Intraday Relationship between Taiwan and Major Asia Equity Markets

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Abstract

Fifteen-minute intraday returns for Taiwan, Tokyo and Hong Kong stock markets are used to examine the interactions between Taiwan and Tokyo/Hong Kong stock markets. The period in study is from August 1991 to June 1992. There are some evidence of market in teractions as well as weak evidence of market inefficiency in these markets. Taiwan intraday returns are impacted by preceding returns in Tokyo and Hong Kong stock markets, while Hong Kong is affected by Taiwan stock market in the same way too. Tokyo stock market is not affected by Taiwan at all. However, R-squares of the OLS results are too low to demonstrate the importance of interactions. A further examination of the sample of large changes of returns greater than 1% weakens the previous OLS evidence of interactions. Finally we collect the news reports for these three stock markets when their market index changes are greater than 1%. After searching for major factors that affected these market returns in the same period as that in study, we find that only a small percentage of large changes in Taiwan stock market are caused by large changes in Tokyo or U.S. stock markets, and not by Hong Kong stock market at all. Tokyo and Hong Kong stock markets are never reported as affected by changes in Taiwan stock market. This study shows that Taiwan, Tokyo and Hong Kong stock markets may interact with each other, but mostly through important international events. They are not integrated markets. The evidence of market inefficiency in Taiwan and Hong Kong stock markets is weak.

Key Words: Intraday returns, stock markets, market interactions, market inefficiency.

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I. INTRODUCTION

Recently a majority of Taiwan investors have access to on-line stock information system. One of the information provided is the international stock indexes. Along with Taiwan Weighted Average Stock Index, there are Nikkei and Hang-Shen indexes. Every fifteen-minute closing index is recorded for these three markets each day. Many Taiwan investors use the information on current changes in Tokyo and Hong Kong stock market to help themselves in making investment decision. Thus, it is interesting to investigate whether this information does enhance the relation between Taiwan stock market and these two major Asia stock markets. In other words, we want to examine whether Taiwan stock market does follow Tokyo and Hong Kong stock markets closely. Also examined is whether Nikkei and Hang-Shen index returns are affected by changes in Taiwan stock market.

Recent studies on international capital markets have focused on the following areas: the merits of diversification, the co-movement of stock prices, or the lead-lag relationship among market indices. Grubel (1968), Levy and Sarnat (1970), Solnik (1974) have employed a mean-variance portfolio framework to examine the merits of international diversification. Eun and Resnick (1984) examines twelve models for estimating the correlation structure of international stock markets. Lessard (1976), Stehle (1977), and Adler and Dumas (1973) have investigated the related issue of segmented and internationally integrated markets. Panton, Lessig and Joy (1976), Ripley (1973), Robichek, Cohn, and Pringle (1972), and Maldonado and Saunders (1981) have addressed the co-movement of world stock exchange indices, or the intertemporal stability of international stock market relationship. Lead-lag relationship have been examined by Agmon (1974), Granger and Morgenstern (1970), Hillard (1979), Eun and

Shin (1989), Hamao, Masulis and Ng (1990), Becker, Finnerty and Gupta (1990), Becker, Finnerty and Tucker (1992) and Yang (1992).

Agmon (1974) used monthly data to examine the relationship among the stock markets of Germany, Japan, the United Kingdom and the United States. No evidence of leads or lags were found. Granger and Mogenstern (1970) employ spectral analysis for stock indices in eight countries on a weekly basis and address that "there is little interrelationship between different stock market exchanges around the world." But they suggest that markets would not likely be independent if a world-wide financial or political crisis occurred. Hillard (1979) examine the structure of international equity market indices during a world-wide financial crisis - the OPEC embargo. He uses the cross-spectral technique based on daily data and arrives at the same conclusion as that in Agmon (1974). Eun and Shim (1989) investigates the international transmission of stock market movements by estimating a nine-market vector autoregression (VAR) system. He uses daily data and obtains an evidence of a substantial amount of interdependence among national stock markets. Most of the responses to a shock are completed within two days. Therefore, he indicates that the VAR analysis generally supports the notion of informationally efficient international stock markets. His paper also indicates that the U. S. stock market is found to be the most influential market in the world.

Hamao, Masulis and Ng (1990) employ GARCH model to examine the short-run interdependence of prices and price volatility across three major international stock markets. They find "daily stock returns measured from close-to-open and open-to-close to be approximated by a GARCH(1,1)-M model." Evidence of price volatility spillovers from New York to Tokyo, London to Tokyo and New York to London is observed. Becker, Finnerty and Gupta (1990) find the S&P 500 returns in the previous day have a great impact on

Nikkei open-to-close returns. That is an evidence of market inefficiency. But later Becker, Finnerty and Tucker (1992) indicate that the impact of the lagged S&P 500 returns on the Nikkei open-to-close returns can be attributed to a sticky Japanese opening value associated with the use of nonsynchrous index data, which is not indicative of market inefficiency.

It is not until recent years that Asia Pacific stock markets attract the attention of international funds managers and other major investors. The prosperity of economy for the Four Dragons[1] and Japan push their stock indices up to record highs. For example, Japanese Nikkei 225 Index and Taiwan Weighted Average Index (TWA) hit historical high in 1989 and 1990 respectively. Their daily trading volume used to top the world-wide capital markets. However, by late July 1992, the Nikkei index has dropped sixty percent and TWA index sixty-five percent, while Hong Kong Hang-Shen Index continuously set record highs to the six thousand level. The economic conditions in these Asia-Pacific countries are varying, so are their stock markets.

A number of research on Asia Pacific stock markets focused on the relations between Japanese stock market and other major ones. However, few papers examine the relations among stock markets in Taiwan, Tokyo and Hong Kong. Furthermore, most of previous papers use daily or monthly data except Becker et al.(1992). Intraday returns data reveal the interaction in different stock markets better than daily returns. The reaction of one market to a change in another market may be accomplished in a few minutes. Daily data cannot reflect this true response, because other noises may cause the stock returns to reverse and eventually make this response immaterial. Thus, in our study, 15-minute closing indices are used to further

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[1] Taiwan, Hong Kong, Singapore and Korea.

examine the interaction among stock markets.

