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Do expirations of Hang Seng Index derivatives affect stock market volatility?

Nicolas P.B. Bollen [a], Robert E. Whaley [b,*]

[a] *David Eccles School of Business, University of Utah, UT 84112, USA*
[b] *The Fuqua School of Business, Duke University, Durham, NC 27708, USA*

Abstract

High volatility in the stock market is often attributed to index derivative expirations. Such has been the case in the US, Japan, Australia, and, most recently, Hong Kong. Investigations of the US, Japanese, and Australian markets, however, fail to establish a direct link. The empirical evidence indicates that, while trading volume is higher than normal on index futures and option expiration days, stock market volatility is no different. This paper examines price and volume data in days surrounding the expirations of the Hong Kong Futures Exchange's Hang Seng Index (HSI) derivative contracts and finds no evidence of increased stock market volatility. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

Stock index derivatives are one of the most important and successful innovations of modern-day financial markets. The markets for such products first appeared in the US in the early 1980s and quickly spread to the major financial centers of Europe and the Pacific Rim. The success of financial contract markets is

* Corresponding author.
E-mail address: whaley@mail.duke.edu (R.E. Whaley).

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usually measured by trading volume. For index derivatives, trading volume of index derivatives often exceeds the trading volume of underlying stocks. The average daily dollar trading volume for the Chicago Mercantile Exchange's S&P 500 futures contract, for example, was US$34 billion in 1998. In contrast, the average daily dollar trading volume for all stocks listed on the New York Stock Exchange combined was about US$29 billion. The primary reason for the popularity of stock index futures and option markets is that they provide a fast and inexpensive means of changing stock market exposures, both domestically and internationally.

Despite their success, derivatives in general, and index derivatives in particular, have their critics. A complaint commonly levied against index derivatives is that they may induce an abnormal level of trading activity in the stock market at expiration. In the early and mid 1980s in the US, for example, the ''triple witching hour'' (i.e., the last hour of trading on the third Friday of the quarterly month when index futures, index options, and equity options expire simultaneously) attracted considerable attention from exchanges, regulators, and the general public. Also, in Australia, the March 1996 expiration was quite controversial. According to press reports, large sales of stocks, apparently as part of an index arbitrage unwinding, occurred late in the day, causing the AOI index to fall by 21 points (about 1%) in the last half hour of trading. Recently, as reported by the *Asian Wall Street Journal* (November 17, 1997), the Hong Kong Futures Exchange has been disputing charges that the expiration of Hang Seng Index (HSI) futures and options contracts has increased volatility in the underlying stocks.

Whether recent stock market volatility is attributable to the expiration of index derivatives is difficult to assess. Many factors affect market volatility. Fig. 1 shows the index level and absolute daily returns for the HSI from January 1996 through December 1998. Clearly, stock market volatility (i.e., absolute daily

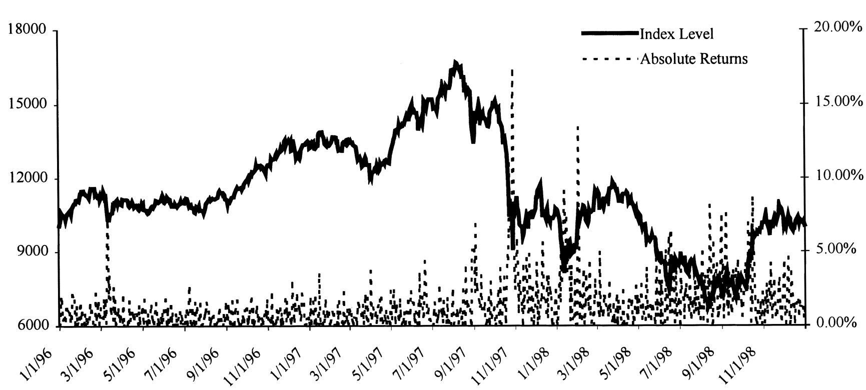

Fig. 1. Index level and absolute daily returns of the Hang Seng Index during the period January 1996 through December 1998.

