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Expiration-day effects, settlement mechanism, and market structure: an empirical examination of Taiwan futures exchange

Abstract

This study constructs a series of nine time windows around expiration-day to dynamically examine the market impact of derivatives' settlements. Further, multiple-regression analysis is set out to investigate the potential factors accounting for the market anomalies of expiration-day effects. The empirical evidence indicates that price effect, volatility effect, and trading volume effect significantly occur in the three consecutive windows immediately after the settlement of derivatives. Moreover, the results seem more favorable on market conditions than market structure in explaining the expiration-day effects.

Keywords: expiration-day, price effect, volatility effect, trading volume effect.
JEL Classification: F10, G18.

Introduction

Derivatives have been the most successful financial innovation since the 1980s and they have largely changed the landscape of modern financial markets. The impacts of derivatives on their underlying spot markets, among them, the expiration-day effects, have been of great concern to both market participants and regulators. The expiration-day effect refers to the unusual movements of spot market prices, volatility, and volume around the settlement of derivatives. The famous triple witching hour is a bona fide example to describe the abnormal stock price movements frequently accompanying the final hour of trading on days when index futures, index options, and individual stock options expire simultaneously. Quite a lot of possible rationales may be attributed to the phenomenon of expiration-day effects, including behaviors of market participants on arbitrage, hedge, and speculation, new information arrival, market manipulation, and regulatory policy.

A variety of financial research has examined the existence of expiration-day effects and ends with mixed results. Another focus of expiration effects centers on the efficacy of changes of settlement mechanisms on the mitigation of abnormal market movements around expirations. Similar to the issue of existence, no general agreement has been reached on the best settlement mechanism. However, researchers do concur on the possibility of individual market microstructures on the efficacy of policy measures, taken on the expiration effects. Surprisingly, few financial research papers have been devoted to investigate the possible factors relevant to the severity of expiration effects. The meaningful results on the causes of expiration effects are indeed important to both market participants and policy makers.

This study contributes to the literature by deliberately examining the expiration-day effects by a two-stage process. First, a dynamic series of time windows around the settlement of derivatives are employed to keep track of abnormal market movements. The detected expiration anomalies are utilized for further multiple-regression analysis to ascertain the potential factors affecting the expiration effects. The empirical results of this study, in general, agree with Stoll and Whaley (1987; 1989; and 1997) that settlement mechanism alone only shift the timing of expiration effects but provide no evidence in mitigation of the market distortion. Moreover, the empirical evidence also indicates market conditions around expiration might have more unfavorable impact on the market anomalies than the underlying market microstructure.

1. Literature survey

Since the first launches of stock index futures and options, respectively in 1982 and 1983, in the U.S. markets, the impact of derivative markets on their underlying spot markets have been of enormous concern to both academics and practitioners. Stoll and Whaley (1987), among the early researchers, examined expiration-day effects of the US markets for the period from July 1, 1983 through December 27, 1985. Stoll and Whaley (1987) concluded that significant effects of price, volatility, and trading volume occur around derivatives' settlement. Stoll and Whaley (1991) and Hancock (1993) examined whether the changes of settlement times of derivatives can mitigate concern over the triple witching hour. The evidence from these studies suggests that expiration-day effects are small and regulators might have overreacted to unfavorable reports on expiration effects. On the same line of reasoning, Stoll and Whaley (1997) examined the Sydney futures exchange and discussed alternative futures settlement procedures. Stoll and Whaley (1997) point out that except for abnormally high trading volume, little evidence has been discovered for aberrant price movements. Meanwhile, Stoll and Whaley (1997) also indicate that cash settlements at the close, instead of settling in a special call auction market that occurs fifteen minutes after the stock market close, for the all ordinaries share price index, appears to have worked well through out the sample period.