The trading intervals of Taiwan stock market are not overlapped with U.S. stock market, but are with Tokyo and Hong Kong Stock markets.[2] Therefore, intraday stock returns, instead of daily returns, can be used to examine the almost instantaneous relations between any two of these three markets. The relations between current intraday returns on one market and lagged returns on another market are examined.

The purpose of this paper is to investigate the intraday lead-lag relationship between Taiwan and Tokyo/Hong Kong stock market indexes. These stock markets have different opening and closing hours, that facilitate a further study of the lead-lag relations among these market price movements. Fifteen-minute closing indexes for these markets are collected each day during the period from August 1, 1991 to June 30, 1992. Returns on overlapping and non-overlapping trading intervals for each pair of markets are calculated and used to investigate the impacts of one market on the other. As Hillard (1979) addressed " in keeping with efficient markets, we expected that if coupling exists between markets, there should be no lag in real time reactions among the indices. " However, we allow 15 minutes for the information of price movements of one market to be delivered to another markets. Thus, a correlation between current 15-minute returns in one market and lagged returns in another is not an evidence of market inefficiency. Furthermore, the opening index is defined as the opening 15-minute closing index. The significant impact of a lagged return in one market on the close-to-open

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[2] Tokyo, Taiwan and Hong Kong stock markets opens at 8 a.m., 9 a.m. and 10 a.m. Taiwan Time, respectively. Tokyo's morning session closes at 10:00, resumes at 11:15 and the afternoon session closes at 14:00 Taiwan time. Hong Kong's morning session closes at 12:15, resumes at 14:30 and finally closes at 16:00 Taiwan time.

returns in another market is not an evidence of market inefficiency either. [3]

Section II introduces data and the methodology used. Due to the availability of data, only Nikkei, TWA and Hang Shen fifteen-minute intraday indices are collected. Section III reports empirical results. We find Taiwan stock market returns are affected by changes in current TSE cumulative intraday returns and HKSE late afternoon returns in a preceding day. Hong Kong stock market returns are affected by TWNSE early session and cumulative intraday returns. Tokyo stock market returns are not affected by all type of TWNSE returns. These results show that Taiwan and Hong Kong stock markets are inefficient in the sense that the impacts from other markets are reflected beyond 15 minutes and even through the close of markets. Tokyo stock market has no evidence of market inefficiency. We go further to examine whether one market is impacted when another markets have large changes greater than 1%, 2% and 3%. The later results do not enhance the OLS results discussed earlier. Finally, we investigate major factors that affect returns in these three markets based on news reports, when the changes of market indexes are greater than 1%. We find that only a small perentage of large changes in Taiwan stock market can be attributed to large changes in Tokyo and New York stock markets. Tokyo and Hong Kong stock markets are never reported as affected by changes in Taiwan stock market.

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[3] Hamao, Masulis and Ng (1990) used the opening 15-minute close index as the opening index. Becker, Finnerty and Tucker (1992) indicated that a significant correlation between current Nikkei close-to-open returns and lagged DJ30 returns does not violate market efficiency.

II. DATA AND METHODOLOGY

A. Data

The closing indexs of each fifteen-minute interval for Nikkei 225, TWA and Hang Shen from August 1991 to June 1992 are collected from Russel's on-line system.[4] Close-to-close, close-to-open, open-to-close, 15-minute, 30-minute, 45-minute and 60-minute returns are then calculated. Here opening index is defined as the closing index of the first 15-minute interval. For each 15-minute interval, 15, 30 and 45-minute returns are calculated too. Of the three capital markets, Tokyo opens first, and Hong Kong closes last. Tokyo opens at 8 a.m., while Hong Kong closes at 4 p.m. Taiwan time. There are 8 hours from the opening of Japanese market to the closing of Hong Kong market. If we divided this eight hours into 15-minute intervals, we have thirty two interv als. Thus, Japanese stock markets opens at interval 1, Taiwan at interval 5 and Hong Kong interval 9; Taiwan stock market closes at interval 16, Japan at interval 24 and Hong Kong interval 32.

Taiwan stock market opens on Saturday, while Tokyo and Hong Kong stock markets close. Therefore, regardless of local holidays, the number of trading days for Taiwan stock market is different from that of Tokyo or Hong Kong stock markets. Tokyo and Hong Kong open and close in the same days of each week except local holidays. The time series of returns data for each pair of Taiwan,

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[4] Russel is a computer service firm located in Taipei, Taiwan, which provides on-line information on local and international financial indices. Only Nikkei, TWA and Hang Shen closing indices are available for each 15-minute trading interval.

Tokyo and Hong Kong stock markets are thus not synchronous. As a result, our empirical analyses are rather cross-sectional type of analyses than time-series type of analyses.[5]

B. Methodology

To facilitate the understanding of the relations among changes in Tokyo, Hong Kong and Taiwan Stock markets, the trading intervals of these markets are examined. Tokyo Stock Exchange opens at 8:00 a.m.[6] and closed at 2:00 p.m. There is no trading between 10:00 a.m. and 11:15 a.m. Hong Kong Stock Exchange opens at 10:00 a.m. and closes at 4:00 p.m., no trading between 12:30 p.m. and 2:15 p.m.[7] Taiwan Stock Exchange opens at 9:00 a.m. and closes at 12:00 p.m. Following are figures that delineate three pairs of the trading hours of these three markets. Figure 1 is the daily trading interval for Taiwan and Tokyo and Figure 2 for Taiwan and Hong Kong. These figures help to investigate how changes in one market may have impact on that in another.

The purpose of this paper is to examine the relations between TWA returns and Nikkei/Hang-Shen returns.[8] Market efficiency can be tested by examining whether an equity market reflect to changes in another market quickly. As Becker, Finnerty and Tucker (1992) indicate, the significant relation between current TSE open-to-close

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5 Since the time series data for these markets are not continuous,it is difficult and may be meaningless to estimate serial correlation of residuals of each of the regression models. The Durbin-Watson statistics are not useful here.

