THE BEHAVIOUR OF MALAYSIAN STOCK PRICES

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ABSTRACT

This study examines the return and risk behaviour of Malaysian stock using the Composite Index and its component stocks. At the individual firm level, stock trading at the Kuala Lumpur Stock Exchange stabilizes over time within a trading day, while the index portfolio returns fail to reveal any systematic trading pattern which indicated price stabilization. During the study period, the Kuala Lumpur Stock Exchange utilized the call market system, a periodic single-price auction, to determine order-matching prices at the market open and close of both the morning and afternoon trading sessions. The results of this study suggest that no particular benefit of reducing market volatility is achieved by the call market system. We also document some evidence that trading volume and firm size are important factors which explain for autocorrelations, price reversals, and the behaviour of intra - and interday returns.

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1. INTRODUCTION

The Kuala Lumpur Stock Exchange (KLSE) provides trading facilities for common equities, preferred stocks, Malaysian government securities, corporate debt securities, transferable subscription rights and warrants. At the end of February 1993, KLSE's market capitalisation totalled US$97 billion for 373 listed companies (which consisted of 318 on the main board and 53 companies on the second board) with an annual reported trading value worth US$20 billion for 1992. Its market capitalisation is the sixth largest in Asia, after the stock exchanges of Tokyo, Osaka, Hong Kong, Taiwan, And Korea.[1] Although initial public trading of Malaysian corporate securities goes back to May 9, 1960, the behaviour of its stock prices remains relatively unknown to academic researchers outside Malaysia.[2]

The main purpose of this study is to document the intraday and interday price behaviour of Malaysian common stocks. We examine the return and risk behaviour of both the KLSE Composite Index (CI) and its component common sotcks. Since its introduction in 1986, the CI has served as the benchmark index for the Malaysian stock market. The CI is a value-weighted average of component stocks. The 85 companies represent the Malaysian blue chip stocks that are actively traded and, consequently, closely followed by local and foreign investors.[3] Since the behaviour of individual stock returns and that of index returns are different in terms of autocorrelations, price reversals, and variance ratios, the availability

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[1] *See Rhee (1992) and Rhee and Chang (1992) for the current status of the Asian capital markets.*

[2] *Refer to Money and Banking in Malaysia published by the Economics Department of Bank Negara Malaysia (1989) for an excellent overview of the institutional background and history of the Malaysian capital market.*

[3] *Until 1/9/93 the KLSE CI was supplemented by subindices for each of five industries including: industrial (30 stocks), financial (33 stocks), property (32 stocks), tin (12 stocks), and plantation (47 stocks). With the exception of the Industrial Index, all subindices include the exhaustive list of companies in each of the industries. The KLSE has also compiled the Second Board Index since January 1991. A new index called the Exchange Main Board All-Share Index (EMAS) was launched on October 16, 1991. All indices introduced by the KLSE, including the CI, are adjusted for dividend payments amounting to 50 sen and above. The PACAP Research Center of The University of Rhode Island compiles and releases both value-and equally-weighted daily composite market portfolio returns. The PACAP Malaysian Index Returns are computed with and without dividend reinvestment with January 1, 1975 as the beginning date of the return series. For a detailed description on CI and its subindices, see Kok (1993).*

of both the individual stock price data and the index data for the Malaysian stock market provides an interesting case study of the market microstructure of an emerging Asian capital market.[4]

On November 13, 1989, the KLSE replaced the traditional open outcry system of trading in favour of a semi-automated trading system known as the System on Computerised Order Routing and Execution (SCORE). Under SCORE's semi automated state, buy and sell orders are entered into computer terminals located at the member companies' offices and are then routed to the KLSE's matching room where the matching is executed by the KLSE's staff. The KLSE (until November 30, 1992) employed two different processes of order-matching price discovery known as (i) the call market system; and (ii) the continuous market system. The call market system represents a periodic single-price auction which is a computerised form of the clearing house auction discussed by Mendelson (1982), whereas the continuous market system is a double auction system where bids and offers are submitted continuously over time and transactions occur when the orders cross. Unlike most of the automated continuous double auction markets that use the clearing house auction solely for market openings, the KLSE used the call market system to determine both the stock's opening price and its closing price for a particular trading session, while its continuous market system was used to determine matching prices throughout the trading session. The fact that the call market system opens and closes the morning and afternoon sessions in the KLSE provides a unique setting which is non-existent either in Tokyo or in New York, where only opening prices are determined by periodic clearing procedures. Therefore, a study of the stock price behaviour of the KLSE adds another dimension to research on the relationship between market volatility and the trading method. The analysis of stock price behaviour at the KLSE addresses an important policy issue relevant not only to the KLSE but also to other exchanges. In accordance with the KLSE's 5 - year plan, the automated matching system, where price determination is based on the call market system only, has replaced the semi-automated system, thus eliminating the continuous auction system.[5] The examination of the open-to-open and close-to-close return behaviour observed for the KLSE stocks and CI will shed light on the KLSE's decision in adopting the call market system for the entire trading day.

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[4] *For the differing behaviour of individual firms returns and index returns, see Lo and MacKinlay (1990), Stoll and Whaley (1990), Amihud and Mendelson (1987, 1991), and Chang, Fukuda, Rhee, and Takano (1993).*

[5] *The automated matching system was implemented in stages beginning on October 19, 1992 and completed on November 30, 1992.*

Chang et al. (1993) finds a negative difference between the sum of TOPIX index return variances during two intraday intervals (i.e., overnight non-trading period and daytime period from morning open to afternoon close) and the 24-hour interday index return variance. They observe the same results when the sum of return variances for any number of the partitioned time intervals is compared with the return variances for the whole period, which is shorter than the 24-hour period. These results based on the TOPIX index returns are different from Amihud and Mendelson's (1991) findings based on 50 Japanese stocks that show positive differences. Chang et al. suggest that their contradictory results are influenced by positive cross-covariances across securities first identified by Lo and MacKinlay (1990) to explain the contrarian profits in the absence of negative autocorrelations of index return series. Chang et al. further report that the correlations between the adjacent index return series are consistently positive for the TOPIX portfolio returns, whereas Amihud and Mendelson (1991) show different results, reporting negative correlations using individual common stock return series. Here, the availability of price data on both the CI and its component stocks makes it possible to study the different behaviour of the index returns and individual stock returns.

Motivated by Lo and MacKinlay's (1990) and Mech's (1992) findings that small firm stock returns lag large firm stock returns, we partition the CI component stocks into subgroups based on firm size as well as on trading volume. At least two interesting hypotheses can be tested using size-and volume-sorted portfolios. It is expected that small size-firms and firms with low trading volume would experience more frequent price reversals as indicated by negative autocorrelations.[6] As an extension of the first hypothesis, it is further expected that small-size firms and firms with low trading volume would show a more rapid decline in their volatility as the trading proceeds.