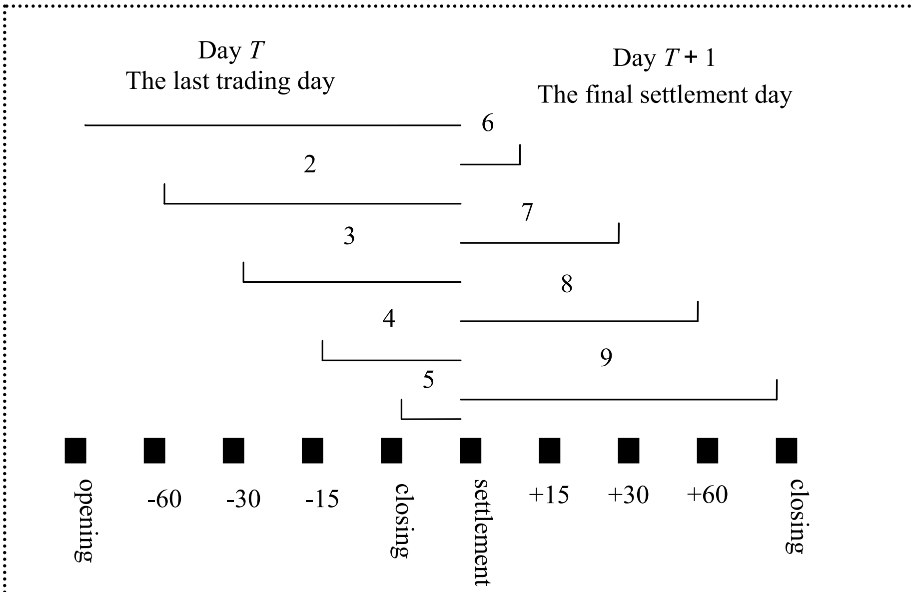
However, other researchers also document convincing evidence that settlement mechanisms can account for expiration-day distortions. Alkeback and Hagelin (2004) examined expiration-day effects of the Swedish OMX index during the period of 1988-1998. Alkeback and Hagelin (2004) found that trading volumes on the spot market were significantly higher on expiration days than on non-expiration days. However, no evidence suggests that price distortions occur around expiration days. Alkeback and Hagelin (2004) attribute this mild price effect on OMX derivatives to the settlement price which is computed as the average volume-weighted value of the last trading day. The settlement period of the OMX is substantially longer than the practice in other markets, and should account for the benign price effect of the OMX. Bansal (2005), Chou et al. (2006), and Hsieh and Ma (2008) documented more international evidence of expiration-day effects and maintain that market microstructure can explain a wide variety of mixed results among different markets.

Even the possible causes of the expiration-day aberration have been discussed in a vast number of research papers; however, there is so far a lack of either formal theoretic treatments or detailed empirical investigations. This study sets out to empirically examine the potential market and institutional factors which might account for the abnormal market movements of expiration-days. The empirical results will contribute more understanding on the market behaviors of derivatives' settlements and will be useful for both market participants and policy makers.

2. Methodology and data

This study adopts the comparison-period approach of Masulis (1980) by defining the expiration-day of derivatives vs. non-expiration-day with six days before and after the expiration of the Taiwan futures exchange (TAIFEX). The difference between expiration-day and the mean of non-expiration forms the basis of expiration-day effects. Meanwhile, the TAIFEX employs opening price information in various settlement methods during different settlement mechanisms. This study utilizes high frequency intra-day data to capture the information revealed in the opening trading section as indicated in Admati and Pfleiderer (1998).

2.1. Research design and data. Taiwan indices derivatives settle (the third Thursday) one day after the last trading data (the third Wednesday). To dynamically keep track of expiration-day effects around settlement, this study draws nine overlapping time windows of settlement point which extend 15 minutes, 30 minutes, 60 minutes, and the whole day before and after the settlement, respectively. The detailed nine time windows are referred in Figure 1.



Note: The settlement point was at the third Thursday, opening before November, 2001 and at the third Thursday, opening 15 minutes thereafter of TAIFEX.

Fig. 1. The nine time windows around the settlement of derivatives in TAIFEX

This study aims to explore the potential determinants of expiration-day effects around the settlement of indices derivatives of the TAIFEX. As indicated in previous literature, the settlement method may account for the abnormal phenomena surrounding derivatives' settlements. Accordingly, this study investigates the available sample including the whole sample: from September 1998 to December 2008, and two sub-periods: from September 1998 to October 2001; and from November 2001 to December 2008 for two distinct settlement methods. Since the limitation of the Taiwan Economic Journal (TEJ) database, the data under investigation has different frequencies, namely, five minute intraday data from September 1, 1998 to April 30, 1999, and one minute intraday data from May 3, 1999 to December 31, 2008. The data were provided by the Taiwan stock exchange, Taiwan futures exchange, and Taiwan Economic Journal.