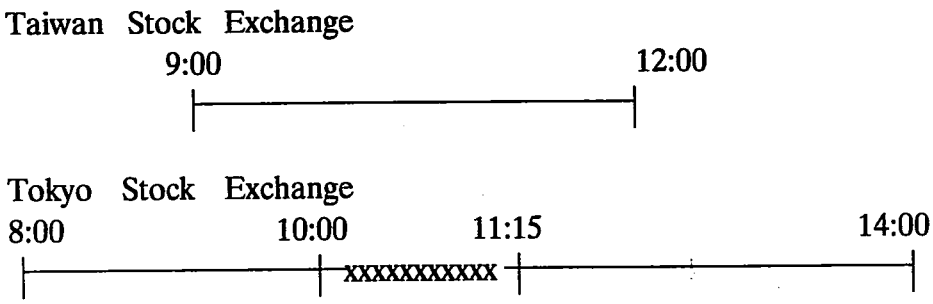
6 Each of the time referred in this paper is Taiwan time which is one hour late than Tokyo.

7 The trading hours for Hong Kong Stock Exchange had changed twice during the period in study. However, it does not affect our study.

8 Hereafter, we use TSE, HK and TWN to denote Nikkei, Heng Shen and TWA Index respectively.

returns and preceding NYSE close-to-close returns will be a violation of market efficiency. In other words, the impact of a change in one market on another should be reflected quickly.[9]

Figure 1. Trading intervals for Taiwan Stock Exchange and Tokyo Stock Exchange



TSE opens earlier and closes later than TWNSE.[10] The possible impacts of TSE on TWNSE are : (1) TSE returns after the close of TWNSE, i.e., TSE returns between 12:00 p.m. and 2:00 p.m., in the previous day; (2) current TSE returns before the opening of TWNSE, i.e., TSE returns between 8:00 a.m. and 9:00 a.m. and (3) contemporary changes in TSE returns. The models are as follow.

$$TWN_{CC} = a_1 + b_1\ TSE_{C\text{-}C} + e_1 \quad (1)$$

$$TWN_{15} = a_1 + b_1\ TSE_{LA} + e_1 \quad (2)$$

$$TWN_{15} = a_1 + b_1\ TSE_{E} + e_1 \quad (3)$$

$$TWN_{15} = a_1 + b_1\ TSE_{E} + c_1\ TSE_{LA} + e_1 \quad (4)$$

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9 The smallest time interval in this paper is 15 minutes. It is assumed that market is efficient if the impact from other markets is effected only in the subsequent 15 minutes.

10 TWNSE, TSE and HKSE denote Taiwan, Tokyo and Hong Kong stock exchange respectively.

$$TWN_{16\text{-}C} = a_1 + b_1\ TSE_E + e_1 \quad (5)$$
$$TWN_{16\text{-}C} = a_1 + b_1\ TSE_E + c_1\ TSE_{15} + e_1 \quad (6)$$
$$TWN_{16\text{-}C} = a_1 + b_1\ TSE_E + c_1\ TWN_{15} + e_1 \quad (7)$$
$$TWN_{16\text{-}60} = a_1 + b_1\ TSE_E + e_1 \quad (8)$$
$$TWN_{16\text{-}60} = a_1 + b_1\ TSE_E + c_1\ TSE_{15} + e_1 \quad (9)$$
$$TWN_{16\text{-}60} = a_1 + b_1\ TSE_E + c_1\ TWN_{15} + e_1 \quad (10)$$
$$TWN_t = a_1 + b_1\ TSE_t + e_1 \quad (11)$$
$$TWN_t = a_1 + b_1\ TSE_{t\text{-}1} + e_1 \quad (12)$$
$$TWN_t = a_1 + b_1\ TSE_{T\text{-}1} + e_1 \quad (13)$$
$$TWN_t = a_1 + b_1\ TSE_{T\text{-}2} + e_1 \quad (14)$$
$$TWN_t = a_1 + b_1\ TSE_{t\text{-}1} + c_1\ TSE_{T\text{-}2} + e_1 \quad (15)$$
$$TWN_t = a_1 + b_1\ TWN_{t\text{-}1} + c_1\ TSE_{T\text{-}2} + e_1 \quad (16)$$

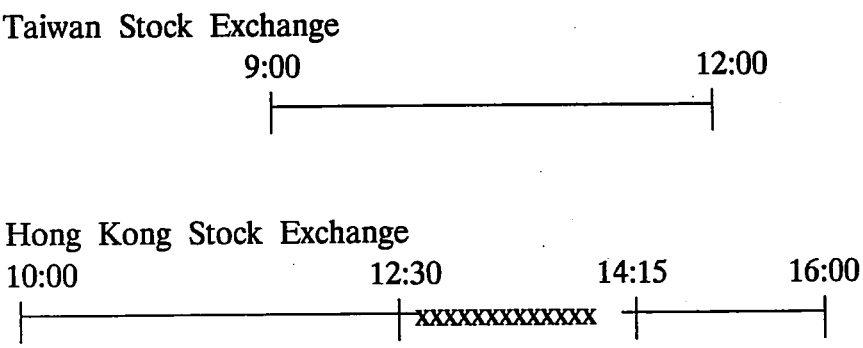
where TWN = TWN returns and TSE = TSE returns;
subscripts:
C-C = close to close;
LA = the interval from 12:00 to 14:00 in the previous day;
E = the interval from 8:00 a.m. to 9:00 a.m. in the same day;
15 = the opening fifteen minutes in the morning session ;
16-C = 16th minute to close;
16-60 = 16th minute to 60th minute;
t = t th interval; the length of each unit interval (t) is 15 minutes;
T-1 = opening to interval T-1; here T-1 stands for cumulative intra-day returns from opening to T-1; -1 means one unit interval lagged;
T-2 = opening to interval T-2; -2 means two unit intervals lagged.

The possible impacts of TWNSE returns on TSE returns are (1) TWNSE close-to-close returns on the following TSE returns after the close of TWNSE, (2) lagged (cumulative) TWNSE returns in the same trading day on TSE returns. Following are the models.

$$TSE_{L15} = a_2 + b_2\ TWN_{C\text{-}C} + e_2 \quad (17)$$
$$TSE_{L16\text{-}C} = a_2 + b_2\ TWN_{C\text{-}C} + e_2 \quad (18)$$
$$TSE_{L16\text{-}C} = a_2 + b_2\ TSE_{L15} + c_2\ TWN_{C\text{-}C} + e_2 \quad (19)$$
$$TSE_t = a_2 + b_2 TWN_t + e_2 \quad (20)$$
$$TSE_t = a_2 + b_2\ TWN_{t\text{-}1} + e_2 \quad (21)$$
$$TSE_t = a_2 + b_2\ TWN_{T\text{-}1} + e_2 \quad (22)$$
$$TSE_t = a_2 + b_2\ TWN_{T\text{-}2} + e_2 \quad (23)$$
$$TSE_t = a_2 + b_2\ TWN_{t\text{-}1} + c_2\ TWN_{T\text{-}2} + e_2 \quad (24)$$
$$TSE_t = a_2 + b_2\ TSE_{t\text{-}1} + c_2\ TWN_{T\text{-}2} + e_2 \quad (25)$$

where subscript L15 = the interval from 12:00 to 12:15 ;
L16-C = the interval from 12:16 to 14:00 (close);
other notations are defined as afore-mentioned.

