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Market Structure and Return Volatility: Evidence from the Hong Kong Stock Market

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Abstract

There is no consensus about the cause for higher volatility at the market open than at the market close in the U.S. market. As an order-driven, nonspecialist market, the Hong Kong stock market provides a useful setting for an examination. If halt of trade were the major cause of higher open-to-open volatility, the open-to-open volatility in the Hong Kong market would be higher. However, this is not observed. The autocorrelation of the open-to-open return series also indicates that the temporary price deviation at the market opening is not significant. We view these findings as consistent with the specialist argument.

Keywords: interdaily return volatility, volume, Hong Kong stock market, market microstructure, cross trading

JEL Classifications: G10/G14

1. Introduction

Market architecture determines how orders are transformed into trades and how this transformation affects price discovery. Understanding the relation between

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market structure and price discovery is necessary for evaluating the impact of changes in market structure on transactional behavior and for guiding public policy on financial markets. Of main concern are issues such as how trading is affected by the institutional structure of the market, how such trading in turn affects prices, and how the market system's performance affects investors. Understanding these issues will enable stock exchanges to design market structures that reduce market inefficiency, price volatility, and transaction costs. A good example of such structures is the introduction of "circuit breakers" designed to suppress excessive volatility in the NYSE after the October Crash in 1987. A current example is the NYSE's plan of introducing an electronic trading system to reduce trading costs.

There is a large volume of literature that looks at the relation between market structure and trading costs. Christie and Schultz (1994, 1999) examine how market makers avoid odd-eighth quotes of Nasdaq stocks to make the bid-ask spreads greater than the minimum tick size. Hasbrouck and Schwartz (1988) find that execution costs, which increase the instability of share prices over short periods of time, appear to be larger for Nasdaq issues than for exchange issues. Ferguson and Mann (2001) examine the trading costs in the open outcry structure of the Chicago Mercantile Exchange. They find that market transparency and market-maker obligations are important determinants of intraday variation in trading costs. Locke and Sarkar (2001) examine the futures markets and find that trading costs do not increase with volatility changes, even though, for inactive contracts, market makers raise the bid-ask spreads significantly under temporary volatility increases.

This paper focuses on a particular impact of market structure on trading costs that was first examined by Amihud and Mendelson (1987). They showed that when NYSE stocks' daily returns are measured at the market open, their return volatility is significantly higher than that of the same measured at the market close. The result is interesting and important because both return series contain identical information. The volatility difference must be due to factors other than information. As the equilibrium price is driven by information, any price movement that is driven by non-information-based forces must be erroneous and transitory. Hence, higher opening volatility indicates a pricing error. Amihud and Mendelson suggest that the auction-opening mechanism in the NYSE is the source of this pricing error.

A series of studies has suggested other explanations. Stoll and Whaley (1990) focus on the monopoly power of the specialist. Later studies by Amihud and Mendelson (1991a, 1991b) argue that the long halt of trade prior to the open seems to be the factor. Foster and Viswanathan (1990, 1993) and Holden and Subrahmanyam (1992) suggest that the concentration of informed trading at the market open can lead to higher opening volatility due to the widening of the bid-ask spreads by market makers. Based on the model of Brock and Kleidon (1992), Forster and George (1996) show that the difference in order flow at the open and close is the reason for higher opening volatility.

Although the studies are many, the results are mixed, and hence no consensus has been reached as to the cause of the seemingly disparate volatility pattern at the open and the close. This paper will shed light on the issue by examining stocks traded on the Stock Exchange of Hong Kong (SEHK). The SEHK is different from most markets examined in the literature, as an important characteristic of the SEHK is that it is an order-driven system, not a specialist system. As such, it provides a relatively clean setting to delineate various possible determining factors. For instance, if a long halt of trade is the reason for larger pricing errors, then higher open-to-open volatility will be observed in the Hong Kong market. In contrast, if monopoly pricing is the reason for the difference in volatility, then there will *not* be any excessive volatility at the market open in Hong Kong. As most of the blue-chip stocks in Hong Kong are cross-traded in London, we contrast our results for these stocks with those of a control portfolio consisting of similar but non-cross-traded stocks. The aim is to ensure that the findings are robust. Chan, Fong, Kho, and Stulz (1996) have already shown that the intraday patterns between local U.S. stocks and dual-listed U.S. stocks are remarkably similar.

Our study shows that the opening volatility in the Hong Kong market is not particularly high. This is true for both cross-traded stocks and non-cross-traded stocks, as the SEHK is an order-driven system rather than a specialist system. We view this finding as supportive of the specialist argument put forth by Stoll and Whaley (1990). Furthermore, we find that for the non-cross-traded stocks, the trading volume at market close is particularly high, but the return volatility is not. Although this seems to contradict the findings of Forster and George (1996), we view it as strong evidence supporting the version of the specialist argument propounded by Brock and Kleidon (1992). Interestingly, for those stocks that are cross-traded on the London Stock Exchange (LSE), both the volatility and the trading volume at the close are substantially higher than at the open. We argue that this is due to London traders placing orders in Hong Kong before the LSE opens. Given the recent trend for exchanges to ally or merge with each other and to extend trading hours, we believe our findings can also shed light on the possible impacts of these changes.

This paper is organized as follows. Section 2 reviews previous studies. Section 3 explains the special institutional features of the Hong Kong stock market and proposes testable hypotheses pertaining to these features. Section 4 describes the data that is used for the empirical tests. Section 5 presents the empirical results and discusses their implications. Section 6 concludes the paper.

2. Previous studies

In an early study of the NYSE, Amihud and Mendelson (1987) show that open-to-open return volatility is higher than close-to-close volatility. They argue that this difference in volatility is due to the call auction at the open and the continuous trade at the close. As a large amount of information is likely to be accumulated overnight, the one-shot auction price at the open tends to deviate from the equilibrium price. In contrast, the price at the market close tends to be closer to the equilibrium price because information is incorporated in the market through continuous trading. In that case, the open-to-open return distribution has a higher dispersion than the close-to-close return distribution.

However, this argument could overlook another possible, halt-of-trade effect. The higher open-to-open return volatility could well be due to the large amount of "unprocessed" information that accumulates overnight before the market's open, rather than to the call auction opening procedure per se. Such is the argument put forth by Amihud and Mendelson (1991a), which is why they recommend a periodic market-clearing trading mechanism. A related but different argument is put forth by Foster and Viswanathan (1990, 1993) and Holden and Subrahmanyam (1992). Instead of focusing on the amount of unprocessed information, they focus on the amount of informed trading at the market open. They suggest that there is a concentration of informed trading at the open. The market makers have to increase the bid-ask spread to cover the information asymmetry cost, which causes higher opening volatility.

Gerety and Mulherin (1994) support the halt-of-trade explanation. They consider the evolution of daily return variance of the Dow Jones Composite Index through time. If an auction opening is responsible for higher open-to-open volatility, then a sudden drop in the interdaily variance after the open will be observed. Instead, they find that the decline is gradual and steady throughout the day. This implies that information is being assimilated and processed in a continuous manner. Hence, halt of trade is more likely to be the driving force behind the difference in volatility.

