Expiration Day Effects of MSCI Taiwan Index Futures
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Introduction
This article investigates the impact of MSCI Taiwan index futures (hereafter MSCI-TW futures) expiration days on its underlying index stocks, and the major factors inducing expiration-day effects. The expiration-day effects refer to abnormal volume, excessive volatility and price reversals of the underlying index when index futures contracts expire.

This study first determines whether the spot market experiences large impact on futures expiration days. Results of this study suggest that futures expiration indeed affects index stocks, showing abnormally high volume, volatility, and price reversal.

The second objective determines how an unwinding arbitrage behavior and cash settlements enhance expiration-day effects. Using regression analysis, this paper finds that expiration-day effects positively relate to futures open interests. Adopting a closing call procedure on the stock market amplifies expiration-day effects.

Literature Review Research on Expiration-day Effects
Previous papers have reported significantly greater volume effects on expiration days than non-expiration days. Volume effects exist in many counties such as the United States (Stoll and Whaley 1986, 1987, 1990, 1991), Finland (Swidler, Schwartz and Kristiansen 1994), Germany (Schlag 1996), Japan (Karolyi 1996), Hong Kong (Bollen and Whaley 1999), Spain (Corredor, Lechon and Santamaria 2001), Sweden (Alkeback and Hagelin 2004) and India (Vipul 2005).


Sources of Expiration-day Effects
Factors regarding expiration-day effects of index derivatives arise from cash settlement and unwinding arbitrage behavior. Stoll and Whaley (1987) indicate that expiration day effects reflect a joint result of the cash settlement procedure of index futures contracts and unwinding arbitrage positions in spot markets. At expiration, the futures contract is settled at the final settlement price. On the other hand, arbitrageurs must unwind their stock positions on the expiration day.

Arbitrage stock positions unwound in the same direction late on the expiration day lead to an order imbalance that creates temporary price pressure. Chow, Yung and Zhang (2003) suggest more volatile price returns around expiration when such temporal price disequilibrium exists. Once price pressure subsides, the price should rebound to a normal level. A number of studies such as Stoll and Whaley (1987, 1990), Chamberlain, Cheung and Kwan (1989), Hancock (1993), Kan (2001) and Vipul (2005) support that unwinding index arbitrage activities are positively related to expiration-day effects. Chueh and Yang (2005) and Lin (2006) do not find out the index arbitrage results in expiration-day effects in the domestic market.

Index futures contracts may expire at closing or opening on expiration days. Herbst and Marbely (1990), Stoll and Whaley (1991) and Hancock (1993) show that expiration-day effects on the triple-witching hours do not disappear even if the settlement time alters from market close to opening. Stoll and Whaley (1997) posit using average price as the final settlement price could mitigate expiration-day effects. Chow, Yung and Zhang (2003), Alkeback and Hagelin (2004), Chung and Hseu (2008) and Hsieh and Ma (2008) attribute insignificant expiration-day effects to using the average settlement price in Hong Kong, Sweden and Taiwan markets.

Research Design
Data
The MSCI-TW futures contract offered by the Singapore Exchange (SGX) consists of 70 to 100 large-cap Taiwan listed stocks, which comprise approximately 71% of total market value. The MSCI-TW futures contract has a monthly expiration cycle, with the last trading day on the
second last business day of the contract month. The closing price of the MSCI-TW index at expiration determines the final settlement price. But on July 1, 2002, the Taiwan Stock Exchange altered the closing procedure from a continuous auction to a call auction. Comerton-Forde and Rydge (2006) suggest that a closing call auction absorbs a large order imbalance to decrease price volatility.

The intraday data are from the MSCI Taiwan index and its futures from January 9, 1997 to December 31, 2005. The sample period includes 107 expiration days and 2160 non-expiration days. This study uses the tick-by-tick MSCI Taiwan spot index, as well as intraday volume and price of its component stocks provided by the SGX and the Taiwan Economic Journal (TEJ) Database. For every 5-minute interval, we extract the open, high, low and close prices and accumulate the trading volume within the interval.

**Methodology**

This paper examines whether potential expiration-day effects exist on the MSCI Taiwan index by comparing the volume and return process at expiration with a comparison group. This research uses two kinds of non-expiration days as appropriate benchmarks to evaluate against expiration-day effects. One benchmark includes all non-expiration days; the other includes a specific non-expiration day: one trading day before expiration (T-1), one trading day after expiration (T+1), seven trading days before expiration (T-7), or seven trading days after expiration (T+7).

This study conducts another comparison between index and non-index stocks on expiration and non-expiration days. The portfolio of non-index stocks is often unrelated to program trading, and stands for a normal market condition without index arbitrage behavior. Finally, this research uses regression models to determine how index arbitrage and the settlement procedure enhance expiration-day effects.

**Empirical findings**

**Volume effect**

The first examination of MSCI-TW expiration-day effects focus on trading volume. The volume ratio and the volume turnover ratio measure abnormal volume: the former is the cross-day average of the volume ratio of all index stocks (Mvol) to all non-index stocks (nMvol). The latter is the cross-day average of the ratio, which is the turnover of all index stocks (Mtover) to the turnover of all non-index stocks (nMtover).

In normal circumstances, the volume ratio is equal to one expectably. Because most index stocks are large-cap, their trading volume is much higher than the non-index stocks. Therefore, this study uses volume turnover ratios to eliminate size effects. The turnover of non-index stocks similar to the turnover of index stocks makes the value of the volume turnover ratio near one.