The remainder of this paper is organized as follows: Intraday and interday returns and volatility of the CI portfolio are analysed in Section 2. The risk and return behaviour of the CI component stocks are analysed in Section 3. Further analyses of autocorrelations and price reversals are presented in Section 4 to contrast the price behaviour of the market portfolio and its component stocks. Summary and conclusions are presented in Section 5.

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[6] *This hypothesis is consistent with Amihud and Mendelson (1991, p. 1774) and Roll (1984). However, Mech (1992) reports that firm size has very little impact on the return autocorrelations when return variance is controlled.*

2. KLSE COMPOSITE INDEX RETURN AND VOLATILITY

2.1. The Behaviour of Intraday Index Return and Risk

The KLSE began recording the CI at 15 minute intervals on February 3, 1990.[7] During the two-year study period from February 3, 1990 to February 10, 1992, the KLSE had two daily trading sessions: a morning session from 10:00 a.m. to 12:30 p.m. and an afternoon session from 2:30 p.m. to 4:00 p.m., from Monday through Friday. Intraday 15-minute returns, r_i, are calculated using equation (1):

$$r_i = \log(I_i/I_{i-1}) \times 100, \quad (1)$$

where I_i signifies the CI observed at minute i and I_{i-1} is the CI observed at i-15 minutes. Additionally, five sets of intraday returns for time intervals longer than 15 minutes are reported to contrast the price behaviour between trading and nontrading periods; they are: (i) overnight nontrading period return, computed using the morning open CI and the afternoon closing CI on the preceding day; (ii) lunch break return between the morning close and the afternoon open; (iii) return over the morning trading session; (iv) return over the afternoon trading session; and (v) daytime return computed using the morning opening CI and the afternoon closing CI on the same day.

Intraday 15-minute returns averaged across 447 trading days are plotted in Figure 1 (a) and summary statistics for intraday returns are presented in Table 1. Similar to the intraday return behaviour observed in the NYSE [Wood, McInish, and Ord (1985), Lockwood and Linn (1990), and Gerety and Mulherin (1992)] and in the TSE [Chang, et al (1993)], intraday returns tend to be large at the beginning and at the end of each of the two trading sessions, while reaching its lowest level during the trading period. The largest returns occur during the first 15-minute trading after the market opens in the morning (0.0548%) and the last 15-minute trading prior to the market close in the afternoon (0.0422%).[8] Interestingly, the first 15-minute returns at the beginning of the afternoon trading session is also positive and relatively large (0.0218%). However, intraday returns are mostly negative throughout the trading day.

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[7] *The authors would like to thank the Kuala Lumpur Stock Exchange for providing the data for this study.*

[8] *This result is analogous to a large mean price change on the last daily NYSE transactions observed by Harris (1989).*

Table 1
Summary Statistics for Intraday Composite Index Behaviour

The study period is from February 3, 1990 to February 10, 1992 with 447 trading days. Intraday 15-minute returns, r_i, are calculated using $r_i = \log(I_i/I_{i-1}) \times 100$, where I_i signifies the CI observed at minute i and I_{i-1} is the CI observed at i-15 minutes. The 15-minute returns are averaged across 447 trading days. Additionally, five sets of intraday returns for time interval longer than 15 minutes are reported to contrast the price behaviour between trading and nontrading periods: They are: (i) overnight nontrading period return computed using the morning open CI and the afternoon closing CI on the preceding day; (ii) lunch break return between the morning close and the afternoon open; (iii) return over the morning trading session;(iv) return over the afternoon trading session; (v) daytime return computed using the morning opening CI and the afternoon closing CI.

Period	Average Return (5%)	Variance (x10⁴)	Skewness	Kurtosis
Overnight	0.0452	0.1212	-1.2690	39.2109
10:00-10:15 a.m.	0.0548	0.0640	3.7386	33.3968
10:15-10:30 a.m.	-0.0017	0.0509	-0.7275	7.9090
10:30-10:45 a.m.	-0.0377	0.0307	-1.1188	8.6292
10:45-11:00 a.m.	-0.0303	0.0233	-1.8882	13.8628
11:00-11:15 a.m.	-0.0234	0.0144	-0.7302	5.1012
11:15-11:30 a.m.	-0.0212	0.0129	-0.4200	9.8901
11:30-11:45 a.m.	-0.0113	0.0160	1.1554	17.9524
11:45-12:00 noon	-0.0063	0.0129	0.4688	13.5011
12:00-12:15 p.m.	-0.0128	0.0141	-2.8699	30.7604
12:15-12:30 p.m.	-0.0160	0.0272	-5.3231	59.8401
Lunch Break	-0.0087	0.0300	9.2957	167.7282
2:30-2:45 p.m.	0.0218	0.0330	3.7469	84.1530
2:45-3:00 p.m.	-0.0221	0.0427	-6.8241	79.5156
3:00-3:15 p.m.	-0.0177	0.0159	-1.0931	11.5623
3:15-3:30 p.m.	-0.0102	0.0161	1.9129	24.4713
3:30-3:45 p.m.	0.0068	0.0308	8.5102	132.6884
3:45-4:00 p.m.	0.0422	0.0258	0.4750	3.6173
Morning Trading Session	-0.1060	0.8181	-0.8265	7.7403
Afternoon Trading Session	0.0209	0.1844	0.0854	3.8324
Daily Trading Session	-0.0938	1.3411	-0.7833	7.5812

