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Studies on the Effect of Trading Volume and Return Volatility on Call Warrants and Underlying Stocks in Taiwan

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This study selects ten call warrants on electronics stocks and utilizes the bivariate GARCH model to investigate the influence of return and expected and unexpected trading volume on the call warrants and underlying stocks. The results reveal that stocks and call warrants are correlated and function as leading factors for each other. The volatilities of underlying stock returns are positively influenced by the expected and unexpected trading volumes of the underlying stocks. The influence of expected and unexpected trading volumes of warrants on the volatility of target stock returns is also positively correlated. Expected and unexpected trading volumes of warrants as well as underlying stocks show a positive correlation with the return volatility of warrants.

Introduction

Call warrants are a kind of derivative financial commodity with a form similar to an option. They are contracted rights issued by a specific securities company or a financial investment institute. They are valuable certificates that allow holders to buy back a specific amount of shares at specific prices before the expiration of the call warrants or conduct spreads via spot negotiation. Call warrants are a right, not an

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obligation; thus, call warrant holders can decide either to exercise the contracts or not. If call warrant holders choose to exercise the contracts, then the issuance company cannot refuse the holders' requests. Currently, approved call warrants on the Taiwan Stock Exchange are issued by local securities houses or banks, instead of the corresponding stock companies. Issued targets are based on listed stocks in the market.

Early in 1996, foreign capital investors were attracted by the potential market in Taiwan and issued a variety of overseas call warrants based on Taiwanese stocks. Domestic brokers also sought cooperation with foreign agents to issue call warrants, which provided foreign institutional investors and chief shareholders an alternative for speculation, arbitrage, and hedging. As the local financial market opened gradually, new financial commodities were available to the market. Local call warrants appeared in Taiwan in August 1997 under wide public expectations, which accordingly provided domestic investors an option for hedging.

Domestic as well as foreign banks and securities houses are currently allowed to issue call warrants based on listed stocks, stock composites, and portfolios in Taiwan. Ever since the first locally-listed warrant Grand Cathay 01 was issued years ago, there have been 267 call warrants issued based on listed stocks in the market through the end of 2002. Composite call warrants have accounted for 30 in total over the same time. Because call warrants based on a single stock are comparatively convenient for investors to conduct arbitrages and hedging, the trading of such call warrants is more popular than other styles of call warrants. Composite call warrants have faded accordingly. As for targets of investment, electronic stocks have a higher volatility and attract wider attention.

Call warrants in Taiwan belong to a kind of call option that gives investors not only hedging but also speculating and arbitraging tools due to their high financial leverage. There are no related studies on call warrants in Taiwan because of their brief development history. Most studies on the correlation between derivative and spot markets focus merely on the correlation studies between these two markets. Because derivative securities also function for hedging purposes, most research studies focus mainly on the volatility impact of derivative securities on their underlying stock returns (Edwards, 1988; Lee and Ohk, 1992; Antoniou and Holmes, 1995; Antoniou, Holmes and Priestley, 1998; Ma and Rao, 1988; Conrad, 1989; Skinner, 1989; Bansal, Pruitt, and Wei, 1989; Damodaran and Lim, 1991; Bollen, 1998) No consistent conclusion has been reached in investigating the volatility impact of derivative securities on their underlying stock returns.

Conrad (1989), Skinner (1989), Bansal, Pruitt, and Wei (1989) and Damodaran and Lim (1991) all realize that option trading reduces the volatility of underlying stocks, as investors migrate from the spot market to the derivatives market and accordingly reduce the volatility of the spot market. The derivatives market also possesses price discovery, which consequently enhances the exchange of market information and thus reduces the volatility of market returns (Arditti and John, 1980). Bollen (1998) finds that there is no significant impact for derivative security trading on spot return volatility, however. On the other hand, Ma and Rao (1988) realize that the more investors are informed, the higher the spot return volatility will be. To sum, there is no consistent conclusion for the influence of derivative security trading on spot market return volatility among previous studies. This has inspired the research motivation of our study.

Earlier studies on the correlation between a derivatives market and spot market emphasize the research of price correlation, where Far-off (1987) shows that trading volume conveys information, i.e. the higher the trading volume is, the more information that one can respond to, in which noise increases the return volatility. Trading volume in general is able to reveal future financial market messages (Karpoff, 1987), i.e., the transmission of financial messages can be detected via an investigation of trading volume changes. For instance, the implied messages of an underlying stock's trading volume influence not only the underlying stock's return volatility, but also the warrant return. Hedgers, speculators, and those who conduct arbitrages thus have to adjust their investment and operation strategies in order to reach their set goals, which influence the returns of stocks and warrants. On the other hand, the implied messages of a warrant's trading volume can also influence the warrant as well as stock returns.

