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An Investigation on Lead-Lag Relationships of Price Movements between Covered Warrants and their Underlying Securities: The Application of the Threshold VECM

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Abstract

The purpose of this study is to explore the lead and lag relationship between the covered warrants and their underlying stocks to determine whether there exists a spot price discovery function of the Taiwanese covered warrants for domestic financial markets. To circumvent the problem of the nonlinear temporal relationship between the prices of the covered warrants and their corresponding underlying stocks, we propose to employ the threshold vector error correction model (TVECM) to analyze their temporal relationships. The empirical evidences indicate that the price of Taiwanese covered warrants for domestic financial market can be taken as a tool for price discovery.

Keywords: Cover Warrants, Price Discovery, Underlying Stocks, Threshold Vector Error Correction Model (TVECM)

JEL : F37, G13, G15

I. Introduction

Covered warrants are important financial derivative products in the financial market. Covered warrants provide investors with operating strategies of hedging, speculating and arbitrating. Theoretically, there exists a nonlinear pricing relationship between covered warrants and their underlying stocks. Based on the spot price discovery function of covered warrants, researchers are interested in investigating the price relationship between them in order to determine whether the prices of the covered warrants lead to corresponding underlying stock prices. Although many articles focus on examining the evaluation problem and hedging strategy of covered warrants for domestic financial markets, there is still room for investigation regarding the lead-lag price relationship between covered warrants and their underlying stocks in Taiwan.

Covered warrants are presented as a type of call options. Distinctive studies have examined the temporal relationship between the option prices and their underlying stocks; however, their conclusions were partly ambiguous (Chan, Chung and Johnson, 1993; Diltz and Kim, 1996; Gwilym and Buckle, 2001; Chiang and Fong, 2001). Some of these past studies suggest that option prices significantly leads the underlying stock prices (e.g., Manaster and Rendleman, 1982; Bhattacharya, 1987; Fleming, Ostdiek and Whaley, 1996; Gwilym and

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Buckle, 2001). For instance, Manaster and Rendlema(1982)employed CRSP daily prices and regression analysis and found that the option prices lead the underlying stock prices by one day. Later on, Bhattacharya (1987) used CBOE bid and asked price data to determine whether there is an existence of arbitrage opportunity. His study revealed that option prices lead the stock prices and that there exists arbitrage opportunity. Fleming, Ostdiek and Whaley (1996) used the error correction model and assessed that S & P 500 index option prices lead the spot market prices by about five minutes. Their results indicated that there exists a spot price discovery function of the option market.

On the contrary, other studies reported that the underlying stock prices lead the option prices (e.g., Stephen and Whaley, 1990; O'Connor, 1999; Chiang and Fong, 2001). Stephen and Whaley (1990) employed the Granger causality analysis and found that the underlying stock prices lead the option prices by fifteen to twenty minutes. Chiang and Fong (2001) found that the young Hong-Kong options market experiences thin trading, and that option returns lag the cash index returns. Chan and Wei (2001) further examined the price and volume effects of underlying stocks around the announcement date of derivative warrants issued in Hong Kong. This might mean that there are lead and lag relationships between the covered warrants and their underlying stocks to determine whether the spot price discovery function of the covered warrants for Taiwanese domestic financial market exists. Therefore, this study attempts to explore this relationship and its associated factors to determine whether there exists a spot price discovery function of the covered warrants for Taiwanese domestic financial markets. Hopefully, the empirical evidences would be able to provide useful information for investors to determine price discovery and investment decisions.

The remainder of the present study is organized as follows. Section II briefly discusses the literature review. Section III begins with a description on the methodology of this study. Section IV describes the data sources and their stationary, threshold and co-integration effects, while Section V reports the empirical results. Section VI provides a summary and the concluding remarks.

II. Literature Review

Considering the effects of the introduction of warrants on the trading behavior of underlying stocks, Aitken and Segara (2005) examined the impact of first-time introduction of warrants by third party issuers on the trading behavior of a sample of underlying stocks listed on the Australian Stock Exchange. They found that significant negative abnormal returns on both the announcement and listing date of derivative warrants are reported, followed by a negative price drift. Relative trading volume and price volatility of underlying stocks are found to be significantly higher post-warrant listing. Interestingly, they also found that warrant holders are unable to realize gains for the majority of trading days when they are alive, consistent with the view that banks trade profitability from their issue.