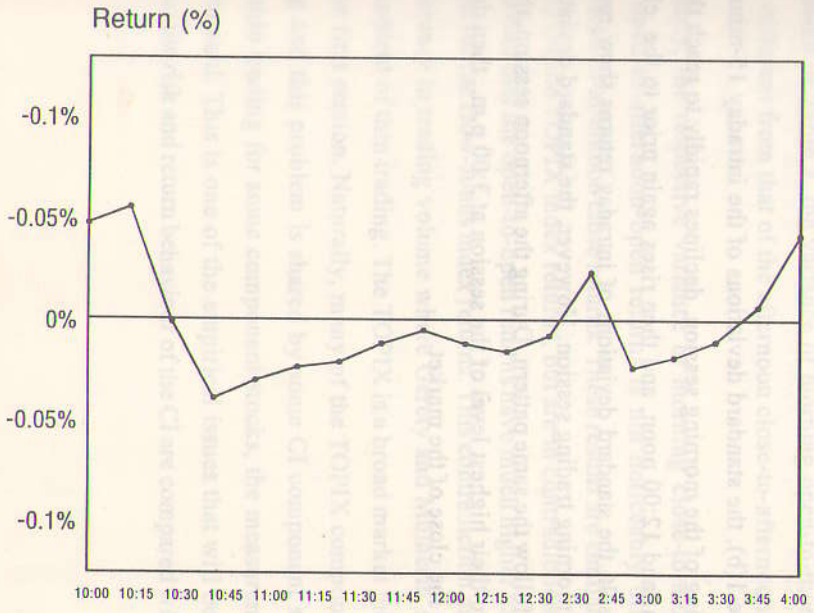

Figure 1(a). Intraday 15-minute CI Returns

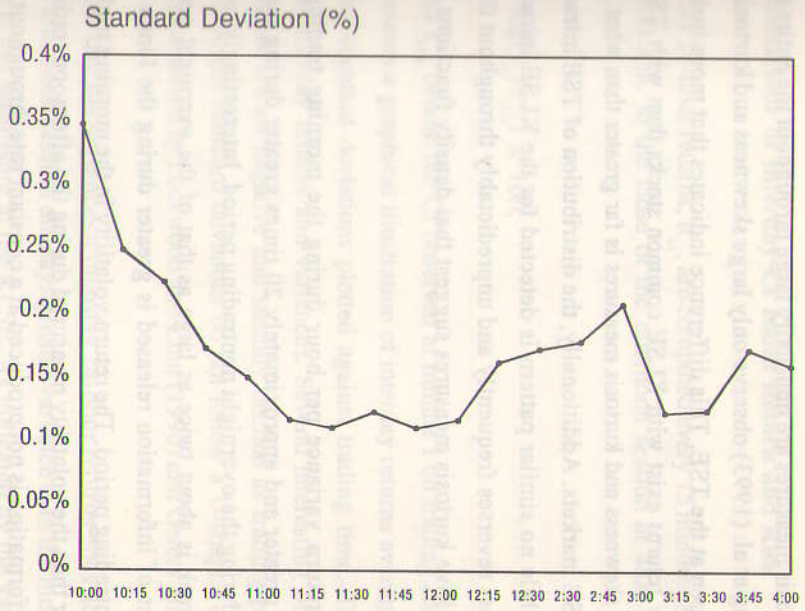

Figure 1(b). Standard Deviations of the Intraday 15-minute CI Returns

Skewness and kurtosis measures are unusually large throughout the entire trading day at the KLSE, while Chang et al. (1993) observe only large skewness and kurtosis measures at the morning market open at the TSE. This difference indicates that more instability and non-normality of intraday returns exist with KLSE common stocks than with TSE common stocks. The magnitude of skewness and kurtosis measures is far greater than what is observed in both the NYSE and TSE markets. Additionally, the distribution of TSE intraday returns is skewed to the right while no similar pattern is detected for the KLSE intraday returns since the sign of skewness reverses frequently and unpredictably throughout the day. The prevailing large and positive kurtosis measures suggest that density functions are peaked near their center.

The CI portfolio return variance per hour during the morning trading period is approximately 50 times greater and approximately 20 times greater during the afternoon trading period than it is during the overnight nontrading period. Interestingly, variance per hour during the lunch break is about twice as large as that of the overnight period, which suggests that the amount of information released is greater during the lunch break than during the overnight nontrading period. The return volatility in the morning trading session is about 2.7 times greater than the volatility measured during the afternoon trading session, indicating that private information is not produced at a constant rate throughout the trading day.

As shown in Figure 1(b), the standard deviations of the intraday 15-minute returns are largest at the beginning of the morning session, declines rapidly to reach their lowest level between 11:30 a.m. and 12:00 noon, and then rises again prior to the close of the morning session. As a result, the standard deviations of intraday returns show roughly a U-shaped curve during the morning trading session. However, the standard deviations in the afternoon session do not follow the same pattern. During the afternoon session, the standard deviations initially rise to their highest level of the session at 3:00 p.m., then decline, and finally rise again toward the close of the market.

2.2. The Behaviour of Interday CI Index Return and Risk

Interday 24-hour returns, $R_{i,t}$, are computed every 15 minutes beginning from the market open at 10:00 a.m. to the close of the afternoon session at 4:00 p.m. using the following equation:

$$R_{i,t} = \log(I_{i,t}/I_{i,t-1}) \times 100, \quad (2)$$

where $I_{i,t}$ and $I_{i,t-1}$ denote the CI observed at minute i on trading days t and t-1, respectively. Figure 2 presents a graphical illustration of interday returns averaged across the 447 trading days and the standard deviations plotted against trading time. Table 2 presents summary statistics for interday returns and variances. Several interesting observations emerge. First, interday returns are all negative and steadily decline as trading proceeds during the study period. Second, the standard deviatons do not follow a U-shaped curve like the Dow-Jones index returns observed by Lockwood and Linn (1990) and Gerety and Mulherin (1991, 1992).

The fact that the variance of interday 24-hour returns does not decline during the day and that the afternoon session displays greater variance than the morning session may imply that trading is not stabilising at the KLSE. As indicated by the variance ratios reported in the last column of Table 2, the variance of morning open-to-morning open returns is not noticeably different from that of the afternoon close-to-afternoon close returns.

Similarly, the respective variance of morning close-to-morning close returns and afternoon open-to-afternoon open returns is not noticeably different from that of the afternoon close-to-afternoon close returns. These results are similar to the findings of Chang et al. (1993) for the TOPIX index returns, but are in contradiction to Gerety and Mulherin (1991) who find that the open-to-open returns have much higher variance than the close-to-close returns for the Dow-Jones index returns. This contradiction may be partially explained by the difference in trading volume where Gerety and Mulherin's result would not suffer from the problem of thin trading. The TOPIX is a broad market index for the TSE's stocks listed on the first section. Naturally, many of the TOPIX component stocks are subject to thin trading and this problem is shared by some CI component stocks. With stale prices caused by thin trading for some component stocks, the measurement of variance may be biased downward. This is one of the empirical issues that will be highlighted in the next section when the risk and return behaviour of the CI are compared with those of its component stocks.

Table 2
Summary Statistics for Interday Composite Index Behaviour

The study period is from February 3, 1990 to February 10, 1992 with 447 trading days. Interday 24-hour returns, $R_{i,t}$, are computed at every 15 minutes beginning from the market open at 10:00 a.m. to the close of the afternoon session at 4:00 p.m. using: $R_{i,t} = \log(I_{i,t}/I_{i,t-1}) \times 100$, where $I_{i,t}$ and $I_{i,t-1}$ are CI observed at minute i on trading days t and t-1, respectively. Interday returns are averaged across the 447 trading days. Variance ratio is defined as the ratio of interday return variance to the interday return variance at the afternoon close.