Because investors are sensitive to unexpected information (especially bad news), they will adjust their position to respond to any new information, making the impact of unexpected trading volume greater than that from expected volume. In addition to taking the impacts of trading volume on price volatility into account, we consider the impacts of unexpected trading volume due to the inconsistent results on the impacts of unexpected trading volumes. We adopt the Kalman filter model, a time-varying approach to estimate parameters, in order to decompose trading volume into expected and unexpected trading volume. We then investigate their impacts on the returns and volatility of warrants and stocks, respectively. Our empirical study reveals decisive results that there exists a positive impact for expected and unexpected trading volume of warrants as well as stocks on their corresponding returns and volatility, which signifies that it is optimal to distinguish the trading volume via the Kalman filter model.

Although numerous studies have focused on the price correlation between call warrants and stocks after localized call warrants were issued, no consistent conclusions have been reached. Most studies focus on the price correlation investigation between call warrants and the underlying stocks, instead of a correlation analysis of the corresponding price and volume. The contributions of this paper account for the following three points: the lead-lag relationships between warrant returns and underlying stocks return are investigated via the supplemented parameter of trading volume; second, the trading volume is divided into expected and unexpected portions via the Kalman filter and put into the GARCH model in order to analyze the asymmetrical effects between the underlying stock return and warrant return volatility; and third, the return and risk correlation between warrants and underlying stocks are investigated via the observation of implied messages from the expected and unexpected trading volumes.

Methodology

This study aims at investigating the lead-lag relationship between prices of call warrants and their underlying stocks and the correlation between the expected as well as unexpected trading volumes and the return volatility of warrants and underlying stocks. The multivariate GARCH model (Bollerslev, 1986) is the major research method. The trading volume of stocks and warrants is first decomposed into two portions, namely expected and unexpected, by means of the Kalman filter model. Unexpected trading volume is obtained via real trading volume subtracted by the expected trading volume.

After obtaining the expected and unexpected trading volumes, the variables are put into the bivariate GARCH model to analyze the correlation among different variables, stock prices, and warrants. Before launching analyses via the bivariate GARCH model, this study adopts the augmented Dickey-Fuller (ADF) approach and the Phillip-Perron (PP) approach to ensure that every variable is under stationarity in order to avoid spurious regressions.

We adopt the near vector autoregressive (Near-VAR) model and select one lag as the optimum lag by Akaike information criterion (AIC). The model is represented as follows. Equations (1) and (2) are the mean equations:

$$\Delta SR_t = \alpha_{10} + \alpha_1 \Delta SR_{t-1} + \beta_1 \Delta WR_{t-1} + \gamma_{11} ESV_{t-1} + \gamma_{12} USV_{t-1} + \lambda_{11} EWV_{t-1} + \lambda_{12} UWV_{t-1} + \varepsilon_{st} \quad (1)$$

$$\Delta WR_t = \alpha_{20} + \alpha_2 \Delta SR_{t-1} + \beta_2 \Delta WR_{t-1} + \gamma_{21} ESV_{t-1} + \gamma_{22} USV_{t-1} + \lambda_{21} EWV_{t-1} + \lambda_{22} UWV_{t-1} + \varepsilon_{wt} \quad (2)$$

where S represents the price of underlying shares, W represents the price of the warrants, ΔSR_t represents the return rate of the underlying shares, ΔWR_t represents the return rate of the warrants, ESV represents the expected trading volumes of the shares, USV represents the unexpected trading volumes of the shares, EWV represents the expected trading volumes of the warrants, and UWV represents the unexpected trading volumes of the warrants.

Equations (3), (4), and (5) are the variance equations. The conditional covariance matrix is:

$$H_t = \begin{bmatrix} h_{ss,t} & h_{sw,t} \\ h_{ws,t} & h_{ww,t} \end{bmatrix}$$

Vector H_t can be represented as:

$$h_{ss,t} = c_{11}^2 + a_{1,11}^2 \varepsilon_{s,t-1}^2 + g_{1,111}^2 h_{ss,t-1} + k_{11} ESV_{t-1} + k_{12} USV_{t-1} \tag{3}$$

$$\begin{aligned} h_{sw,t} = {} & c_{12} c_{11} + a_{1,11} a_{1,12} \varepsilon_{s,t-1} \varepsilon_{w,t-1} + g_{1,11} g_{1,22} h_{sw,t-1} h_{ss,t-1} + \\ & k_{21} ESV_{t-1} + k_{22} USV_{t-1} + k_{23} EWV_{t-1} + k_{24} UWV_{t-1} \end{aligned} \tag{4}$$

$$\begin{aligned} h_{ww,t} = {} & c_{22}^2 + c_{12}^2 + \left(a_{1,22}^2 + a_{2,22}^2\right) \varepsilon_{w,t-1} + \left(g_{1,22}^2 + g_{2,22}^2\right) h_{ww,t-1} \\ & + k_{31} EWV_{t-1} + k_{32} UWV_{t-1} \end{aligned} \tag{5}$$

where $h_{ss,t}$ represents the return variance of underlying shares, $h_{ww,t}$ represents the return variance of the warrants, and $h_{sw,t}$ represents the return covariance of the warrants and underlying shares. The influence of every variable on stock and warrant return volatility and the lead-lag relationship of return volatility between the underlying stocks and warrants can be detected via the above-mentioned equations. We use maximization likelihood estimation with a normal distribution to estimate the parameters in the model. The simplified log-likelihood function is:

$$L(\theta) = -\frac{1}{2} \sum_{t=1}^{T} \left(\ln |H_t| + \varepsilon_t' H_t^{-1} \varepsilon_t \right) \tag{6}$$

where θ is the parameter to estimate, and T is the number of observations.