2.2. Measures of expiration-day effects. This study employs three measures of expiration-day effects, namely price effect, volatility effect, and volume effect. The detailed formulation of the expiration-day effect is illustrated as follows.

2.2.1. Price effect. Two price effects are utilized in this study. The first price effect is the abnormal return of expiration-day which is defined as the difference between the expiration-day return and the mean return of non-expiration days and represents the abnormal return on expiration-days. The price reversal of Stoll and Whaley (1987) serves as the second measure of the price effect on expiration days.

Namely,

$$REV_i = \begin{cases} R_{after,i}, & if \quad R_{before,i} < 0 \\ -R_{after,i}, & if \quad R_{before,i} \geq 0, \end{cases}$$

where, REV_i is the price reversal of the expiration-day *i*, $R_{before,i}$ and $R_{after,i}$ are the returns before and after the settlement within time windows.

2.2.2. Volatility effect. The study adopts the intraday volatility of Kan (2001) as follows:

$$Vol_i = \sum_t \left| \ln\left(\frac{P_i^t}{P_{i,}^{t-1}} \right) \right|,$$

where Vol_i is the volatility of time windows, P_i^t represents the indices price at time point *t*. The abnormal volatility around the expiration-day is defined as the difference of volatility between the expiration-day and the mean volatility of non-expiration-days.

2.2.3. Trading volume effect. To display the trading activity around expiration, this study adopts Stoll and Whaley (1991) by taking the ratio of trading volume on the settlement period to the trading volume of the whole expiration day as the measurement of the transaction effect. Meanwhile, the abnormal trading volume effect is defined as the difference of the trading activity between the expiration-day and the mean of non-expiration-days.

2.3. Determinants of expiration-day effects. This study empirically examines the potential factors on the phenomena of expiration-day effects. Two categories of variables, market conditions and market structure, are presumably specified to account for the anomalies around expiration.

Market conditional variables include basis, trend line (5-day moving average of spot indices), open interests, and the return of the Dow Jones industry average index (DJIA). Market structure variables consist of settlement methods (dummy variable), activities of institutional investors in spot market, and institutional participation of futures markets. The detailed multiple regression is specified as follows:

$$AE_t = \alpha + \beta_1 Mon_t + \beta_2 D_t + \beta_3 BASIS_t + \beta_4 TREND_t + \beta_5 RF_t + \beta_6 OI_t + \beta_7 ROI_t + \beta_8 DJIAI_t + \\ + \beta_{10} DEALER_t + \beta_{11} TRUST + \beta_{12} FOREIGN_t + \beta_{13} PARTICIPAT_t + \varepsilon_t,$$

where, AE_t is abnormal expiration-day effects, representing the price effect, volatility effect, and transaction effect, respectively; Mon_t is the month of expiration-day; D_t is the dummy variable of settlement methods, D_t = 1 when the TAIFEX adopted Thursday opening as the settlement price, and D_t = 0 when the TAIFEX adopted the average of opening 15 minutes of indices prices as the settlement price; $BASIS_t$ is the basis of the third Tuesday; $TREND_t$ is the five-day moving average of spot indices up to the third Tuesday; RF_t is the return of index futures on the third Tuesday; OI_t is the open interests of the third Tuesday; ROI_t is the ratio of the open interests on Tuesday to the average of five-day open interest up to the third Tuesday; $DJIAI_t$ is the return of DJIAI on the third Tuesday; $DEALER_t$ is the abnormal trading volume of domestic dealers on the spot market (TAIFEX) defined by the difference between trading volume of domestic dealers on expiration-day and the mean of non-expiration-days; $TRUST_t$ is the abnormal trading volume of investment trusts on the spot market (TAIFEX) defined by the difference between trading volume of investment trusts on expiration-day and the mean of non-expiration-days; $FOREIGN_t$ is the abnormal trading volume of foreign institutional traders on the spot market (TAIFEX) defined by the difference between trading volume of foreign institutional traders on expiration-day and the mean of non-expiration-days; $PARTICIPAT_t$ is the share of transaction volume by institutional investors in TAIFEX; ε_t is the error term.