Period	Average Return (%)	Variance ($\times 10^4$)	Skewness	Kurtosis	Variance Ratio
Morning Open	-0.0137	1.6517	-0.4512	6.0219	0.9951
10:15 a.m.	-0.0206	1.5696	-0.4104	6.3686	0.9456
10:30 a.m.	-0.0275	1.6367	-0.4512	6.0219	0.9860
10:45 a.m.	-0.0307	1.6435	-0.3604	7.3350	0.9901
11:00 a.m.	-0.0348	1.6236	-0.0585	6.2564	0.9781
11:15 a.m.	-0.0378	1.6413	0.0579	6.5428	0.9888
11:30 a.m.	-0.0397	1.5940	0.1863	6.7777	0.9603
11:45 a.m.	-0.0403	1.5271	0.1149	5.6429	0.9200
12:00 noon	-0.0432	1.4780	0.0184	4.9055	0.8904
12:15 p.m.	-0.0434	1.5163	-0.0796	5.2746	0.9135
Morning Close	-0.0452	1.6593	-0.1333	6.3882	0.9996
Afternoon Open	-0.0456	1.6415	-0.1051	6.7191	0.9889
2:45 p.m.	-0.0476	1.7564	-0.2250	8.1624	1.0581
3:00 p.m.	-0.0486	1.9056	-0.5387	12.8279	1.1480
3:15 p.m.	-0.0490	1.9948	-0.6286	15.4498	1.2018
3:30 p.m.	-0.0493	1.8968	-0.6217	11.8220	1.1427
3:45 p.m.	-0.0490	1.6968	-0.4780	7.4114	1.0222
Afternoon Close	-0.0486	1.6599	-0.4814	6.9195	1.0000

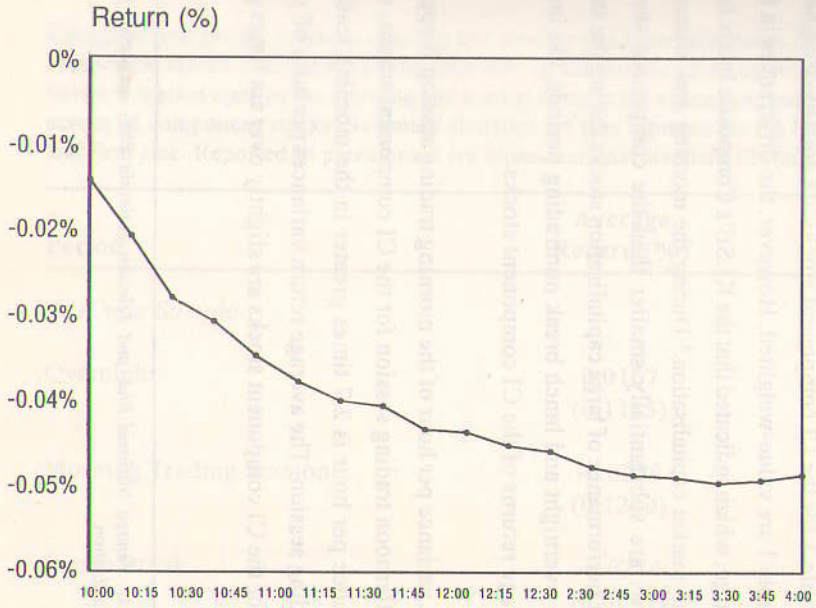

Figure 2(a). Interday CI Returns

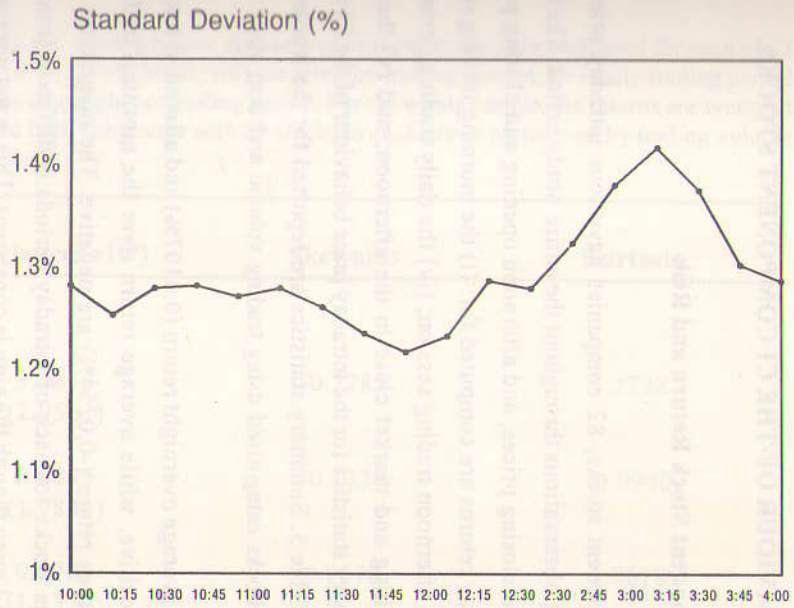

Figure 2(b). Standard Deviations of Interday CI Returns

3. THE PRICE BEHAVIOUR OF THE CI COMPONENT STOCKS

3.1. Intraday CI Component Stock Return and Risk

Of the 85 CI component stocks, 82 companies have four intraday price records available without missing observations throughout the entire study period. The four prices are: morning opening and closing prices, and afternoon opening and closing prices. As a result, five sets of intraday returns are computed for: (i) the morning trading session; (ii) the lunch break; (iii) the afternoon trading session; (iv) the daily trading period between market open in the morning and market close in the afternoon; and (v) the overnight nontrading period. Summary statistics for the intraday price behaviour of the CI component stocks are presented in Table 3. Summary statistics are reported for the whole sample as well as by subgroups of stocks categorised using trading volume and firm size.

Table 3 shows that average overnight return (0.0107%) and afternoon trading period return (0.0434%) are positive, while average return over the morning trading period (-0.0229%) and lunch break return (-0.0254%) are negative. The magnitude of average return for CI components stocks for each of intraday periods is different from the index returns reported in Table 1 even though the sign is consistent. This is not unexpected since the reported returns in Table 3 for the CI component stocks are equally-weighted whereas the CI index returns in Table 1 are value-weighted. However, the differences in the two sets of returns are unusually large, which indicated that the KLSE's Composite Index is dominated by a few stocks with large market capitalisation.[9] During the morning and afternoon trading periods, the index returns are substantially smaller than the component stock returns, indicating relatively poor performance of large capitalisation stocks during the study period. Interestingly, during the overnight and lunch break nontrading periods, the index returns are greater than the average returns of the CI component stocks.

The average return variance per hour of the morning trading session is approximately the same as that of the afternoon trading session for the CI component stocks, whereas the CI portfolio return variance per hour is 2.7 times greater in the morning trading session than in the afternoon trading session. The average return variances per hour of the morning and afternoon sessions for the CI component stocks are slightly over six times greater than

[9] *Two Malaysian utility stocks, Tenaga Nasional Bhd. and Telekom Malaysia Bhd., accounted for about 40% of CI's total market capitalisation.*

Table 3
Summary Statistics for Intraday CI Component Stock Price Behaviour

Using the four prices: morning opening and closing prices and afternoon opening and closing prices, five sets of intraday returns are computed for each of CI component stocks over the following intervals: (i) the morning trading session; (ii) the lunch break; (iii) the afternon trading session; (iv) daily trading period between market open in the morning and market close in the afternoon; and (v) the overnight nontrading period. For the whole sample, the returns are averaged across 82 component stocks. Summary statistics are also reported for the low and high subgroups with 27 stocks in each group partitioned by trading volume and firm size. Reported in parentheses are cross-sectional standard deviations.