Patterns of the two ratios in Figure 1 and 2 show that the dramatically increased volume concentrates in the last 5-minutes prior to market closing. After eliminating size effects, the volume turnover ratio is 1.4, which is greater than one. Both of their pooled and paired t statistics are significant. The evidence remarkably points out that greater trading volume exists in the last 5-minute interval on expiration days for index stocks than for non-index stocks.

**Volatility effect**

The significant volume effect of index stocks does not necessarily bring increased volatility to the underlying market, if market liquidity is sufficient to absorb order imbalance without unduly moving price due to unwinding demand. The current investigation uses four volatility measures, absolute return (|R|), range ((H-C)/C), and two measures proposed by Daigler (1997) and Parkinson (1980) to calculate the five-minute volatility of index and non-index on expiration days compared to non-expiration days.

Table 1 reports a cross-day average volatility of index (non-index) stocks and excess return (the MSCI return minus the non-MSCI return) in the last 10-minutes, the last 5-minutes, and the next open intervals of expiration days relative to non-expiration days. Estimators are positive and significant only in the last 5-minute interval. Results indicate that abnormal increased volatility of index stocks occurs in the last 5-minute interval and subsides during the overnight interval.

**Price reversal effect**

Stoll and Whaley (1987, 1990, 1997) suggest that if the unwinding activity creates an order imbalance, driving price from the normal level, the index price will reverse at the next opening when price pressure subsides. To assess the extent of price reversals, this subsection applies three measures proposed by Stoll and Whaley (1987): REV_p, REV^l_p and REV^r_p. If price reversals occur, the values of REV^p_p are positive. If price is continuous, the values of REV^p_p are negative.

Empirical results show a more significant magnitude and frequency of price reversals of index stocks during the last 5-minute interval on expiration periods, than those of non-index stocks. This result indicates that abnormal increased volume and large price volatility in the last five minutes at expiration will accompany price reversals.

**The influential factors to the expiration-day effects**

From the yearly result, this investigation finds that expiration-day effects are increasingly more significant after July 1, 2002 (after the settlement reform). Stoll and Whaley (1987, 1990) suggest that a unwinding index arbitrage positively relate to expiration effects. Therefore, this research considers the settlement reform and open interests as the basis in regressions. Results of this study show that open interests of futures are significantly positive.
to the two volume ratios. The coefficients of reform dummy are significantly positive to volume effects. These results indicate that unwinding index arbitrage behaviors improve expiration-day effects, but the reform fails to mitigate expiration-day effects.

**Conclusions**

This paper reports that MSCI-TW index stocks experience abnormally large volume, return volatility and price reversals during the last 5-minute trading interval on expiration days. The significantly positive relationship between futures open interests and volume effects (and price reversals) implies that the index arbitrage likely improve expiration-day effects. Furthermore, the regulatory change that switches to a closing call does not effectively reduce expiration-day effects. Our results call for a more effective means for mitigating expiration-day impacts.
Table 1. Mean volatility on expiration and non-expiration days

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<td>(2.00)</td>
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<td>(1.80)</td>
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<td>0.17</td>
<td>0.04</td>
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<td>0.18</td>
<td>0.14</td>
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<td>0.003</td>
<td>0.002</td>
<td>0.002</td>
<td>0.128</td>
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<td>(0.18)</td>
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<td>(1.51)</td>
<td>(0.46)</td>
<td>(-1.64)</td>
<td>(0.94)</td>
<td>(1.22)</td>
<td>(-0.55)</td>
<td>(-0.78)</td>
<td>(1.50)</td>
<td>(-0.84)</td>
<td>(1.87)</td>
<td>(-0.4)</td>
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</table>

Panel C: Excess volatility

| [R]   | 0.089  | 1.657 | 0.101| 0.079   | 1.312 | 0.659| 0.202   | 1.345 | -0.005| 0.204   | 1.419 | 0.293|
|       | (0.41) | (3.94)| (0.32)| (0.37)  | (2.88)| (2.15)| (1.00)  | (2.75)| (-0.02)| (0.98)  | (3.25)| (0.87)|
| (H-L)/C | 0.231  | 1.817 | 0.176| 0.452   | 1.779 | 0.657| 0.393   | 1.283 | -0.015| 0.350   | 1.543 | 0.325|
|       | (1.19) | (4.88)| (0.55)| (2.33)  | (4.61)| (2.29)| (2.17)  | (3.00)| (-0.05)| (1.76)  | (4.00)| (1.04)|
| Daigler| 0.076  | 0.228 | 0.033| 0.114   | 0.355 | 0.121| 0.082   | 0.121 | 0.043| 0.072   | 0.225 | 0.095|
|       | (1.41) | (3.23)| (0.35)| (2.43)  | (4.21)| (1.52)| (1.80)  | (1.42)| (0.54)| (1.54)  | (3.16)| (1.24)|
| Parkinson| 0.032 | 0.654| 0.064| 0.062   | 0.624 | 0.285| 0.080   | 0.455 | 0.056| 0.067   | 0.608 | 0.177|
|       | (0.56) | (3.98)| (0.43)| (1.21)  | (3.66)| (2.09)| (1.75)  | (2.18)| (0.39)| (1.35)  | (3.63)| (1.26)|

REFERENCES


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