

## The Relationship between Trading Volume, Returns and Volatility in the Kuala Lumpur Stock Exchange

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### ABSTRACT

*This paper presents an empirical analysis of the relationship between trading volume, returns and volatility on the Main Board of Kuala Lumpur Stock Exchange. The findings in this paper help to explain how returns are generated and the implications for inferring return behavior from trading volume data. It provides evidence for the positive relationship between trading volume and volatility. The asymmetric relationship which is hypothesised to exist due to the differential cost of taking long and short positions is evident through the smaller slope for negative return in the volume-price change relationship. This paper also studies the relationship at individual stock level. Consistent with the belief of non-normality in returns (and ARCH effects) through the rate of arrival of information, the study shows that there is a reduction in the significance and magnitude of persistence in volatility.*

### ABSTRAK

*Kertas ini membentangkan kajian empirikal berkaitan perhubungan antara volum urusaniaga, pulangan dan volatiliti di Papan Utama Bursa Saham Kuala Lumpur. Penemuan dalam kajian ini dapat membantu menjelaskan bagaimana pulangan timbul dan kesannya ke atas kelakuan yang ditunjukkan oleh data volum urusaniaga. Penemuan ini juga menyediakan asas sokongan kepada perhubungan positif antara volum dagangan dengan volatiliti. Kajian awal menumpukan kepada perhubungan volum-perubahan harga. Tambahan pula, bukti yang didapati menyokong hipotesis yang mengatakan bahawa cerun volum-perubahan harga bagi pulangan negatif adalah lebih kecil daripada cerun bagi pulangan tak-negatif. Ini menyokong perhubungan hipotesis asimetri yang wujud akibat daripada perbezaan kos untuk mengambil kedudukan singkat dan panjang. Keputusan menunjukkan pengurangan dalam signifikan dan magnitud pada ketetapan volatiliti yang mana ini konsisten dengan penjelasan tentang pulangan tak-normal (kesan ARCH) melalui kadar ketibaan maklumat.*

## INTRODUCTION

The role of information in pricing is an issue heavily discussed in the areas of finance, economic and accounting. Few theories were forwarded including that of Fama (1991) in the Efficient Market Theory. Generally it is known that prices react to the arrival of new information. Studies relating to the association of prices, volume traded and the arrival of information can be found in Bamber (1986), Barclay and Litzenberger (1968), Brown, Clinch and Foster (1992), Cready and Mynat (1991), Jain and Joh (1988), Kiger (1972), Morse (1981) and Winsen (1976). All of these studies, in general, found that there is a relationship between volume traded and arrival of information. Korpoff (1987) suggested that, due to the fixed supply of securities in any fixed point, the results of previous studies were due to the demand for securities. The difference in the demand for securities depends on the micro structure including trading cost, strength of information, number of investors and number of securities in the market (Jennings, Starks & Flemming 1981). However, these studies were limited due to the problem of evaluating the information. The arrival of new information increases the volume traded and subsequently changes the price. Since the information could be bad or good, the price change can be negative or positive but the volume traded will never be negative.

The objective of this paper is first to identify a proxy for volume traded and subsequently use it to study the asymmetric relationship between aggregate volume and returns in the Kuala Lumpur Stock Exchange. Recognizing the linkage between information arrival, trading volume, returns and volatility, the second objective is to incorporate the arrival of information and expectation of "news" in the study of returns using the conditional variance models (ARCH and GARCH).

In this paper, two models which incorporate trading volumes are tested. The first model hypothesizes that volume traded is a positive function of the absolute price change. However this relationship is asymmetric which means that it depend on whether the price change is negative or positive. It is further hypothesized that the relationship between volume and positive price change is greater than the relationship between volume and negative price change. This model is tested on both the aggregate market and individual stock data. The second model recognizes that the first model explicitly incorporate the relationship between information arrival, trading volume, the of stock returns follow non-normal distribution. The non-normal distribution of the error terms can be modeled with the conditional variance process. These hypotheses need examination as previous studies on similar relationship do take conditional variance process into consideration. Thus the importance of this study is that it will enable investors to understand more on the generation of returns, their distribution and volatility.

## REVIEW OF PREVIOUS STUDIES

After the event studies by Ball and Brown (1968) and Fama et. al. (1969), many similar studies emerged in the areas of finance, accounting and economy. These studies were done from four angles, i.e., information contents, market efficiencies, model evaluation and matrix information (Bowman 1983; Damodran 1985).