3. Empirical results and analysis.

3.1. The expiration-day effects. The empirical results of expiration-day effects are reported in terms of price effect, volatility effect, and volume effect**.**

3.1.1. Price effect. Table 1 documents the basic statistics of the price effect of the TAIFEX around expiration-days of the whole sample period and two sub-periods. The measure of abnormal returns dynamically keeps track of the nine time windows from the opening of the last trading day (*T*) to the closing of the settlement day (*T* + 1). As indicated in Table 1, the abnormal returns of the expiration-day are significantly larger than non-expiration-days from window 6 through window 9 in terms of Mann-Whitney test. The magnitude of the increase reaches its highest in window 6 (i.e., the fifteen-minute interval after the settlement) as 0.001891 in the whole sample period and then gradually diminishes through out the rest of time windows. The pattern of abnormal returns of expiration-days can also be found in the two sub-periods. However, on the contrary, the return anomaly only occurs in the average open-15-minutes settlement regime (the second sub-period) and cannot be detected in the opening settlement regime (the first sub-period). The interesting finding is generally in agreement with the point of Herbst and Maberly (1990) and Stoll and Whaley (1991) who maintained that the change of settlement method can only shift the market congestion around expiration-days but cannot mitigate the impact of expiration-day.

Table 1. Basic statistics of price effects

Variables	September 1998-December 2008	September 1998-October 2001	Nobember 2001-December 2008
T1	0.652688 * (0.333089)	0.832552 (0.670212)	0.512422 * (0.280469)
T2	0.159551 * (0.082398)	0.404296 (0.258408)	0.262121 * (0.145978)
T3	0.358152 * (0.143249)	0.778015 (0.600186)	0.350186 * (0.164089)
T4	0.677309 * (0.175394)	0.943814 (0.611626)	0.637584 * (0.179469)
T5	0.613813 * (0.140372)	0.823399 (0.501873)	0.396116 * (0.175172)
T6	0.001891 * (0.004219)	0.318077 (0.481244)	0.002361 * (0.003153)
T7	0.022480 * (0.006206)	0.733377 (0.793270)	0.002595 * (0.000936)
T8	0.000730 * (0.000926)	0.630097 (0.441407)	0.000151 * (0.000464)
T9	0.008201 * (0.017375)	0.213100 (0.238279)	0.014389 * (0.037686)
RR1	0.744610 (0.429388)	0.832552 (0.670212)	0.512422 * (0.280469)
RR2	0.635136 * (0.136839)	0.404296 (0.258408)	0.262121 * (0.145978)
RR3	0.457012 * (0.029669)	0.778015 (0.600186)	0.350186 * (0.164089)
RR4	0.871356 * (0.054202)	0.943814 (0.611626)	0.637584 * (0.179469)

Note: T1, T2, …, T9 designate the nine time windows around the settlement of derivatives as illustrated in Figure 1. The figures of T1, T2… T9 are the mean excessive returns of expiration over the non-expiration. RR1, RP2, RP3 and RP4 designate the four windows of price reversals and respectively cover the whole day, six minutes, thirty minutes, and fifteen minutes before and after the settlement of derivatives. The figures in parentheses are the p-values of the Mann-Whitney test; *designates 5% significance.

The price reversal of Stoll and Whaley (1987) is shown in Table 1 by four price reversal windows. The empirical evidence indicates that only the fifteen minute and thirty minute reversal zones exhibit a significant abnormal price reversal effect of expiration-days in the whole sample period. However, the price reversal anomaly totally disappears in the two sub-periods. In short, the empirical evidence of the price effect on expiration-days demonstrates a strong abnormal return and a minor price reversal effect around the expiration of the TAIFEX. In addition, the average price settlement regime seems to indicate a stronger price effect than the opening price settlement regime.

3.1.2. Volatility effect. The basic statistics of the volatility effect on expiration-days of the TAIFEX are reported in Table 2. The figures generally show strong volatility effect of the selected nine time windows around expiration-days in the whole sample and second sub-period. As expected, the effect is stronger in post settlement windows than the time windows before settlement. However, similar to the price effect, the abnormal volatility of expiration-days, even with positive magnitude, is still not shown in significance in the opening price settlement regime. The empirical evidence of the volatility effect supports the fact that the average pricing settlement mechanism is not necessarily mitigating the excessive volatility around expiration of the TAIFEX.