Stoll and Whaley (1990) focus instead on the role of specialists. They suggest that specialists can exploit their monopoly power at the open. Because specialists can observe the order imbalance and have information on who is trading before deciding the price to trade, they can set the price to earn monopoly profit. However, such monopoly pricing is not possible for the rest of the day because specialists must post bid and ask prices ex ante to incoming buy/sell orders. Moreover, floor traders can compete with specialists for the rest of the day to limit their monopoly power. When specialists exploit their monopoly power at the open and monopoly pricing deviates from competitive pricing, the open-to-open volatility will be higher. George and Hwang (1995) reexamine stocks traded on the Tokyo Stock Exchange and find that only those most actively traded exhibit higher open-to-open volatility than close-to-close volatility. Most of the other stocks in the sample show no difference, and some show higher close-to-close volatility. Chang, Fukuda, Rhee, and Takano (1993) study the TOPIX index of the Japanese market and find that the opening variance ratio (the ratio of open-to-open variance to close-to-close variance) is quite close to one. All of these studies suggest that the absence of specialists in the Tokyo Stock Exchange market could be the reason for the difference in volatility.

Several studies examine stocks that are cross-listed in different markets. Forster and George (1996) examine stocks that are cross-traded in London, Tokyo, and New York. They find that the foreign stocks that are traded on the NYSE do not show higher opening volatility on the NYSE. This is inconsistent with the auction-opening argument because these foreign stocks, like local stocks, are subject to the same opening procedures in the NYSE. U.S. stocks that are cross-listed in London show higher opening volatility in the NYSE. This is inconsistent with the halt-of-trade argument because, when the NYSE opens, stocks that are cross-listed in London are already trading on the LSE. They do not face any halt of trade and should not have higher volatility.

Forster and George (1996) also find that higher volatility at the open is associated with a higher trading volume. After controlling for this, volatility at the open and the close are statistically the same. They interpret their results as consistent with the model of Brock and Kleidon (1992) who suggest that trading needs are higher at both the market open and the market close. The higher trading need at the market open is due to the accumulation of information during the overnight non-trading period. The higher trading need at the market close is due to portfolio adjustments made in anticipation of a long period of inability to trade. Hence, the relatively inelastic demand for trade at the market open and close enables market makers to extract surplus. Consequently, higher trading volume is associated with larger pricing errors. Note that this argument is very similar to that of Stoll and Whaley (1990), that is, market specialists are the cause of higher volatility at the market open.

Using the same data set as Forster and George (1996), Chan, Fong, Kho, and Stulz (1996) examine the issue from a different angle by looking at the intraday patterns of volatility and trading volume. They find that U.S. stocks have lower opening volatility than London stocks that are also traded in the United States. As the LSE is still trading when the NYSE opens at 10:00 a.m., it is harder for the market specialists of the London stocks to extract their monopoly rent than it is for those specialists of the NYSE stocks. The opening volatility of the London stocks would be lower if the specialist argument for volatility is correct. Hence, Chan, Fong, Kho, and Stulz argue that their findings are inconsistent with the specialist argument but consistent with the trading models of Varian (1989) and Harris and Raviv (1993).[1] The major argument underlying the work of Chan, Fong, Kho, and Stulz is that investors trade on public information, and, as they do so, they prefer to trade stocks in their home market. Before the U.S. market opens, foreign stocks have already accumulated more public information than U.S. stocks because trading of foreign stocks has already started earlier on their respective exchanges. Hence, when the U.S. market opens, investors trade relatively more in the foreign stocks, as they need to adjust their priors according to the public information revealed in the foreign markets. This argument does signify the influence of public information on volatility; however, it is not necessarily inconsistent with the specialist argument. If investors prefer trading in their home markets, their demand for trading at the market open is still relatively inelastic. In fact, Chan, Fong, Kho, and Stulz do find that the trading volume at the

[1] Forster and George (1996) also view their results as consistent with these models.

U.S. market open is higher for foreign stocks than for U.S. stocks. Hence, there is still room for the market specialist to extract monopoly rent, provided that the rent is not higher than the direct and indirect costs of moving orders to the foreign markets. Therefore, the public information argument and the specialist argument need not be mutually exclusive in explaining stock return volatility.

Ferguson, Mann, and Schneck (1998) look at the effect of trading halts on intraday volume and volatility of currency futures market in Chicago when trading is introduced in Singapore. Changes are not found in trading patterns that are predicted by the market closure model when non-trading hours are significantly reduced.

3. Market structure of the SEHK

The SEHK has a market capitalization of over $400 billion and a daily trading volume of around $1 to $2 billion. Its size and importance have grown tremendously in recent years. Other than large Chinese enterprises such as Shanghai Petrochemical and China Telecom that have dual listing on the SEHK, seven large Nasdaq stocks—Dell, Amgen, Cisco, Intel, Applied Material, Starbucks, and Microsoft—are now also dual-traded on the SEHK. Moreover, the NYSE is negotiating with Hong Kong and eight other stock exchanges to form a global equity market.

The SEHK commissions a customized automated trading system, which is called the Automatic Order Matching and Execution System. The system is order-driven and does not require the services of specialists or market makers. Orders are placed and traded through the system, but the system also permits manual trading. Each security that is traded is assigned a spread that represents the permissible price increments at which it can be quoted and struck. There is no special opening procedure. The opening quotations that are posted by traders are governed by Rule 503 of the Exchange:

(i) where there has been no first ask price quoted on that day, the first bid price must be above or equal to the prior day's closing price minus four spreads;
(ii) where there has been no first bid price quoted on that day, the first ask price must be below orequal to the prior day's closing price plus four spreads.[2]

The opening quotation parameters are designed to ensure price continuity between trading days and to inhibit market swings at the open.[3] A continuous trade system runs throughout the trading day.

The setting of the Hong Kong stock market allows us to test the halt-of-trade argument against the specialist system argument. If information accumulation due to an overnight halt of trade is the driving force for higher return volatility at the open, then we will observe higher open-to-open volatility than close-to-close volatility in the Hong Kong market. Specifically, the ratio of the open-to-open return variance

[2] The spread table is given in Appendix A.

[3] Young and Chiang (1997, p. 106).

to the close-to-close return variance, defined as the variance ratio, will be greater than one. In contrast, if the monopoly pricing of the specialist is the reason for the higher open-to-open return volatility, then we will not observe any abnormality in the open-to-open volatility in the Hong Kong market because it is not a specialist system. The variance ratio of the open-to-open to close-to-close returns will be the same.

Stoll and Whaley (1990) provide another way to examine the issue. Greater volatility in open-to-open returns than close-to-close returns implies that the correlation between the daytime and the following overnight return exceeds the correlation between the overnight and the following daytime return. The reason for this discrepancy is that the variance ratio of the open volatility to the close volatility is governed by the following equation:

$$\frac{\mathrm{var}(R_{\text{o-o},t})}{\mathrm{var}(R_{\text{c-c},t})} = \frac{\mathrm{var}(R_{d,t-1}) + \mathrm{var}(R_{n,t}) + 2\mathrm{cov}(R_{d,t-1}, R_{n,t})}{\mathrm{var}(R_{d,t}) + \mathrm{var}(R_{n,t}) + 2\mathrm{cov}(R_{n,t}, R_{d,t})} \tag{1}$$

where $R_{\text{o-o}}$ and $R_{\text{c-c}}$ are open-to-open and close-to-close returns respectively, and $R_{d,t-1}$, $R_{n,t}$, and $R_{d,t}$ are the previous daytime return, overnight return, and the following daytime return, respectively. In a long time series, $\mathrm{var}(R_{d,t-1}) = \mathrm{var}(R_{d,t})$, which implies that the difference in the variance ratio comes only from the difference in the two covariance terms. Hence, a variance ratio greater than one implies that the correlation between the daytime and following nighttime returns must be larger than that between the nighttime return and the following daytime return; that is, $\mathrm{corr}(R_{d,t-1}, R_{n,t}) > \mathrm{corr}(R_{n,t}, R_{d,t})$. In fact, Stoll and Whaley (1990) find that $\mathrm{corr}(R_{d,t-1}, R_{n,t})$ is significantly positive and $\mathrm{corr}(R_{n,t}, R_{d,t})$ is significantly negative. The daytime return tends to continue in the night return, but the overnight return tends to be reversed by the following daytime return. As they point out, this is an indication of a price continuation after the close and a temporary price deviation at the opening.