Many studies in various markets show that the pattern of returns on the markets during the daily trading is U-shape. These results were reported by McInish and Wood (1990a), Wood, McInish and Ord (1988) and Lockwood and Lin (1990) for NYSE. Similar results were also reported by Aitken, Brown and Walter (1994), Brailsford (1995a) and Hodgson, Kending and Tahir (1993) for the Australian Stock Exchange. Other studies that reported the U-shape pattern were Ho and Cheung (1991) for the Hong Kong Stock Exchange, Yadav and Pope (1992) for the London Stock Exchange, Chang et. al. (1993) for Tokyo Stock Exchange and McInish, Wood (1990b) for Toronto Stock Exchange and Muhammed, Fauzias and Othman (1995) for the Kuala Lumpur Stock Exchange. In addition, Chan, Chan and Karolyi (1991) and Peterson (1990) found similar pattern in the volatility on the returns for futures and options markets respectively.

Harris (1989) reported that there was a positive correlation between returns, variance and volume traded. This was supported by Gallant, Rossi and Tauchen (1992) and Jones, Kaul and Lipson (1994), Cornell (1981) and Basseminder and Seguin (1992). The volatility is found to be high during the hours when the informations were at its peak (French & Roll 1986; Oldfield & Rogalski 1980; Stoll & Whaley 1990). Trading volume and transacted were found to be high immediately after the announcement of profit (Brown, Clinch & Foster 1992; Cready & Mynatt 1991; Kiger 1972; Morse 1981) and quickly eased back during the first hour. Barclay and Litzenberger (1988) found that new equity issues announcement was followed by a drop in prices and an increase in volume that was abnormal. An intraday study by Muhammed, Fauzias and Othman (1995) also support the volatility behaviour in the Kuala Lumpur Stock Exchange. On the other hand, Jain (1988) found that macroeconomic announcements, including money supply, consumers price index, industrial output and unemployment statistics did not show similar abnormality.

Karpoff (1986) forwarded a theory that relates returns and volatility with volume traded, which resulted in an asymmetric relationship between volume and price change. However, Karpof (1987) repeated the study empirically and found a weak evidence to support the relationship between volume and return, and further suggested a model that relates trading volume, return and volatility.

Studies have shown that returns, especially in the short run, are not normal and the typical distributions are volatility clustering or autoregressive conditional heteroskedasticity (ARCH) (Bollerslev, Chou & Kroner 1992). The ARCH model was suggested to overcome the problem of group volatility. According to this model, if the arrival of news is serially correlated, the innovation for information process will result in the momentum of the squared daily returns (Lamoureux & Lastrapes 1990). The ARCH model in this case will overcome the problem of continuous volatility. Lamoureux and Lastrapes (1990) found that the Generalized ARCH model is most suitable for the existence of continuous volatility.

Shamsher and Annuar (1993, 1995) studied the stock price volatility and factors associated with price volatility in the Kuala Lumpur Stock Exchange (KLSE). In the causality study, no causal relationship was found in the direction of volume cause price change. However, significant causal relationship was found at lag 1 and 2 in the direction of price change cause volume. Due to higher cost in selling short, they expect asymmetric relationship between price change and volume in the KLSE.

## DATA AND METHODOLOGY

The samples used in this study are the price and volume of an aggregate of randomly selected 55 counters that make up the 100 counters included in the Kuala Lumpur Composite Index (KLCI). Individual counter studies are also done on 8 of the counters randomly selected to compare with the aggregate results. All the counters selected are from the Main Board of KLSE for the period between December 18, 1990 and December 31, 1996.

*Hypothesis 1:* Here we hypothesised that there is a positive relationship between volume and price change in the KLSE, however it is in the form of asymmetric relationship. Given the inconsistency in the measurement of volume and the inconsistency in the results, this study will look at two possible proxies for volume. They are value traded and volume traded, of which both will be used. The characteristic of these values will be presented. We first study the association between the different measures for trading volume and price change on the Main Board of the KLSE for the daily data of the selected group. The regression model used, as suggested by Jain and Joh (1988), is:

$$V_t = \alpha_0 + \gamma_1 |r_t| + \gamma_2 D_t |r_t| + \mu_t \quad (1)$$

$$V_t = \alpha_0 + \gamma_3 r_t^2 + \gamma_4 D_t r_t^2 + \mu_t \quad (2)$$

where:

