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An Empirical Analysis of the Taiwan Institutional Trading Volume Volatility Spillover on Stock Market Index Return

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Abstract

This paper provides interesting empirical evidence on the relation between the volatility impact effect of the Taiwan institutional trading volume and the stock market index by using the MEGARCH model. We found a significant autoregressive coefficient of institutional trading volume and stock market index. The cross-volatility spillover effect, asymmetric leverage effect, and persistence of volatility effect are statistically significant. The feedback and lead-lag relationship between trading volume and stock index return are also statistically significant. Therefore, Taiwan¡¦s institutional trading volume can affect the stock market index through volatility effect and causality.

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1. Introduction

An extensive quantity of research into the theoretical and empirical aspects of the relationship among stock index return, volatility, and trading volume has spurred the interest of financial economists for a number of years. Suppose that a company has the available set of information and that its stock price reflects investors' expectations concerning the future performance of that firm. The arrival of new information causes investors to reflect price movements. Most previous work on this area has primarily focused on the dynamic relationship between trading volume and stock return. Karpoff (1987), for example, examined the relationship between trading volume and index return prices and found a positive relationship between them. Prior research has also provided evidence for the causal relationship between trading volume and stock price. Roland *et al*. (2003) found that stock price return volatility and trading volume have a strong positive relationship and reported evidence of causality among return volatility, return, and trading volume. Similarly, Brock and LeBaron (1996) investigated the autocorrelation relationship between return volatility and trading volume and found a positive relationship between them.

Interest in the behavior of institutional investors has greatly increased among investors in recent years. For example, Vincentiu (2004) reported that the daily trading volume of individual and institutional investors shows a positive autocorrelation with stock prices. However, few previous studies on institutional trading volume and stock return have shown that there is no positive autocorrelation relationship. Martin (2004) extended the analysis into institutional trading volume, stock returns, and volatility and showed that pension funds reduce the positive return autocorrelation and volatility. Florors and Vougas (2007) examined the relationship between trading volume and returns in the Greek stock index future market by using the GARCH and GMM methods. The empirical result found no evidence of a positive relationship between trading volume and returns. Chen *et al*. (2008) used a VAR model to examine the dynamic relations among return volatility, trading imbalances, and trading variables for the S&P 500 futures and Japanese Yen future markets. The results indicated strong feedback effects between volatility and trading variables in the Granger causality test, and the sequential arrival of information hypothesis to explain the volatility-volume relation.

There is an extensive and growing list of studies on the relations among institutional change of ownership, holdings, preference, and stock price returns (see, for example, Mark (1997), Shuming Liu (2005), Martin T. Bohl (2004), Josef (1992), and Christo (2004)). Several other studies also examine the autocorrelation relation between institutional buying and selling on stock price return (see, for example, F. Doulgas (2005), Roger M. Edelen (2000), Bartosz (2003), Vicentiu (2004), John (2003), Aslihan (2001), Joseph (2004), Xavier (2005), Fang Cai (2004), Chiraphol (2004)). Some others have focused on institutional and stock return serial autocorrelation (see, for example, Richard (1997), Bartosz Gebka (2003), Martin T. Bohl (2004)). The primary objective of this study is to examine institutional trading behavior and stock index return with a focus on the analysis of mean and volatility spillover. However, this analysis incorporates the theory of institutional trading activity and stock index return and the idea of volume-return risk. We combine these theories together to determine whether there is any mean or volatility spillover effect between institutional trading volume and stock index returns. This is an extension analysis of the effects of institutional trading behavior and stock index return by using the MEGARCH(1,1) model; this research includes a discussion of asymmetric volatility spillover.

The paper proceeds as follows. Section I briefly discusses related research and theory. Section II describes the data and the methodology used to examine the relation between institutional trading and stock index return. Section III presents our interpretation of the empirical results for practical use of daily trading volume and index data to examine the relationship of institutional trading volume and stock index return. Finally, Section V reviews the conclusions.