Figure 2. Trading intervals for Taiwan Stock Exchange and Hong Kong Stock Exchange



The TWNSE returns before the opening of HKSE may have an impact on subsequent HKSE returns. In addition, current TWNSE returns may affect subsequent HKSE returns. The models can be formed as follows.

$$HK_{C\text{-}C} = a_1 + b_1\ TWN_{C\text{-}C} + e_1 \quad (26)$$
$$HK_{15} = a_1 + b_1 TWN_E + e_1 \quad (27)$$

$$HK_{16\text{-}C} = a_1 + b_1 TWN_E + e_1 \quad (28)$$
$$HK_{16\text{-}C} = a_1 + b_1 TWN_E + + c_1\ TWN_{15} + e_1 \quad (29)$$
$$HK_{16\text{-}C} = a_1 + b_1 HK_{15} + c_1\ TWN_E + e_1 \quad (30)$$
$$HK_{16\text{-}60} = a_1 + b_1\ TWN_E + e_1 \quad (31)$$
$$HK_{16\text{-}60} = a_1 + b_1\ TWN_E + c_1\ TWN_{15} + e_1 \quad (32)$$
$$HK_{16\text{-}60} = a_1 + b_1\ HKSE_{15} + c_1\ TWNSE_E + e_1 \quad (33)$$
$$HKL_{15} = a_1 + b_1\ TWN_{C\text{-}C} + e_1 \quad (34)$$
$$HKL_{16\text{-}C} = a_1 + b_1\ TWN_{C\text{-}C} + e_1 \quad (35)$$
$$HKL_{16\text{-}C} = a_1 + b_1\ HKL_{15} + C_1\ TWN_{C\text{-}C} + e_1 \quad (36)$$
$$HK_t = a_1 + b_1\ TWN_t + e_1 \quad (37)$$
$$HK_t = a_1 + b_1\ TWN_{t\text{-}1} + e_1 \quad (38)$$
$$HK_t = a_1 + b_1\ TWN_{T\text{-}1} + e_1 \quad (39)$$
$$HK_t = a_1 + b_1\ TWN_{T\text{-}2} + e_1 \quad (40)$$
$$HK_t = a_1 + b_1\ TWN_{T\text{-}2} + c_1\ TWN_{t\text{-}1} + e_1 \quad (41)$$
$$HK_t = a_1 + b_1\ TWN_{T\text{-}2} + c_1\ HK_{t\text{-}1} + e_1 \quad (42)$$

where HK = HK returns and TWN = TWN returns;
subscripts:

C-C = close to close;

E = the interval from 9:00 a.m. to 10:00 a.m.;

15 = the opening fifteen minutes in the morning session ;

16-C = the 16th minute to close;

16-60 = the 16th minute to 60th minute;

L15 = the first 15-minute HKSE returns right after the close of TSE;

L16-C = the 16th-minute-to-close HKSE trading interval right after the close of TSE.

t = t th interval; the length of each unit interval (t) is 15 minutes;

T-1 = opening to interval T-1; here T-1 stands for cumulative intra-day returns from opening to T-1; -1 means one unit interval lagged;

T-2 = opening to interval T-2; -2 means two unit intervals lagged.

The HKSE returns after the close of TWNSE in a preceding trading day may affect current TWNSE returns, so do contemporary HKSE returns in the same day. The following models are used to examine possible impacts of HKSE returns on TWNSE returns.

$$TWN_{C\text{-}C} = a_2 + b_2\, HK_{C\text{-}C} + e_2 \quad (43)$$
$$TWN_{15} = a_2 + b_2\, HK_{LA} + e_2 \quad (44)$$
$$TWN_{16\text{-}C} = a_2 + b_2\, HK_{LA} + e_2 \quad (45)$$
$$TWN_{16\text{-}C} = a_2 + b_2\, HK_{LA} + c_2\, TWN_{15} + e_2 \quad (46)$$
$$TWN_t = a_2 + b_2\, HK_t + e_2 \quad (47)$$
$$TWN_t = a_2 + b_2\, HK_{t\text{-}1} + e_2 \quad (48)$$
$$TWN_t = a_2 + b_2\, HK_{T\text{-}1} + e_2 \quad (49)$$
$$TWN_t = a_2 + b_2\, HK_{T\text{-}2} + e_2 \quad (50)$$
$$TWN_t = a_2 + b_2\, HK_{t\text{-}1} + c_2\, HK_{T\text{-}2} + e_2 \quad (51)$$
$$TWN_t = a_2 + b_2\, TWN_{t\text{-}1} + c_2\, HK_{T\text{-}2} + e_2 \quad (52)$$

where, C-C = close to close;
LA = the interval from 12:00 to 16:00 ;
other variables are defined as before.

III. EMPIRICAL RESULTS

A. Basic Statistics

The trading interval each day is divided into smaller intervals: 15, 30, 45 and 60 minute-intervals. Every 15 minutes, 15, 30, 45 and 60-minute returns are calculated, if data are available. Basic statistics for returns, such as maximums, minimums, means and standard de-

viations are calculated for these intervals for the period in study. Results in Table 1, 2 and 3 show that returns on equity markets in Taiwan, Japan and Hong Kong have different pattern of statistics.

(A) Taiwan Stock Market

The highest mean intraday return, whether 15, 30, 45 or 60-minute interval, occurs in the first trading interval. The lowest mean returns of 15, 30,45 and 60-minute interval occur in the second interval. The highest variability occurs in the first interval and the second highest in the last interval, for all intervals. Both the maximum and minimum returns occur in the first interval.

