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The Expiration-Day Effect of Derivatives' Trading: Evidence from the Taiwanese Stock Market

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Abstract

This work examines whether the expiration-day effect of derivatives' trading exists in the Taiwanese stock market. The empirical results indicate that the futures' volatility does not increase steadily as the expiration-day approaches, but only in the three days before this date. Further, the stock volatility decreases after the opening of the options market. Next, while the trading volumes increase after the opening of options trading, the variations in them decrease significantly. Finally, significant price reversal exists in both the stock and futures markets, but not in the options market.

JEL classification numbers: G14, G15
Keywords: Expiration-Day Effects, Price Reversal

1 Introduction

Derivatives have recently attracted much attention from both scholars and investors. One of the features of these instruments is delivery at the expiration day. The time for delivery not only affects the market itself, but also generates price pressure with regard to the underlying assets. Most studies related to this issue focus on the spot price (Garbade & Silber, 1983; Stoll & Whaley, 1987 & 1991; Edwards, 1988; Witherspan, 1993) or the expiration-day effect of the spot market (Klemkosky, 1978; Herbst & Maberly, 1990; Hancock, 1993; Chen & Williams, 1994; Karolyi, 1996; Pardo, 1998; Bollen & Whaley, 1999; Corredor, Lechon & Santhamaria, 2001). Many studies (e.g., Stoll & Whaley, 1997; Corredor, Lechon & Santhamaria, 2001) indicate that the cause of the expiration-day effect is the settlements that occur in the derivatives market. This is because investors will reverse their positions by buying or selling the spot goods, leading to more order imbalances, especially when there are inconsistencies between the settlement and spot prices. In such

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cases, the contracts of physical delivery will be expected to have strong expiration-day effects.

Sutcliffe (1997) indicates that the underlying assets will have a direct influence on the variations in the margins, hedging strategies, and the pricing of options (futures), and so the study of such assets is very important (Anderson, 1985; Milonas, 1986; Gallaway & Kolb, 1996; Chen, Duan & Hung, 1999; Han, Kling & Sell, 1999). In addition, the opening price of the stock the day after the final settlement day is used as the settlement price of futures. Therefore, on both the expiration date and settlement date, the stock price will be expected to be affected by the related futures positions.

Although many works have examined the expiration-day effect, most of them focus on the developed markets, such as the US, but less focus on emerging markets that have low liquidity and a greater ability to engage in arbitrage. To address this gap in the literature, this work examines whether the expiration-day effect exists in the Taiwanese Stock Market using the firms listed on the Taiwan Stock Exchange Corporation (TSEC) for the 16-year period covering 1998/9/1 to 2004/3/31. More specifically, this article discusses the following issues. First, it examines whether the trading volume, price and volatility change significantly as the expiration day of Taiwanese stock index futures and options approaches. Next, it examines whether the Samuelson effect or other specific trading patterns exist on the expiration day. Finally, this study investigates whether there are reversals with regard to stock price, trading volume and volatility after the expiration of options and futures in the Taiwanese market.

The empirical results show that the stock return volatility does not increase steadily, but steadily only increases in the two or three days before the expiration of futures. Further, the volatility decreases but the stock returns increase after the opening of the options market. Similarly, while the trading volume significantly increases after the opening of the options market, the volatility of the trading volume decreases. Finally, price reversal does exist in both the stock and futures markets, but no reversals are found with regard to the stock trading volume.

The remainder of this paper proceeds as follows. Section 2 will discuss the data and measurement of the variables. Next, Section 3 discusses the empirical findings. Finally, Section 4 gives the conclusions of this work.

2 Data and Measurement of the Variables

2.1 Data

This work uses the following variables, including stock returns, trading volume, the volatility of stock returns and the volatility of trading volume, to examine whether the expiration-day effect exists in the TSEC. The study period is from 1998/9/1 to 2004/3/31, a total of 6 years. The data are obtained from the TEJ (Taiwan Economics Journal) Database.