Table 2. Basic statistics of the volatility effect

Variables	September 1998-December 2008	September 1998-October 2001	November 2001-December 2008
T1	0.591511 (0.054869)	1.000000 (0.921714)	0.466594 (0.012508)
T2	0.099821 * (0.000201)	0.518257 (0.076903)	0.127442 * (0.001149)
T3	0.046144 * (0.000066)	0.760063 (0.140449)	0.047229 * (0.000161)
T4	0.016026 * (0.000066)	0.724551 (0.115858)	0.020314 * (0.000251)
T5	0.004934 * (0.000018)	0.495699 * (0.055319)	0.004032 * (0.000125)
T6	0.062037 * (0.002251)	0.488297 (0.623162)	0.002515 * (0.000007)
T7	0.211191 (0.003656)	0.646882 (0.718592)	0.032897 * (0.000061)
T8	0.387431 (0.016282)	0.733377 (0.908719)	0.174048 (0.001968)
T9	0.544303 (0.010027)	0.805165 (0.768128)	0.313843 (0.001567)

Notes: T1, T2, …, T9 designate the nine time windows around the settlement of derivatives as illustrated in Figure 1. The figures of T1, T2… T9 are the mean excessive volatilities of expiration over the non-expiration. The figures in parentheses are the p-values of the Mann-Whitney test; * designates 5% significance.

3.1.3. Trading volume effect. The basic statistics of excessive trading volume around expiration-days of the TAIFEX are illustrated in Table 3. The abnormal trading volume is shown significantly for the time windows after the settlement for both the whole sample period and the second sub-period. In particular, the strongest excessive trading volume apparently appears in the time windows of fifteen-minutes immediately after the settlement in all three sample periods and accounts for 0.1985, 0.4312, and 0.0888, respectively. The trading abnormal phenomenon demonstrates a similar pattern among different settlement mechanisms as those of the price effect and volatility effect. The basic statistics of expiration-day effects consistently confirm the existence of market anomalies of the TAIFEX around the settlements of derivatives. Moreover, the evidence also delineates the fact that settlement mechanisms may not play the determinant role in forming expiration-effects and this conforms with the view of Stoll and Whaley (1997).

Table 3. Basic statistics of the transaction effect

Variables	September 1998-December 2008	September 1998-October 2001	Nobember 2001-December 2008
T1	0.455305 (0.122103)	0.878631 (0.947763)	0.381279 (0.198996)
T2	0.926487 (0.968271)	0.814269 (0.522962)	0.963312 (0.608039)
T3	0.987981 (0.900812)	0.841728 (0.577602)	0.930483 (0.583313)
T4	0.971461 (0.930266)	0.841728 (0.544496)	0.953202 (0.601814)
T5	0.198418 (0.000695)	0.431285 (0.184604)	0.088771 * (0.001385)
T6	0.209136 (0.010988)	0.981258 (1.000000)	0.116723 (0.002389)
T7	0.273126 (0.012583)	0.953167 (0.908719)	0.176066 (0.002933)
T8	0.283138 (0.008326)	0.878635 (0.566462)	0.220170 (0.003745)
T9	0.339745 (0.004326)	0.715762 (0.265373)	0.378697 (0.005614)

Notes: T1, T2, …, T9 designate the nine time windows around the settlement of derivatives as illustrated in Figure 1. The figures of T1, T2… T9 are the mean excessive trading volumes of expiration over the non-expiration. The figures in parentheses are the p-values of Mann-Whitney test; * designates 5% significance.

3.2. Factors of expiration-day effects: regression analysis. This study further investigates the potential factors that might explain the abnormal expiration-day effects of the TAIFEX. According to the empirical results above, the three windows of six, seven, and eight that right after the settlement of derivatives for fifteen, thirty, and sixty minutes exhibit strong expiration-day effects. This study specifies empirical models to account for the expiration-day effects on the three windows in terms of multiple regression analysis. The explanatory variables consist of three categories, namely, market condition variables, market structure variables, and their interaction terms.