(B) Japan Stock Market

There are no patterns for mean, maximum and minimum intraday returns in the Japanese market, except that the standard deviation is highest in the first trading interval, for all length of intervals. It is interesting to find that, during the studying period, Japanese stock market does not have a highest mean return in the first interval to reflect the overnight return.

(C) Hong Kong Stock Market

The highest maximum, mean and standard deviation of HKSE intraday returns lie in the first trading interval, for all length of intervals. There exist no patterns for minimum.

Summary

The highest mean and standard deviation occur in the first trading interval for Taiwan and Hong Kong stock markets. However, we are not able to observe this phenomenon for Japanese market. Interestingly, for Taiwan stock market, the second highest variability occurs in the last trading interval. In other words, the first and last

trading intervals are the most volatile of all.

B. Intraday Relationship between Taiwan and Major Asia Equity Markets

(A) Impacts of TSE Returns on TWNSE Returns

Table 4A[11] list the first empirical results of the impact of TSE returns on TWNSE returns. A number of regressions are done to examine whether or not the preceding-day afternoon returns and the current early-morning returns of TSE have any impact on the TW NSE opening 15-minute returns as well as the subsequent 16th-minute-to-close returns of the same day. Each of the regression coefficients, except the constant term, are not significant. Furthermore, adjusted R-squares of these regressions are very low. T his also indicates that changes in these TSE returns contribute little to the explanation of changes in TWNSE returns.

However, as we look into the second regression results, as listed in Table 4B, the lag-one and lag-two-interval cumulative TSE returns do have significantly positive relations with current 15-minute returns. Current TWNSE 15-minute returns have no relation with lag-one TSE 15-minute returns.

It seems that investors in Taiwan pay attention to the lag-one and lag-two-interval cumulative TSE returns in the same day. Information on the current TSE index can be acquired in 15 minutes for most investors in Taiwan. The significant correlation between current 15-minute TWNSE returns and lag-one TSE returns is not a violation of market efficiency. However, the significant correlation between current TWNSE returns and the lag-two TSE cumulative returns maybe a violation of market efficiency. Taiwan stock market reacts to the changes in Tokyo stock market not quickly enough.

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11 Table 4A denotes panel A in Table 4, vice versa for other tables and panels.

It is observed that sometimes large price falls in Tokyo stock market have negative impact on Taiwan stock markets, but not always. Instability of political condition in Taiwan may also reduce the positive impact of jumps from Tokyo stock market. That may help to explain why the R squares are so low.

(B) Impacts of HKSE returns on TWNSE returns

Results of the relation between HKSE and TWNSE returns are listed in Table 5. Except that HKLA, the HKSE returns in the interval between 12:00 a.m. and 16:00 p.m. in a preceding day, have positive impact on current TWN opening 15-minute returns, there are no other impacts.

(C) Impacts of TWNSE returns on TSE returns

Results in Table 6 show that close-to-close TWNSE returns do not affect the TSE returns after the close of TWNSE, i.e., the TSE returns in the interval between 12:00 a.m. and 14:00. p.m. Cumulative TWNSE intraday returns such as TWN_{T-1} and TWN_{T-2} do not have any impact on subsequent TSE returns either. This is reasonable. Investors in Tokyo are major international investors and they don't treat TWNSE as a major security exchange in world-wide capital markets. They don't expect changes in Taiwan stock market to have any impact on Tokyo stock market.

(D) Impacts of TWNSE returns on HKSE returns

The impacts of TWNSE returns on HKSE returns are listed in Table 7. TWNE, the TWNSE one-hour returns before the opening of HKSE, have significant and positive impacts on HKSE 16th-to-60th-minute returns, but not on the opening 15-minute returns. Cumulative intraday returns, TWN_{T-1} and TWN_{T-2}, do positively affect subsequent HKSE 15-minute intraday returns, HKSEt. Hong Kong

investors do not ignore the information on changes in TWNSE in the first trading hour before HKSE opens, as well as the information on cumulative TWNSE intraday returns, TWN_{T-1} and TWN_{T-2}. The significant regression coefficient of TWN_{T-2} may indicate that HKSE do not react to the changes in TWNSE quickly, which may lead to market inefficiency.

C. Reactions of One Stock Market to Large Changes in Another Stock Markets

To further understand how one market may have been affected when another market has large changes, we examine the sign of changes of one market when another market have large changes of more than 1%, 2% or 3%. High proportion of chanegs with signs in the same (opposite) direction is an evidence of positive (negative) impact from another market. The proportion of changes with correct signs is a better measure than mean changes when used to examine the impact from another market, because the mean changes may be biased by a small number of large changes.

Following are the empirical results of one market's reaction in terms of proportion of changes with the same sign when another market has large changes of more than 1%, 2% or 3%.

(A) The Impact of Large TSE and HKSE Changes on TWNSE returns

1. Large positive changes of TSE and HKSE

There is a significant impact of HK_{LA} on TWN_{15} as listed in Table 5A. This finding is further supported by the correspondent proportion of 4/5 in Table 8A. In other words, when HK_{LA} returns is greater than 1%, [12] there are four out of five times that TWN returns are also positive. The late afternoon HK returns in a previous day do have an impact on the opening TWN returns.

Though there is a 000significant relation between TWN_t and TSE_{T-1} (TSE_{T-2}) in Table 4B, we find no further support in Table 8D through 8E. That indicates when cumulative TSE changes are greater than 1%, 2% or 3%, we find no apparent relation between TWN_t and TSE_{T-1} and TSE_{T-2}. Thus, the significant OLS results may be meaningless.

Yet there are cases when the OLS parameters are not significant, but the value of proportions in Table 8A may be greater than 60%. For example, the proportion is 19/29 for the impact of TWN_E on HK_{15}, i.e., the impact of TWN early morning returns on the HKSE opening 15-minute returns. That means there is a 65.5% chance that HK_{15} returns will be positive when TWN_E are greater than 1%. If we use 60% as a benchmark, we have more, such as TSE on TWN_{15} when changes are greater than 1%; TWN_E on HK 15 and HK_{16-C}, TSE_E on TWN_{15} and TWN_{16-60}, when greater than 2%; TSE_Eon HK_{15} and HK_{16-C}, and TSE_E on TWN_{15}, when greater than 3%.

