R_{t-3}	Θ_3	0.0607	0.0018***
Constant	α_0	-3.0645	0.0000***
ε^2_{t-1}	α_1	0.1565	0.0000***
ε^2_{t-2}	α_2	0.3115	0.0000***
σ^2_{t-1}	β_1	0.2264	0.0000***
LTV	λ	0.1914	0.0000***
Log LL		-2990.0440	
AIC		2.6816	
SC		2.7021	
Q(8)		2.6681	0.8490
Q(16)		13.6990	0.4720
$Q^2(8)$		2.6979	0.8460
$Q^2(16)$		2.8197	0.9990

Note. *** indicates significant at the 0.01 level

5.0 CONCLUSIONS

The relationship between trading volume and return volatility has long been discussed either theoretically or empirically. Researchers have also found two alternative views regarding this relation. First, trading volume and return volatility is contemporaneously related. And second, there is a causal (lead-lag) relation among two variables. The contemporaneous correlation and causal relation are based on MDH hypothesis as argued by Clark (1973) and SIAH hypothesis as predicted by Copeland (1976), respectively. The purpose of this study is empirically to test the relationship between trading volume and return volatility by using simultaneous approach (GARCH-cum trading volume). We have employed the Kuala Lumpur Composite Index (KLCI) and trading volume daily data from 3 January 2000 to 31 July 2008. In this study, return volatility is measured by using GARCH model. The findings could be divided into three : firstly, our results strongly support the MDH hypothesis, which the relationship between trading volume and return volatility is found to follow a contemporaneous correlation in Malaysia stock returns. Secondly, GARCH model is chosen to be used in modelling of return volatility based on these information criteria. Lastly, inclusion of trading volume variable in conditional variance equation tends to reduce the volatility persistence. Hence, serially correlated arrival of new information into the market is a source of GARCH effects in the Malaysia stock market. It could be interpreted that total trading volume is a suitable proxy for the arrival information or persistence is due to time dependence in the rate of arrival of new information. Therefore, the changes in trading volume can be used when formulating new strategy, instead of taking into account of changes in price.

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