Beside theoretical discussions and predictions, many empirical studies have documented that derivatives markets have significant impacts on underlying assets, including the effect of option expirations (Klemkosky (1978), Officer and Trennepohl (1981), and Ni, Pearson, and Poteshman (2005)), the option introduction effect (Bansal, Pruitt, and Wei (1989), Conrad (1989), Detemple and Jorion (1990), Bollen (1998), and Sorescu (2000)), and the pervasive impact on underlying stock prices (Pearson, Poteshman, and White (2008)). In particular, Pearson, Poteshman and White (2008) tested whether and to what extent option trading impacts underlying stock prices. They found a statistically and economically significant negative relationship between stock return volatility and net purchased option positions of investors who are likely to hedge. And hence provide the evidence for a substantial and pervasive influence of option trading on stock prices. De Peretti and Chan (2009) delineated the theme of a new nonlinear panel unit root test, which mitigates the cross sectional dependences between the series. Their empirical results indicated that the synchronous trading in UK leads to a long-run price equilibrium, with no lead and lag relation between covered warrants and their underlying shares. It seems to show covered warrants permit approximations of the underlying share prices, based on the results of an estimation of implied underlying stock prices. Concerning information asymmetry or nonlinear movement, Visaltanachoti, Wong and Ding (2011) detected information asymmetry in warrants and their underlying stocks on the stock exchange of Thailand**.** The estimated probability of informed trading (PIN) in warrants is found to be statistically higher than their underlying stocks regardless of order submission type and order size. The PIN explains a substantial portion of the cross-sectional variation in the opening spread beyond trading volume and minimum tick size. They signify evidences that a signed warrants trade contains information about the future stock price and that warrants with a higher PIN have greater predictive powers. Xiao, Yao and Wang (2013) provided a risk-management tool, namely the stock price distribution of a firm issuing both debt and warrants. Their empirical evidence confirms theoretical findings and showed that issuing warrants and debt has effects on the distribution of stock price processes. Their research implies that the lead-lag relationships between the option and their corresponding underlying prices may involve one or more regimes of the linear structural model. Recently, Chung, Liu and Tsai (2014) examined the impact of derivatives hedging on the spot market using accurate hedge ratios of covered warrants traded in the Taiwan Stock Exchange (TWSE). Results present significantly positive abnormal returns and trading volumes before the announcement of a warrant's issuance, and the effect is stronger when the hedging demand is larger; also, a significantly positive relationship was found between stock return volatility and the price elasticity of hedging demand. The results can help investors to gain a better understanding of the trading behavior in underlying stocks surrounding warrant issuances, enabling investors to make informed investment decisions.

Since the past few decades, derivatives markets such as covered warrants and their underlying stocks have experienced a rapid growth, regarding both the types of derivatives and their trading volumes. Since warrants were introduced for the first time into Taiwan during 2004, how it impacted the underlying stock exchange and provided price discovery function in the Taiwanese financial market is of utmost attention. As a result, an important research topic in the Taiwanese finance literature is the extent to which derivatives markets influence its underlying stocks markets. This paper attempts to examine the impact effects of initial time introduction of warrants by issuers on the trading behavior of the selected samples of underlying stocks listed on the Taiwan Stock Exchange (TWSE). Hence, we investigate the lead-lag relationships of price movements between covered warrants and their underlying securities, mainly focused on initial dates after warrant issuance and finding the differences to those for option listings. Our study period begins from dates near the warrant issuance (January 1, 2004 to December 31, 2004) since during this period (after January 1, 2004) covered warrants and their underlying securities have experienced a rapid growth, both in the types (classes) of warrants and the trading volumes.

III. Methodology

For this research, the typical methodology which examines the temporal relationship between the option and their corresponding underlying prices usually involves one regime of the linear structural model. However, the lead-lag relationships between the option and their corresponding underlying prices may involve one or more regimes of the linear structural model, as evidenced by the following two figures:

Figure 1 indicates that one regime may be suitable to depict the temporal price relationship between the warrant Taiwan International Securities Corporation (TISC) 13 and its corresponding underlying China Steel Corporation (CSC). However, Figure 2 reveals that it may be more appropriate to utilize two regimes of the model to depict the temporal price relationship between the warrant Yuanta Core Pacific Securities Co.,Ltd (YUANTA) C5 and its corresponding underlying CMC Magnetics Corporation(CMC).

Refer Figure 1 and 2

To circumvent the problem of the nonlinear temporal relationship between the prices of the covered warrants and their corresponding underlying stocks, we propose to employ the threshold vector error correction model (TVECM) to analyze their temporal relationships.

Therefore, the main purpose of this study is to employ the non-linear TVECM to determine whether there exists a spot price discovery function of the covered warrants for domestic financial market.