The temporary price dispersion at the market open also implies that the open-to-open return series exhibits more negative autocorrelation than the close-to-close return series. Interestingly, Amihud and Mendelson (1991b) obtain similar results from the Japanese market, even though that market is not a specialist system. They do not posit any explanation for this, but instead suggest that temporary price deviations generate negative serial correlation, which could be due to monopoly pricing or a long halt of trade.

As there is no specialist system in Hong Kong and there is continuous trading from the market open to the market close, there are no large price deviations at the open to cause later price reversals. Under the specialist hypothesis, the open-to-open return series will not exhibit strong, negative autocorrelation.[4] On the other hand, if the long halt of trade causes opening prices to be more dispersed, then price reversals will occur. This means that the open-to-open return series will exhibit strong, negative

[4] Under the specialist hypothesis, nonetheless, an individual stock return would still exhibit a mild degree of negative serial correlation due to the bid-ask bounce. See Lo and MacKinlay (1990).

autocorrelation, but the close-to-close return series will not. The testable implications of the two hypotheses are as follows:

Null and Alternative Hypothesis	Halt of Trade	Specialist
H_o: VR = 1 H_A: VR > 1	Reject null in favor of alternative	Do not reject null
H_o:, $\rho_{o\text{-}o} = 0$ H_A:, $\rho_{c\text{-}c} < 0$	Reject null in favor of alternative	Do not reject null
H_o: $\rho_{o\text{-}o} = \rho_{c\text{-}c}$ H_A: $\rho_{o\text{-}o} < \rho_{c\text{-}c}$	Reject null in favor of alternative	Do not reject null

where VR is the variance ration, $\rho_{o\text{-}o}$ is the autocorrelation of the open-to-open return series, and $\rho_{c\text{-}c}$ is the autocorrelation of the close-to-close return series.

4. Data

We use tick-by-tick data on two sets of stocks that are listed in the SEHK from the Bridge Information System. The first set consists of 28 Hang Seng Index component stocks, which are the major blue-chip stocks that occupy over 60% of the total market capitalization. The fact that they are also cross-traded on the LSE necessitates our use of a control set of "purely" local stocks. We pick 28 stocks based on comparable liquidity.[5] The period is from December 1994 to February 1996. Considering that the SEHK extended its afternoon trading session from 15:45 p.m. to 15:55 p.m. on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

Our major focus is on the interdaily return series. They are computed through time as indicated in Figure 1.
Of any two consecutive trading days, Day $t-1$ and Day t, the opening prices of a stock at 10:00 on Day $t-1$ and at 10:00 on Day t are used to compute the first interdaily return series. This is the open-to-open return series at 10:00. Similarly, the prices of the stock at 10:05 on Day $t-1$ and at 10:05 on Day t form the second interdaily return series, which is at 10:05. As such, there is a total of 12 daily return series in a trading hour and 47 return series for the whole day when the market opens at 10:00 and closes at 15:55. The variances of these return series are computed for each of the 56 stocks. The cross-sectional medians of the return variances for the 28 cross-traded stocks give one set of 47 "average" interdaily return volatilities for this group. The same procedure is applied to the 28 non-cross-traded stocks to obtain another set of "average" interdaily volatilities.

[5] Ideally, we should have stocks of comparable market capitalization to form the control set. But given that the index component stocks are typically the largest, there is simply no one firm whose size is comparable to these cross-traded, index component stocks. See Appendix B for the list.

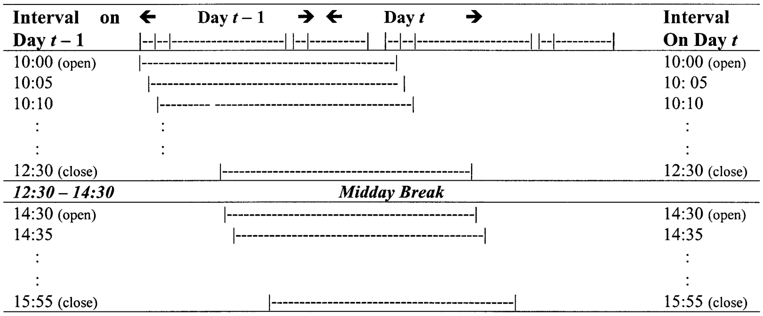


Figure 1

The construction of inter-daily return series

Note: The interdaily-return series are daily return series constructed at every 5-minute interval throughout the trading time of a day from 10:00 opening to 15:55 closing. Since there are 12 daily return series in a trading hour, there are totally 47 inter-daily return series so constructed in the sample.

5. Empirical results

Before the analysis, let us consider some descriptive statistics of the samples over the two periods to ascertain how closely they match.

Panel A of Table 1 gives the data for cross-traded stocks in the two sample periods, and Panel B gives the corresponding data for non-cross-traded stocks. The cross-traded stocks are much larger than the non-cross-traded stocks in terms of market size—on average, the former are ten times larger. Their stock prices are also five times higher than the prices of non-cross-traded stocks. Moreover, these index component stocks generally have lower mean returns, lower volatility, and lower trading volumes. In the cross-traded stocks, \$150,000 worth of shares changes hands per day on average during the first sample period, and \$390,000 worth of shares changes hands per day on average during the second sample period. Non-cross-traded stocks have higher trading volumes, especially during the second period. However, in terms of the number of quotes posted and the number of trades per day, the cross-traded stocks dominate. The two groups of stocks are not comparable in firm size, but both are liquid during the sample period.

5.1. Variance of stock returns

The median return volatility for the 28 cross-traded stocks (denoted as HSI) and the 28 non-cross-traded stocks (denoted as NHSI) are plotted across time in Figure 2. Panel A is for the first sample period, during which time the market closes at 15:45, and Panel B is for the second sample period, during which time the market closes at 15:55.

For the non-cross-traded NHSI stocks, the open-to-open and close-to-close volatilities tend to be similar. For the first sample period, the median open-to-open

Table 1

Statistical description of trading activity of sample firms

The table shows several descriptive statistics of interest. Other than the market capitalization and price, which are for the whole sample period, the other statistics are captured on a daily basis. For instance, "Max" of return, volatility, volume, and number of bid and ask quotes refers to the maximum daily return, maximum daily volatility, maximum daily volume, and maximum number of daily bid and ask quotes, respectively, during the sample period. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