$V_t$  = Daily volume

$r_t$  = Daily return (from 2a)

$$r_t = \sum_{i=1}^{55} \frac{V_{it}}{TV_t} \times \text{ret} \quad (2a)$$

where:

$$\text{ret} = \frac{P_1 - P_0}{P_0}$$

$P_1$  = closing price

$P_0$  = opening price

$$TV_t = \sum_{i=1}^{55} V_{it}$$

$V_{it}$  = volume  $\times P_0$

$$D_t = 1 \text{ if } r_t < 0 \text{ and } D_t = 0 \text{ if } r_t \geq 0.$$

This model is consistent with the causality finding for the KLSE by Shamsheer and Annuar (1995). In (1),  $\gamma_1$  measures the relationship between return and volume traded without taking into consideration the direction of the change. Estimation of  $\gamma_2$  allows for asymmetric relationship. This can be seen from rearranging (1) resulting in  $V_t = \alpha_0 + (\gamma_1 + \gamma_2 D_t) |r_t| + U_t$ . A significant negative  $\gamma_2$  shows that the slope or respond for the negative return is smaller than the response for non-negative return. This is referred to the asymmetric relationship discussed earlier. Equation (2) is the repetition of equation (1) using the squared return. Both equations (1) and (2) show that returns are the estimate measure for volatility. Thus the hypothesis of asymmetric relationship would be indicative if  $\gamma_2$  is significantly negative.

Before (1) and (2) can be estimated, econometric issues need to be considered. Firstly, there exist a significant difference in the level size for the dependent and independent variables. This will result in difficulties in interpreting the results. To correct this problem, the volume traded and the returns are standardized by dividing the deviation from the mean by its standard deviation.

The second econometric issue relates to the statistical inference. The t- and F-statistic that were usually used in parametric tests were usually associated with regression analysis that required the normality of residual for correct inference. The use of the absolute values in regression will direct the X- and Y-coordinates into the first and second quadrants and this will affect

the distribution of the residuals. Estimations of (1) and (2) caused the non-normality of the residuals and will show high degree of serial dependence. This will necessitate the use of first-order autoregressive model (AR). The third issue results from the use of the autoregressive model on the aggregate study. However, this can be corrected by using the Wald-test (Savin 1976). Finally, the use of autoregressive process may still results in the non-normality of the residuals due to serial correlation. To remove this, a lag of the dependent variable was added to (1) and (2) (see Arif & Lee 1993).

Hypothesis 2: We then study the eight securities selected from the 100 securities that make up the KLCI. The counters included are Amsteel Corporation, Cold Storage, Genting, IGB Corporation, KL Kepong, Maybank, Metropolitan and Sime Darby. The purpose here is to see whether the result will differ from the aggregate study in test 1.

Hypothesis 3: Finally, we study the relationship between the arrival of information, volume traded and returns using conditional volatility. The test used the ARCH model to handle the non-normality of the return. The methodology used is consistent with that suggested by Lamoureux and Lastrapes (1990) where the GARCH model was used for returns that exhibit non-normality. In this study the standardized GARCH(1,1) was initially estimated. The AR(1) process was used in the conditional mean to account for the first-order autocorrelation. The estimated model is:

$$\begin{aligned} r_t &= \alpha_0 + r_{t-1} + \varepsilon_t \\ \text{where } \varepsilon_t | \Omega_{t-1} &\sim N(0, h_t) \\ h_t &= \alpha_0 + \varepsilon_{t-1}^2 + h_{t-1} \end{aligned}$$

The second stage of the estimation modified the GARCH(1,1) where the US overnight return (measured by the return on S&P 500 daily closing index) was added to the conditional mean and the standardized volume traded was added to the conditional variance. The overnight return is assumed to capture the expectation of "news" and the volume proxies the arrival of information for the trading day. This modification will result in the model below:

$$\begin{aligned} r_t &= \alpha_0 + r_{t-1} + M_t + \varepsilon_t \\ \text{where } \varepsilon_t | \Omega_{t-1} &\sim N(0, h_t) \\ h_t &= \alpha_0 + \varepsilon_{t-1}^2 + h_{t-1} + V_t \\ \text{and } M_t &= \text{overnight return on S\&P 500} \\ V_t &= \text{standardized volume traded of securities} \end{aligned}$$

## FINDINGS

The summary statistics for two possible measures to represent volume traded is given in Table 1.

TABLE 1. Summary statistics for daily volume traded, from 18/12/1990 to 16/12/1996

	volume (000) <sup>a</sup>	value (000) <sup>b</sup>
Mean	35,927	141,813
Standard Deviation	32,950	132,454
Skewness	1.980	1.959
Kurtosis	4.219	5.871
Minimum	0.00	71.05
Maximum	208,887	1,114,608

Note: <sup>a</sup>daily volume traded.

<sup>b</sup>daily value traded.

The Pearson correlation for two possible measures of daily volume trade is given Table 2. The two measures that could be used to proxy volume traded is significantly correlated.