Period	Average Return (%)	Variance ($x10^4$)	Skewness	Kurtosis
A. Whole Sample				
Overnight	0.0107	3.4873	-0.2285	1.2728
	(0.1133)	(2.9561)		
Morning Trading Session	-0.0229	3.0845	-0.1238	-0.0940
	(0.1240)	(1.9848)		
Lunch Break	-0.0254	0.9760	0.9678	1.8618
	(0.0647)	(1.1370)		
Afternoon Trading Session	0.0434	1.7859	0.5639	0.7934
	(0.1054)	(1.0138)		
Daily Trading Period	-0.0114	5.4141	0.0876	-0.4627
	(0.1863)	(2.8536)		

Table 3 (continued)
Summary Statistics for Intraday CI Component Stock Price Behaviour

Period	Average Return (%)		Variance (x10⁴)		Skewness		Kurtosis	
B. Subgroup by Trading Volume								
	Low	High	Low	High	Low	High	Low	High
Overnight	-0.0131	0.0667	4.2874	2.9329	-0.9658	0.5606	1.3826	0.5227
	(0.1072)	(0.1094)	(4.1653)	(1.2653)				
Morning Trading Session	0.0525	-0.1373	2.0378	4.0714	0.1116	0.1365	-0.4237	0.7607
	(0.0941)	(0.0960)	(1.7455)	(1.8607)				
Lunch Break	-0.0026	-0.0224	1.3571	0.4424	0.3120	0.5734	-0.2143	1.8450
	(0.0836)	(0.0289)	(1.3265)	(0.2650)				
Afternoon Trading Session	0.0982	-0.0102	1.4004	2.1217	1.0439	0.4144	1.6477	0.5110
	(0.0923)	(0.0892)	(1.0673)	(0.8491)				
Daily Trading Period	0.1317	-0.1686	3.9521	6.7940	0.4037	0.6714	-0.0399	1.9198
	(0.1300)	(0.1307)	(2.2438)	(2.9719)				

Table 3 (continued)
Summary Statistics for Intraday CI Component Stock Price Behaviour

Period	Average Return (%)		Variance ($x10^4$)		Skewness		Kurtosis	
C. Subgroup by Firm Size								
	Small	Large	Small	Large	Small	Large	Small	Large
Overnight	0.0118	-0.0216	4.5703	2.7170	-0.8777	-0.2957	1.9497	-0.3471
	(0.1296)	(0.0773)	(2.6804)	(3.3588)				
Morning Trading Session	-0.0156	-0.0344	4.0618	2.0800	-0.2593	-0.4579	-0.4000	0.1598
	(0.1561)	(0.0893)	(2.2707)	(1.3414)				
Lunch Break	-0.0264	-0.0131	1.2219	0.7175	0.9417	1.3023	0.7985	2.9385
	(0.0808)	(0.0607)	(1.0774)	(0.8774)				
Afternoon Trading Session	0.0632	0.0597	2.1739	1.4619	1.2247	0.1352	1.6683	0.0429
	(0.1155)	(0.0887)	(1.1373)	(0.8548)				
Daily Trading Period	0.0113	0.0071	7.0698	3.9864	0.1235	0.7264	-0.6998	-0.5225
	(0.2223)	(0.1377)	(3.2856)	(1.9450)				

that of the overnight nontrading period. They are also about 2.5 times greater than the variance measured during the lunch break. The differences in market volatility measured for individual stocks in the trading and nontrading periods are not as great as those observed for the index returns. Nevertheless, the results suggest that private information is disclosed during trading hours. The results are consistent with empirical evidence reported by Wood et al. (1985) and Stoll and Whaley (1990) for the U.S. market and Amihud and Mendelson (1991) for Japan.

In an effort to examine the dependence of the above results on trading volume and firm size, the 82 CI component stocks were partitioned into three subgroups based on their average trading volume and market capitalisation during the study period, but results are reported only for two extreme subgroups with 27 stocks in each group. From Panel B of Table 3, the two trading volume-based subgroups show the following results. First, the low-volume subgroup has smaller variances during the trading sessions (morning, afternoon and daily trading period) than the high-volume subgroup. Not only is the difference noteworthy, but it is also remarkably large. For example, during the morning trading session Intraday returns of the low-volume subgroup show a variance of 2.0378 as opposed to 4.0714 computed for the high-volume subgroup. Second, during the nontrading period (overnight and lunch break) the low-volume subgroup show greater variances than the high-volume subgroup. Although it is intuitive that low trading volume stocks exhibit lower variance during the trading period, the higher variance observed for the low trading volume stocks during the nontrading hours is less intuitive and somewhat puzzling. Another interesting observation is that the low-volume subgroup has a higher return during the trading hours than the high-volume subgroup even though the variance is smaller.

As reported in Panel C of Table 3, the small-size subgroup consistently exhibits greater variance than the large-size subgroup regardless of whether it is a trading or nontrading period. Also, the small-size subgroup shows higher returns than the large-size subgroup during both the trading and nontrading periods, with the lunch breaks being the only exception. It appears that trading volume and firm size are important factors in determining the return and volatility behaviour.

Table 4 compares intraday behaviour of the CI index and the CI component stocks, and summarises the changes in intraday return variance. The results reported in the second column for the whole sample indicate that the difference between the sum of return variances (measured over three intraday periods including the morning trading session, the lunch break, and the afternoon trading session) with the return variance measured during the daytime trading period between morning open and afternoon close is 0.4323. The comparable number for the intraday CI index return variance is -0.3086. The difference between the sum of return variances during the two intraday intervals, including overnight nontrading period and daytime period from morning open to afternoon close, and the daily return variance measured using afternoon close-to-afternoon close is 1.2910 as opposed to the index return-based difference of -0.1976. The last row of Table 4 reports the difference between return variances of the sum of four intraday intervals, including the overnight period, the morning session, the lunch break, and the afternoon session, and the 24-hour period from afternoon close to afternoon close. The differences are 1.7233 for the CI component stocks and -0.5062 for the CI.