Panel A: 28 firms cross-traded in London from December 1994 to February 1996

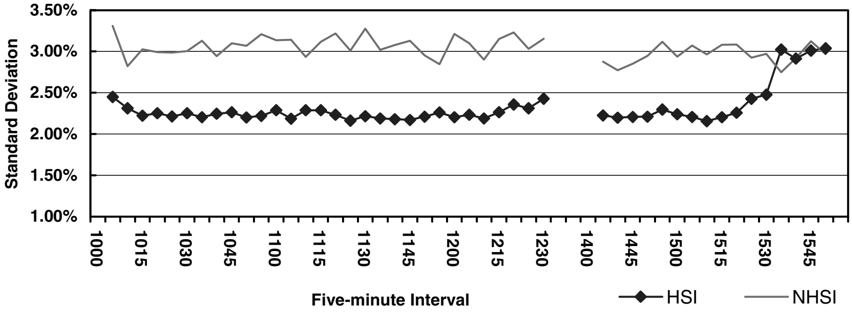
	Before Sept. 1995				After Sept. 1995			
	Max	Mean	Median	Min.	Max	Mean	Median	Min.
Market Cap. (in HK$B)	183.31	51.84	31.84	4.65	220.05	64.01	37.96	4.98
Price	108.00	24.55	18.09	2.93	128.50	29.34	23.53	2.28
Return	0.1720	0.0002	0.0001	−0.1295	0.1091	0.0018	0.0007	−0.1656
Volatility	0.0358	0.0284	0.0278	0.0224	0.0298	0.0215	0.0236	0.0191
Volume	150,914.00	31,679.43	24,108.50	2,015.00	378,742.00	39,122.81	26,304.50	1,797.00
No. of Bid Quotes	9,114.00	1,108.62	714.50	32.00	26,174.00	1,645.73	748.00	31.00
No. of Ask Quotes	16,821.00	1,275.34	664.00	30.00	19,275.00	2,097.02	963.50	29.00
No. of Trades	315	127.561	125.5	17	303	126.6726	124	18

Panel B: 28 firms not cross-traded in London from December 1994 to February 1996

	Before Sept. 1995				After Sept. 1995			
	Max	Mean	Median	Min.	Max	Mean	Median	Min.
Market Cap. (in $B)	15.98	5.89	4.72	0.21	26.64	7.18	6.47	0.21
Price	53.00	5.47	1.60	0.07	55.50	6.14	1.90	0.08
Return	0.2273	0.0004	−0.0002	−0.3084	0.2000	0.0012	0.0000	−0.1360
Volatility	0.0427	0.0296	0.0292	0.0146	0.0466	0.0297	0.0299	0.0192
Volume	238,676.00	34,263.79	24,931.50	215.00	946,081.00	50,206.35	27,255.50	515.00
No. of Bid Quotes	1,314.00	276.55	202.50	6.00	1,996.00	364.50	224.50	18.00
No. of Ask Quotes	1,352.00	285.58	179.50	5.00	2,383.00	395.95	235.50	15.00
No. of Trades	192.00	56.11	50.00	5.00	184.00	57.48	50.50	9.00

volatility is 3.31%, whereas the median close-to-close volatility is 3.12%. For the second sample period, the corresponding figures are 3.11% and 3.08%, respectively. To ascertain the statistical significance, we follow Forster and George (1996) and use the Mann-Whitney nonparametric test, as there is no formal distribution theory for variances that are constructed using overlapping returns. For the first sample, the test statistic is 0.77, which gives a p-value of 0.44. For the second sample, the test statistic is 0.47, which gives a p-value of 0.63. Hence, the open-to-open volatility is

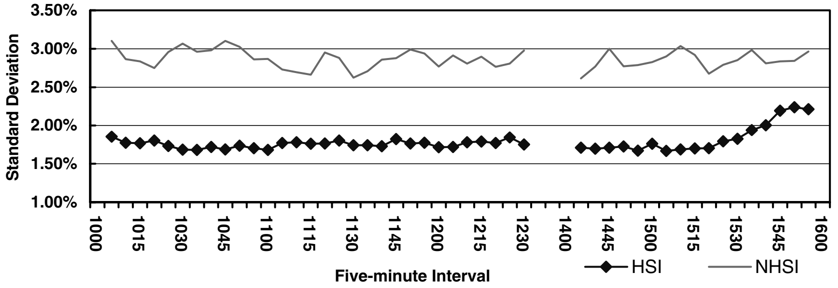
Panel A: First sample period (December 1994 to August 1995)



The Wilcoxon/Mann-Whitney test for equality of open-to-open and close-to-close return volatilities:

Stock Type	Value	Probability
HSI stocks	1.8271	0.0677
NHSI stocks	0.7726	0.4398

Panel B: Second sample period (September 1995 to February 1996



The Wilcoxon/Mann-Whitney test for equality of open-to-open and close-to-close return volatilities:

Stock Type	Value	Probability
HSI stocks	3.1053	0.0019
NHSI stocks	0.4711	0.6376

Figure 2

Interdaily return volatility on the SEHK

Note: HSI refers to the Hang Seng Index constituent stocks, which are cross-traded on the LSE. NHSI refers to the non-Index constituent stocks, which are only traded on the SEHK. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

the same as the close-to-close volatility in both sample periods.[6] This clearly suggests that the accumulation of information during a long overnight halt of trade alone does not necessarily cause higher volatility at the market open. Specialists seem to play a role here.[7]

However, Choe and Shin (1993) study the Korean market and find that interdaily volatility is not only higher in the morning open, but also in the afternoon open after the one-and-a-half hour midday break. The reason for this is not clear. First, there is also a midday break in the Japanese market, but Amihud and Mendelson (1991b) find that the afternoon open volatility is not particularly high. Second, the morning close volatility in the Korean market is high. Hence, the high afternoon open volatility could simply be a continuation of the already high volatility in the morning close. In fact, from the Choe and Shin (1993) figure, it can be seen that the morning close-to-close volatility is the same as the afternoon open-to-open volatility. The SEHK has a two-hour break from 12:30 p.m. to 2:30 p.m. The plot, however, does not show that the midday halt of trade leads to unusual afternoon open-to-open volatility.

One interesting finding is that the close-to-close volatility is significantly higher than the open-to-open volatility for the cross-traded HSI stocks in both sample periods. The Mann-Whitney statistic is 1.82 (which gives a p-value of 6.77%) in the first sample period and 3.10 (which gives a p-value of 0.19%) in the second sample period. This is in sharp contrast to findings in other markets. Forster and George (1996) suggest that the higher volatility of NYSE stocks at the market open is due to a higher trading volume at that time. Therefore, the higher volatility of the HSI component stocks at the market close could also be driven by a higher trading volume during this period. To consider this possibility, we now examine the trading volume.

5.2. Volume of trade

For each stock, we first calculate the trading volume in each five-minute interval throughout the trading period. The volume figures are then divided by the total trading volume of the stock on that day. This volume ratio (as denoted by "percent volume") is then averaged across stocks for each five-minute interval. The volume ratio represents the distribution of trades during the trading period. The time-series plot is shown in Figure 3.

It is surprising to see that the trading volume increases dramatically in the last 20 minutes for both the NHSI and the HSI stocks. The trading volume of the opening

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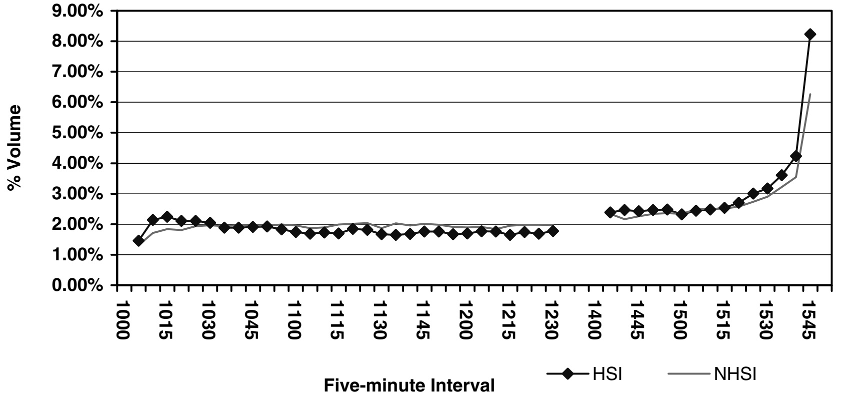
[6] Appendix A presents the spread table of the SEHK. In Hong Kong, the tick size increases with the stock price. Although they are not strictly proportional, we do not believe that this will affect greatly the variance comparison.