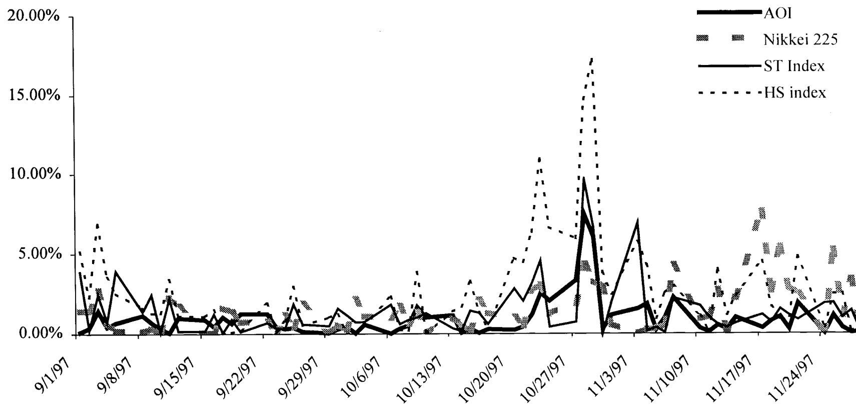

Fig. 2. Absolute daily returns of Australia's All Ordinaries Index, Japan's Nikkei 225 Index, Singapore's Straits Times Index, and Hong Kong's Hang Seng Index during the period September through November 1997.

returns) is greater in the latter half of the period than the first. Indeed, the latter half contains periodic spikes in daily absolute returns — the largest spike happened to occur in the days just before the expiration of the October 1997 HSI derivatives. Is this evidence of expiration-related activity or of some other unrelated sequence of events?

Circumstantial evidence can be brought to bear to help distinguish between the two possible explanations. Fig. 2 plots the absolute daily returns of the HSI over the three-month period, September 1997 through November 1997. In addition, the absolute daily returns for three other Pacific Basin stock indexes — Australia's All Ordinaries Share Price Index, Japan's Nikkei 225 Index, and Singapore's Straits Times Index — are also shown. Note that, when the HSI spiked on October 28th and 29th, 1997, all three other Pacific Basin indexes did also. Moreover, these simultaneous spikes followed directly on the heels of the mini-crash in the US on October 27th.[1] Since volatility spiked in several integrated markets simultaneously, it is unlikely that expiration of the October 1997 HSI derivatives were the cause of the stock market turbulence. This example illustrates the importance of careful interpretation of the evidence and provides the motivation for the formal statistical tests that follow.

Stock index expirations have been studied in the past. Widely known is a series of studies by Stoll and Whaley (1986, 1987, 1991) that examine expiration-day

[1] The US stock market volatility could not have been driven by index derivatives since all October 1997 index derivatives had expired earlier in the month.

effects of US index derivatives. Across all contract expirations since the inception of index futures, they find that the effects are remarkably consistent: index stock trading volume is abnormally high and observed price movements are small and within the bounds of transaction costs. Karolyi (1996) examines Nikkei 225 futures contract expirations, and, like Stoll and Whaley, concludes that the expiration of the Nikkei 225 futures induces abnormal trading volume but economically insignificant price effects. Stoll and Whaley (1997) find similar results for Australian All Ordinaries Share Price Index futures and option expirations.

Recent high volatility in the HSI has recharged the debate regarding the impact of index derivatives expirations on underlying stock volatility. The purpose of this study is to examine expiration-day effects of the HSI futures and options on the underlying index. Section 2 describes the HSI and its derivatives. Section 3 discusses the potential sources of expiration-day price effects, and Section 4 summarizes past research on expiration effects. Section 5 discusses our empirical methodology. Section 6 presents our empirical results. Section 7 summarizes the main conclusions.

2. Hang Seng Stock Index derivatives

The Hong Kong Futures Exchange's index futures market is among the most active and fastest growing worldwide. Table 1 shows the number of index futures contracts traded by country during the calendar years 1996 and 1997. Of the 25 countries reported in the table, Hong Kong ranks fifth in trading volume for 1997, up by over 41% from 1996. Of the 6,589,774 index contracts traded, the lion's share belongs to the HSI futures, which accounts for 6,446,696. The remainder belongs to the Red Chip Index futures, with 143,078 contracts traded.

Index options are also actively traded on the Hong Kong Futures Exchange. Table 2 shows that the HSI options are the second most active contracts on the exchange (next to the HSI futures), with over 1.1 million contracts traded during 1997. Options on the Red Chip Index are also traded but not nearly as actively.

The Hang Seng Stock Index underlies the Hong Kong Futures Exchange's index derivatives. The index is a value-weighted index of a portfolio of the Hong Kong Stock Exchange's largest stocks. The futures and options on the HSI have traded on the Hong Kong Futures Exchange since May 1986 and March 1993, respectively. Current contract specifications are provided in Table 3. The HSI futures and option contracts have a monthly expiration cycle and close trading on the penultimate business day of the contract month. The current minimum tick size is 1.0 index point. The value of the contract is 50 HKD times the underlying index.