2. Data and Methodology

2.1 Data Analysis

The data used in this study are the time series of trading volume and stock index return on three institutions, namely, foreign investors (FI), investment trusts (IT), and dealers (DE) for the Taiwan Stock Exchange (TSE) markets at Taiwan. They are obtained from the *TEJ Data Bank*. The sample period covers 2 January 2001 through 28 December 2007. We investigate the volume-return relationship, daily return, and trading volume.

Daily return is calculated as the change in the logarithm of the closing price on successive days:

$$R_t = \ln(P_t / P_{t-1}) \quad . \tag{1}$$

Table I presents the basic descriptive analysis of the time series of stock return and the institution's trading volume, and the summary statistics for the daily returns of the OTC and TSE markets and foreign investors, investment trusts, and brokerage firms markets. The mean returns for all markets are positive, and all kurtosis values are much larger than 3. This shows that for all series, the distribution of those variables is fat-tailed as compared to the normal distribution. Applying the Jarque-Bera test of normality, we additionally find strong support for the hypothesis that the return and volume series do not have a normal distribution.

Table I : Summary statistics

	LDE	LFI	LIT	LTSE
Mean	133076.7	660169.1	157605.1	6109.968
Median	120853.0	613351.0	144014.0	5952.320
Maximum	755374.0	3000817	488876.0	9809.880
Minimum	9575.000	39857.00	39144.00	3446.260
Std. Dev.	72559.75	367457.2	64346.14	1278.535
Skewness	1.481135	1.174650	1.112914	0.707689
Kurtosis	7.933567	5.751546	4.530469	3.358954
Jarque-Bera	2388.428***	944.1317***	526.2705***	153.7808***
L-B(6)	503.01***	5048.2***	4726.1***	3653.3***
$L\text{-}B^2(6)$	2467.2***	2277.3***	1988.9***	1872.5***
ARCH-LM(6)	112.79***	81.14***	77.26***	93.44***

Note: (1). ***, **, ** indicated at least significant at 1%, 5% and 10% level, respectively. (2). LDE, LFI, LIT and LTSE are the log of the dealer, foreign investor, investment trust and Taiwan stock exchange market index, respectively. (3). ARCH-LM statistics are all significant at 1% level, indicating the existence of ARCH phenomena for all variables series.

Next, we are interested in the non-stationarity characteristic of the data that may be present in the individual volumes and return series. If the time series is non-stationary, subsequent tests for the effect of volume on conditional variance may be invalid. We conduct tests for stationarity among the variables using both Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) unit root tests. Table II reports the unit root test results, and they indicate that all individual volumes and return series are stationary with or without the presence of a deterministic trend in the level of each volume series. The F-statistics indicate the presence of an intercept, and a deterministic trend is statistically important in the unit root test.

Table II: Unit root test

	Level		1st different	
Variables	ADF	PP	ADF	PP
LFI	-1.4579	-1.4872	-10.3746***	-31.1817***
LIT	-1.9543	-1.9846	-6.6992***	-22.8234***
LDE	-1.8198	-1.9247	-6.0999***	-21.4279***
LTSE	-0.9472	-0.9869	-39.7670***	-39.7597***

Note: ***, **, ** indicated at least significant at 1%, 5% and 10% level, respectively

2.2 Methodology

We estimate the MEGARCH(1,1) model suggested by Bollerslev (1990), which is used as a framework to take account of asymmetric volatility spillovers and the standard MEGARCH(1,1) model that assumes that the underlying correlations between shocks are constant over time. This constant correlation specification has generally a well-behaved likelihood function as well as limits the number of estimation of coefficients to a workable level. However, the dynamic conditional correlation model allows these correlations to be time varying.