The positive differences estimated at the individual firm level are consistent with Amihud and Mendelson (1991) who suggest that trading noise, dissipated through the trading day, should explain the results. In contrast, the negative differences at the index porfolio level are consistent with Chang et al. (1993) who note that the positive cross-covariances across securities within the index portfolio explain the results.[10] At the individual firm level, correlations between the adjacent return series are expected to be negative, implying price reversals and contrarian profit opportunities. The negative correlations at the individual firm level cause the return variances over the entire period to be smaller than the sum of variances in the partitioned time intervals. However, at the portfolio level, the positive correlations cause the return variances over the entire period to be greater than the sum of variances in the partitioned time intervals. In general, we would expect the small-size subgroup and the stocks with low trading volume to have more trading noise than large-size firms with high trading volume due to the more frequent price reversals associated with the low-volume and small-size stocks. If trading noise is the major cause for the positive differences as explained by Amihud and Mendelson (1991), then the positive difference between the return variances should be larger for the small-size subgroup and the low-

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[10] *Lo and MacKinlay (1990) note the role of positive cross-covariances across securities in causing the index returns to be positively autocorrelated. Based on the cross effects, they further demonstrate that a systematic lead-lag relationship among returns of size-sorted portfolios is the source of contrarian profits.*

Table 4
Change in Intraday Return Variance

Using the four prices: morning opening and closing prices and afternoon opening and closing prices, five sets of intraday return variances are computed for each of CI component stocks and the CI portfolio over the following intervals: (i) the morning trading session; (ii) the lunch break; (iii) the afternoon trading session; (iv) daily trading period between market open in the morning and market close in the afternoon; and (v) the overnight nontrading period. Summary statistics are also computed for subgroups of stocks partitioned by trading volume and firm size. AC - AC denotes the 24 hour period from the afternoon close on day t-1 to the afternoon close on day t.

	Period	Composite Index Return Variance ($x10^4$)	CI Component Stock Return Variance ($x10^4$)				
			Whole Sample	Subgroup by Trading Volume		Subgroup by Firm Size	
				Low	High	Small	Large
1.	Overnight	0.1212	3.4873	4.2874	2.9329	4.5703	2.7170
2.	Morning Session	0.8181	3.0845	2.0378	4.0714	4.0618	2.0799
3	Lunch Break	0.0300	0.9760	1.3571	0.4424	1.2219	0.7175
4.	Afternoon Session	0.1844	1.7859	1.4004	2.1217	2.1739	1.4619
5.	Daily Trading Session	1.3411	5.4141	3.9521	6.7940	7.0698	3.9864
6.	AC - AC	1.6599	7.6104	6.3702	8.9506	9.5623	6.1735
7.	(2+3+4)-5	-0.3086	0.4323	0.8432	-0.1585	0.3878	0.2729
8.	(1+5)-6	-0.1976	1.2910	1.8693	0.7763	2.0778	0.5299
9.	(1+2+3+4)-6	-0.5062	1.7233	2.7125	0.6178	2.4656	0.8028

volume subgroup. The results reported in the last two columns provide empirical support of this hypothesis. For example, as shown in the last row of Table 4, the difference between the sum of return variances over four intraday time-intervals (including overnight period, morning session, lunch break, and the afternoon session) and the return variance measured for the 24-hour period at the afternoon close is 2.7125, and for the low-volume and the small-size subgroups it is 2.4656, whereas the comparable figures for the high-volume and the large-size subgroups are 0.6178 and 0.8028, respectively.

3.2. Interday CI Component Stock Return and Risk

Table 5 summarises the averages of the 24-hour interday returns, return variances, and variance ratios. Unlike the negative CI portfolio returns as reported in Table 2, the morning open-to-morning open returns (0.0361%) and the morning close-to-morning close returns (0.0145%) at the individual firm level result in positive returns. The results are caused by the difference in the weight assigned to each component stock and the unusual dominance of CI index returns by a few large-capitalisation stocks. In contrast, the interday returns measured using afternoon opening and afternoon closing prices are negative at -0.0329% and -0.0411%, respectively, but are still greater than the CI portfolio interday returns.

Table 5 also shows that the variance of the morning open-to-morning open returns is the largest, followed by the variances of the morning close-to-morning close returns, afternoon open-to-afternoon open returns, and afternoon close-to-afternoon close returns. In fact, the smallest variance is observed at the afternoon close. The average variance ratios for the open-to-open and close-to-close returns in the morning trading session are 1.3554 and 1.1104, respectively. A total of 69 stocks have a variance ratio greater than unity at the morning open whereas 52 stocks have a variance ratio exeeding unity at the morning close. At the market open of the afternoon session, however, this number declines to 45, while the average variance ratio drops to 1.0977. The results at the individual firm level indicate that the highest volatility is observed at the morning market open which is very different from the variance ratios reported in Table 2 for the CI portfolio return variances. Although the call market method is employed to determine not only morning opening prices but also morning closing, afternoon opening, and afternoon closing prices in the KLSE, the observed variances are not the same. Rather, as Amihud and Mendelson(1991) suggest, these differences in the variances are probably caused by the preceding nontrading hours.

Table 5
Summary Statistics for Interday CI Component Stock Price Behaviour

Interday 24-hour returns, $R_{i,t}$, are computed at the morning market open (MO), at the morning market close (MC), at the afternoon market open (AO), and at the afternoon market close (AC) for each of the 82 CI component stocks. Interday returns are averaged across the 447 trading days and then averaged across the component stocks. Variance ratio is defined as the ratio of interday return variance to the interday return variance at the afternoon close. Reported in parentheses are cross-sectional standard deviations. Summary statistics are also computed for subgroups of stocks partitioned by trading volume and firm size.

Period	Average Return (%)	Variance (x10⁴)	Skewness	Kurtosis	Variance Ratio
A. Whole Sample					
MO - MO	0.0361 (0.1675)	9.7911 (5.2560)	0.7306	0.1392	1.3554 (0.5632)
MC - MC	0.0145 (0.1575)	8.0896 (4.3643)	0.6565	-0.0226	1.1104 (0.3737)
AO - AO	-0.0329 (0.1287)	7.9306 (4.0143)	0.3772	-0.3195	1.0977 (0.4461)
AC - AC	-0.0411 (0.1124)	7.6104 (3.9344)	0.2877	-0.4261	1.0000 (0.0000)
B.Subgroup by Trading Volume					
	Low High	Low High	Low High	Low High	Low High
MO - MO	0.1903 -0.0862 (0.1630) (0.0759)	8.5646 11.2000 (5.6654) (4.8010)	-0.0240 0.1108	-0.5578 0.3615	1.5049 1.2415 (0.7887) (0.1757)
MC - MC	0.1583 -0.1069 (0.1424) (0.0689)	7.5958 9.0839 (5.3322) (3.9198)	-0.1907 -0.1300	0.5063 2.4835	1.2985 1.0121 (0.5583) (0.1374)
AO - AO	0.0571 -0.1316 (0.1201) (0.0768)	6.6959 9.4471 (4.4479) (3.7613)	-0.2850 0.1114	-0.1284 1.7209	1.1737 1.0677 (0.7102) (0.1601)
AC - AC	0.0449 -0.1207 (0.1015) (0.0768)	6.3702 8.9506 (4.4960) (3.4786)	-0.2591 0.3597	-0.2572 0.4075	1.0000 1.0000 (0.0000) (0.0000)

Table 5 (continued)
Summary Statistics for Interday CI Component Stock Price Behaviour