All stock index futures are cash settled on the expiration day. Cash settlement eliminates the cost and difficulty of delivering all of the index stocks. The futures

Table 1
Trading volume of index futures contracts in 25 major markets during 1996 and 1997

Country	No. of contracts traded		Increase
	1996	1997	
US	22,174,804	25,775,363	16.2%
Brazil	15,312,524	15,250,600	−0.4%
Japan	11,774,232	12,046,444	2.3%
Germany	5,500,370	6,803,955	23.7%
Hong Kong	4,656,084	6,589,774	41.5%
France	5,853,172	6,461,308	10.4%
Spain	2,924,367	6,053,283	107.0%
Singapore	5,044,394	5,651,485	12.0%
South Africa	4,051,245	5,054,810	24.8%
Italy	2,675,238	4,463,034	66.8%
United Kingdom	3,661,112	3,766,648	2.9%
Korea	715,621	3,252,060	354.4%
Australia	2,675,754	3,204,266	19.8%
Netherlands	2,497,603	2,613,916	4.7%
Sweden	1,625,521	2,163,560	33.1%
Switzerland	1,720,053	1,810,698	5.3%
Hungary	136,920	1,208,388	782.6%
Austria	412,047	1,030,939	150.2%
Finland	478,310	887,175	85.5%
Belgium	326,542	551,044	68.8%
Malaysia	71,278	382,974	437.3%
Canada	163,787	336,725	105.6%
Denmark	303,856	252,571	−16.9%
Norway	36,366	135,284	272.0%
New Zealand	5686	3037	−46.6%

position is simply closed out at the settlement price determined by the rules of the exchange. Some futures exchanges use the closing trade prices of the index stocks.

Table 2
Trading volume of derivative contracts traded on the Hong Kong Futures Exchange during 1996 and 1997

Contract	Type	Commodity	No. of contracts traded	
			1996	1997
HSI	Futures	Equity	4,656,084	6,446,696
Red-Chip Index	Futures	Equity		143,078
Deutschemark Rolling Forex	Futures	Foreign	76,075	121,173
Japanese Yen Rolling Forex	Futures	Foreign	106,888	109,578
British Pound Rolling Forex	Futures	Foreign	12,392	20,475
Three Month HIBOR	Futures	Interest		87,819
All Futures on Individual Equities	Futures	Individual Equities		4453
HSI	Options	Equity Options	1,093,871	1,147,374
Red Chip Index	Options	Equity Options		1234

Table 3
Selected specifications of the HSI futures and option contracts traded on the Hong Kong Futures Exchange

Futures on the HSI	
Contract unit	HKD 50 times Hang Seng Stock Index
Minimum tick size	One index point
Contract expirations	Monthly, current and next calendar months, plus two from the March, June, September, December cycle
Last trading day	Penultimate business day of the contract month
Settlement price	The settlement price is an average of the quotations for the HSI taken at 5-minute intervals, rounded down to the nearest whole number, on the last trading day
Trading hours	9:45 AM–12:30 PM and 2:30 PM–4:15 PM
Put and call options on the HSI	
Contract unit	HKD 50 times Hang Seng Stock Index
Minimum tick size	One index point
Contract expirations	Monthly, current and next calendar months, plus two from the March, June, September, December cycle
Last trading day	Last business day of the contract month
Settlement price	The settlement price is an average of the quotations for the HSI taken at 5-minute intervals, rounded down to the nearest whole number, on the last trading day
Striking price	Set at intervals of 100 index points
Exercise	European
Trading hours	9:45 AM–12:30 PM and 2:30 PM–4:15 PM

Others use a special price determined using the opening trade prices. Yet others compute the settlement price based on the average prices of the individual stocks during some interval of time on the last trading day.

3. Source of expiration-day effects

The main source of concern regarding expiration-day effects of index derivatives arises from cash settlement. Stock index arbitrageurs carrying positions into expiration day must liquidate their index stocks at the same prices as those used in determining the cash-settlement value of the futures and options. For index derivatives with the settlement price based on the closing index level, an arbitrageur who is long the underlying stocks and short the index futures must sell the underlying stocks at their closing prices. As long as the stocks are sold at the same prices used in calculating the index level for cash settling the futures contract, the arbitrageur exits his position risklessly, independent of the level of the prices at which the stocks are sold. If many arbitrageurs liquidate positions at the same time, abnormal trading activity will occur. If the unwindings also tend to be in the same direction, abnormal stock market volatility may be observed.