Following Koutmos and Booth (1995) and Antoniou *et al.* (2003), we specify the MEGARCH(1,1) model as follows:

$$R_{i,t} = \beta_{i,0} + \sum_{j=1}^{n} \beta_{i,j} R_{j,t-1} + \varepsilon_{i,t} \tag{1}$$

$$\sigma_{i,t} = \exp\left[\alpha_{i,\mathbf{0}} + \sum_{j=\mathbf{1}}^{n} \alpha_{ij} \quad f_j(Z_{j,t-\mathbf{1}}) + \delta_i \ln(\sigma_{i,t-\mathbf{1}}^{\mathbf{2}}) \right] \tag{2}$$

$$f_i(Z_{j,t-\mathbf{1}}) = (\left|Z_{j,t-\mathbf{1}}\right| - E(\left|Z_{j,t-\mathbf{1}}\right|) + r_j Z_{j,t-\mathbf{1}}) \tag{3}$$

$$\sigma_{i,j,t} = \rho_{i,j} \sigma_{i,t} \sigma_{j,t} \tag{4}$$

From the mean equation, the dynamic relationships in returns are captured by using a Vector Autoregressive (VAR) model, where the conditional mean in each market ($R_{i,t}$) is a function of their own past returns and cross-market past returns ($R_{i,t}$). Let $R_{i,t}$ be the return at time *t* for market *i* where, *i*= 1,2,3,4, (1=foreign investment, 2=investment trust, 3=dealer, 4=Taiwan stock index return). However, β_{ij} captures the lead-lag relationship between returns in the different markets, for $i \neq j$. A significant β_{ij} value implies that market j is ahead of market *i*. In this study, the first-order VAR is adopted because we think the stock market will quickly respond to information from other markets.

Equation (2) explains the MEGARCH(1,1) representation of the variance of error term. According to the MEGARCH(1,1) representation, the conditional variance of the returns in each market is an exponential function of past own, cross-market standardized innovations and past own conditional variance. The estimated value of δ_t measures the persistence of volatility. If δ_t =1, then the unconditional variance does not exist and the conditional variance follows an integrated process of order one.

Asymmetry is modeled by Eq.(3), which captures the ARCH effect, and is asymmetric function of past standardized innovations. Parameter r_j in Eq.(3) measures the impact of innovations with the following partial derivatives:

$$\frac{\partial f_j(Z_j, t-1)}{\partial Z_{ij}} = 1 + r_j \quad \text{, for } Z_j > 0 \quad \text{and,} \qquad (6)$$

$$\frac{\partial f_j(Z_j, t-1)}{\partial Z_{ij}} = -1 + r_j \quad \text{, for } \; Z_j < 0 \qquad (7)$$

The conditional variance equation describes the conditional variance in each market as an exponential function of past standardized innovation, ($Z_{j,t-1} = \frac{\varepsilon_{j,t-1}}{\sigma_{j,t-1}}$) that is from its own market and other markets, and $E(|Z_{jt}|)$ is the expected value of $|Z_{jt}|$. Spillovers are captured by the coefficients $\alpha_{ij}(i \neq j)$, while asymmetry implies a negative r_j. The asymmetric influence of innovation on the conditional variance is captured by the term ($\sum_{j=1}^{n} \alpha_{ij} f_i(Z_{j,t-1})$). In this study, a statistically significant positive r_j together with a negative (positive) r_j shows that the negative innovations in market *j* have a greater impact on the volatility of market *i* than positive (negative) innovations. The relative importance of asymmetry (or leverage effect) can be measured by the ratio $|-1 + r_j| / (1 + r_j)$.

The term $|Z_{jt}| - E(|Z_{jt}|)$ measures the size effect. Assuming positive α_{ij}, the impact of $|Z_{jt}|$ on δ_t will be positive (negative) if the magnitude of $|Z_{jt}|$ is greater (smaller) than its expected value $E(|Z_{jt}|)$. Assuming that the conditional joint distribution of the returns of the three markets is normal, the log likelihood for the MEGARCH(1,1) model can be written as follows:

$$L(\theta) = -(1/2)(NT)\ln(2\pi) - (1/2)\sum_{t-1}^{T}\left(\ln|s_t| + \in_t^{'} \; S_t^{-1} \in_t\right) \qquad (7)$$