2.2 Variable Measures

2.2.1 Price reversal

The trading volume or stock price may be abnormally high or low when open interest is closed out before the expiration date. Generally, if no new trading information appears, the stock price should revert to the fair price. If not, this result should be regarded as the arrival of new trading information, rather than being due to arbitrage or manipulation by investors. This work follows previous studies (Stoll & Whaley, 1991; Hancock, 1993), and uses the binomial distribution to examine whether price reversal exists near the expiration days. If the $\mathrm{R}_{\mathrm{i,t}}$ has the opposite sign to $\mathrm{R}_{\mathrm{i,t+1}}$, then this means that a price reversal has occurred.

$$R_{i,t} = \ln(C_{i,t} / O_{i,t}) \tag{1}$$

$$R_{i,t+1} = \ln(O_{i,t} / C_{i,t-1}); \tag{2}$$

where $\mathrm{R}_{\mathrm{i,t}}$ is the stock return on the expiration day *t* in stock *i*; $\mathrm{R}_{\mathrm{i,t+1}}$ is the stock return on the day after the expiration day; $\mathrm{C}_{\mathrm{i,t}}$ denotes the closing price at day *t* in stock *i*; $O_{i,t}$ denotes the opening price at day *t* in stock *i*.

2.2.2 The reversal in trading volume

A change in trading volume can be seen as a change in trading information, and regarded as the arrival of new information. If the order imbalance at the expiration day is due to arbitrage between investors, the stock price will revert to the fair price the next day if no new information arrives. This work uses the difference between trading volumes to examine whether there is any reversal in trading volume, which is as follows:

$$D_{i,t} = volume_{i,t} - volume_{i,t-1}; \tag{3}$$

Where $Volume_{i,t}$ is the trading volume on the expiration day *t* in stock *i*; $Volume_{i,t+1}$ is the trading volume on the day after the expiration day.

3 Empirical Analysis

3.1 Descriptive Statistics

The descriptive statistics are shown in Table 1. First, the stock returns are about two times greater than the futures returns, although there is no significant difference with regard to the risk. Next, before using traditional linear regression analysis, the assumptions need further to be examined. Based on the results of skewness and kurtosis, the distribution is highly skewed to right, with a high degree of kurtosis. We also use the ADF test to examine whether the stock returns, futures returns or options returns are stationary, with the results being positive in all cases. Furthermore, the results show that the issue of multi-collinearity among these variables can be ignored, because all their Variance Inflation Factor (VIF) values are less than 2.

The ARCH effect is also examined using the LM test, and the empirical results show that it has a significant effect in this context. Therefore, the AR(m)-GARCH(1,1) or AR(m)-EGARCH(1,1) (m≦6) are used to estimate the regression analysis. Further, the J-B test indicates that assumption of normality is rejected for the two series, and the QMLE (Quasi Maximum Likelihood Estimate) will be used in the later analysis to increase the efficiency of the coefficient estimations. Furthermore, the results of the Ljung-Box test indicate that the residual does not exhibit serial correlations. Finally, similar results with regard to the ARCH effect and the violation of the normality assumptions, are also obtained for the trading volume of stock market. Therefore, in the later analysis, EGARCH (1, 1) will be used to capture the heterogeneity of returns.

Table 1: Descriptive statistics

	Stock returns		**Futures returns**		**ln (Trading volume)**	
Return	6.09×10^{-5}		3.71×10^{-5}		3.4467	
Std. Dev	0.0176		0.01998		0.2086	
Skewness	0.0657		0.0249		0.1333	
Kurtosis	3.9604		4.9438		2.7342	
J-B	55.4812	***	223.2969	***	8.3747	**
Q(15)	46.9650		23.5080		366.2700	***
LM(5)	79.6531	***	92.2699	***	28.7658	***
Unit Root Test	-16.3181	***	-16.4953	***	-4.2446	***