This study employs the TVECM to investigate the lead-lag relationships between the prices of the covered warrants and their corresponding underlying stocks for domestic financial market. Due to the fact that most of the financial variables are nonstationary, the initial step for the TVECM framework is to conduct the unit root test. Next, we formulate the linear vector autoregressive model and conduct the test for cointegration. Finally, we test whether there exists a threshold effect for the cointegrated system. The steps of the TVECM framework can be summarized as follows:

Step one: Testing for unit root

We use the Phillips-Perron (PP) test to test for the stationarity of the financial variables; i.e., the prices of the Taiwanese covered warrants and their underlying stock prices in this study. According to the test results of stationarity, we can construct the linear vector autoregressive (VAR) model after appropriate differencing procedure.

Step two: Testing for cointegration

Three methods can be used to test for cointegration: Engle-Granger (1987), Engle-Yoo (1987) and Johansen (1988). Based on the previous VARs, we use the Johansen technique to test for and estimate the cointegrating systems.

Step three: Testing for the threshold effect

If there exists cointegrating relationship for financial variables then we can construct vector error correction model (VECM) for these variables. Next, it can further test for the threshold effect for the VECM. If there does not exist threshold effects for the VECM, the linear VECM will be employed to analyze the lead-lag relationship between the prices of Taiwanese covered warrants and their underlying stocks. If there are threshold effects for the VECM, then, the TVECM will be employed to analyze the temporal relationship between the prices of Taiwanese covered warrants and their underlying stocks.

Basically, the construction of a two-regime threshold cointegration model and the test of a threshold for this non-linear two-regime model can be detailed in the following sections.

III.1. The vector error correction model

Suppose x_t be a p-dimensional I (1) time series. Let $w_t(\beta) = \beta^{'} x_t$ denote the I (0)

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error-correction term where β is a p × 1 cointegrating vector for x_t. In matrix notation, a linear VECM can be written as follows:

$$\Delta x_t = A' x_{t-1}(\beta) + u_t \qquad (1)$$

where Δx_t is the first difference of x_t; $x_{t-1}(\beta) = [1, w_{t-1}, \Delta x_{t-1}, \Delta x_{t-2}, ..., \Delta x_{t-\ell}]'$ and ℓ is the optimal lag length based on Akaike information criterion(1974); A is $k \times p$ coefficient matrix with $k = p\ell + 2$; the error term u_t is assumed to be a vector martingale difference sequence with finite covariance matrix $E(u_t u_t') = \Sigma$. The parameters (β, A, Σ) can be estimated by maximum likelihood method under the assumption that the errors are iid Gaussian. Let these estimates be denoted $(\tilde{\beta}, \tilde{A}, \tilde{\Sigma})$. Then, $\tilde{u}_t = \Delta x_t - \tilde{A}' x_{t-1}(\tilde{\beta})$ are the residual vectors.

III.2. Threshold vector error correction model

Model (1) can be extended to obtain the following two-regime threshold co-integration model:

$$\Delta x_t = \begin{cases} A_1' x_{t-1}(\beta) + u_t & \text{if} \quad w_{t-1}(\beta) \le \gamma \\ A_2' x_{t-1}(\beta) + u_t & \text{if} \quad w_{t-1}(\beta) > \gamma \end{cases}$$

where

γ is the threshold parameter.

The above model may alternatively be written as

$$\Delta x_t = A_1' x_{t-1}(\beta) \cdot d_{1t}(\beta, \gamma) + A_2' x_{t-1}(\beta) \cdot d_{2t}(\beta, \gamma) + u_t \qquad (2)$$

where

$$d_{1t}(\beta, \gamma) = 1(w_{t-1}(\beta) \le \gamma),$$

$$d_{2t}(\beta, \gamma) = 1(w_{t-1}(\beta) > \gamma)$$

and $1(.)$ denotes the indicator function.

The threshold VECM will be meaningful only if $0 < P(w_{t-1} \le \gamma) < 1$, otherwise it will be

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degenerated into a linear cointegration. Therefore, we impose the following constraint

$$\pi_0 \le P(w_{t-1} \le \gamma) \le 1 - \pi_0$$

where π_0=0.05 is a trimming parameter (Hansen and Seo, 2002).