The sample data adopted in this study are the daily data; thus, the investigated lead-lag relationship means leading one day ahead or having a one day lag. Return impacts are the effect of the square error term of the return residual. Return volatility means the conditional variance of return.

Data

Because the current warrant market is mature enough with active trading, this study adopts ten call warrants based on electronic stocks issued from January to August 2001 as samples.[1] The sample data were obtained from the database of the *Taiwan Economic Journal* (TEJ).

The average returns and trading volume of warrants and underlying stocks reveal inconsistent relations. The standard deviation of warrants is higher than that of the underlying stocks, which means that the investment risk from warrants is higher than that from stocks, revealing the high risk and high return properties of warrant investment. A non-normal distribution of the returns of warrants and underlying

[1] The duration for Taiwan's call warrants lasts for one year, and the local stock market generally focuses on electronics industry stocks. The underlying stocks mainly consist of the electronics industry with high turnover. The turnover rates of these underlying stocks are 0.4886, 0.7592, 1.5757, 1.1007, 2.2847, 1.6924, 1.8064, 2.0898, and 0.5227, respectively.

stocks exists via the J-B statistics. The Jarque-Bera statistics of trading volume reveal that either the trading volume of warrants or underlying stocks shows a normal distribution.[2]

To verify if the series data are stationary, this study uses the ADF and PP tests, respectively. The minimum AIC is taken as the most proper lag length. The test results reveal that no matter how the ADF test or PP test is for the daily closes, they do not refute the null hypotheses, which means that the data are non-stationary. The ADF test and PP test of trading volume are stationary, which implies that the original series of trading volume is stationary. After taking a first difference, the non-stationarity of the series of the original daily closes can be transferred into the form of returns. After launching the unit root test again, all series data will refute the null hypotheses, exhibiting that the data reach a state of stationarity.[3]

Empirical Results

Before performing empirical analyses, the Kalman filter model is taken to separate trading volume into expected and unexpected volumes, where unexpected trading volume is obtained from the real trading volume subtracted by the expected trading volume. The results are portrayed in Figures 1 to 10.

Figure 1A–Grand Cathay 13 Unexpected Trading Volume

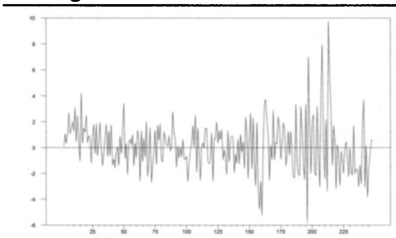


Figure 1B–Delta Elect. (Grand Cathay 13) Unexpected Trading Volume

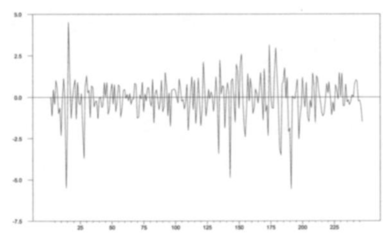


Figure 2A–Barits 01 Unexpected Trading Volume

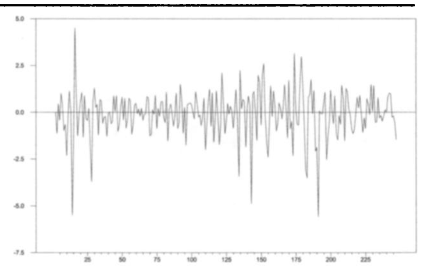
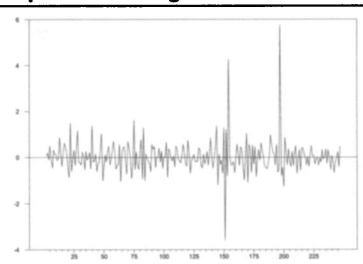


Figure 2B–Compal Elect. (Barits 01) Unexpected Trading Volume



[2] Tables are condensed. All results are available upon request.

[3] Tables are condensed. Full results can be obtained from the authors.