where N is the number of equations(four in this case), T is the number of observations, θ is the parameter vector to be estimated, $\in_t^{'} = [\in_{1,t} \in_{2,t} \in_{3,t} \in_{4,t}]$ is the 1×4 vector of innovations at time *t*, and S_t is the 4×4 time varying conditional variance-covariance matrix with diagonal elements given by Eq.(2) for *i* = 1,2,3,4 and cross diagonal elements are given in Eq.(4) for *i, j* = 1,2,3,4. and $i \neq j$. The log-likelihood function is highly non-linear in θ, and therefore, numerical maximization techniques have to be used.

3. Empirical Results

However, a better picture concerning the influence of trading volume on stock index returns and vice versa can be obtained from the Granger causality test[1]. Table III reports our results from the Granger testing for the unidirectional causality between return and trading volume. The null hypothesis is that right hand side variable doesn't Granger causes let hand side variable. In line with our expectations, we find evidence that the Taiwan stock index return unidirectional causality investment trust and dealer trading volumes, but not foreign investment. However, there is no evidence of significant causality running from foreign investor, investment trust, and dealers to the TSE stock index. In general, Taiwan stock index return have unidirectional causality to local institution trading volume(investment trust and dealer) but three institutional trading volumes did not unidirectional causality Taiwan stock index return. Finally, we also found that there exists a significant bi-directional causality relationship between investment trust and foreign investment and also between investment trust and dealer.

Table III: Pairwise Granges Causality test for Taiwan's institutional trading volume and stock index return

			F-Statistic
LTSE	$\nrightarrow$	LFI	0.5495
LFI	$\nrightarrow$	LTSE	0.3908
LTSE	$\nrightarrow$	LIT	4.6335***
LIT	$\nrightarrow$	LTSE	0.7326
LTSE	$\nrightarrow$	LDE	5.7356***
LDE	$\nrightarrow$	LTSE	1.5131
LFI	$\nrightarrow$	LTSE	0.3908
LTSE	$\nrightarrow$	LFI	0.5495
LIT	$\nrightarrow$	LFI	3.1563***
LFI	$\nrightarrow$	LIT	1.9647**
LDE	$\nrightarrow$	LFI	0.5251
LFI	$\nrightarrow$	LDE	0.4035
LDE	$\nrightarrow$	LIT	3.6426***
LIT	$\nrightarrow$	LDE	2.9954***

Note：(1). ***, **, ** indicated at least significant at 1%, 5% and 10% level, respectively. (2). Null hypothesis is right hard side of variables dose not granger cause left hand side variables.

The maximum likelihood estimates of the parameters for the MEGARCH(1,1) model describing conditional means are reported at panel A of Table IV. The autoregressive

[1] Causality test show that if y1 cause y2, lags of y1 should be significant in the equation of y2. If this is the case and not vice versa, it would be said that there exists unidirectional causality. If both were significant, it would be said that there exists bi-directional causality.

coefficients β_{ij} are statistically significant at least at the 5% level for the three institutional trading volumes to the stock index (-0.006, 0.0019, and 0.0017) and among the three institutional trading volume markets. The conditional variance for each market is a function of past innovations and past conditional variances. The past innovation and past conditional variances are estimated by coefficients α_{ij} and δ_i, respectively. However, coefficients γ_j measured the leverage effect or asymmetric impact of past innovations on current volatility. Based on this table, we found that all the coefficients which measure asymmetry are statistically significant (from -0.3541 to 0.0829). The estimated parameter of the cross-market innovation spillover parameter indicates a significant impact of past volatility from the three institutional trading volumes to the stock market index, and the feed-back effect among those variables. The values of δ_j that measure the persistence of volatility are positively and statistically significant at the 1% level (from 0.3439 to 0.8745). In this study, the degree of asymmetry, based on the estimated γ_j coefficient, is statistically significant with a negative (positive) innovation in the market of foreign investment trading volume, and stock market (investment trust and dealer) has a greater impact than positive (negative) innovations. The estimated Ljung-Box Q statistics for the standardized and squared standardized residuals show that the MEGARCH(1,1) model can successfully account for the linear and non-linear dependence present in the series.