According to Hansen and Seo (2002), under the assumption that the errors are iid Gaussian, the Gaussian likelihood is

$$Ln(A_1, A_2, \Sigma, \beta, \gamma) = -\frac{n}{2}\log|\Sigma| - \frac{1}{2}\sum_{t=1}^{n} u_t(A_1, A_2, \beta, \gamma)' \Sigma^{-1} u_t(A_1, A_2, \beta, \gamma) \qquad (3)$$

where $u_t(A_1, A_2, \beta, \gamma) = \Delta x_t - A_1' x_{t-1}(\beta) \cdot d_{1t}(\beta, \gamma) - A_2' x_{t-1}(\beta) \cdot d_{2t}(\beta, \gamma)$

The $MLE(\hat{A}_1, \hat{A}_2, \hat{\Sigma}, \hat{\beta}, \hat{\gamma})$ is the maximization for the $Ln(A_1, A_2, \Sigma, \beta, \gamma)$. Following the estimation method indicated by Hansen and Seo (2002), we can estimate $MLE(\hat{A}_1, \hat{A}_2, \hat{\Sigma}, \hat{\beta}, \hat{\gamma})$ by estimating the following concentrated likelihood function

$$Ln(\beta, \gamma) = Ln(\hat{A}_1(\beta, \gamma), \hat{A}_2(\beta, \gamma), \hat{\Sigma}(\beta, \gamma), \beta, \gamma)$$

$$= -\frac{n}{2}\log|\hat{\Sigma}(\beta, \gamma)| - \frac{np}{2} \qquad \ldots\ldots \qquad (4)$$

where $(\hat{A}_1(\beta, \gamma))$, $(\hat{A}_2(\beta, \gamma))$ and $(\hat{\Sigma}(\beta, \gamma))$ can be obtained from the OLS regressions of Δx_t on $x_{t-1}(\beta)$ for the sub samples for which $w_{t-1}(\beta) \le \gamma$ and $w_{t-1}(\beta) > \gamma$, respectively.

The $MLE(\hat{\beta}, \hat{\gamma})$ can thus be found as the maximization of $\ln|\hat{\Sigma}(\beta, \gamma)|$ subject to the normalization imposed on β and the following constraint

$$\pi_0 \le n^{-1} \sum_{t=1}^{n} I(X_t' \beta \le \gamma) \le 1 - \pi_0.$$

III.3. Testing for a threshold

The Sup*LM* test statistic of Hansen and Seo(2002) will be used to test whether the model is linear cointegration or threshold cointegration. Let the null hypothesis H_0 denote the class

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of linear VECM models (1) and the alternative hypothesis H_1 denote the class of two-regime threshold models (2). The restriction H_0 are the models in H_1 which satisfy $A_1^{'} = A_2$.

Assume that (β,γ) are known and fixed. The heteroskedasticity-robust LM-like test statistic can be formulated as follows:

$$LM(\beta,\gamma) = vec\left(\hat{A}_1(\beta,\gamma) - \hat{A}_2(\beta,\gamma)\right)^{'}\left(\hat{V}_1(\beta,\gamma) + \hat{V}_2(\beta,\gamma)\right)vec\left(\hat{A}_1(\beta,\gamma) - \hat{A}_2(\beta,\gamma)\right) \quad (5)$$

where

$$\hat{V}_1(\beta,\gamma) = M_1(\beta,\gamma)^{-1}\,\Omega_1(\beta,\gamma)M_1(\beta,\gamma)^{-1}$$

$$\hat{V}_2(\beta,\gamma) = M_2(\beta,\gamma)^{-1}\,\Omega_2(\beta,\gamma)M_2(\beta,\gamma)^{-1}$$

$$M_1(\beta,\gamma) = I_p \otimes x_1(\beta,\gamma)^{'}\,x_1(\beta,\gamma)$$

$$M_2(\beta,\gamma) = I_p \otimes x_2(\beta,\gamma)^{'}\,x_2(\beta,\gamma)$$

$$\Omega_1(\beta,\gamma) = \varepsilon_1(\beta,\gamma)^{'}\,\varepsilon_1(\beta,\gamma)$$

$$\Omega_2(\beta,\gamma) = \varepsilon_2(\beta,\gamma)^{'}\,\varepsilon_2(\beta,\gamma)$$

If (β,γ) are unknown, the LM statistic is Equation (5) to evaluate at point estimates obtained under H_0. The null estimate of β is $\hat{\beta}$. Then, the test statistic is proposed to be calculated as follows:

$$\sup_{\gamma} LM = \sup_{\gamma} LM\left(\hat{\beta},\gamma\right) \quad (6)$$

For the sup LM test, the search region $[\gamma_L,\gamma_U]$ is set so that γ_L is the π_0 percentile of w_{t-1} and γ_U is the $(1-\pi_0)$ percentile. Finally, Hansen and Seo(2002) suggest using the residual bootstrap or fixed regressor Bootstrap to calculate asymptotic critical values and p-values for Equation(6).

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IV. Sources of data and its natures

The data used in this study are daily prices of Taiwanese covered warrants and their corresponding underlying stocks from January 1, 2004 to December 31, 2004. This period is selected since our study especially wants to examine the impacts and effects of the initial-time introduction of warrants by issuers on the trading behavior of the selected samples of underlying stocks listed on the Taiwan Stock Exchange (TWSE). The warrants utilized are single-stock, American style. The underlying stocks are classified into three categories in this study, including traditional, electronic and financial classes. The underlying stocks also are further classified into industries for each class.