Figure 3A–President 05 Unexpected Trading Volume

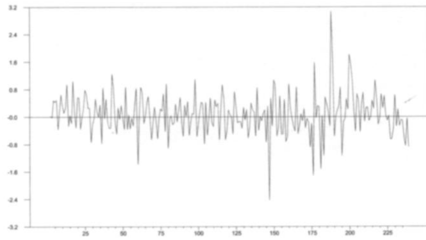


Figure 3B–Macronix (President 05) Unexpected Trading Volume

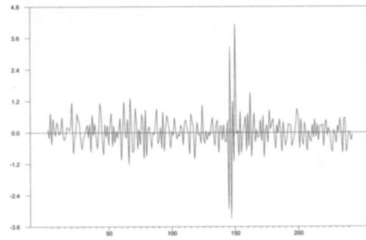


Figure 4A–Sampo 01 Unexpected Trading Volume

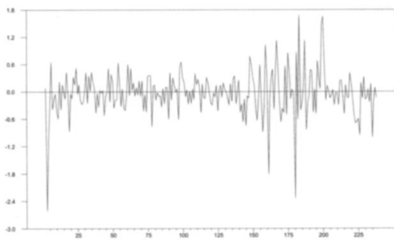


Figure 4B–Delta Elect. (Sampo 01) Unexpected Trading Volume

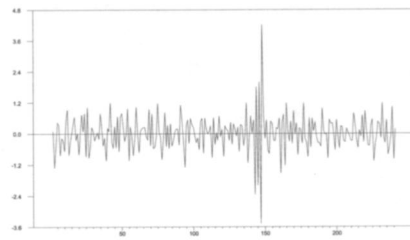


Figure 5A–Twn Int'l 06 Unexpected Trading Volume

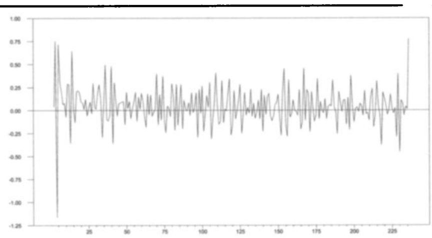


Figure 5B–Benq (Twn Int'l 06) Unexpected Trading Volume

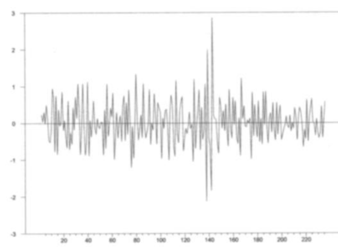


Figure 6A–Merrill Lynch 02 Unexpected Trading Volume

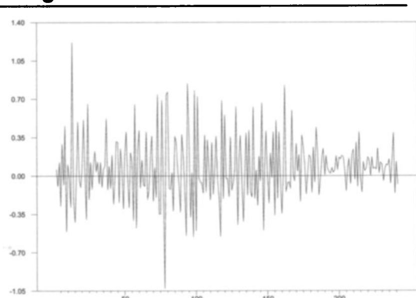


Figure 6B–Asustek (Merrill Lynch 02) Unexpected Trading Volume

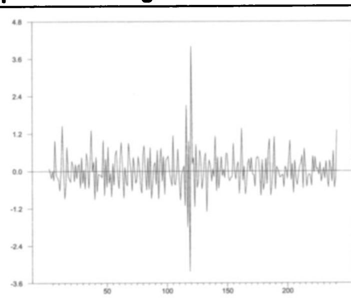


Figure 7A–Yung Chang 01 Unexpected Trading Volume

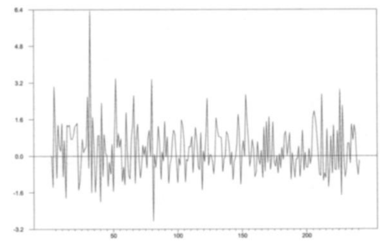


Figure 7B–UMC (Yung Chang 01) Unexpected Trading Volume

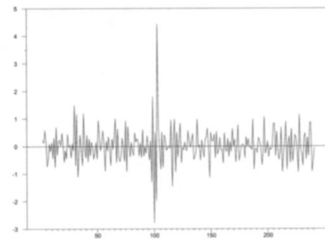


Figure 8A–National 09 Unexpected Trading Volume

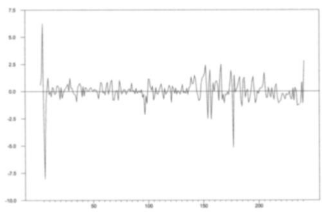


Figure 8B–Winbond (National 09) Unexpected Trading Volume

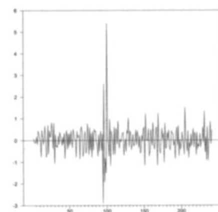


Figure 9A–Sinopac 01 Unexpected Trading Volume

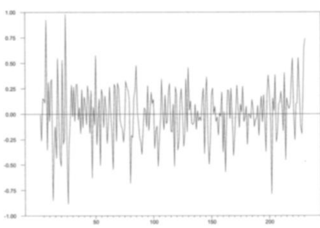


Figure 9B–Yageo (Sinopac 01) Unexpected Trading Volume

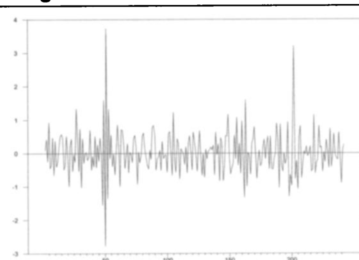


Figure 10A–Yuanta 27 Unexpected Trading Volume

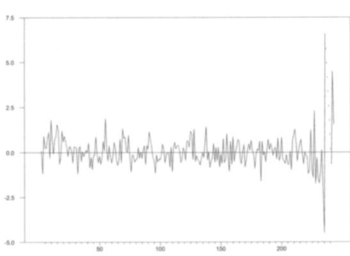
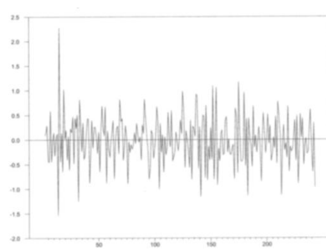