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

3.2 Expiration-day Effect: Return and Volatility

Because volatility has asymmetric effects in the US, French and Japanese stock markets, this work uses the EGARCH(1,1) model to estimate the regression equation. This model is defined as follows:

$$R_{i,t} = \alpha_0 + \alpha_1 R_{i,t-1} + \gamma_1 D_i + \gamma_2 Option + u_{i,t} + \sum_{i=1}^{5} \gamma_i Week_{i,t}$$
$$\ln \sigma^2{}_{i,t} = \kappa_0 + \eta_1 D_i + \eta_2 Option + \varsigma_1 \left| \frac{\varepsilon_{i,t-1}}{\sigma_{i,t-1}} \right| + \varsigma_2 \frac{\varepsilon_{i,t-1}}{\sigma_{i,t-1}} + \beta \ln \sigma^2_{i,t-1}; \tag{4}$$

where $Week_{i,t}$, i = 1 if Monday, 2 if Tuesday, 3 if Wednesday, 4 if Thursday, 5 if Friday, and 0 otherwise. $R_{i,t} = \ln(C_{i,t} / C_{i,t-1})$ indicates the closing price at day *t* in stock *i*; $u_{i,t} \sim \text{Normal}(0, \sigma_t^2)$.

Investors will close out their positions before the options or futures expire if open interest exists due to arbitrage in the market. The order imbalance will thus increase, leading the stock price to move away from the equilibrium, further increasing the volatility of stock returns. In Table 2, the volatility of stock returns significantly decreases after options trading starts, while the returns significantly increase. The opening of options trading provides a hedging tool to the stock market. However, volatility does not increase steadily as the options expire, apart from in the last two or three days, in which it rises.

Table 2: Expiration-day effect: returns and volatility: EGARCH(1,1)

Coefficient	Model 1		Model 2		Model 3		Model 4		Model 5	
Panel A: Returns										
γ_1	-0.0040		-0.0022		-0.0042	*	-0.0027		-0.0018	
γ_2	0.0052	***	0.0053	***	0.0043	***	0.0041	***	0.0039	***
Panel B: Conditional volatility										
η_1	0.1173		0.1127		0.2870	*	0.2494	*	0.1788	
η_2	-0.4506	***	-0.4564	***	-0.4169	**	-0.4115	***	-0.3955	***
R^2	0.1145		0.1139		0.1111		0.1105		0.1095	

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The standard error is included in parentheses. Model 1: the time to maturity day includes only one day (the expiration day); Model 2: the time to maturity day includes two days (the day before the expiration day and the expiration day); Model 3: the time to maturity day includes three days (the two days before the expiration day and the expiration day); Model 4: the time to maturity day includes four days (the three days before the expiration day and the expiration day); Model 5: the time to maturity day includes five days (the five days before the maturity day and the expiration day).

3.3 Expiration-day Effect: Trading Volume and Volatility of Trading Volume

If the open interest is not closed out near the expiration day, investors will be eager to reverse their positions and the trading volume will be abnormally high (Bhattacharya, 1987; Stoll & Whaley, 1991; Karolyi, 1996). Because the trading volume is non-stationary, this work uses its logarithm as a variable and the five lags of trading volume as the explanatory variables. The regression equations are defined as follows:[3]

$$\log(Volume_{i,t}) = \alpha_0 + \sum_{i=1}^{5} \alpha_i \log(Volume_{i,t-1}) + \sum_{i=1}^{4} \beta_i D_i + \gamma_1 Option_1 + \gamma_2 D_i + \delta T + u_{i,t}$$

$$\sigma^2_{i,t} = \kappa_0 + \eta_1 Option + \eta_2 D_i + \kappa_1 \sigma^2_{i,t-1} + \phi_1 \varepsilon^2_{i,t-1} \quad ; \tag{5}$$

where $Volume_{i,t}$ is the trading volume at day t in stock i; T denotes time trend; $u_{i,t} \sim \mathrm{Normal}(0, \sigma_t^2)$.