This study adopts the Phillips-Perron (PP) unit root test to examine whether a financial time series of this study is stationary or not. According to the results of the PP test for unit root on the logarithm, these time series are not stationary. However, after first differentiation, all series significantly reject hypothesis with unit root I (1), suggesting that all series are non-stationary and there may be a co-integrating relationship between the prices of these Taiwanese covered warrants and their underlying stocks. Co-integration is frequently utilized to analyze the long-run equilibrium among different variables. This method examines not only the relationship in long-run equilibrium using Vector Error-Correction Model (VECM) but also sort-run dynamic adjustment (Engle and Granger, 1987; Engle, 1982). As indicated above, the Sup*LM* test statistic of Hansen and Seo (2002) will be used to test to see if the model is linear co-integration or threshold co-integration since this test will detect whether a threshold stands or not. The testing results indicate that these two series are co-integrated and some series appear as threshold effects. This information would reveal that the linear VECM or threshold VECM (TVECM) can be employed to analyze the lead-lag relationship between the prices of these Taiwanese covered warrants and their underlying stocks.

V. Empirical results

The empirical results of the threshold cointegration test of traditional, electronic and financial classes of Taiwanese covered warrants and their underlying stocks are reported in Table I. Table I reveal that there are not threshold effects for 41 covered warrants from the overall sample of 136 covered warrants. For these 41 warrants, we will employ the linear VECM to analyze the lead-lag relationship between the prices of covered warrants and their underlying stocks.

Refer Table I

Table I also reveals that there are 95 covered warrants that show threshold effects. Therefore, we will employ the TVECM to analyze the lead-lag relationship between the prices of these covered warrants and their underlying stocks.

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The empirical results of the linear and TVECM for the Taiwanese traditional covered warrants and their underlying stocks are reported on Tables II and III, respectively. From Table II we can see that within the 10 traditional covered warrants of the linear VECM, there are 6 covered warrants whose prices lead their underlying stocks. The rest of 4 covered warrants and their underlying stocks exhibit the feedback effect, i.e., their prices lead with each other.

Refer Table II and III

Table III points out that there are 34 traditional covered warrants that show threshold effects. Therefore, we employ the TVECM to analyze its lead-lag relationship between covered warrants and their underlying stocks. In the first regime of the threshold VECM, within these 34 covered warrants, there are 30 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. In the second regime of the threshold VECM, there are 28 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. Therefore, the preliminary evidence indicates that the prices of Taiwanese traditional covered warrants would lead those of the corresponding stocks, or these prices would lead with each other.

The empirical results of the linear and TVECM for the Taiwanese electronic covered warrants and their underlying stocks are reported on Tables IV and V, respectively. Based on Table IV, it can be seen that within the 23 electronic covered warrants of the linear VECM, there are 18 covered warrants whose prices lead their underlying stocks. The rest of 5 covered warrants and their underlying stocks exhibit the feedback effects, i.e., their prices lead with each other.

Refer Table IV and V

Table V displays that there are 40 electronic covered warrants that display threshold effects. The threshold VECM can be employed to analyze the lead-lag relationship between these covered warrants and their underlying stocks. In the first regime of the threshold VECM, within these 40 covered warrants, there are 30 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. In the second regime of the threshold VECM, there are 36 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. Therefore, the preliminary evidence indicates that the prices of Taiwanese electronic covered warrants would lead those of the corresponding stocks, or these prices would lead with each other.

The empirical results of the linear and TVECM for the financial covered warrants and their underlying stocks are reported on Tables VI and VII, respectively. In Table VI, it can be seen

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that within the 8 financial covered warrants of the linear VECM, there are 7 covered warrants whose prices lead its underlying stock. There is only one covered warrant and their underlying stocks exhibiting the feedback effect.

Refer Table VI and VII

In Table VII, it indicates that there are 21 Taiwanese financial covered warrants that show threshold effects. The TVECM can be employed to analyze the lead-lag relationship between these covered warrants and their underlying stocks. In the first regime of the threshold VECM, all of the prices of covered warrants lead their underlying stocks. In the second regime of the threshold VECM, there are 18 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. Therefore, the preliminary evidence indicates that the prices of financial covered warrants would lead those of the corresponding stocks, or these prices would lead with each other.