2. Large negative changes of TSE and HKSE

Results are listed in of Table 9A and 9D which are also correspondent to 4A, 4B, 5A and 5B. Table 4A shows no significant relations between TWN returns and TSE returns. Table 5A indicates a significant relation between HK_{LA} and TWN opening fifteen-minute returns. Table 4B shows significant and positive relation between TWN_t and TSE_{T-1}(TSE_{T-2}). Table 5B shows no relation between TWN_t and HKSE intraday returns at all.

The proportion of same sign of TWN_{15} correspondent to HK_{LA} is 1/3 in Table 9A, not a strong support for the finding in Table 5A; but is 1/1 in 9B and 9C. When the changes of TSE_{T-1} or TSE $_{T-2}$ are greater than 1%, 2% or 3%, there are no strong evidence

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12 HK_{LA} returns are never greater than 2% in the period in research.

that TWN_t will be positive. That is not consistent with the OLS results in Table 4B.

Similar to last section, there are cases when the OLS parameters are not significant, but the value of proportions in Table 9A may be greater than 60%. In all, when TSE or HKSE changes are negative, the proportions of same sign of TWN returns do not provide support to the findings of OLS results.

(B) The Impact of Large TWNSE Changes on TSE and HKSE Returns

1. Large positive changes of TWNSE

There are no significant impact of TWN returns on TSE returns as shown in Table 6A and 6B. But TWN_E does has impact on HK_{16-60}, so do TWN_{T-1} and TWN_{T-2} on HK_t, as addressed in Table 7A and 7B.

In the case of TWN changes greater than 1%, the proportion is 18/29 for the impact of TWN_E on HK_{16-60}, i.e., the impact of TWN early morning returns on the HKSE opening 16th-to-60th-minute returns. That means there is a 65.5% chance that HK_{16-60} returns will be positive when TWN_E are greater than 1%. The proportion are 5/8 and 3/3 for TWN_Echanges greater than 2% and 3% respectively. This support the correspondent OLS results in Table 7A. However, the results in 8D through 8E do not lend support to the significant OLS results of the impacts of TWN_{T-1} and TWN_{T-2} on HK_t.

As to the cases of no significant OLS parameters, there still exist proportions greater than 60%. That is not consistent with the OLS results either.

2. Large negative changes of TWNSE

For large negative changes of TWNSE returns, the results of proportions of same sign are similar to that in the previous section.

(C) Summary

Therefore, based on the value of (adjusted) R-squares of OLS results and the evidence in this section, we must be cautious in interpreting the relation between Tokyo (Hong Kong) and Taiwan Stock markets. The evidence in this section should be used to fur ther examine the importance of the OLS results.

D. Majors Factors That Affect Taiwan, Tokyo and Hong Kong Stock Markets When The Magnitude of Market Changes Are Greater Than 1%

In Table 10 we list major factors that affect the returns of Taiwan, Tokyo and Hong Kong stock market when absolute values of these returns are greater than 1%. [13] There are 107, 109 and 51 days that the Taiwan, Tokyo and Hong Kong stock market respectively have absolute returns greater than 1%. Only 6 out of 107 TWN returns can be attributed to large changes in major foreign stock market such as Tokyo or U.S. stock markets; vice versa, 9 out of 109 and 13 out of 51 for TSE and HKSE returns respectively. A pparently, Hong Kong stock market is influenced by large changes in other major foreign markets the most of the three markets in study. Taiwan and Tokyo stock markets can hardly be affected by other stock market. Major affecting factors for these three markets also include interest rate changes, market technical adjustments and political issues. Based on the ex-post reports, Taiwan stock market are sometimes impacted by large changes in Tokyo and U.S. stock markets, but hardly by large changes in Hong Kong stock

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[13] Ex-post explanations for each large changes are extracted from reports in newspapers of a subsequent day. The listed factors reflect the possible causes of large market changes only for the period in study.

markets. Tokyo and Hong Kong stock markets are never reported as being affected by large changes in Taiwan stock market. Thus, based on the ex-post news reports, we observe that Taiwan, Tokyo and Hong Kong stock markets are not integrated markets. An important international event may simultaneously affect these three markets. However, an important local event to one market may not affect another markets. Ex-post reports support the empirical finding that the interactions among these three markets are weak.

IV. CONCLUSIONS

Taiwan, Japan and Hong Kong stock markets have the highest variability of intraday returns in the first trading interval. In addition, Taiwan has the second highest variability in the last interval. Taiwan and Hong Kong also have the highest mean intraday return in the first trading interval. This may not be surprising, because the return on the first trading interval represents overnight close-to-open return plus the open-to-first-interval return. Being intriguing is that Tokyo stock market does not have this overnight mean-variance pattern as found in another markets.

The OLS results show that TSE cumulative intraday returns at each 15-minute interval do have significant impact on the subsequent 15-minute TWNSE returns. HKSE returns after the close of TWNSE have a significant impact on the TWNSE opening 15-minute returns in a subsequent day. TWNSE returns do not affect TSE returns at all. TWNSE opening 60-minute returns do not have an impact on subsequent HKSE opening 15-minute returns, but do on the HKSE 16th-to-60th-minute returns. TWNSE cumulative intraday returns at each 15-minute interval do have significant impact on the

subsequent HKSE 15-minute (and 16-to-30-minute) returns. No other relations exist between TWNSE and HKSE or TSE returns.

These results show that Taiwan and Hong Kong stock markets are inefficient in the sense that the impacts from another markets are reflected beyond 15 minutes. Tokyo stock market has no evidence of market inefficiency. Though these relations exist, the R-squares are pretty low. That may indicate that other than the impacts from changes in another markets there are other important factors that contribute to changes in these stock markets.

After we calculate the proportions of changes in the same direction of one market when another market has large changes, (i.e., absolute changes greater than 1%, 2% or 3%,) we find that the results do not lend strong support to the OLS results. Investigating ex-post news reports on large daily changes in these three stock markets, we found that the numbers of times that one market is affected by large changes in another two markets are 6, 9 and 6 for Taiwan, Tokyo and Hong Kong respectively. While the num ber of times that the absolute change of returns greater than 1% are 107, 109 and 51 for Taiwan, Tokyo and Hong Kong stock markets respectively, that may indicates that each market is hardly affected by large changes in another markets. There are other major factors that explain the changes in returns to these three markets, which are reported as economic conditions, interest rate changes, political issues and market technical adjustments.