[7] If there is no specialist charging a monopoly rent, as in the case of Hong Kong, then the opening volatility is not higher. In fact, Chang, Fukuda, Rhee, and Takano (1993) study the Japanese market using the TOPIX market index and find the opening variance ratio quite close to one. George and Hwang (1995) analyze Tokyo Stock Exchange stocks and find that the variance ratios are either no different from, or less than, unity for most of the stocks.

Panel A: First sample period (December 1994 to August 1995)



Panel B: Second sample period (September 1995 to February 1996)

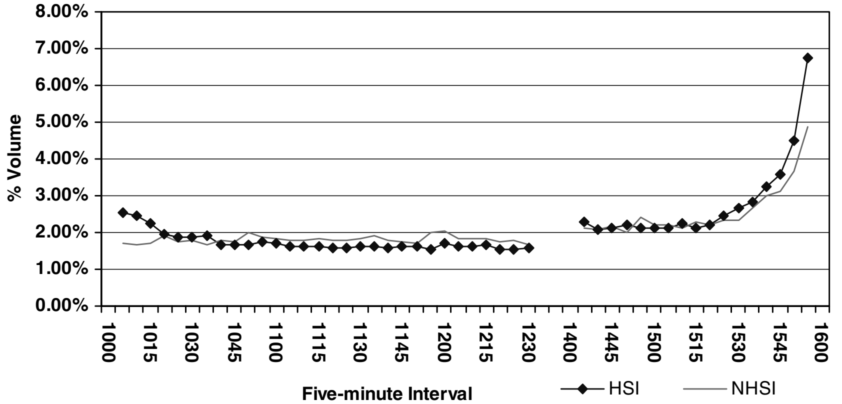


Figure 3

Trading volume on the SEHK

Note: "% volume" is the ratio of the trading volume of five-minute intervals to the total trading volume of the day. HSI refers to the Hang Seng Index constituent stocks, which are cross-traded on the LSE. NHSI refers to the non-Index constituent stocks, which are only traded on the SEHK. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

and closing 20 minutes takes up around 2% and 7%, respectively, of the total daily trading volume.[8] In fact, the trading volume starts to increase in the afternoon trading session and shoots up quickly in the last 10 to 20 minutes before the market close. This is the case in both sample periods.

[8] Interestingly, it is almost the opposite in the U.S. market. Forster and George (1996) report the mean open-to-total daily volume for U.S. stocks is 6.6% and the mean close-to-total daily volume is 2.1%.

We further look at the frequency of transactions. Jones, Kaul, and Lipson (1994) demonstrate that the positive volatility–volume relation actually reflects the positive relation between volatility and the number of transactions. They find that volatility is related to the number of transactions, not the trade size per se. Hence, if Forster and George (1996) are correct, then we will also observe high trading frequency near the market close.

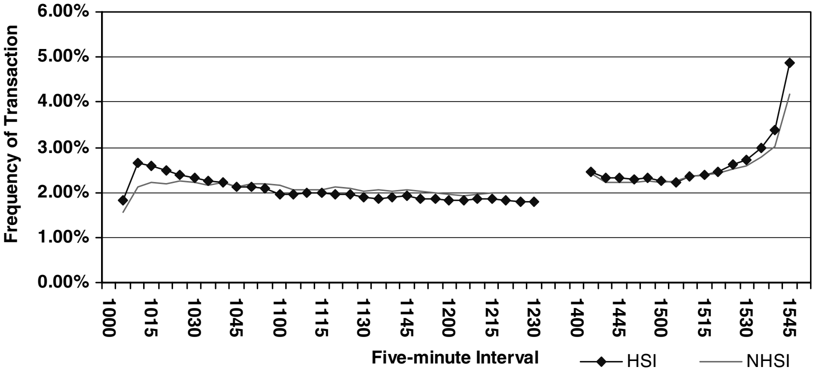
To investigate the relation between volatility and the number of transactions, we construct a transaction measure similar to the "percent volume" measure. The "percent transaction" measure of a stock is the number of transactions within each five-minute interval divided by the total number of transactions of the stock on that day. Figure 4 plots the cross-sectional averages of the "percent transaction" across time.

The patterns are quite similar to those of the trading volume. The activities are higher in the afternoon and shoot up near the market close. That is, a higher trading volume is accompanied by a higher number of transactions.

The observations so far seem to be consistent with the argument of Forster and George (1996) that higher volatility is associated with a higher trading volume. However, if we focus on the NHSI stocks traded only in Hong Kong, the situation is more complicated. The trading volume and the frequency of transactions for these stocks are higher at the market close, but their return volatility is not. This clearly indicates that trading volume itself is not the driving force. According to Brock and Kleidon (1992), the driving force is the market specialist. A higher trading volume at the market open (and at the market close) reflects a higher demand for liquidity during the period. This allows the opportunity for the monopoly specialist to price discriminate against the traders, which leads to higher pricing errors. As the Hong Kong stock market has no specialist system, higher trading volumes need not bring forth higher pricing errors and higher volatility. This suggests that the behavior of the NHSI stocks is consistent with the specialist argument put forth by Brock and Kleidon (1992), Stoll and Whaley (1990), and Stoll and Whaley (1990), and Forster and George (1996).

However, the behavior of the HSI stocks is unusual. A possible explanation stems from the cross-trading of these stocks in London. Although there is no overlapping in the trading time of the SEHK and the LSE, a considerable flow of London orders is usually placed in Hong Kong. Many London market makers claim that a substantial portion of the London volume is in fact Hong Kong volume by London traders. The reason is that London dealers need to report trade to the LSE irrespective of where their transactions actually take place. According to a study by the Hong Kong Securities and Futures Commission, approximately 14% of the reported London volume is Hong Kong volume by London traders (Securities & Futures Commission, 1997, p. 15). Only 0.28% of the daily volume occurs in the morning trading session of the SEHK, and 1.45% occurs in the afternoon before 3:00 p.m. There is then a big jump of 11% in trading volume from 3:00 p.m. to 4:00 p.m., and then the

Panel A: First sample period (December 1994 to August 1995)



Panel B: Second sample period (September 1995 to February 1996)

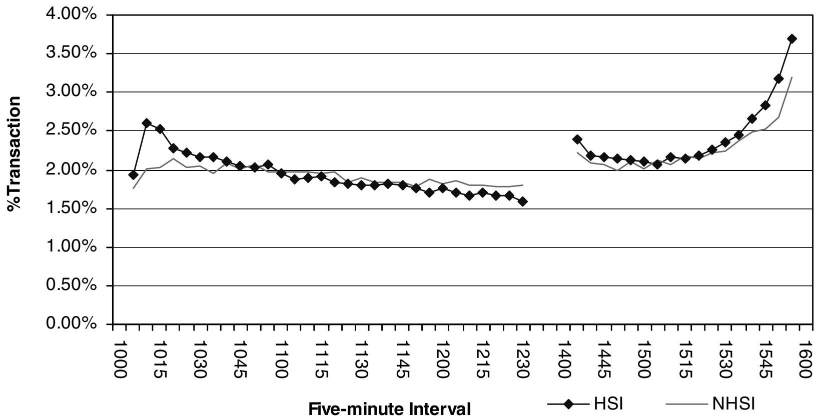


Figure 4

Frequency of transactions (in percentage)

Note: "% transaction" is the ratio of the number of transactions within each five-minute interval to the total number of transactions of the day. HSI refers to the Hang Seng Index constituent stocks, which are cross-traded on the LSE. NHSI refers to the non-Index constituent stocks, which are only traded on the SEHK. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

Hong Kong market closes. When the London market opens at 4:30 p.m., the trading volume is 12%.[9]

To help visualize such linkage, we superimpose Figure 4 of the Hong Kong Securities and Futures Commission study, which is the distribution of the LSE trading

[9] We reproduce the Securities & Futures Commission Figure 3 in Appendix C.

volume on SEHK-listed stocks, on our previous Figure 3.[10] However, such imposition needs some adjustments. Specifically, we convert the time scale of the trading volume in Figure 3 from a 15-minute interval to an hourly interval. The relative trading volume hence becomes an hourly trading volume relative to the daily trading volume of the SEHK. We then combine the two sample periods in Panels A and B of Figure 3 to obtain a similar time span as the Hong Kong Securities and Futures Commission's graph.[11] However, no conversion is made to the time interval of the return standard deviation, which remains as a five-minute return standard deviation.