3.2.1. Factors of expiration-day price effects. Table 4 reports the results of regression analysis of the price effects for abnormal returns and price reversals. The four models exhibit similar significant factors and almost the same signs of estimated coefficients. The settlement dummy variable D_t exerts a negative effect on expiration-day price effects. The immediate implication of the result indicates that the price effect has been lessened during the opening price settlement regime comparing it to the average opening 15-minute price settlement regime. The market condition variable of the *DJIAI* indicates that stronger international equity markets bring forth higher price effects on derivatives settlement of TAIFEX.

Table 4. Regression analysis of price effects

Variables	T6	T7	T8	RR
Constant	0.256350 [a] (0.694232)	0.704113 (1.973103)	0.741664 (2.124042)	0.000000 (0.000000)
Mon_t	0.014406 (0.315558)	-0.019143 (-0.433894)	-0.050358 (-1.166533)	0.161749 (1.012142)
D_t	-1.196750 (-1.829171)*	-1.961906 (-3.102886)*	-1.385005 (-2.238656)*	-0.681324 (-2.291130)*

Table 4 (cont.). Regression analysis of price effects

Variables	T6	T7	T8	RR
$BASIS_t$	-0.035956 (-0.330112)	-0.031550 (-0.299723)	0.003043 (0.029544)	0.044977 (0.415704)
OI_t	-0.064133 (-0.276476)	0.039343 (0.175499)	-0.029210 (-0.133165)	-0.027973 (-0.121399)
RF_t	0.031381 (0.288588)	-0.123976 (-1.179748)	-0.079838 (-0.776442)	-0.052477 (-0.485832)
$TREND_t$	-0.021147 (-0.189467)	0.020621 (0.191177)	0.062136 (0.588724)	-0.088786 (-0.800810)
ROI_t	0.030160 (0.233103)	-0.027502 (-0.219952)	0.101020 (0.825684)	0.233716 (1.818511)*
$DJIAI_t$	0.211486 (2.231401)*	0.206379 (2.253199)*	0.241722 (2.697105)*	0.252369 (2.680637)
$FOREIGN_t$	-0.523469 (-2.317992)*	-0.168558 (-0.772339)	-0.263275 (-1.232865)	-0.198353 (-0.884229)*
$TRUST_t$	0.110085 (1.031448)	0.071482 (0.693031)	0.156427 (1.549941)	-0.040411 (-0.381173)
$DEALER_t$	0.246483 (2.283164)*	0.272339 (2.610335)*	0.304027 (2.978157)*	0.028933 (0.269800)
$PARTICIPAT_t$	-0.117680 (-0.443283)	-0.500616 (-1.951276)*	-0.545184 (-2.171732)*	-0.038622 (-0.146460)
$Mon_t \times FOREIGN_t$	0.270313 (1.256848)	-0.044649 (-0.214816)	0.150914 (0.742043)	0.033546 (0.157021)
$Mon_t \times PARTICIPAT_t$	-0.035137 (-0.144134)	0.140189 (0.595043)	0.248851 (1.079501)	-0.178094 (-0.735448)
$D_t \times FOREIGN_t$	-0.006244 (-0.062094)	-0.053544 (-0.550982)	-0.036828 (-0.387300)	0.125699 (1.258415)
$D_t \times PARTICIPAT_t$	0.405069 (1.461911)	0.577080 (2.155088)*	0.350091 (1.336157)	0.684045 (2.485312)*
Adjusted R^2	0.058507	0.120687	0.158127	0.071017

Notes: T6, T7, and T8 designate the time windows of fifteen minutes, thirty minutes, and sixty minutes immediately after the settlement point. RR designates the reversal time window of thirty minutes before and after the settlement of derivatives. The explained variable: AE_t represents abnormal expiration-day effects. The explanatory variables including: Mon_t (the month of the expiration-day), D_t (the dummy of settlement method), $BASIS_t$ (the basis of futures), RF_t (the return of index $_{\text{futures}}$), $TREND_t$ (the five-day moving average of spot), OI_t (the open interests), ROI_t (the ratio of open interests), $DJIAI_t$ (the return of *DJIAI*), $DEALER_t$ (the abnormal trading volume of domestic dealers), $TRUST_t$ (the abnormal trading volume of investment trusts), $FOREIGN_t$ (the abnormal trading volume of foreign institutional traders), $PSRTICIPAT_t$ (the share of institutional investors in TAIFEX), and other four interactive terms. The figures in parentheses are t-statistics corrected from White heteroscedasticity; * designates 5% significance level.