The severity of price effects induced by index arbitrage unwinding on expiration day depends on the method for determining the index derivatives' settlement price as well as the depth of the stock market. Settlement prices for some index derivatives are based on the prices of the underlying index stocks at a single point in time during the expiration day. The Chicago Board Options Exchange's (CBOE's) S&P 100 index options and the Sydney Futures Exchange's (SFE's) AOI index futures and options, for example, have settlement prices based on the closing prices of the stocks in the underlying index. The Chicago Mercantile Exchange's (CME's) S&P 500 futures contract, on the other hand, has a settlement price based on the opening prices of the index stocks. By having the settlement price based on stock prices at a single point in time, the liquidation of index stocks must occur at a single point in time. This concentration of trading may or may not move stock prices, depending on the depth of the stock market as well as the ability of suppliers of liquidity to step in quickly when order imbalances occur.

Settlement prices for other index derivatives are average prices. The settlement price of the Hong Kong Futures Exchange's (HKFE's) HSI derivatives, for example, is computed by taking the average of 5-minute quotations of the HSI on the last day of trading. Using an average price implicitly encourages index arbitrageurs to liquidate their stock positions uniformly throughout the last day of trading,[2] thereby making their liquidation demand less concentrated and mitigating the market volatility induced by order imbalances.

4. Past evidence and its implications

Prior to June 1987, all US stock index futures and options cash-settled at closing index levels. Stoll and Whaley (1986, 1987) examine the expiration-day effects for this period and find abnormally high index stock trading volume and small stock price movements during the last hour of trading on quarterly expiration days when all index derivative contracts expire simultaneously. On non-quarterly expirations, fewer index contracts expire, and, consequently, trading volumes are not as high and price effects are smaller.[3]

Starting with the June 1987 expiration, the CME's S&P 500 futures contract began settling at an index value calculated from the opening prices of the component stocks, while the CBOE's S&P 100 index options continued to settle

[2] With average price settlement, the only way to eliminate basis risk and ensure that the derivative's settlement price equals the liquidation proceeds of the stock position is to liquidate the stock portfolio in a manner so as to mimic the settlement price computation.

[3] The S&P 500 futures contract, the most actively-traded index futures in the world, has only quarterly expirations.

at the close. Stoll and Whaley (1991) analyze the effect of this change in settlement procedure on index stock trading activity in the US.[4] At least three important results emerge. First, the trading activity of S&P 500 stocks in the last half-hour before the close on expiration days declined significantly — from an average of 20.8% of two-day volume on expiration days in the period before June 1987 to 9.4% of two-day volume after June 1987. Second, the trading activity of S&P 100 stocks in the last half-hour before the close on expiration days remained significantly higher than on non-expiration days after June 1987 — an average of 13.8% of two-day volume on expiration days versus 4.9% for non-expiration days. Third, the trading activity of S&P 500 stocks at the open on expiration days increased significantly — from an average of 8.5% of two-day volume on expiration days in the period before June 1987 to 26.3% of two-day volume after June 1987. Taken together, this evidence implies that (a) cash-settled index derivatives cause abnormal trading in the underlying stock market at the time of expiration, and (b) the degree of abnormal trading activity depends directly on the concentration (i.e., open interest) of index derivative positions outstanding.

Stoll and Whaley (1991) also measure price effects by the extent to which the S&P 500 index reverses after the expiration. In the period before June 1987, when all index derivatives expired at the close on Friday, the S&P 500 index reversed by an average of 0.364% from Friday's close to Monday's open on expiration days, significantly greater than the 0.074% for non-expiration days. A reversal is a price decline (increase) followed by a price increase (decline). The magnitude net difference in the reversals, 0.290%, is small when measured against trading costs. The minimum bid-ask spread for stocks at the time was US$0.125, which amounts to 0.357% of the typical stock price of US$35. Even when all index derivatives expired simultaneously at the close (the notorious ''triple-witching hour''), the price change or volatility effects appeared to be economically insignificant.