Figure 10B–UMC (Yuanta 27) Unexpected Trading Volume



GARCH tests are used to analyze the expected and unexpected trading volumes as well as the return series data. Before estimating the bivariate asymmetric GARCH model, we first test the residuals of the fitting model to determine if the ARCH effects exist. This study adopts the Q test of the Ljung-Box approach to perform related tests for the residuals and the squares of the model's residuals. The results (not reported here) show that only warrant TWN Int'l 06 and warrant Merrill-Lynch 02 have an ARCH effect. As for the underlying stocks, only Macronix, Delta Elect., and Asustek have an ARCH effect. Other residuals are not exhibited significantly. This study also adopts the LM test to analyze the residuals, which reveals that the underlying stocks and warrants both exhibit the ARCH effect.

This study adopts the bivariate GARCH (1, 1) model to for empirical analyses. The research focuses on two portions; namely, the effect of the expected and unexpected trading volumes of the call warrants and underlying stocks on the return volatility of the warrants and underlying stocks and the lead-lag relationships between these two markets.

The lead/lag relationships between the underlying stocks and warrants and the effects of the expected stock trading volume, unexpected stock trading volume, expected warrant trading volume, and unexpected warrant trading volume on warrant and underlying stock returns can be characterized by equations (1) and (2). Equations (3), (4), and (5) present the variance equations. The effect of every variable on the return volatility of stocks and warrants can be detected via the variance equations.

Term β_1 in Table 1 reveals the lead/lag relationships of the warrants on underlying stock returns. The results reveal that each individual stock exhibits different outcomes. There are no significant leading effects of the warrants on underlying stock returns except in the instances found in Grand Cathay 13 (Delta Elect.), Barits 01 (Compal Elect.), President 05 (Macronix), Twn Int'l 06 (Benq), Yung Chang 01 (UMC), and Sinopac 01 (Yageo). These exceptions may be caused by the uncertainties of the overall investment environment, which reduce the securities houses' desire to issue warrants. Thus, the eagerness of the firms to issue different types of warrants influences investors' participation in the warrant market and the volatility of stock market.

Terms γ_{11} and γ_{11} are taken to investigate the effects of expected and unexpected trading volumes of the underlying stocks on the stock returns. The results reveal that a significantly positive effect is detected for both expected and unexpected trading volumes of the underlying stocks on the self-stock returns, which implies that the stock trading volume does influence the returns of self-stocks. The asymmetric effect joint test results, H_0: $\gamma_{11} = \gamma_{12}$, reveal that different underlying stocks exhibit different degrees of impact results according to the different asymmetric degrees of underlying stock information.

In our investigation of the influence of expected and unexpected trading volumes of call warrants on underlying stock returns, the results of λ_{11} and λ_{12} reveal that a significantly positive correlation is detected for the influence of both expected as well as unexpected trading volumes of warrants on underlying stock returns. This indicates that the trading volume of warrants does influence the returns of the underlying stocks. Moreover, the asymmetric effect joint test result, H_0: $\lambda_{11} = \lambda_{12}$, reveals that different degrees of asymmetric warrant information result in different outcomes. The results also reveal that there exists a more significant impact of the volatility of unexpected spot and warrant trading volumes on underlying stock return ($\gamma_{12} > \gamma_{11}$ and $\lambda_{12} > \lambda_{11}$). As stock volatility is predictable, investors will adjust their strategies in advance; thus, the impact of trading volumes on stock price will not be so significant. On the other hand, a more significant impact on spot market will result under unexpected circumstances.

Table 1—Underlying Stock Return Estimation of the Parameters in the Mean Equations

	α_{10}	α_1	β_1	γ_{11}	γ_{12}
Grand Cathay 13 (Delta Elect.)	-1.89***	0.15***	0.02***	0.10***	0.09***
Barits 01 (Compal Elect.)	-1.52***	0.05***	0.02***	0.09***	0.29***
President 05 (Macronix)	-0.57***	-0.02***	0.02***	0.03***	0.36***
Sampo 01 (Delta Elect.)	-0.37***	0.21***	0.01	0.01	0.32
TWN Int'l 06 (Benq)	0.32***	0.04***	0.04***	0.16***	0.01***
Merrill Lynch 02 (Asustek)	0.07	0.01	0.01	0.01	-0.05
Yung Chang 01 (UMC)	-0.05***	0.10***	0.01***	0.01	0.01***
National 09 (Winbond)	1.09***	0.05	0.01	0.02***	-0.08
Sinopac 01 (Yageo)	0.01	0.01	0.06***	0.00	0.57*
Yuanta 27 (CMC)	1.30	0.03	0.01	-0.17	0.31***