Period	Average Return (%)		Variance ($x10^4$)		Skewness		Kurtosis		Variance Ratio	
C. Subgroup by Firm Size										
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
MO - MO	0.0781	0.0080	12.9660	7.1559	0.1446	1.1705	-0.8168	1.3130	1.4016	1.2418
	(0.2132)	(0.1288)	(5.4630)	(3.9704)					(0.5016)	(0.3242)
MC - MC	0.0560	-0.0086	10.6240	6.2051	0.1531	1.2470	-0.8249	1.5881	1.1553	1.0646
	(0.2010)	(0.1318)	(3.9984)	(3.9613)					(0.3579)	(0.2762)
AO - AO	-0.0391	-0.0313	9.7917	6.4244	0.3224	0.5082	-0.2670	-0.0816	1.0476	1.1409
	(0.1515)	(0.1103)	(3.8036)	(3.7629)					(0.2423)	(0.6130)
AC - AC	-0.0366	-0.0493	9.5623	6.1735	0.1305	0.2150	-0.9318	-0.0658	1.0000	1.0000
	(0.1394)	(0.0960)	(3.6323)	(3.8657)					(0.0000)	(0.0000)

In examining the CI component stocks, two noteworthy observations can be made. First, the interday return variances decline during the day and second, the interday return variance observed at the afternoon close is the smallest suggesting that at the individual stock level, KLSE trading is stabilising. These two observations are different from the CI portfolio returns. The variances for the CI portfolio reported in Table 2 do not fluctuate much throughout the day and range from 1.6415 and 1.6599.

The variance ratios tend to be inversely related to firm size or trading volume when the ratios are measured using morning open-to-morning open returns and morning close-to-morning close returns. The relatively short nontrading hours during the lunch break do not appear to have any significant impact on market volatility of the component stocks at the beginning of the afternoon trading session. However, at the afternoon open, the observed variance ratios are positively related to firm size and negatively related to trading volume.

As reported in Panel B of Table 5, the low-volume subgroup consistently shows higher returns and lower variance than the high-volume subgroup. Interestingly, the 24-hour interday returns are all negative for the high-volume subgroup but all positive for the low-volume subgroup. On average, the interday return variances of the high-volume subgroup is about 20% to 40% greater than those of the low-volume subgroup. When the CI component stocks are partitioned on the basis of firm size, the small-firm subgroup exhibit consistently greater variance than the large-firm subgroup, as indicated in Panel C. Also, interday returns of the small-size subgroup are greater than those of the large-size subgroup with the exception of the afternoon open-to-afternoon open return.

The last column of Panels B and C of Table 5 demonstrates the impact of trading volume and firm size on the behaviour of variance ratios. The variance ratios computed for the low-volume and the small-size subgroups at the morning market open start at relatively high ratios (1.5049 and 1.4016, respectively) compared with the high-volume and the large-size subgroups (1.2415 and 1.2418, respectively). The results indicate that thinly traded stocks and small-size stocks tend to be more volatile at the market open and experience a faster rate of decline in variance ratios.

4. INTRADAY PRICE REVERSALS

4.1 Correlations among Intraday Returns

Table 6 reports the estimated correlations between returns in each of the four time intervals (morning session, lunch break, afternoon session, and overnight period) with the returns in the immediately preceding intervals. The correlation analysis is expected to confirm the following hypotheses: first, that correlations estimated at the individual firm level tend to be negative, while those estimated at the index portfolio level tend to be positive; and second, that small-size firms and firms with low trading volume will show more significant negative correlations than large size-firms or firms with high trading volume, because the former are expected to have more price reversals.

Intraday returns are denoted by r_k, where k = 1, 2, 3, and 4, k = 1 for afternoon close to morning open, k = 2 for morning open to morning close, k = 3 for morning close to afternoon open, and k = 4 for afternoon open to afternoon close. $\rho(r_k, r_{k-1})$ signifies the correlation between r_k and the return from the immediately preceding interval. Table 6 summarises the results. The estimated correlations at the CI portfolio level are presented in the first column and those at the individual CI component stock index portfolio level are summarised in the second through sixth columns. As expected $\rho(r_k, r_{k-1})$ are all negative for the CI component stocks. In contrast, as shown in column two, the results for the CI portfolio show that $\rho(r_k, r_{k-1})$ is positive for two (i.e., k = 1 and 2) of the four cases examined. The reported results for the two subgroups formed on the basis of trading volume and firm size are mixed. In summary, no particular behaviour pattern is detected in support of the two hypotheses.

4.2 First-Order Autocorrelations of Interday and Intraday Returns

Panel A of Table 7 presents the first-order autocorrelations of intraday returns estimated for the CI and the CI component stocks. From this panel, there are three noteworthy observations. First, the CI component stock returns consistently have smaller first-order autocorrelations than the CI portfolio returns. For example, the intraday CI index returns, measured during the morning trading session have an autocorrelation coefficient of 0.2450 while the comparable number for the CI component stocks is only 0.0411. An additional interesting observation is that the magnitude of autocorrelations estimated for the overnight nontrading period is not much different between the CI portfolio returns and the CI component stock returns. Second, the intraday returns of the small-size subgroup have consistently exhibited smaller autocorrelations than those of the large-size subgroup,

Table 6
Correlations of Returns for Intraday Intervals

Correlation coefficients are computed between returns in each of the four time intervals (morning session, lunch break, afternoon session, and overnight period) and the returns in the immediately preceding intervals. Intraday returns are denoted by r_k, where k = 1,2,3, and 4: k = 1 for afternoon close to morning open, k = 2 for morning open to morning close, k = 3 for morning close to afternoon open, and k = 4 for afternoon open to afternoon close. $\rho(r_k,r_{k-1})$ signifies the correlation between r_k and the return over the immediately preceding interval. Statistical significance is noted by ** at the 0.01 level, * at the 0.05 level, and $^+$ at the 0.10 level. The number of negative ρ is shown in brackets with the denominator signifying the number of stocks in the sample.

Period	Composite Index Return Variance (x10^4)	CI Component Stock Return Variance (x10^4)				
		Whole Sample	Subgroup by Trading Volume		Subgroup by Firm Size	
			Low	High	Small	Large
$\rho(r_2,r_1)$	0.0413	-0.0003 [45/82]	0.0034 [13/27]	-0.0152 [17/27]	-0.0110 [14/27]	0.0243* [14/27]
$\rho(r_3,r_2)$	-0.0268	-0.0219* [42/82]	-0.0464$^+$ [13/27]	-0.0308* [16/27]	-0.0391 [15/27]	-0.0217 [14/27]
$\rho(r_4,r_3)$	-0.1144*	-0.0187* [55/82]	0.0235 [13/27]	-0.0574** [24/27]	-0.0128 [17/27]	-0.0194$^+$ [17/27]
$\rho(r_1,r_4)$	0.1836**	-0.0285 [44/82]	-0.0783$^+$ [16/27]	0.0129 [11/27]	0.0094 [12/27]	-0.0283 [16/27]

indicating the strong influence of firm size on the magnitude of autocorrelations. Third, the low-volume subgroup has larger autocorrelations during the morning and afternoon trading sessions than the high-volume subgroup. However, the reverse holds true during the nontrading periods.