In sum of the previous analysis, the overall empirical results of the linear and threshold VECM for the traditional, electronic and financial covered warrants and their underlying stocks are summarized in Table VIII. Table VIII reveals that there does not appear threshold effects for 41 covered warrants from the overall sample of 136 covered warrants. Within these 41 covered warrants, there are 31 covered warrants whose prices lead their underlying stocks. The rest of 10 covered warrants and their underlying stocks lead with each other.

Refer Table VIII

Table VIII also indicates that there are 95 covered warrants that present threshold effects. In the first regime of threshold VECM, there are 81 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. In the second regime of threshold VECM, there are 82 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. Therefore, the preliminary evidences indicate that the price of Taiwanese covered warrant would lead that of the corresponding stock, or these prices would lead with each other. These empirical results also present the preliminary evidences that there exist the spot price discovery function of the Taiwanese covered warrants for domestic financial market.

VI. Summary and Concluding Remarks

Covered warrants are one of the most important financial derivative products in the financial market. Covered warrants provide investors with operating strategies of hedging, speculating and arbitraging. Since there exists theoretically a nonlinear relationship between covered

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warrants and their underlying stocks, many researchers investigate the price relationship between them. Based on the spot price discovery function of covered warrants, one of the purposes of this study is to explore the lead and lag relationship between the Taiwanese covered warrants and their underlying stocks to determine whether there exists the spot price discovery function of the covered warrants for domestic financial market. Therefore, to circumvent the problem of the nonlinear temporal relationship between the prices of the Taiwanese covered warrants and their corresponding underlying stocks, we propose employing the threshold vector error correction model to analyze their temporal relationship.

The data used in this study are daily prices of Taiwanese covered warrants and their underlying stocks from January 1, 2004 to December 31, 2004. The warrants utilized are single-stock American style. The underlying stocks are further classified into three categories in this study, including traditional, electronic and financial classes.

We employ threshold vector error correction model to analyze the lead-lag relationship between Taiwanese covered warrants and their underlying stocks. The empirical results reveal that there does not exist threshold effects for 41 covered warrants from the overall sample of 136 covered warrants. For these 41 covered warrants, we employ the linear vector error correction model to analyze the lead-lag relationship between covered warrants and their underlying stocks. Within these 41 covered warrants, there are 31 covered warrants whose prices lead their underlying stocks. The rest of 10 covered warrants and their underlying stocks lead with each other.

There are 95 Taiwanese covered warrants that have threshold effects. Therefore, we employ the threshold vector error correction model to analyze the lead-lag relationship between the covered warrants and their underlying stocks. In the first regime of threshold vector error correction model, within these 95 covered warrants, there are 81 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. In the second regime of threshold vector error correction model, there are 82 covered warrants whose prices lead their underlying stocks. The rest of them lead with each other. Therefore, the preliminary evidences indicate that the prices of Taiwanese covered warrants would lead those of the corresponding stocks, or these prices would lead with each other. The empirical results also present the preliminary evidences that there exists prove the spot price discovery function of the Taiwanese covered warrants for domestic financial market.

References

Aitken, M. and R. Segara, 2005, "Impact of Warrant Introductions on the Behavior of Underlying Stocks: Australian Evidence," Accounting and Finance, 45: 127–144

DOI: 10.0704/article-3

Bansal, V. K., Stephen W. Pruitt, K. C. Wei, 1989, "An Empirical Reexamination of the Impact of CBOE Option Initiation on the Volatility and Trading Volume of the Underlying Equities: 1973-1986," Financial Review, 24: 19-29.

Bhattacharya, M., 1987, "Price Changes of Related Securities: The Case of Call Options and Stocks," Journal of Financial and Quantitative Analysis, .22: 1-15.

Bollen, N. P., 1998, "A Note on the Impact of Options on Stock Return Volatility," Journal of Banking and Finance, 22: 1181–1191.

Chan, K., Y. P. Chung, and H. Johnson 1993, "Why Option Prices Lag Stock Prices: A Trading Base Explanation," Journal of Finance, Vol. 58, No. 5, 1957-1967.

Chan, Y. C. and K. C. Wei, 2001, Price and Volume Effects Associated with Derivative Warrant Issuance on the Stock Exchange of Hong Kong, Journal of Banking and Finance, 25(8): 1401–1426.

Chiang, R. and W. Fong, 2001, "Relative Informational Efficiency of Cash, Futures, and Options Markets：The Case of an Emerging Market," Journal of Banking and Finance, Vol. 25, pp. 355-375

Chung, S. L., W. G. Liu and W. C. Tsai 2014, "The Impact of Derivatives Hedging on the Stock Market: Evidence from Taiwan's Covered Warrants Market," Journal of Empirical Finance, Vol.42, pp. 123–133.