Switching the S&P 500 expiration to the open after June 1987 reduced the magnitude of the S&P 500 reversal at the close to 0.255% from 0.364%. Not surprisingly, it also introduced a reversal at the open on expiration day. Where prior to the change in procedure in June 1987 the reversal was 0.011% at the open on expiration days for the S&P 500 index stocks, the average reversal after June 1987 became 0.208%. Finally, even with the change in the settlement of the S&P 500 to the open, the S&P 100 index options continue to expire at the close. The average reversal of the S&P 100 index from Friday's close to Monday's open since June 1987 is 0.178%.

Expiration-day effects of index futures contracts in other countries have not been studied to the same degree as those in the United States. The only two exceptions are investigations of the Nikkei 225 index futures contract by Karolyi (1996) and the All Ordinaries Index derivatives by Stoll and Whaley (1997).

[4] See Stoll and Whaley (1991, p. 62, Table 2).

Applying methodology similar to that used by Stoll and Whaley (1991), Karolyi examines abnormal price and volume effects for Japanese stocks during the period May 1988 through November 1991. Consistent with earlier findings, Karolyi documents abnormally large trading volume at the point of expiration and small but economically insignificant price effects (reversals of about 0.20%). Stoll and Whaley (1997) find similar results for the SFE's AOI futures and options. Volume in the last half-hour of trading is 30.81% of the total daily volume on expiration days as compared with 21.07% on non-expiration days. No significant price effects on expiration days, however, have been observed.

In summary, past investigations of the US, Japanese, and Australian markets indicate that, independent of the market, the price effects surrounding derivatives expirations are not economically significant. The null hypothesis for our statistical tests of the Hong Kong markets, therefore, is that the HSI derivative expirations have no effect on the volatility of underlying stocks.

5. Measuring expiration-day effects for the HSI contracts

Following the lead of previous work, we assess expiration-day effects of index derivatives by focusing on abnormal trading volume and price movements. Abnormal trading volume is measured by deviations from the average daily growth rate in the number of shares traded on the stock exchange. If index arbitrage unwinding induces abnormally high trading volume, we should expect to see a significantly higher daily growth rate on expiration days than non-expiration days. Abnormal price movement is measured in two ways — by the degree to which index arbitrage unwinding drives stock prices away from their equilibrium levels and by the variance of stock returns on expiration days compared to non-expiration days. If large price changes are attributable only to unwinding activity, prices should rebound in the opposite direction after the futures contract has expired. Thus, we compare price reversals on expiration days to price reversals on non-expiration days. Along the same line, if index arbitrage unwinding produces large price changes, larger stock return variance should be observed on expiration days than on other days. Below we describe the data used in our analysis and our measurement procedures.

5.1. Data

This study analyzes the expiration-day effects of the 152 futures expirations during the period May 6, 1986 to December 31, 1998. The data used in this study were gathered from Datastream and include daily observations for the closing HSI level and the number of shares traded on the Hong Kong Stock Exchange. The number of days in the sample period is 3166. For the abnormal trading activity tests, growth rates are computed by taking the natural logarithm of the ratio of trading volume on successive trading days.[5] The index returns for the abnormal return variance tests are computed by taking the natural logarithm of the ratio of the closing index levels on successive trading days.

5.2. Changes in trading volume

The analysis of trading volume has two parts. First, we compute and report summary statistics for the daily growth rate in trading volume for expiration days versus for non-expiration days. Next, we estimate the mean and the variance of trading volume growth rate, allowing the mean growth rate to be different on expiration days than non-expiration days. The daily growth rate in trading volume is assumed to be normally distributed,

$$g_t \sim \mathrm{N}(\mu_1 + \mu_2 I_t, \sigma^2), \tag{1}$$

where I_t equals zero if t is a non-expiration day (week) and one otherwise. The parameter μ_1 (μ_2) is the expected (expected incremental) growth rate in trading volume on non-expiration days (expiration days), and σ^2 is the variance of the growth rate across all days in the sample period. All three parameters in Eq. (1) are estimated using a maximum likelihood procedure, thereby allowing us to conduct formal tests of significance using the distribution of the parameter estimates.