The graph clearly shows that the trading volume in Hong Kong starts to build up in the afternoon, presumably in part due to the orders from London. These London orders intensify in the last 10 to 20 minutes before the Hong Kong market closes. The intensity of trading remains when the London market opens. This indicates that London traders start trading SEHK-listed stocks in Hong Kong even before the London market opens. In other words, the London market for SEHK-listed stocks effectively opens before the close of the Hong Kong market. The higher volatility of the HSI stocks at the Hong Kong market close is partly driven by the London institutional traders.

There is a recent trend for exchanges to ally with each other to forge round-the-clock trading links.[12] Yet, there are very few studies on the implications and possible impacts. Arnold, Hersch, Mulherin, and Netter (1999) studied the mergers of regional stock exchanges in the United States and found that the merger attracted market share and resulted in narrower bid-ask spreads. They viewed this as a result of competition for order flow with NYSE. A study more related to ours is by Tse (1999), who examines the London International Financial Futures and Options Exchange and the

[10] We thank the referee for suggesting this to us.

[11] Notice that their sample spans from January 1995 to March 1996 and our Figure 2 spans from December 1994 to February 1996. There is a one-month lag difference and hence the combined graph serves an illustration purpose only.

[12] The Nasdaq merged with the American Stock Exchange in 1998. It also planned to launch a new market called Nasdaq iX in 2001, which would give European investors the chance to trade high-growth technology companies based in both Europe and the United States. The Frankfurt stock exchange extended its trading time by two-and-a-half hours in June 2000 before it merged with the LSE later that year (*New York Times*, May 4, 2000, C8). In Europe, the Amsterdam, Brussels, and Paris bourses announced in April 2000 their joining forces to form Euronext. The Luxembourg exchange is likely to join in later (*Corporate Finance*, April 2000, p. 9). Europe's hi-tech stock market alliance—the EURO.NM network—links up the Nuovo Mercato of Italy, the Neuer Markt of Frankfurt, the Nouveau Marche of Paris, NMAX of Amsterdam, and Euro.NM in Belgium. There is a widely held belief that eventually there will be a pan-European alliance (*Corporate Finance*, May 2000, pp. 4–6). On the other hand, Nasdaq is expected to launch the European section that joins with the Neuer Markt and the London's techMARK to form the Nasdaq iX (*Euroweek*, May 5, 2000, p. 1). Even in the Far East, the Australian exchange has begun talks with counterparts in Singapore and Hong Kong.

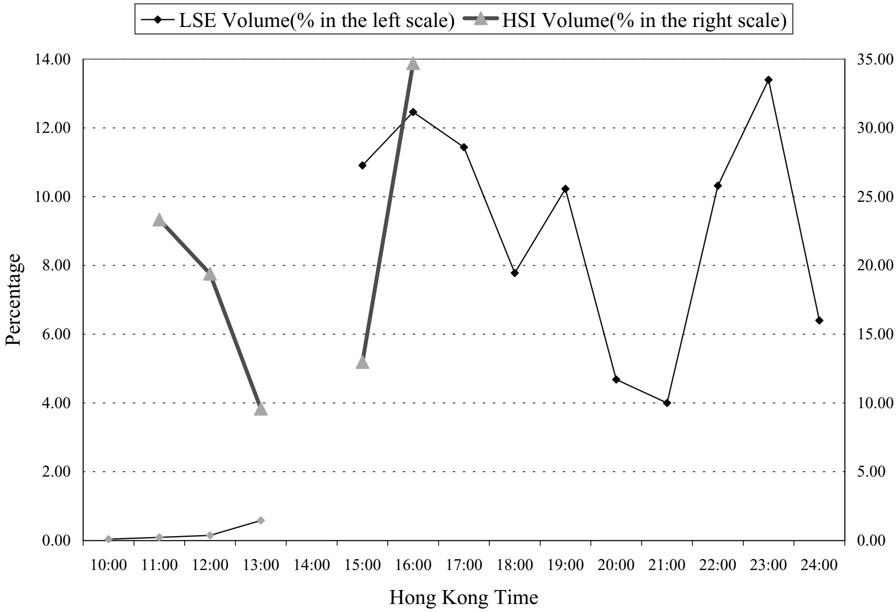


Figure 5

Comparison of trading volume in SEHK and LSE (1995–1996)

Note: The left-hand Y-axis represents the average trading volume of the Hang Seng Index, HSI constituent stocks relative to the daily trading volume of the LSE. The right-hand Y-axis represents the average trading volume of the HSI constituent stocks relative to the daily trading volume of the SEHK. During our sample period, SEHK opens at 10:00 and closes at 15:55, whereas LSE opens at 16:30 closes at 24:30, all in Hong Kong time. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

Tokyo Stock Exchange Japanese government bond futures. His results suggest home bias in international investments. Specifically, at the London International Financial Futures and Options Exchange open, London investors rush to rebalance portfolios instead of doing so at the Tokyo Stock Exchange close, which is only one hour before the London International Financial Futures and Options Exchange opens. Our results suggest a different picture. London institutional traders do not exhibit home bias and trade in Hong Kong before LSE opens.

5.3. Panel-data analysis on volatility and volume of trade

To confirm our assertions that a higher trading volume at the market close affects only HSI stocks and not NHSI stocks, we perform a panel-data analysis on the following equation:

Table 2

Relation between variance ratio and volume ratio

The feasible generalized least squares method is used for estimating the following panel-data model:

$$\ln\left(\frac{\mathrm{OVAR_{it}}}{\mathrm{CVAR_{it}}}\right) = \alpha_0 + \alpha_1 \times \mathrm{HS} + \beta_1 \ln\left(\frac{\mathrm{OVOL_{it}}}{\mathrm{CVOL_{it}}}\right) + \delta_1 \times \mathrm{HS} \times \ln\left(\frac{\mathrm{OVOL_{it}}}{\mathrm{CVOL_{it}}}\right) + \beta_2 \ln(\mathrm{TVOL_{it}}) + \delta_2 \times \mathrm{HS} \times \ln(\mathrm{TVOL_{it}}) + \varepsilon_{\mathrm{it}}$$

where OVAR and CVAR are respectively the variance of open-to-open and close-to-close squared returns, OVOL and CVOL are respectively the daily open and close volume, and TVOL is the total daily volume for each stock. HS is a dummy variable with a value of one when stock *i* is a Hang Seng component stock and zero otherwise. Heteroskedasticity across panels has been corrected according to the White (1980) heteroskedasticity consistent estimate of the covariance matrix. Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point. *T*-statistics are in parentheses.