Among institutional investors' activities, domestic dealers of $DEALER_t$ can cause a significantly positive effect on the price effects. Market indices arbitrages, hedging strategies, and even speculative trades may be the reason that abnormal trading volume of domestic dealers connects with the stronger price effects. The share of institutional investors in the TAIFEX, *PARTICIPAT*, on the contrary, can mitigate the abnormal price effects around the settlement of derivatives. As indicated in Stoll (1988) and Stoll and Whaley (1997), market regulators take closer surveillance on spot markets and necessary measures to improve market congestion when there is greater institutional transaction on derivatives markets. The Taiwan stock exchange seems to increase greater liquidity during the opening section around derivatives' settlement after more institutionalization of the Taiwan futures exchange. However, the interaction term, $D_t \times PARTICIPAT_t$, turns out to have a significantly positive influence on the price effect. The evidence indicates that higher institutional participation in the first settlement regime results in stronger price effects which occur around the settlement of derivatives. The empirical evidence of Table 5 points out that the T8 window had the best model fitness with the highest adjusted R^2.

3.2.2. Factors of volatility effect. The empirical results of regression analysis on the volatility effect around expiration are documented in Table 5. The settlement dummy variable exhibits mixed results on the three time windows, however, with no statistical significance. The trend line of the five-day moving average price, $TREND_t$, shows a negative impact on the excessive volatility around the expiration of derivatives. In particular, in time window 6, a stronger spot market price trend seems to diminish the market volatility on the settlement of derivatives contracts. The ratio of open interests, ROI_t, on the contrary, convincingly indicates positive influence on the market volatility of expiration. However, the market structure variables, in general, show no significance on market volatility. Moreover, the model fitness of the volatility effect is lower than the price effect in terms of smaller adjusted R^2.

Table 5. Regression analysis of the volatility effect

Variables	T6	T7	T8
Constant	-0.137814 [a] (-0.376632)	0.324073 (0.869020)	0.474742 (1.286503)
Mon_t	0.017293 (0.382261)	-0.000374 (-0.008115)	-0.036872 (-0.808215)
D_t	0.078246 (0.120688)	-1.093404 (-1.654809)	-0.781861 (-1.195812)
$BASIS_t$	-0.032123 (-0.297612)	-0.054230 (-0.492994)	-0.000772 (-0.007097)
OI_t	0.309696 (1.347291)	-0.220204 (-0.939972)	-0.358259 (-1.545443)
RF_t	-0.023376 (-0.216937)	0.004269 (0.038875)	0.078550 (0.722841)
$TREND_t$	-0.326759 (-2.954344)*	-0.054850 (-0.486606)	-0.089379 (-0.801308)
ROI_t	0.068252 (0.532344)	0.327675 (2.507739)*	0.308241 (2.383936)*
$DJIAI_t$	0.100390 (1.068903)	0.091486 (0.955802)	0.078039 (0.823933)
$FOREIGN_t$	0.059572 (0.266207)	0.052007 (0.228032)	-0.000005 (-0.000021)
$TRUST_t$	-0.049020 (-0.463496)	-0.031314 (-0.290515)	0.020103 (0.188479)
$DEALER_t$	-0.074821 (-0.699398)	-0.059844 (-0.548895)	-0.071580 (-0.663479)
$PARTICIPAT_t$	0.048865 (0.185750)	0.131903 (0.491981)	0.279186 (1.052335)
$Mon_t \times FOREIGN_t$	-0.015329 (-0.071925)	-0.122903 (-0.565839)	-0.120837 (-0.562210)
$Mon_t \times PARTICIPAT_t$	-0.203856 (-0.843868)	-0.086377 (-0.350841)	-0.028967 (-0.118901)
$D_t \times FOREIGN_t$	0.019995 (0.200662)	-0.133320 (-1.312808)	-0.174092 (-1.732408)*
$D_t \times PARTICIPAT_t$	0.194572 (0.708640)	0.453920 (1.622136)	0.374332 (1.351860)
Adjusted R^2	0.075489	0.039751	0.059733

Note: All symbols are the same as those in Table 4.