5.3. Index reversals

Volatility of stock returns on expiration days could reflect either new information or unwarranted volatility associated with the unwinding of index arbitrage positions. New information would cause permanent price changes in stocks, whereas unwarranted volatility would cause temporary price changes. Temporary price effects are measured by the degree to which the index level reverses after contract expiration. Unwinding of an arbitrage position requires purchases or sales of portfolios of stocks, which would generate a common reversal. To measure the systematic degree of reversal in the stock market, we adopt the measure used by Stoll and Whaley (1991):

$$\mathrm{REV}_t = \begin{cases} R_{t+1} & \text{if} \quad R_t < 0.0, \\ -R_{t+1} & \text{if} \quad R_t \geq 0.0, \end{cases} \tag{2}$$

where R_t is the index return on an expiration day and R_{t+1} is the index return on the day after an expiration day. The reversal is positive when the sign of the index

[5] Daily trading volume figures did not appear in Datastream for nine of the 3166 tradings days including one expiration day. The missing observations reduce the sample size of the trading volume tests to 3149.

return after expiration is the opposite sign of the index return the day of expiration, and the reversal is negative when the index level moves the day after expiration in the same direction as the day of expiration.

5.4. Variance of stock returns

The analysis of stock return variance has two parts. First, we compare the squared return of the HSI on expiration days to non-expiration days. Second, and more formally, we estimate the variance of returns on the HSI and include an indicator variable on expiration days. The coefficient on the indicator variable measures the difference in variance between expiration and non-expiration days.

Index returns are assumed to be normally distributed,

$$r_t \sim \mathrm{N}\left(\mu_1 + \mu_2 I_t, \sigma_1^2 + \sigma_2^2 I_t \right), \tag{3}$$

where I_t equals zero if t is a non-expiration day and one otherwise. The parameters μ_1 and σ_1^2 are the expected return and variance of return on non-expiration days, whereas μ_2 and σ_2^2 are the incremental expected return and variance on expiration days. All four parameters in Eq. (3) are estimated using a maximum likelihood procedure.

6. Empirical results

This section summarizes the results of our empirical investigations. The abnormal trading volume results are discussed first, followed by the evidence on daily price reversals and stock return variances.

6.1. Trading volume

The results of the abnormal trading volume investigations are reported in Tables 4 and 5. If the expiration of index derivatives affects trading in underlying stocks, we might expect to detect abnormal trading volume around expirations.

Table 4
Average daily growth rate of the trading volume (in number of shares) of the Hong Kong Stock Exchange during the period May 6, 1986 through December 31, 1998

	(A) Entire period (May 6, 1986–December 31, 1998)		(B) Recent subperiod (January 1, 1993–December 31, 1998)	
	No. of observations	Average growth rate	No. of observations	Average growth rate
All days	3149	0.123%	1484	0.067%
Expiration days	151	−1.080%	72	0.967%
Non-expiration days	2998	0.184%	1412	0.021%
Expiration weeks	759	−0.896%	360	−0.097%
Non-expiration weeks	2390	0.447%	1124	0.120%

Table 5
Maximum likelihood estimates of the mean and the variance of the growth rate of the trading volume (in number of shares) of the Hong Kong Stock Exchange during the period May 6, 1986 through December 31, 1998

	(A) Entire period (May 6, 1986–December 31, 1998)			(B) Recent subperiod (January 1, 1993–December 31, 1998)		
	μ_1	μ_2	σ^2	μ_1	μ_2	σ^2
All days						
$N(\mu_1, \sigma^2)$						
Estimate	0.123		720.354	0.067		669.310
t-statistics	0.258		15.742	0.100		10.394
p-value	0.797		0.000	0.920		0.000
Expiration days						
$N(\mu_1 + \mu_2 I_D, \sigma^2)$						
Estimate	0.184	−1.264	720.296	0.021	0.946	669.607
t-statistics	0.374	−0.604	15.740	0.031	0.329	10.388
p-value	0.709	0.546	0.000	0.975	0.742	0.000
No. of observations	3149			1484		
F-statistics	0.319			0.092		
p-value	0.956			1.000		
Expiration weeks						
$N(\mu_1 + \mu_2 I_W, \sigma^2)$						
Estimate	0.447	−1.343	720.121	0.120	−0.217	669.286
t-statistics	0.784	−1.318	15.736	0.149	−0.153	10.393
p-value	0.433	0.188	0.000	0.882	0.879	0.000
No. of observations	3149			1484		
F-statistics	1.443			0.020		
p-value	0.500			1.000		

Panel A of Table 4 shows the average daily growth rate in trading volume for the entire sample period. The average across all days is 0.123%, which corresponds to annual volume growth of over 36%. Surprisingly, the average daily growth rate is lower on expiration days, −1.080%, than on non-expiration days, 0.184%. The reduction in relative trading volume is insignificant in a statistical sense, however. Panel A of Table 5 reports the significance of the incremental mean growth rate for incremental days. The *t*-statistic is −0.604.