Panel A: December 28, 1994 to August 31, 1995[a]					
α_0	α_1	β_1	β_2	δ_1	δ_2
0.1882**	−0.0312**	0.0732	0.1621	0.2264**	0.2643
(0.1012)	(0.0164)	(0.0648)	(0.4011)	(0.1073)	(0.3722)
Panel B: September 1, 1995 to February 29, 1996[b]					
α_0	α_1	β_1	β_2	δ_1	δ_2
0.04671	−0.0447**	0.1415*	−0.1194	0.1887*	0.01643
(0.0366)	(0.0243)	(0.0843)	(0.0871)	(0.1124)	(0.2147)

[a] There are 28 Hang Seng component stocks and 16 non-Hang Seng component stocks. The total number of observations during the period is 3,696. $\chi^2(1)$-statistic = 6.21 and Pr > $\chi^2(1) = 0.0000$.

[b] There are 28 Hang Seng component stocks and 16 non-Hang Seng component stocks. The total number of observations during the period is 2,948. $\chi^2(1)$-statistic = 8.13 and Pr > $\chi^2(1) = 0.0000$.

** More than two standard errors away from zero.

* More than one standard error away from zero.

$$\ln\left(\frac{\mathrm{OVAR}_{it}}{\mathrm{CVAR}_{it}}\right) = \alpha_o + \alpha_1\mathrm{HS} + \beta_1 \ln\left(\frac{\mathrm{OVOL}_{it}}{\mathrm{CVOL}_{it}}\right) + \delta_1\mathrm{HS} * \ln\left(\frac{\mathrm{OVOL}_{it}}{\mathrm{CVOL}_{it}}\right) + \beta_2 \ln(\mathrm{TVOL}_{it}) + \delta_2\mathrm{HS} * \ln(\mathrm{TVOL}_{it}) + \varepsilon_{it} \tag{2}$$

Following Forster and George (1996), the variables OVAR and CVAR are the open-to-open and the close-to-close squared returns, respectively. They serve as proxies for the daily return variances. OVOL and CVOL are the daily opening and closing volume, respectively. TVOL is the total daily volume and is used for capturing the relation between volatility and volume. We use TVOL to ensure that our volume ratios are not proxies for the total daily volume.[13] HS is a dummy variable that takes the value of one when a stock is an HSI stock and zero otherwise.

The hypothesis to be tested is as follows. If a higher trading volume at the market close is the cause for the higher close-to-close volatility of the HSI stocks only, then

[13] See footnote 13 of Forster and George (1996).

Table 3

Average correlation between various return series

Since the SEHK extended its afternoon trading session from 15:45 to 15:55 on September 1, 1995, the sample is divided into two periods, with September 1, 1995, as the cut-off point.

Panel A: December 28, 1994 to August 31, 1995		
Autocorrelation	HSI	Non-HSI
$\rho_{\text{o-o}}$	−0.048	−0.038
Relative No. of Firms with $-\ \rho_{\text{o-o}}$	21/33	16/28
Relative No. of Firms with 10% significant $-\ \rho_{\text{o-o}}$	7/33	8/28
$\rho_{\text{c-c}}$	−0.168	−0.044
Relative No. of Firms with $-\ \rho_{\text{c-c}}$	25/33	16/28
Relative No. of Firms with 10% significant $-\ \rho_{\text{c-c}}$	17/33	7/28
Panel B: September 1, 1995 to February 29, 1996		
Autocorrelation	HSI	Non-HSI
$\rho_{\text{o-o}}$	−0.091	−0.021
Relative No. of Firms with $-\ \rho_{\text{o-o}}$	25/33	15/28
Relative No. of Firms with 10% significant $-\ \rho_{\text{o-o}}$	10/33	8/28
$\rho_{\text{o-o}}$	−0.273	−0.139
Relative No. of Firms with $-\ \rho_{\text{c-c}}$	27/33	16/28
Relative No. of Firms with 10% significant $-\ \rho_{\text{c-c}}$	20/33	10/28

Note: $\rho_{\text{o-o}}$ is the autocorrelation of the open-to-open return series (i.e., 10:00–10:00). $\rho_{\text{c-c}}$ is the autocorrelation of the close-to-close return series (i.e., 15:45–15:45 for the first sample period and 15:55–15:55 for the second sample period).

β_1 will not be different from zero, whereas δ_1 will be significantly positive. Table 2 presents the estimation results.

The result for the first sample period (Panel A) clearly supports our hypothesis. The estimated coefficient β_1 shows no statistical significance. This confirms that a high trading volume near the market close has no impact on the closing volatility of the NHSI stocks. On the contrary, the estimated coefficient δ_1 is highly significant with a positive sign, which implies that the high trading volume near the market close does lead to higher closing volatility in HIS stocks. The result for the second sample period (Panel B) is essentially the same and bears similar implications. The coefficient δ_1 is significant at the 10% level.

5.4. Serial correlation

Studying the correlations in various return series provides further insight into the nature of the price discovery process. According to Stoll and Whaley (1990), if there is transitory price dispersion at the market open, then the open-to-open return series will be negatively correlated due to price reversal. As we find transitory price dispersion at the market close only for the HSI stocks but not for the NHSI stocks, we expect the close-to-close return series to be negatively correlated for the former group of stocks. To investigate this, we estimate the autocorrelations of the opening return series and the closing return series for all of the stocks.

In Table 3, we display the average stock return autocorrelations. For the HSI stocks, the open-to-open return series have an average autocorrelation of –0.048. Twenty-one out of the 28 stocks have negative autocorrelation, but only 7 stocks are significantly negative at the 10% level. According to Lo and MacKinlay (1990), this observation is expected, as individual stock returns generally tend to have negative serial correlation. For the close-to-close return series, the autocorrelation is –0.168. Twenty-five stocks exhibit negative return correlation, and 17 out of the 25 are statistically significant at the 10% level. This strongly indicates that the closing return correlation is negative to a much higher extent than the opening return correlation, and it also reveals strong price reversal in the close return correlation.

The 28 NHSI stocks show quite a different picture. The average autocorrelation of open-to-open return series is –0.038, with 16 out of the 28 stocks showing negative autocorrelation. Out of the 16 stocks showing negative autocorrelation, only 8 are significant at the 10% level. The major difference between this group and the HSI group lies in the close-to-close return series. The autocorrelation is –0.044, which is substantially smaller than the –0.168 of the HSI stocks. Furthermore, 16 stocks exhibit negative return correlation, with only 7 statistically significant at the 10% level. These figures strongly suggest that wide price dispersion at the market close and the following strong price reversal are severe only for the cross-traded HSI stocks.

All of these results also hold during the second sample period, as shown in Panel B of Table 3, which leads to the conclusion that the returns for the HSI stocks that are cross-traded on the LSE are more volatile at the market close, and there is a tendency for price reversal on the following day.

6. Conclusions

Amihud and Mendelson (1987) first indicate that the open-to-open return volatility is higher than the close-to-close return volatility in the U.S. market. Although studies of various markets with different structures have been conducted, there is still no consensus on the underlying cause of the phenomenon. As an order-driven, nonspecialist market, the Hong Kong stock market provides a useful setting to test various hypotheses. If halt of trade is the major reason for the discrepancy in volatilities, then the open-to-open volatility in the Hong Kong market will be higher. If the presence of a specialist system is the reason, then the open-to-open volatility will be normal and will not be significantly different from other intradaily volatilities. Our overall result confirms the specialist explanation. We contrast the trading patterns of two groups of stocks. The first group consists of Hang Seng Index constituent stocks that are cross-traded in London. The second group consists of nonconstituent stocks that are traded only on the local exchange. Although the trading volume of the nonconstituent stocks is higher near the market close, the close-to-close volatility of this group of stocks is not higher. This provides support for the specialist explanations of Stoll and Whaley (1990) and Brock and Kleidon (1992).