3.2.3. Factors of volume effect. Table 6 shows the empirical results of regression analysis of the transaction effect on expiration-day. The settlement dummy variable, D_t, exhibits a positive effect on the excessive trading activity around the settlement of derivatives. The evidence indicates that the abnormal trading volume is comparatively larger in the first settlement regime than in the second settlement regime. The trend line, $TREND_t$, has a significantly positive impact on the trading volume around expirations. The evidence means that the up-trend market generates larger excessive trading volume on the settlement of derivatives. The ratio of open interests, ROI_t, also accompany with greater abnormal trading activity on expiration. Intuitively, the relatively higher open interests, the more trading congestion that would be expected around expiration-days. The specified market structure variables seem to account for little on the excessive trading activity around the expiration-days of the TAIFEX. However, the models of transaction effects possess the highest fitness among all expiration-day effects.

Table 6. Regression analysis of the transaction effect

Variables	T6	T7	T8
Constant	-0.113762 [a] (-0.326070)	-0.044952 (-0.129105)	-0.078521 (-0.224328)
Mon_t	0.006907 (0.160205)	-0.002940 (-0.068338)	-0.003737 (-0.086397)
D_t	0.230880 (0.373732)	0.219208 (0.355558)	0.351327 (0.566852)
$BASIS_t$	-0.153257 (-1.489619)	-0.174556 (-1.700083)*	-0.194296 (-1.882363)*
OI_t	0.256937 (1.172234)	0.104367 (0.477123)	0.027320 (0.124236)
RF_t	-0.002148 (-0.020841)	-0.011810 (-0.114828)	0.012990 (0.125641)
$TREND_t$	0.187428 (1.775554)*	0.245187 (2.327430)*	0.247942 (2.341173)*
ROI_t	0.162729 (1.332702)	0.229139 (1.880395)*	0.212381 (1.733682)
$DJIAI_t$	-0.037136 (-0.414940)	0.009051 (0.101335)	0.017185 (0.191396)
$FOREIGN_t$	0.179754 (0.843976)	0.124188 (0.584267)	0.089732 (0.419937)
$TRUST_t$	0.292749 (2.906240)*	0.285989 (2.844887)*	0.302473 (2.992997)*
$DEALER_t$	-0.018130 (-0.177933)	0.030501 (0.299952)	0.056734 (0.554991)
$PARTICIPAT_t$	0.037589 (0.149567)	0.023585 (0.094035)	0.061858 (0.245331)
$Mon_t \times FOREIGN_t$	-0.042248 (-0.208120)	-0.034749 (-0.171526)	-0.048203 (-0.236685)
$Mon_t \times PARTICIPAT_t$	-0.057926 (-0.251332)	-0.000688 (-0.002989)	-0.021915 (-0.094778)
$D_t \times FOREIGN_t$	0.119199 (1.256040)	0.134885 (1.424217)	0.136581 (1.434519)
$D_t \times PARTICIPAT_t$	-0.001823 (-0.006969)	-0.021630 (-0.082841)	-0.067963 (-0.258921)
Adjusted R^2	0.161404	0.164796	0.155918

Note: All symbols are the same as those in Table 4.

Conclusion

This study empirically examines the effects and causes of the expiration-day in the Taiwan futures exchange during the period of 1998-2009. The empirical results indicate that excessive return, excessive volatility, and abnormally high trading volume occur around the settlement of derivatives. The three consecutive time windows, immediately after the settlement, show significant expiration-day effects. The multiple-regression analysis indicates the opening price settlement (in the first sub-period) even worked better than the average of the opening 15 minutes prices (in the second sub-period) and is favorable with the findings of Stoll and Whaley (1987; 1991; and 1997). Moreover, the short-term market conditions variables exhibit meaningful explanatory power for the expiration-day anomalies. The empirical evidence drawn from this study seems to explain the phenomena of expiration-days more by market-orientation than by institution-orientation.

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