Therefore, we may conclude that (1) there exists weak evidence of market inefficiency, (2) the interactions among these three markets do sometimes exist, but through important international events, (3) other than the impacts of large changes in another stock market, there are other major factors that contribute to changes of returns in these three stock markets.

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Table 1 Statistics for TSE Intraday Returns

		Length of Interval (minutes)			
	Interval	15	30	45	60
Mean	1	-0.0001			
Mean	2	-0.0006	-0.0007		
Mean	3	-0.0002	-0.0009	-0.0009	
Mean	4	0.0001	-0.0001	-0.0008	-0.0008
Mean	5	0.0002	0.0003	0.0001	-0.0006
Mean	6	0.0003	0.0005	0.0006	0.0004
Mean	7	0.0000	0.0003	0.0005	0.0006
Mean	8	-0.0002	-0.0002	0.0002	0.0003
Mean	14	0.0005	0.0005	0.0004	0.0010
Mean	15	-0.0015	-0.0010	-0.0011	-0.0014
Mean	16	-0.0007	-0.0022	-0.0017	-0.0017
Mean	17	0.0004	-0.0004	-0.0018	-0.0013
Mean	18	0.0003	0.0007	-0.0001	-0.0015
Mean	19	-0.0002	-0.0001	-0.0001	-0.0006
Mean	20	0.0000	-0.0002	-0.0001	-0.0001
Mean	21	-0.0003	-0.0003	-0.0005	-0.0004
Mean	22	-0.0002	-0.0005	-0.0005	-0.0007
Mean	23	0.0000	-0.0002	-0.0005	-0.0005
Mean	24	-0.0002	-0.0002	-0.0004	-0.0007
Standard Dev.	1	0.0075			
Standard Dev.	2	0.0028	0.0087		
Standard Dev.	3	0.0030	0.0044	0.0094	
Standard Dev.	4	0.0031	0.0042	0.0050	0.0095
Standard Dev.	5	0.0026	0.0044	0.0052	0.0058
Standard Dev.	6	0.0029	0.0040	0.0053	0.0061
Standard Dev.	7	0.0029	0.0041	0.0052	0.0065
Standard Dev.	8	0.0030	0.0045	0.0054	0.0062
Standard Dev.	14	0.0031	0.0041	0.0055	0.0064
Standard Dev.	15	0.0039	0.0040	0.0050	0.0061
Standard Dev.	16	0.0075	0.0085	0.0087	0.0091
Standard Dev.	17	0.0079	0.0042	0.0058	0.0058
Standard Dev.	18	0.0070	0.0102	0.0078	0.0087
Standard Dev.	19	0.0061	0.0059	0.0072	0.0064
Standard Dev.	20	0.0053	0.0055	0.0054	0.0067
Standard Dev.	21	0.0029	0.0057	0.0058	0.0057
Standard Dev.	22	0.0030	0.0043	0.0064	0.0065
Standard Dev.	23	0.0032	0.0048	0.0060	0.0074
Standard Dev.	24	0.0052	0.0062	0.0070	0.0080

Table 1 Statistics for TSE Intraday Returns - continued

	Interval	Length of Interval (minutes) 15	30	45	60
Maximum	1	0.0171			
Maximum	2	0.0072	0.0232		
Maximum	3	0.0107	0.0141	0.0291	
Maximum	4	0.0143	0.0136	0.0138	0.0290
Maximum	5	0.0098	0.0163	0.0169	0.0236
Maximum	6	0.0093	0.0184	0.0196	0.0256
Maximum	7	0.0095	0.0133	0.0193	0.0213
Maximum	8	0.0102	0.0137	0.0147	0.0206
Maximum	14	0.0233	0.0189	0.0218	0.0174
Maximum	15	0.0127	0.0119	0.0159	0.0151
Maximum	16	0.0332	0.0254	0.0237	0.0186
Maximum	17	0.0529	0.0136	0.0195	0.0215
Maximum	18	0.0518	0.0491	0.0472	0.0458
Maximum	19	0.0400	0.0390	0.0456	0.0309
Maximum	20	0.0458	0.0114	0.0214	0.0447
Maximum	21	0.0107	0.0446	0.0157	0.0203
Maximum	22	0.0164	0.0197	0.0447	0.0230
Maximum	23	0.0089	0.0195	0.0227	0.0426
Maximum	24	0.0340	0.0317	0.0311	0.0293
Minimum	1	-0.0205			
Minimum	2	-0.0077	-0.0225		
Minimum	3	-0.0087	-0.0117	-0.0271	
Minimum	4	-0.0109	-0.0158	-0.0176	-0.0260
Minimum	5	-0.0074	-0.0136	-0.0199	-0.0217
Minimum	6	-0.0093	-0.0124	-0.0133	-0.0170
Minimum	7	-0.0084	-0.0102	-0.0114	-0.0191
Minimum	8	-0.0088	-0.0128	-0.0145	-0.0154
Minimum	14	-0.0137	-0.0137	-0.0137	-0.0139
Minimum	15	-0.0206	-0.0118	-0.0143	-0.0167
Minimum	16	-0.0513	-0.0567	-0.0581	-0.0606
Minimum	17	-0.0336	-0.0383	-0.0218	-0.0439
Minimum	18	-0.0112	-0.0403	-0.0158	-0.0197
Minimum	19	-0.0522	-0.0427	-0.0398	-0.0426
Minimum	20	-0.0421	-0.0549	-0.0212	-0.0344
Minimum	21	-0.0093	-0.0391	-0.0531	-0.0229
Minimum	22	-0.0080	-0.0126	-0.0372	-0.0547
Minimum	23	-0.0085	-0.0124	-0.0193	-0.0389
Minimum	24	-0.0196	-0.0274	-0.0275	-0.0328