Interestingly, we find that both the trading volume and the volatility of the index-constituent stocks are higher at the market close. This is due to London institutional traders positioning their trades by placing orders in Hong Kong before the Hong Kong market closes and the London market opens. In view of the growing trend in around-the-clock trading and global market linkage, our findings shed light on the possible impacts of such changes on order flows and the price discovery process.

Appendix A

Table A1

The SEHK Bid-Ask Spread Table

Each security traded on the SEHK is assigned a spread that represents the permissible price increments at which a stock may be quoted and deals struck. The Spread Table specifies different spreads for different share price ranges.

Price Range (HK$)			Spread (HK$)
> 0.01	-	0.25	0.001
> 0.25	-	0.50	0.005
> 0.50	-	2.00	0.010
> 2.00	-	5.00	0.025
> 5.00	-	30.00	0.050
> 30.00	-	50.00	0.100
> 50.00	-	100.00	0.250
> 100.00	-	200.00	0.500
> 200.00	-	1,000.00	1.000
> 1,000.00	-	9,995.00	2.500

Appendix B

Panel A: 28 sample stocks listed on the SEHK and cross-listed on the LSE

SEHK CODE	MKTCAP	NAME
1	84,386,154.00	CHEUNG KONG HOLDINGS LTD
2	79,825,303.00	CHINA LIGHT AND POWER CO LTD
3	31,043,463.00	HONG KONG AND CHINA GAS CO LTD
4	54,543,056.00	WHARF HOLDINGS LTD
5	174,000,000.00	HSBC HOLDINGS PLC
6	53,942,919.00	HONG KONG ELECTRIC HOLDINGS LTD
8	171,000,000.00	HONG KONG TELECOMMUNICATIONS LTD
10	16,581,114.00	HANG LUNG DEVELOPMENT CO LTD
11	113,000,000.00	HANG SENG BANK LTD
12	68,467,973.00	HENDERSON LAND DEVELOPMENT CO LTD
13	135,000,000.00	HUTCHISON WHAMPOA LTD
14	17,754,269.00	HYSAN DEVELOPMENT CO LTD

(continued)

Appendix B *(continued)*

Panel A: 28 sample stocks listed on the SEHK and cross-listed on the LSE

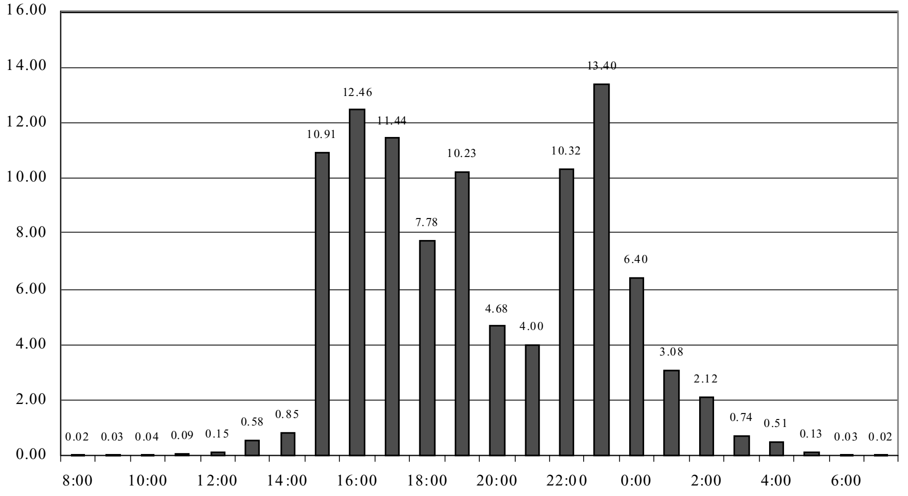
SEHK CODE	MKTCAP	NAME
16	133,000,000.00	SUN HUNG KAI PROPERTIES LTD
17	41,207,059.00	NEW WORLD DEVELOPMENT CO LTD
18	4,395,891.00	ORIENTAL PRESS GROUP LTD
19	56,988,029.00	SWIRE PACIFIC LTD
20	25,395,263.00	WHEELOCK AND COMPANY LTD
23	20,603,861.00	BANK OF EAST ASIA LTD
41	7,338,943.00	GREAT EAGLE HOLDINGS LTD
54	28,807,495.00	HOPEWELL HOLDINGS LTD
69	9,849,379.00	SHANGRI LA ASIA LTD
83	13,501,650.00	SINO LAND CO LTD
101	17,240,899.00	AMOY PROPERTIES LTD
179	5,946,720.00	JOHNSON ELECTRIC HOLDINGS LTD
267	38,653,173.00	CITIC PACIFIC LTD
293	31,939,297.00	CATHAY PACIFIC AIRWAYS LTD
511	11,130,106.00	TELEVISION BROADCASTS LTD
583	6,825,000.00	SOUTH CHINA MORNING POST HLDGS LTD

Panel B: 28 sample stocks listed only on the SEHK

31	1,015,838.00	CHINA AEROSPACE INTERNATIONAL HOLDIN
44	3,666,821.00	HONG KONG AIRCRAFT ENGINEERING CO
56	2,662,768.00	ALLIED PROPERTIES HK LTD
78	4,395,454.00	REGAL HOTELS INTL HOLDINGS LTD
90	6,629,590.00	PEREGRINE INVESTMENTS HOLDINGS LTD
96	7,030,195.00	WING LUNG BANK LTD
97	16,030,169.00	HENDERSON INVESTMENT LTD
123	3,320,629.00	GUANGZHOU INVESTMENT CO LTD
127	8,829,822.00	CHINESE ESTATES HOLDINGS LTD
130	10,313,141.00	NATIONAL MUTUAL ASIA LTD
135	442,505.20	CNPC HONG KONG LTD
142	13,359,130.00	FIRST PACIFIC CO LTD
234	129,255.20	CHESTERFIELD LTD
242	8,675,016.00	SHUN TAK HOLDINGS LTD
268	1,739,265.00	TOP GLORY INTERNATIONAL HOLDINGS LTD
270	8,228,699.00	GUANGDONG INVESTMENT LTD
279	265,464.00	TUNG FONG HUNG HOLDINGS LTD
302	5,181,750.00	WING HANG BANK LTD
323	2,703,371.00	MAANSHAN IRON AND STEEL CO LTD H SHS
355	3,598,637.00	CENTURY CITY INTERNATIONAL HOLDINGS
480	6,141,405.00	HKR INTERNATIONAL LTD
488	3,970,133.00	LAI SUN DEVELOPMENT CO LTD
551	4,134,748.00	YUE YUEN INDUSTRIAL HOLDINGS LTD
617	1,890,000.00	PALIBURG DEVELOPMENT LTD
666	820,725.40	SHK HONG KONG INDUSTRIES LTD
688	5,018,629.00	CHINA OVERSEAS LAND AND INVESTMENT
988	3,602,302.00	PEARL ORIENTAL HOLDINGS LTD
1138	1,782,000.00	SHANGHAI HAI XING SHIPPING CO H SHS

Appendix C

Distribution of proportional trading volume (in percentage) of 18 Hang Seng Index component stocks on the LSE (January 1995–March 1996)



Note: The proportional trading volume is the proportion of the hourly trading volume in the total daily trading volume of the LSE. The time is Hong Kong time. Source: Securities & Futures Commission, 1997, Offshore Trading of Hong Kong Stocks: Migration of Trading or a Growing Pie?

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