Conrad, J., 1989, "The Price Effect of Option Introduction," The Journal of Finance, 44: 487-498

De Peretti, C. and C. Y. Chan 2009, UK Covered Warrants and Their Underlying Shares: A Panel Co-integration Approach, Working Paper, Available at SSRN: http://ssrn.com/abstract=1326242

Detemple, J., 1990, Financial Innovation, Values and Volatilities when Markets Are Incomplete," Geneva Papers on Risk and Insurance Theory, 15:47-53.

Dickey, D.A. and W. A. Fuller, 1979, "Distributions of the Estimators for Autoregressive Time Series with a Unit Root," Journal of American Statistical Association 74, 427-431

Diltz, D. and S. Kim 1996," The Relationship between Stock and Option Price Changes," The Financial Review 31, 499-519.

Fleming, J., B. Ostdiek and R. E. Whaley, 1996, "Trading Costs and the Relative Rates of Price Discovery in Stock, Futures, and Option Markets," Journal of Futures Markets, Vol. 16, No. 4, pp. 353-387

Gwilym, O. A. and M. Buckle, 2001, "The Lead-Lag Relationship between the FTSE100 Stock Index and its Derivative contracts," Applied Financial Economics, Vol. 11, pp. 385-393.

Hansen, B. E. and B. Seo, 2002, "Testing for Two-Regime Threshold Cointegration in Vector Error Correction Models," Journal of Econometrics, 110, 29-318

Klemkosky, R. C., 1978, "The Impact of Option Expirations on Stock Prices," Journal of Financial and Quantitative Analysis, 13: 507-518

Manaster, S. and R. J. Rendleman Jr. 1982, "Option Prices as Predictors of Equilibrium Stock Prices," Journal of Finance 42, 1035-1048.

Ni, S. X., N. D. Pearson and A. M. Poteshman, 2005, "Stock Price Clustering on Option Expiration Dates," Journal of Financial Economics, 78:49-87.

O'Connor and L. Matthew, 1999, "The Cross-Sectional Relationship between Trading Costs and Lead/Lag Effects in Stock and option Markets," The Financial Review, Vol. 34, No. 4, 95-117

Officer, D. T. and G. L. Trennepoh, 1981, "Price Behavior of Corporate Equities Near Option Expiration Dates," Financial Management, 10:75-80.

Pearson, N. D., A. M. Poteshman, and J. S. White, 2008, "Does Option Trading Have a Pervasive Impact on underlying Stock Prices?" Working Paper, University of Illinois at Urbana-Champaign, US

Said, S. E. and D. A. Dickey, 1984, "Testing for Unit Root in Autoregressive Moving Average Models of Unknown Order," Biometrica 71, 599-607

Sorescu, S. M. 2000, "The Effect of Options on Stock Prices: 1973 to 1995," Journal of Finance, 55: 487-514

Stephen, J. A. and R. E. Whaley, 1990, "Intraday Price Change and Trading Volume Relations in the Stock and Stock Option Markets," Journal of Finance, Vol. 45, 191-220

Visaltanachoti, N. V., C. C. Wong and D. K. Ding 2011, "Information Asymmetry in Warrants and Their Underlying Stocks on the Stock Exchange of Thailand," Journal of Empirical Finance, Vol. 45, pp. 127–144.

Xiao, W. L., W. G. Zhang, Z. Yao and X. H. Wang, 2013, "The Impact of Issuing Warrant and Debt on Behavior of the Firm's Stock," Economic Modeling 31: 635–641.

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Tables

Table I The threshold co-integration test of traditional, electronic and financial classes of covered warrants and their underlying stocks

Classes	VECM	TVECM	Total
Traditional	10	34	44
Electronic	23	40	63
Fianacial	8	21	29
Total	41	95	136

Table II The empirical results of linear VECM: Traditional covered warrants

		Linear VECM		
classes	Industries	Total	Warrant Leads	Feedback
Traditional	Cement	1		1
Traditional	Textiles	1		1
Traditional	Plastics	1	1	
Traditional	Transportation	1	1	
Traditional	Appliance	3	2	1
Traditional	Steel, Iron	3	2	1
Total		10	6	4

Table III The empirical results of threshold VECM: Traditional covered warrants

		Threshold VECM				
			Regime 1		Regime 2	
Classes	Industries	Total	Warrant Leads	Feedback	Warrant Leads	Feedback
Traditional	Chemical	3	3		2	1
Traditional	Cement	4	4		3	1
Traditional	Other	3	2	1	2	1
Traditional	Food	2	1	1	2	
Traditional	Textiles	1	1		1	
Traditional	Plastics	5	4	1	5	
Traditional	Transportation	8	8		7	1
Traditional	Appliance	3	3		3	
Traditional	Steel, Iron	4	3	1	3	1