	λ_{11}	λ_{12}	H_o=γ_{11}= γ_{12}	H_o=λ_{11}=λ_{12}
Grand Cathay 13 (Delta Elect.)	0.06***	0.34***	33.89***	81755.08***
Barits 01 (Compal Elect.)	0.04***	0.01***	76.04***	978140.33***
President 05 (Macronix)	0.01***	-0.79	34435.25**	5141.82***
Sampo 01 (Delta Elect.)	0.07***	1.14***	4.94***	9.96***
TWN Int'l 06 (Benq)	0.28***	-1.05***	2699.23***	107.10**
Merrill Lynch 02 (Asustek)	0.01	0.01	0.17	36.94***
Yung Chang 01 (UMC)	0.01	-0.22***	0.47	5174.07***
National 09 (Winbond)	-0.16	0.29***	24493.11***	3286895.42***
Sinopac 01 (Yageo)	-0.01	0.02	2.65	0.01
Yuanta 27 (CMC)	0.11	0.10	14032105.83***	42523.65***

Note: *, **, and *** represent 10 percent, 5 percent, and 1 percent of significance, respectively

Term α_2 in Table 2 indicates that stock returns and warrants are correlated. Most warrants reveal a positive correlation under a 1 percent significance level except for President 05 (Macronix), Merrill Lynch 02 (Asustek), Sinopac 01 (Yageo), and Yuanta 27 (CMC), which indicates that the stock market also leads the warrant market. Existing variations may be caused by liquidity in the warrant market. In general, the influence of spot returns on warrant returns is determined by the warrant market liquidity. Whenever there exist liquidity problems in the warrant market (i.e., when the trading volume of the warrant market is insufficient, or the warrant price is not able to follow the spot trend, or there is a decline in the spot market), the influence of spot returns on warrant returns then becomes insignificant.

Terms γ_{21} and γ_{22} examine the influence of expected and unexpected trading volumes of the underlying stocks on warrant returns, respectively. The results reveal that except for Yuanta 27 (CMC) and Merrill Lynch 02 (Asustek), the expected and unexpected trading volumes of the other underlying stocks exhibit a significantly positive effect on warrant returns, indicating that stock trading volume does influence warrant returns. The asymmetric effect joint test result, H_0: $\gamma_{21} = \gamma_{12}$, reveals that except for Sinopac 01 (Yageo) and Merrill Lynch 02 (Asustek), the other outcomes indicate that there does exist an asymmetric effect between the expected and unexpected trading volumes of the underlying stocks and the stock returns.

As for the influence of expected and unexpected trading volumes of call warrants on self returns, an examination of λ_{21} and λ_{22} reveals that except for Yuanta 27 (CMC) and Merrill Lynch 02 (Asustek), the expected and unexpected trading volumes of the other warrants reveal significant positive correlations with their own returns. The asymmetric effect joint test result, H_0: $\gamma_{21} = \gamma_{12}$, reveals that except for President 05 (Macronix), Sinopac 01 (Yageo), and Merrill Lynch 02 (Asustek), there exists an asymmetric effect between the expected and unexpected trading volumes of the warrants and their own returns. As for warrant returns, $\gamma_{22} > \gamma_{21}$ and $\lambda_{22} > \lambda_{21}$ reveals that there exists a more significant impact of the trading volumes on spot and warrant returns under the unexpected circumstances.

Table 2—Call Warrant Return Estimation of the Parameters in the Mean Equations

	α_{20}	α_2	β_2	γ_{21}	γ_{22}
Grand Cathay 13 (Delta Elect.)	-2.30 ***	0.06 ***	0.07 ***	0.01 ***	0.01 ***
Barits 01 (Compal Elect.)	-2.31 ***	0.32 ***	0.01 ***	0.05 ***	1.02 ***
President 05 (Macronix)	-0.82 ***	-0.02	0.12 ***	0.01 ***	0.01 ***
Sampo 01 (Delta Elect.)	-0.13 ***	0.80 ***	0.10 ***	0.01 ***	0.21
TWN Int'l 06 (Benq)	-1.23 ***	0.13 ***	-0.03 ***	1.12 ***	0.85 ***
Merrill Lynch 02 (Asustek)	0.07	0.01	0.01	-0.02	0.06
Yung Chang 01 (UMC)	-0.07 ***	0.10 ***	-0.10 ***	-0.01 ***	0.05 ***
National 09 (Winbond)	-0.07 ***	-0.21 ***	-0.04	0.25 ***	0.00
Sinopac 01 (Yageo)	0.05	0.00	0.39 ***	0.00	0.02 ***
Yuanta 27 (CMC)	1.71 **	0.07	-0.06	0.34	2.06