[3]Due to the absence of any week effect, it will be ignored in this work.

Table 3: Expiration-day effect: trading volume and volatility of trading volume: GARCH(1,1)

Variable	Model 1		Model 2		Model 3		Model 4		Model 5	
Panel A: Trading Volume										
γ_1	0.0181	**	0.0177	**	0.0191	**	0.0191	**	0.0189	**
γ_2	-0.0062		0.0038		-0.0059		-0.0060		-0.0041	
Panel B: Conditional Volatility										
η_1	-0.0012	*	-0.0012		-0.0012		-0.0012	*	-0.0012	*
η_2	0.0016		0.0001		0.0008		0.0006		0.0005	
R^2	0.8008		0.8008		0.8001		0.8909		0.8009	

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The standard error is included in the parentheses. Model 1: the time to maturity day includes only one day (the maturity day); Model 2: the time to maturity day includes two days (the day before the maturity day and the maturity day); Model 3: the time to maturity day includes three days (the two days before the maturity day and the maturity day); Model 4: the time to maturity day includes four days (the three days before the maturity day and the maturity day); Model 5: the time to maturity day includes five days (the five days before the maturity day and the maturity day).

The empirical results in Table 3 show that trading volume does not significantly increase using the t-test or median test. After the opening of options trading, the trading volumes of the stock market significantly increase and the changes in these are significantly smaller than before the opening of such trading.

3.4 Reversal Effect: Price and Trading Volume

The trading volume or stock price will be abnormally high or low when the open interest is closed out due to expiration day arriving. Generally, if no new information arrives, the stock price should revert to the fair price, and if not this should be regarded as the arrival of new trading information, rather than due to arbitrage or manipulation by investors. Klemkosky (1978), Stoll and Whaley (1991) and Pope and Yadav (1992) indicate that price pressure exists when a derivative expires, and that the stock price will revert to the fair price after this. The empirical results are shown in Table 4. It can be seen that price reversal exists in the futures market, in both the full study periods and the various sub-periods. In addition, the same is also true for the stock market. Therefore, the abnormal stock prices found during the whole study period may be due to arbitrage or manipulations by investors. However, this reversal effect is not found for the trading volume.

Table 4: Reversal effect: price and trading volume

Periods	Stock Returns	Futures Returns	Trading Volume	n
1998/9~1998/12	1 (0.3125)	0 (0.0625)	3 (0.9375)	4
1999/1~1999/12	6 (0.6127)	3 (0.0730)	8 (0.9270)	12
2000/1~2000/12	5 (0.3872)	5 (0.3872)	6 (0.6127)	12
2001/1~2001/12	2 (0.0193)	2 (0.0193)	5 (0.3872)	12
2002/1~2002/12	4 (0.1938)	2 (0.0193)	6 (0.6127)	12
2003/1~2003/12	2 (0.0192)	0 (0.0002)	9 (0.9807)	12
2004/1~2004/03	2 (0.8750)	0 (0.0002)	2 (0.8750)	3
1998/9~2004/03	22 (0.003)	12 (0.0000)	39 (0.9289)	67

Note: n is the number of reversals in returns or trading volume. The number in parentheses is the p-value, which is defined as follows: binomial (numbers, numbers of reversal, 0.5).

4 Conclusions

Based on the findings of previous studies, the stock returns, volatility and trading volume will be affected by the expirations of options or futures. This paper examines whether the expiration effect exists in the Taiwanese stock market. The empirical results show that stock return volatility does not increase steadily in the TSEC, but only increases in the two or three days before the expiration of futures. In addition, the volatility decreases but stock returns increase after the opening of the options market. Furthermore, the trading volume increases significantly before the expiration day, but its volatility decreases. Finally, price reversal exists in both the Taiwanese stock market and futures market, but no reversal effect with regard to trading volume exists.

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