Traditional	Electric, Machinery	1	1			1
	Total	34	30	4	28	6

Table IV The empirical results of linear VECM: Electron covered warrants

			Linear VECM	
			Warrant	
Classes	Industries	Total	Leads	Feedback
Electron	IC Testing and Packaging	1		1
Electron	IC Design	1	1	
Electron	LCD	2	2	
Electron	TFT-LCD	2	2	
Electron	Main Board	2	1	1
Electron	CD ROM	5	5	
Electron	Printed Circuit Board	1		1
Electron	Mobile Phone	1	1	
Electron	Software	2	1	1
Electron	Foundry	2	2	
Electron	Light Emitting Diode	2	2	
Electron	Notebook	1		1
Electron	Monitor	1	1	
	Total	23	18	5

Table V The empirical results of threshold VECM: Electron covered warrants

			Threshold VECM			
			Regime 1		Regime 2	
			Warrant		Warrant	
Classes	Industries	Total	Leads	Feedback	Leads	Feedback
Electron	IC Testing and Packaging	3	3		3	
Electron	IC Design	1	1		1	
Electron	TFT-LCD	4	4		4	
Electron	CD ROM	3	2	1	2	1
Electron	Printed Circuit Board	1	1		1	
Electron	Mobile Phone	4	3	1	4	
Electron	Software	1	1		1	

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Electron	Communication	1		1	1	
Electron	Connector	3	1	2	3	
Electron	Foundry	2	1	1	2	
Electron	Light Emitting Diode	4	3	1	3	1
Electron	Notebook	6	5	1	5	1
Electron	Telecommunications Service	3	2	1	3	
Electron	Computer System	1	1		1	
Electron	Monitor	1	1		1	
Electron	Network Equipment	1		1		1
Electron	Digital Camera	1	1		1	
Total		40	30	10	36	4

Table VI The empirical results of linear VECM: Financial covered warrants

		Linear VECM		
Classes	Industries	Total	Warrant Leads	Feedback
Financial	Financial Holding Companies	5	5	
Financial	Non-Financial Holding Companies	3	2	1
Total		8	7	1

Table VII The empirical results of threshold VECM: Financial covered warrants

		Threshold VECM:			
		Regime 1		Regime 2	
Classes	Industries	Total	Warrant Leads	Warrant Leads	Feedback
Financial	Financial Holding Companies	17	17	15	2
Financial	Non-Financial Holding Companies	4	4	3	1
Total		21	21	18	3

Table VIII The summary of the lead-lag price relationship between covered warrants and their underlying

	Linear VECM				Threshold VECM:				
					Regime 1		Regime 2		
Classes	Total	Warrant Leads	Feedback	Total	Warrant Leads	Feedback	Warrant Leads	Feedback	Total

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Traditional	44	6	4	10	30	4	28	6	34
Electronic	63	18	5	23	30	10	36	4	40
Financial	29	7	1	8	21	0	18	3	21
Total	136	31	10	41	81	14	82	13	95

Figures

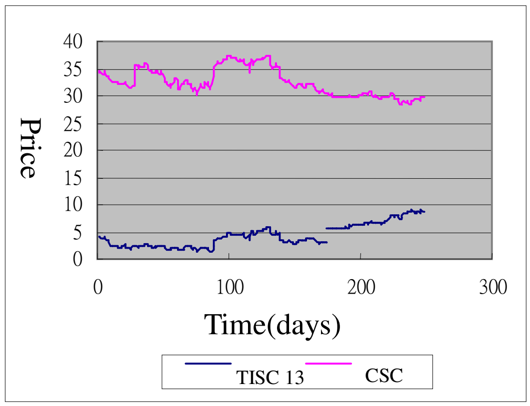

Figure 1 Price trend of the warrant TISC 13 and its underlying CSC

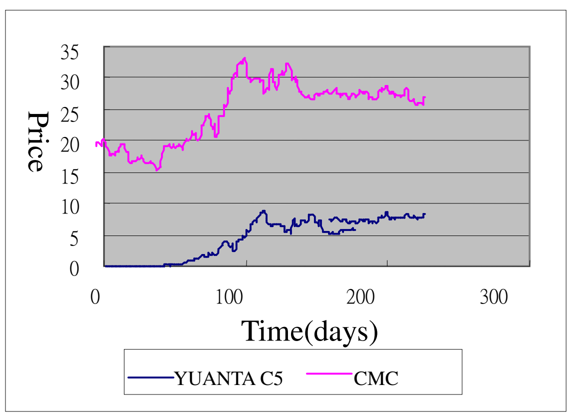

Figure 2 Price trend of the warrant YUANTA C5 and its underlying CMC