One possible explanation for this result is that index arbitrageurs unwind their positions prior to contract expiration. To see whether this is the case, we also compute average daily growth rate in trading volume in the five business days leading up to and including contract expiration (dubbed the ‘‘expiration week’’) and compare it to non-expiration weeks. At the bottom of Panel A in Table 4, the average daily growth rate in trading volume is reported to be −0.896% during expiration weeks and 0.447% during non-expiration weeks. The difference is statistically insignificant, as shown in Panel A of Table 5. Thus, for the entire sample period, stock market trading volume appears no different on expiration days/weeks than non-expiration days/weeks, contrary to the evidence reported for markets in the US, Japan, and Australia.

Another possible explanation for ''non-abnormal'' trading volume surrounding the expiration of the HSI derivatives is that active index arbitrage programs may be only a recent phenomenon. To test this proposition, we examined the average daily growth rate in trading volume during the recent sub-period, January 1, 1993 through December 31, 1998. The evidence is reported in Panel B of Tables 4 and 5. The average daily growth rate in trading volume is higher on expiration days than on non-expirations days, 0.967% versus 0.021%. The difference is not statistically significant, however. At the same time, the average daily growth rate in trading volume during expiration weeks is less than non-expiration weeks, −0.097% versus 0.120%. The difference is again insignificant. Thus, even for the more recent expirations, HSI futures and option contract expirations appear to have little effect on stock market trading volume.

6.2. Expiration-day reversals in the HSI

To assess whether there is a direct effect of the index expiration on stock prices, we examine whether the closing HSI levels on expiration days are only temporary deviations from equilibrium levels. If the movement of stock prices on expiration days is directly attributable to HIS contract expirations, prices should reverse on the day following. On the other hand, if the movement of stock prices on expiration days is related to new information about the stocks, no systematic reversals should be observed.

Using the REV measure of reversal described by Eq. (2), we computed the average reversal across all 152 HSI expiration days in the sample period May 6, 1986 to December 31, 1998. The results are reported in Table 6. The average reversal following the expiration day is −0.156% but is statistically insignificant. To test the robustness of this result, we computed the average reversal over the more recent sub-period, January 1, 1993 through December 31, 1998. The average

Table 6
Average reversals of the HSI on HIS futures and option expiration days during the period May 6, 1986 through December 31, 1998

	(A) Entire period (May 6, 1986–December 31, 1998)	(B) Recent subperiod (January 1, 1993–December 31, 1998)
No. of observations	152	72
Average reversal	−0.156%	−0.335%
t-statistic	1.259	1.567
p-value	0.210	0.122

reversal over this sub-period is −0.335% and is again statistically insignificant. This evidence suggests that the unwinding of index arbitrage positions had little, if any, effect on driving the HSI from its equilibrium level. In other words, there appears to be scant support for the conjecture that the HSI derivatives cause abnormal pressure on stock prices on expiration days.

6.3. Expiration-day volatility of the HSI

Table 7 shows the average daily return and the average daily squared return for the HSI. Like in the previous tables, Panel A contains the results for the entire sample period, and Panel B contains the results for the more recent sub-period. Interestingly, the average daily squared return, a common measure of stock market volatility, is lower on expiration days, 1.780%, than on non-expiration days, 3.593%. This same is true for the sub-period results reported in Panel B — the average daily squared return is 2.055% on expiration days and 3.841% on non-expiration days. The fact that the average daily squared return is lower on expiration days than non-expiration days is consistent with the evidence regarding trading volume. The expiration of the HSI derivatives appears to be a non-event from the underlying stock market's standpoint.

The expiration-week results are somewhat different. For the entire sample period, the average daily squared return is higher during the expiration week, 4.902%, than during non-expiration weeks, 3.065% For the more recent sub-period, on the other hand, the average daily squared returns are about the same — 3.741% during expiration weeks and 3.758% during non-expiration weeks. We now turn to investigating the daily and weekly volatility differences more formally.

The formal tests of significant differences in stock return variance on expiration days versus non-expiration days are based on maximum likelihood analysis. Table 8 contains the results. Again, the results for the entire sample period are reported in Panel A, and the sub-period results in Panel B. For the model that restricts the mean and the variance to be constant over the sample period, the mean is 0.054 and the variance is 3.503.