Panel B of Table 7 reports the averages of first-order autocorrelations of the four interday return series. As expected, none of the autocorrelations estimated for the CI index returns are negative, whereas the 24 hour interday returns measured using morning open prices have negative autocorrelations of -0.0114 for the CI component stocks. This suggests that morning open prices tend to reverse at the individual firm level. However, only the morning open-to- morning open return show small negative autocorrelations which suggest a mild price overreaction, while the other return series display positive autocorrelations. Furthermore, negative autocorrelations observed at the morning open are limited to the high-volume subgroup and the small-size subgroup. Even though we expected that the small-size firms show more frequent price reversals, the negative autocorrelation observed for the high-volume subgroup is surprising.

It is expected that the autocorrelations estimated for small-size firms are smaller than those estimated for large size-firms. For example, the morning open-to morning open returns show a negative autocorrelation (-0.0391) for small size-firms but a positive autocorrelation (0.0188) for large size-firms. Unlike the firm size-based subgroups, the trading volume-based subgroups show mixed results. At the market open in the morning and at the market close in the afternoon, interday returns of the high-volume subgroup have smaller autocorrelations than those of the low-volume subgroup. The reverse is true at the morning close and the afternoon open.

5. SUMMARY AND CONCLUSION

We examine the return and risk behaviour of the Malaysian stock prices using the KLSE CI and its component stocks. Consistent with the index return behaviour observed for the US and Japanese stock markets, intraday CI portfolio returns tend to be large at the beginning and at the end of each of the two trading sessions of a trading day. Also, the standard deviations of intraday returns show roughly a similar U-shaped curve during the morning trading session. However, the afternoon session does not follow the expected similar pattern.

Table 7
First-Order Autocorrelations for Intraday and Interday Returns

The first-order autocorrelations of intraday and interday returns are computed for both the CI component stocks and the CI portfolio. They are also computed for subgroups of stocks partitioned by trading volume and firm size. MO, MC, AO, and AC denote morning open, morning close, afternoon open, and afternoon close, respectively. Statistical significance is noted by ** at the 0.01 level, * at the 0.05 level, and $^{+}$ at the 0.10 level. The number of positive ρ is shown in brackets with the denominator signifying the number of stocks in the sample.

Period	Composite Index	CI Component Stocks				
		Whole Sample	Subgroup by Trading Volume		Subgroup by Firm Size	
			Low	High	Small	Large
A. Intraday Returns						
Overnight	0.0777	0.0632** [66/82]	0.0594* [21/27]	0.0669** [24/27]	0.0440** [20/27]	0.0751** [23/27]
Morning Trading Session	0.2450**	0.0411** [56/82]	0.0731** [20/27]	0.0332** [23/27]	0.0301^{+} [17/27]	0.0596** [22/27]
Lunch Break	0.0529	-0.0059 [39/82]	-0.0024 [13/27]	-0.0009 [14/27]	-0.0138 [12/27]	0.0067 [17/27]
Afternoon Trading Session	0.0822^{+}	0.0245* [50/82]	0.0454* [18/27]	-0.0093 [14/27]	-0.0109 [13/27]	0.0445** [19/27]
B. Interday Returns						
MO - MO	0.2723	-0.0114 [39/82]	0.0155 [18/27]	-0.0394* [6/27]	-0.0391 [11/27]	0.0188 [17/27]
MC - MC	0.2836	0.0770** [71/82]	0.0636** [22/27]	0.0762** [25/27]	0.0562** [24/27]	0.0970** [24/27]
AO - AO	0.2869	0.0302* [58/82]	0.0051 [19/27]	0.0446 [20/27]	0.0221 [19/27]	0.0335 [18/27]
AC - AC	0.2591	0.0582** [65/82]	0.0603* [21/27]	0.0487** [21/27]	0.0495** [22/27]	0.0740** [22/27]

Although the overall behaviour of intraday return and risk of the CI component stocks are similar to those of the CI portfolio some differences are observed. First, intraday returns measured by the CI component stocks tend to be greater than the CI portfolio returns during the trading periods, while the opposite is true during the nontrading periods. From this, we conclude that the dominance of a few large-capitalisation stocks over the CI causes the results. Second, the differences in market volatility measured for individual stocks in the trading and nontrading periods are not as great as those observed for the index returns. Nevertheless, the results confirm evidence that private information is disclosed during trading hours.

Interday CI portfolio return and risk reveal several interesting observations. First, interday returns are all negative and steadily decline as trading proceeds during the study period. Second, the standard deviations do not follow a U-shaped curve as observed by Lockwood and Linn (1990) and Gerety and Mulherin (1991, 1992) on the basis of the Dow-Jones Index returns. The fact that: (i) the variance of interday 24-hour returns does not decline during the day; and (ii) the afternoon session displays greater variance than the morning session may imply that trading is not stabilizing at the KLSE. Third, the variance of morning open-to-morning open returns is not different from that of the afternoon close-to-afternoon close returns. Meanwhile, the respective variance of morning close-to-morning close returns and afternoon open-to-afternoon open returns is not different from that of the afternoon close-to afternoon close returns. The results are similar to the findings of Chang et al. (1993) for the TOPIX index returns, but are contradictory to Gerety and Mulherin (1992) who find that the open-to-open returns have much higher variance than the close-to-close returns. This contradiction may be partially explained by the difference in trading volume.

Interday return and risk of the CI component stocks, however, render a different picture. First, unlike the negative CI portfoliio returns, the morning open-to-morning open returns and the morning close-to-morning close returns are positive at the individual firm level. Second, the variance of the morning open-to-morning open returns is the largest, followed by the variances of the morning close-to-morning close returns, afternoon open-to-afternoon open returns, and afternoon close-to-afternoon close returns. In fact, the smallest variance is observed at the afternoon close. Thus, at the individual stock level, KLSE trading is stabilising.

Trading volume and firm size are important for the KLSE stocks in explaining th different return and risk behaviour of interday and intraday prices. However, the subgroup of CI component stocks partitioned on the basis of trading volume and firm size produc mixed results in explaining price reversals. Generally, one would expect frequent pric reversals for the small-size subgroup and stocks with low trading volume. The analysis o intraday variances renders empirical support to this hypothesis, but the analysis o correlations between returns in each of the four intraday time-intervals and the returns i the immediately preceding intervals does not.

First-order autocorrelations confirm the differences between the CI portfolio return and the CI component stock returns. For example, intraday returns of the CI componen stocks have consistently exhibited smaller first-order autocorrelations than the CI portfoli returns. Also, none of the autocorrelations estimated for the CI index interday returns ar negative, whereas the 24-hour interday returns measured using morning open prices hav negative autocorrelations for the CI component stocks. This suggests that the morning ope prices tend to reverse at the individual firm level. Only the morning open-to-morning ope returns show mild negative autocorrelations, while the other return series display positiv autocorrelations.

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