Table IV: Parameter estimates for the MEGARCH model of Taiwan institutional trading volume and stock index return

Panel A: Mean and conditional variance equation

Mean Equation	DLFI		DLIT		DLDE		DLTSE
β_{10}	-0.4716 (0.4679)	β_{20}	0.1301*** (0.0106)	β_{30}	0.1535*** (0.0178)	β_{40}	0.0387** (0.0221)
β_{11}	-0.3043*** (0.0055)	β_{21}	0.0052*** (0.0004)	β_{31}	0.0391*** (0.0004)	β_{41}	-0.0006*** (0.0002)
β_{12}	0.0178 (0.0136)	β_{22}	-0.3762*** (0.0059)	β_{32}	0.0222*** (0.0014)	β_{42}	0.0019** (0.0009)
β_{13}	-0.0094 (0.0123)	β_{23}	0.0629*** (0.0102)	β_{33}	-0.3992*** (0.0080)	β_{43}	0.00167** (0.0007)
β_{14}	0.3769*** (0.0943)	β_{24}	1.5603*** (0.0264)	β_{34}	2.6298*** (0.2073)	β_{44}	0.0602*** (0.0099)
Variance Equation							
α_{10}	433.7727*** (8.4141)	α_{20}	265.7551*** (1.5689)	α_{30}	191.2407*** (0.6991)	α_{40}	0.0532*** (0.0009)
α_{11}	0.4704*** (0.0081)	α_{21}	0.0347*** (0.0006)	α_{31}	0.0657*** (0.0003)	α_{41}	0.0159*** (0.0001)
α_{12}	0.0476*** (0.0125)	α_{22}	0.0395*** (0.0004)	α_{32}	0.0892*** (0.0001)	α_{42}	-0.0122 (0.0002)
α_{13}	0.1244*** (0.0082)	α_{23}	0.1011*** (0.0091)	α_{33}	0.1183*** (0.0003)	α_{43}	0.0660*** (0.0001)
δ_1	0.3439*** (0.008)	δ_2	0.5120*** (0.0004)	δ_3	0.6965*** (0.0011)	δ_4	0.8745*** (0.0044)
γ_1	-0.3541*** (0.0083)	γ_2	0.0829*** (0.0006)	γ_3	0.0090*** (0.0008)	γ_4	-0.0910*** (0.0018)

Panel B: Model diagnostic checking

L-BQ(6): 5.7829

L-BQ^2(6): 2.6745

ARCH-LM(6): 4.1162

Note: (1). ***, **, ** indicated at least significant at 1%, 5% and 10% level, respectively. (2). DLDE, DLFI, DLIT and DLTSE are the difference log of the dealer, foreign investor, investment trust and Taiwan stock exchange market index, respectively.

4. Conclusions

This paper analyzed the volatility impact effect of Taiwan's three institutional trading volumes to the stock market index by using the MEGARCH(1,1) model, which considers the dynamic relationship among variables. From the empirical results, we found a significant autoregressive coefficient effect for the three institutional trading markets and the stock market. The cross-volatility spillover effect, the asymmetric leverage effect, and the persistence of the volatility effect are statistically significant. Based on this analysis, the Taiwan stock market is affected by the trading volumes of the three institutions, and trading volume volatility can affect the stock market index. We found the feedback volatility effect between institutional trading volume and stock market index. Our results are consistent with those of Chen *et al.* (2008), who indicated a strong feedback relationship between trading volume and stock index return. Additionally, a significant lead-lag relationship is exhibited between trading volume and stock market index.

Therefore, the volume-return relationships tell investors when they want to execute an investment decision, and then the information flow of trading volume should be considered. Neglecting this information may result in the wrong investment decision. Based on our empirical results, the arrival of trading volume information plays an important role among investors, indicating when to perform a stock investment decision.

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