	λ_{21}	λ_{22}	$H_o=\gamma_{21}=\gamma_{22}$	$H_o=\lambda_{21}=\lambda_{22}$
Grand Cathay 13 (Delta Elect.)	0.04 ***	1.22 ***	293.79	19422623.41***
Barits 01 (Compal Elect.)	0.13 ***	0.18 ***	1.029604e+09***	783475.02***
President 05 (Macronix)	0.01 ***	0.00	1154.41***	0.01
Sampo 01 (Delta Elect.)	-0.08 ***	0.44 ***	75.41***	2.76*
TWN Int'l 06 (Benq)	0.03 ***	0.94 ***	4400.63***	21.95***
Merrill Lynch 02 (Asustek)	-0.04	-0.02	0.11	0.01
Yung Chang 01 (UMC)	-0.03 ***	0.07 ***	1170386.00	3275056.18***
National 09 (Winbond)	-0.01	0.71 ***	64858586.67***	8037589.91***
Sinopac 01 (Yageo)	-0.03	0.04 ***	0.18	0.03
Yuanta 27 (CMC)	0.40	-1.98	15795492.37***	15534113.77***

Note: *, **, and *** represent 10 percent, 5 percent, and 1 percent of significance, respectively

The influence of expected and unexpected trading volumes on the volatility of the underlying stocks and warrants can be examined by the variance equations, where k_{11} and k_{21} represent the influence of the expected underlying stock trading volume on its own volatility and k_{12} and k_{22} represent the influence of the unexpected underlying stock trading volume on its own volatility. The results in Table 3 reveal that the coefficients k_{11} and k_{21} exhibit statistical significance, signifying that the expected underlying stock trading volumes do influence their own volatility. As for unexpected trading volume, except for Yuanta 27 (CMC) and Merrill Lynch 02 (Asustek), the k_{12} and k_{22} coefficients reveal a statistical significance, showing that unexpected underlying stock trading volumes do influence their own volatility.

Table 3—Underlying Stock Return Estimation of Parameters in the Variance Equations

	K_{11}	K_{12}	K_{21}	K_{22}
Grand Cathay 13 (Delta Elect.)	0.02***	0.08***	-0.44***	0.62***
Barits 01 (Compal Elect.)	-0.03***	0.32***	-0.32**	0.82***
President 05 (Macronix)	0.01***	1.01***	0.13***	-0.01
Sampo 01 (Delta Elect.)	0.55***	0.08***	0.14***	2.57***
TWN Int'l 06 (Benq)	0.17***	0.32***	0.01***	4.60***
Merrill Lynch 02 (Asustek)	0.65***	-0.54	-0.47***	0.03
Yung Chang 01 (UMC)	0.01***	-0.02***	5.16***	0.01***
National 09 (Winbond)	-0.37***	0.01***	-0.01	1.61***
Sinopac 01 (Yageo)	0.88***	0.01	0.07***	-0.01***
Yuanta 27 (CMC)	0.09**	-1.53	0.56*	3.21

	H_o=K_{11}=K_{12}	H_o=K_{21}=K_{22}
Grand Cathay 13 (Delta Elect.)	713.65***	140287881.63***
Barits 01 (Compal Elect.)	2298.45***	282581607.91***
President 05 (Macronix)	0.09	0.01
Sampo 01 (Delta Elect.)	152346.85***	152346.85***
TWN Int'l 06 (Benq)	188613.51***	66916.32***
Merrill Lynch 02 (Asustek)	51941.91***	11910.41***
Yung Chang 01 (UMC)	72851439.77***	6.050590e+11***
National 09 (Winbond)	182063314.91***	48680.37***
Sinopac 01 (Yageo)	0.22	4.385027e-06
Yuanta 27 (CMC)	1.819345e+09***	48323372.22***

Note: *, **, and *** represent 10 percent, 5 percent, and 1 percent significance, respectively

To examine whether asymmetric effect exist between expected and unexpected trading volumes of underlying stocks and their own volatilities, this study adopts the joint tests, H_0: $k_{11} = k_{12}$ and H_0: $k_{21} + k_{22}$. The results reveal that, except for President 05 (Macronix) and Sinopac 01 (Yageo), the other outcomes show that asymmetric effects do exist between the expected and unexpected trading volumes of the underlying stocks and their own volatilities. This indicates that the effects of expected and unexpected properties of trading volumes on volatility are different.

Table 4 illustrates the influence of expected and unexpected trading volumes of warrants on their own volatilities, where k_{23} and k_{31} represent the influence of expected warrant trading volumes on their own volatility and k_{24} and k_{32} represent the influence of unexpected warrant trading volumes on their own volatility. Terms k_{23} and k_{31} reveal a statistical significance, signifying that the expected warrant trading volumes do influence the volatility of the warrants. As for unexpected trading volume, except for Yuanta 27 (CMC), the test outcomes of k_{24} and k_{32} reveal a statistical significance, showing that the effect of unexpected underlying trading volume on the stock volatility itself is significant. Finally, the results also show a larger impact of the volatility of unexpected trading volume on the volatility of spot and warrant returns. To further examine if asymmetric effects exist between the expected and unexpected trading volumes of warrants and their own volatilities, this study adopts the joint test approach. The results reveal that asymmetric effects do exist between the expected and unexpected trading volumes of warrants and volatilities, signifying that the effects of the expected and unexpected properties of warrant trading volumes on the volatilities of warrants differ. The empirical results are summarized in Table 5.