TABLE 2. Matrix Pearson correlation between volume and value

	volume	value
Volume <sup>a</sup>	1.0000	0.8792*
Value <sup>b</sup>	0.8792*	1.0000

Note: \*significant at 0.001 level.

<sup>a</sup>daily volume traded.

<sup>b</sup>daily value traded.

The relationship between volume and the aggregate return is given in Table 3. Using equation (1), it is found that both  $\gamma_1$  and  $\gamma_2$  are significant when volume is used and the signs support both the hypothesised positive relationship between volume and returns and asymmetric relationship. This shows that the response for negative return is smaller than non-negative return.

Estimation for  $\gamma_1$  that measured the relationship between price change and volume without taking into consideration the direction is positively significant only when volume traded is used as measurements for volume whereas the use of value traded is not significant. Estimation for  $\gamma_2$ , that

TABLE 3. The relationship between standardized volume traded and standardized absolute return<sup>a</sup>

estimator	$v_t = \text{volume}^b$	$v_t = \text{value}^c$
$\alpha_0$	0.07586 (0.6587)	-0.2991 (-28.2261)*
$\gamma_1$	0.89008 (6.6145)*	2.59E-06 (0.01634)
$\gamma_2$	-0.7470 (-2.2795)*	3.60E-05 (0.0940)

Note: \*significant at 0.05 level.

<sup>a</sup>results from equation (1).

<sup>b</sup>daily number of securities traded.

<sup>c</sup>daily value of securities traded.

measures asymmetric relationship, was also found to be significant when volume is used and not significant when value traded is used. Thus, the use of (1) favors volume traded over value traded.

Equation (2) uses return square instead of the absolute return for the independent variables. It is used to test the association between daily volume traded and the alternative specification of  $\hat{w}\hat{a}\hat{t}$  volatility (Timothy 1996). The estimation results for (2) is reported in Table (4). The results also support our hypothesis and favor the used of volume traded.

TABLE 4. Relationship between standardized volume traded and standardized return square<sup>a</sup>

estimator	$v_t = \text{volume}^b$	$v_t = \text{value}^c$
$\alpha_0$	0.4121 (2.9622)	-0.2991 (-28.1840)*
$\gamma_3$	0.1095 (5.9170)*	1.83E-07 (0.0073)
$\gamma_4$	-0.6538 (-1.4558)	6.07E-05 (0.1149)

Note: \*significant at 0.05 level.

<sup>a</sup>results from equation (2).

<sup>b</sup>daily number of securities traded.

<sup>c</sup>daily value of securities traded.

Association between volume and return for individual securities traded is given in Table 5. It shows the results for estimations of coefficients in equation (1) using daily volume traded to proxy for volume for eight



securities. Generally the results show that the estimations are more significant for individual securities than the aggregate securities. The estimation of  $\gamma_1$ , that measures the association between return and volume without taking the direction into consideration, is significant for all the securities studied. For the estimation of  $\gamma_2$ , that measures the asymmetric relationship, only two securities were insignificant. All the significant  $\gamma_2$  have negative values which indicate that the slope for negative return is smaller than the positive return.

TABLE 5. Relationship between standardized volume traded and standardized absolute return for individual securitiesa.

	$\alpha_0$	$\gamma_1$	$\gamma_2$
Ams	-0.245 (-6.960)*	0.373 (10.96)*	-0.139 (-3.32)*
Coldst	-0.26 (-8.490)*	0.668 (18.72)*	-0.438 (-8.43)*
Gent	-0.153 (-4.680)*	0.089 (2.160)*	0.056 -1.066
IGB	-0.208 (-6.090)*	0.374 (11.08)*	-0.208 (-4.690)*
KLK	-0.029 (-9.430)*	0.539 (15.45)*	-0.177 (-3.700)*
Mayban	0.945 (7.970)*	0.805 (5.360)*	0.168 -0.795
Metrop	-0.399 (-12.10)*	0.762 (18.78)*	-0.416 (-8.640)*
Simeda	-0.212 (-6.180)*	0.496 (10.35)*	-0.275 (-4.630)*

Note: \*significant at 0.05 level.

\*regression results for equation (1).