The model that allows the mean and variance to be different on expiration days than on non-expiration days shows that, while the mean is not different, the variance is. The incremental variance on expiration days is −1.832% and is statistically significant. Contrary to past results, the expiration of HSI derivative contracts is strongly associated with *reduced* stock market volatility.[6] An *F*-test

[6] The robustness of the test results was examined using a model that permitted time-varying return variance. Under the GARCH-based framework, the expiration-day variance was again found to be significantly less than non-expiration day variance.

Table 7
Average daily returns and daily squared returns of the Hang Seng Stock Index during the period May 6, 1986 through December 31, 1998

	(A) Entire period (May 6, 1986–December 31, 1998)			(B) Recent subperiod (January 1, 1993–December 31, 1998)		
	No. of observations	Average return rate	Average squared return rate	No. of observations	Average return rate	Average squared return rate
All days	3165	0.054%	3.506%	1484	0.041%	3.754%
Expiration days	152	−0.150%	1.780%	72	−0.157%	2.055%
Non-expiration days	3013	0.064%	3.593%	1412	0.052%	3.841%
Expiration weeks	760	0.022%	4.902%	360	0.115%	3.741%
Non-expiration weeks	2405	0.064%	3.065%	1124	0.018%	3.758%

Table 8
Variance estimates from maximum likelihood estimation for the Hang Seng Stock Index during the period May 6, 1986 through December 31, 1998

	(A) Entire period (May 6, 1986–December 31, 1998)				(B) Recent subperiod (January 1, 1993–December 31, 1998)			
	μ_1	μ_2	σ_1^2	σ_2^2	μ_1	μ_2	σ_1^2	σ_2^2
All days								
$N(\mu_1, \sigma_1^2)$								
Estimate	0.054		3.503		0.041		3.752	
t-statistic	1.611		6.002		0.823		11.024	
p-value	0.107		0.000		0.411		0.000	
Expiration days								
$N(\mu_1 + \mu_2 I_D, \sigma_1^2 + \sigma_2^2 I_D)$								
Estimate	0.064	−0.214	3.589	−1.832	0.052	−0.209	3.838	−1.807
t-statistic	1.850	−1.893	5.854	−2.523	0.988	−1.188	10.756	−3.258
p-value	0.064	0.058	0.000	0.012	0.323	0.235	0.000	0.001
No. of obs.	3165				1.484			
F-statistic	31.893				12.333			
p-value	0.031				0.078			
Expiration weeks								
$N(\mu_1 + \mu_2 I_W, \sigma_1^2 + \sigma_2^2 I_W)$								
Estimate	0.064	−0.042	3.061	1.840	0.018	0.097	3.758	−0.030
t-statistic	1.784	−0.476	9.896	0.821	0.308	0.830	12.497	−0.028
p-value	0.075	0.634	0.000	0.412	0.758	0.407	0.000	0.978
No. of observations	3.165				1484			
F-statistic	69.323				0.695			
p-value	0.014				0.762			

rejects the simpler model in favor of the model that allows mean and variance to change on expiration days.

The estimation results for the model that allows the mean and variance to be different on expiration weeks than on non-expiration weeks (reported in the bottom panel) shows that neither the mean nor the variance is significantly different on expiration weeks than on non-expiration weeks. The sign of the variance increment for the expiration-week indicator variable, however, is positive — opposite the expiration day results.

Panel B shows the results for the latter period, from January 1, 1993 to December 31, 1998. Once again stock return variance is significantly lower on expiration days than on non-expiration days. The indicator variable coefficient estimate is -1.807, with a t-statistic of -3.258. For expiration weeks, the indicator variable coefficient is negative and insignificant, and the F-test fails to reject the model with constant variance across expiration and non-expiration periods. In summary, the stock return variance results indicate that the expiration of the HSI contracts does *not* increase stock market volatility.

7. Conclusions

Recent high volatility in the HSI has recharged the debate regarding the impact of index derivatives expirations on underlying stock volatility. This study investigates whether the Hong Kong Futures Exchange's HSI derivatives induce abnormal trading volume and return volatility. The empirical results show that the HSI derivative expirations are largely a non-event in the stock market. Neither trading volume nor return variance is higher on expiration days/weeks than on non-expiration days/weeks. This evidence is consistent with that reported for other index derivatives markets internationally and lends further support to the notion that index derivatives, in general, are not disruptive to the underlying stock market.

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