Table 4—Estimation Results of Call Warrant Returns in the Parameters of the Variation Equations

	K_{23}	K_{24}	K_{31}	K_{32}
Grand Cathay 13 (Delta Elect.)	-0.23***	0.01***	0.01***	1.81***
Barits 01 (Compal Elect.)	0.08***	0.18***	0.08***	-1.39***
President 05 (Macronix)	0.01***	0.41***	0.13***	-2.37*
Sampo 01 (Delta Elect.)	1.26***	-3.63***	0.19***	0.32***
TWN Int'l 06 (Benq)	0.01***	0.19***	-2.97***	1.21***
Merrill Lynch 02 (Asustek)	-0.28	4.98***	0.01***	-0.01
Yung Chang 01 (UMC)	0.90***	-0.77***	0.09***	0.19***
National 09 (Winbond)	0.01	0.12***	1.67***	3.30***
Sinopac 01 (Yageo)	-0.01	-0.01	1.37***	0.01***
Yuanta 27 (CMC)	0.01***	0.04	-2.71	5.86

	H_o=K_{23}=K_{24}	H_o=K_{31}=K_{32}
Grand Cathay 13 (Delta Elect.)	9969.37***	260500.29***
Barits 01 (Compal Elect.)	116.65***	1.236867e+10***
President 05 (Macronix)	84273.70***	15971395.05***
Sampo 01 (Delta Elect.)	23650.45***	23650.45***
TWN Int'l 06 (Benq)	2180179.55***	78635152.61***
Merrill Lynch 02 (Asustek)	147.00***	6.22***
Yung Chang 01 (UMC)	2.611323e+10***	703101.96***
National 09 (Winbond)	136.74***	50769156.96***
Sinopac 01 (Yageo)	7.329472e+09***	350.16***
Yuanta 27 (CMC)	1.036349e+09***	521036657.89***

Note: *, **, and *** represent 10 percent, 5 percent, and 1 percent significance, respectively

Conclusions

This study investigates the correlation between localized call warrants and their underlying stocks. Our sample includes ten issued call warrants based on electronic stocks from January until August 2001. In addition to studying the lead-lag relationships of returns, this study also uses the Kalman filter model to decompose the expected trading volume and unexpected volume, with an eye toward analyzing the impact of the volumes on the returns of warrants and underlying stocks and the corresponding volatility responses.

Table 5—Summaries of Empirical Results

1. Return correlation between call warrants and underlying stocks: feedback or bilateral causality

2. Correlation between trading volume and return:

	Expected trading volume of stocks	Unexpected trading volume of stocks
Call warrants	Positive correlation	Positive correlation
Underlying stocks	Positive correlation	Positive correlation
	Expected trading volume of warrants	Unexpected trading volume of warrants
Call warrants	Positive correlation	Positive correlation
Underlying stocks	Positive correlation	Positive correlation

Notes:

1. Effect of stocks' unexpected trading volumes on call warrants is greater than the effect of stocks' expected trading volumes on call warrants
2. Effect of warrants' unexpected trading volumes on warrants is greater than the effect of expected trading volumes on warrants
3. Effect of warrants' expected trading volumes on underlying stocks is greater than the effect of unexpected trading volumes on underlying stocks

3. Correlation between trading volume and return volatility

	Expected trading volume of stocks	Unexpected trading volume of stocks
Call warrants	Positive correlation	Positive correlation
Underlying stocks	Positive correlation	Positive correlation
	Expected trading volume of warrants	Unexpected trading volume of warrants
Call warrants	Positive correlation	Positive correlation
Underlying stocks	Positive correlation	Positive correlation

Note: Effect of stocks' unexpected trading volume on call warrants is greater than the effect of stocks' expected trading volume on call warrants

The empirical results reveal that there is no significant leading relation for warrant returns over stock returns. The results reveal a significant positive relation between the underlying stock volumes and the stock returns, signifying that the stock trading volumes do influence the stock returns. The results also show a significant positive correlation between warrant trading volumes and underlying stock returns, meaning that the warrant trading volumes do influence the underlying stock returns. Moreover, the stock return is correlated to warrant trading. The stock market leads the warrant market. An examination of expected and unexpected trading volumes and warrant returns reveals that the underlying stock trading volumes do influence the warrant returns and that the warrant trading volumes also influence the warrant returns. Warrant trading volumes influence the returns of underlying stocks.

Expected underlying stock volumes do influence stock volatility significantly. Except for Yuanta 27 (CMC) and Merrill Lynch 02 (Asustek), the unexpected stock trading volumes also affect the stock volatility significantly. Except for President 05 (Macronix) and Sinopac 01 (Yageo), the joint test results reveal that asymmetric effects exist between the expected and unexpected trading volumes of underlying stocks and volatility, which signify that the effects of expected volume and unexpected volume on self volatility differ. Expected warrant volumes do influence significantly the volatility of warrants. For unexpected trading volumes, except for Yuanta 27 (CMC), all exhibit that unexpected underlying volumes influence volatility significantly. The joint test results reveal that asymmetric effects exist between the expected and unexpected trading volumes of warrants and the volatility of warrants, which signify that the effects of expected and unexpected warrant trading volumes on the volatility of warrants are different.

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