Further analysis is to study the association between the arrival of information, volume traded and return used conditional volatility model (ARCH) to take into account the non-normality series of return (Lamoureux and Lastrapes, 1990). In this study, standardized GARCH(1,1) model was identified at the early stage. Autoregressive process (AR) of order one was used in the conditional mean to clean the autocorrelation. The results of this estimation is given by

$$r_t = -0.0825 + 0.8851 r_{t-1} + \varepsilon_t \quad (3)$$

(-6.25)\*    (48.21)\*

where  $\varepsilon_t | \Omega_{t-1} \sim N(0, h_t)$

$$h_t = 3.93E-05 + 0.3519 \varepsilon_{t-1}^2 + 0.8118 h_{t-1} \quad (4)$$

(3.75)\*      (40.79)\*      (226.13)\*

The analysis using the ARCH model was found to produce a significant results, where the conditional volatility is able to statistically explain the relationship between the arrival of information, traded volume and returns. Using the LM-test (Eagle 1982) for the ARCH's return that was already cleaned through the AR(1) process, it was found that the ARCH error in all lags is significant. This shows that the AR(1) process has overcome the problem of autocorrelation of the first order in the conditional mean.

The second stage of the analysis involved the modification of the standard GARCH(1,1) with an addition of overnight return of the KLSE index in the conditional mean and standard volume traded in the conditional variance. The overnight return may capture an expectation of "news" (Timothy 1996). The standardized volume traded on the other hand is a proxy for the arrival of information throughout the trading day.

The estimation of the modified model, using standardized daily value traded to proxy daily volume traded is

$$r_t = -0.0789 + 0.8137 r_{t-1} + 0.6730 M_t + \varepsilon_t \quad (5)$$

(-5.37)\*      (45.27)\*      (3.71)\*

$$h_t = -0.0031 + 0.3170 \varepsilon_{t-1}^2 + 0.4846 h_{t-1} + 0.0248 V_t \quad (6)$$

(-14.35)\*      (42.12)\*      (229.36)\*      (38.92)\*

where  $\varepsilon_t | \Omega_{t-1} \sim N(0, h_t)$ ,  $M_t$  is the overnight return on S&P 500 index and  $V_t$  is the standardized volume traded.

The main features of the GARCH model are the significance of all the estimated coefficients especially the two new independent variables. From the results above, it is found that the addition of the value traded in (6) decreases the coefficient of  $\varepsilon_{t-1}^2$  by 10% from 0.3519 to 0.3170. The coefficient for  $h_{t-1}$  decreases by 40%. The addition of the two independent variables in the GARCH model has reduced the coefficient for the lagged daily return by 8% from 0.8851 to 0.8137. It may indicate that part of the autocorrelation in the daily return of the aggregate securities could be due to the overnight return of S&P 500 index return, which is used to proxy the arrival of expected "news" and found to be significant. The magnitude of the GARCH coefficients have reduced from 0.8118 in (4) to 0.4846 in (6). This GARCH term, which explains "yesterdays forecast variance" thus can partly be

captured in the volume traded. The persistence in variance, which is defined as the sum of the coefficients for the Arch ( $\epsilon^2_{t-1}$ ) and Garch ( $h_{t-1}$ ) has reduced from by 31% from 1.1637 to 0.8016. Thus the volume that was added in (6) can explain some of the persistence variance in (4).

## CONCLUSION

This paper analyzed the relationship between trading volume, return and volatility on the KLSE. The early stage of this study evolved in looking at the relationship between volume trade and returns. The aggregate relationship, without taking the direction of returns into consideration, was found to be significantly positive using both volume traded and value traded as proxies for volume. However, volume traded was found to be a better proxy for volume, implying that volume traded should be more preferred than value traded in studying the relationship between volume and returns. This study also supports the hypothesis that the negative slope in volume-return relationship is less than non-negative slope. This is consistent with the asymmetric relationship suggested by Karpoff (1987). The implication of this result is that investors in KLSE should expect the association of returns and volume to be greater when the market is in the upward trend and less in the downward trend. If risk is reflected in price, then an unusual increase in volume traded may indicate a highly speculative market. Generally, the results for the relationship between volume traded and return give similar interpretation when individual securities were used.

The relationship between trading volume and return was extended to conditional framework where volume traded was used as proxy for the rate of information arrival and overnight return on the KLSE for expected news. The results show a reduction in the significance and magnitude of coefficients in the conditional variance. This implies that some of the observed autocorrelation in the KLSE returns can be captured by the US overnight returns. The GARCH model also implies that investors can reduce "yesterday's forecast variance" by including volume traded in the conditional variance.

The results presented in this study help to increase our understanding regarding the relationship between trading volume, returns and volatility, particularly for the KLSE. These findings also help us in explaining the behavior of returns, their distribution and volatility and a better understanding of market movement. It also indicates that any study of trading volume and returns is necessarily related to information flow and possibly to identify a better proxy for information flow.

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