Table 2 Statistics for TWNSE Intraday Returns

	Interval	Length of Interval (minutes) 15	30	45	60
Mean	5	0.0028			
Mean	6	-0.0011	0.0016		
Mean	7	0.0001	-0.0011	0.0017	
Mean	8	-0.0005	-0.0004	-0.0016	0.0012
Mean	9	-0.0001	-0.0006	-0.0006	-0.0017
Mean	10	0.0001	0.0000	-0.0005	-0.0005
Mean	11	0.0003	0.0004	0.0003	-0.0002
Mean	12	-0.0005	-0.0001	0.0000	-0.0002
Mean	13	-0.0005	-0.0010	-0.0007	-0.0005
Mean	14	-0.0002	-0.0007	-0.0012	-0.0009
Mean	15	-0.0004	-0.0006	-0.0011	-0.0016
Mean	16	-0.0005	-0.0008	-0.0011	-0.0016
Standard Dev.	5	0.0101			
Standard Dev.	6	0.0052	0.0103		
Standard Dev.	7	0.0037	0.0057	0.0112	
Standard Dev.	8	0.0038	0.0053	0.0064	0.0122
Standard Dev.	9	0.0038	0.0050	0.0060	0.0066
Standard Dev.	10	0.0032	0.0041	0.0053	0.0060
Standard Dev.	11	0.0028	0.0043	0.0051	0.0058
Standard Dev.	12	0.0032	0.0042	0.0055	0.0061
Standard Dev.	13	0.0033	0.0045	0.0054	0.0065
Standard Dev.	14	0.0033	0.0044	0.0053	0.0060
Standard Dev.	15	0.0043	0.0053	0.0062	0.0071
Standard Dev.	16	0.0052	0.0067	0.0074	0.0086

Table 2 Statistics for TWNSE Intraday Returns - continued

	Interval	Length of Interval (minutes) 15	30	45	60
Maximum	5	0.0547			
Maximum	6	0.0158	0.0577		
Maximum	7	0.0196	0.0134	0.0528	
Maximum	8	0.0182	0.0186	0.0183	0.0549
Maximum	9	0.0093	0.0117	0.0205	0.0209
Maximum	10	0.0214	0.0129	0.0153	0.0241
Maximum	11	0.0117	0.0221	0.0246	0.0270
Maximum	12	0.0120	0.0237	0.0273	0.0366
Maximum	13	0.0085	0.0113	0.0204	0.0260
Minimum	14	0.0094	0.0126	0.0148	0.0196
Minimum	15	0.0122	0.0160	0.0163	0.0206
Minimum	16	0.0154	0.0171	0.0221	0.0223
Minimum	5	-0.0525			
Minimum	6	-0.0384	-0.0623		
Minimum	7	-0.0093	-0.0375	-0.0699	
Minimum	8	-0.0205	-0.0276	-0.0311	-0.0655
Minimum	9	-0.0219	-0.0234	-0.0310	-0.0352
Minimum	10	-0.0098	-0.0114	-0.0152	-0.0223
Minimum	11	-0.0098	-0.0108	-0.0161	-0.0167
Minimum	12	-0.0133	-0.0135	-0.0174	-0.0249
Minimum	13	-0.0209	-0.0303	-0.0326	-0.0383
Maximum	14	-0.0152	-0.0183	-0.0248	-0.0271
Maximum	15	-0.0165	-0.0216	-0.0260	-0.0347
Maximum	16	-0.0172	-0.0295	-0.0292	-0.0347

Table 3 Statistics for HKSE Intraday Returns

		Length of Interval (minutes)			
	Interval	15	30	45	60
Mean	9	0.0018			
Mean	10	-0.0002	0.0016		
Mean	11	-0.0002	-0.0005	0.0014	
Mean	12	-0.0001	-0.0003	-0.0005	0.0013
Mean	13	0.0000	-0.0001	-0.0004	-0.0006
Mean	14	0.0002	0.0002	0.0001	-0.0001
Mean	15	0.0003	0.0005	0.0005	0.0004
Mean	16	0.0000	0.0002	0.0004	0.0004
Mean	17	0.0000	-0.0001	0.0002	0.0004
Mean	18	0.0000	0.0000	-0.0001	0.0002
Mean	26	0.0000	0.0002	0.0002	0.0003
Mean	27	-0.0004	-0.0004	-0.0002	-0.0002
Mean	28	-0.0002	-0.0006	-0.0006	-0.0004
Mean	29	0.0000	-0.0002	-0.0006	-0.0006
Mean	30	0.0003	0.0002	0.0000	-0.0004
Mean	31	0.0000	0.0003	0.0002	0.0000
Mean	32	0.0000	0.0000	0.0002	0.0002
Standard Dev.	9	0.0073			
Standard Dev.	10	0.0023	0.0072		
Standard Dev.	11	0.0019	0.0030	0.0069	
Standard Dev.	12	0.0014	0.0026	0.0037	0.0067
Standard Dev.	13	0.0012	0.0022	0.0033	0.0042
Standard Dev.	14	0.0013	0.0020	0.0028	0.0038
Standard Dev.	15	0.0022	0.0025	0.0032	0.0039
Standard Dev.	16	0.0024	0.0025	0.0030	0.0035
Standard Dev.	17	0.0015	0.0031	0.0034	0.0038
Standard Dev.	18	0.0017	0.0028	0.0044	0.0047
Standard Dev.	26	0.0016	0.0016	0.0020	0.0024
Standard Dev.	27	0.0029	0.0034	0.0034	0.0038
Standard Dev.	28	0.0018	0.0042	0.0046	0.0047
Standard Dev.	29	0.0023	0.0033	0.0047	0.0051
Standard Dev.	30	0.0015	0.0030	0.0037	0.0049
Standard Dev.	31	0.0009	0.0018	0.0031	0.0039
Standard Dev.	32	0.0020	0.0019	0.0023	0.0033

Table 3 Statistics for HKSE Intraday Returns - continued

		Length of Interval (minutes)			
	Interval	15	30	45	60
Mean	9	0.0018			
Mean	10	-0.0002	0.0016		
Mean	11	-0.0002	-0.0005	0.0014	
Mean	12	-0.0001	-0.0003	-0.0005	0.0013
Maximum	9	0.0559			
Maximum	10	0.0115	0.0475		
Maximum	11	0.0069	0.0085	0.0488	
Maximum	12	0.0040	0.0091	0.0107	0.0463
Maximum	13	0.0039	0.0065	0.0089	0.0124
Maximum	14	0.0055	0.0057	0.0080	0.0111
Maximum	15	0.0263	0.0250	0.0279	0.0315
Maximum	16	0.0045	0.0074	0.0095	0.0107
Maximum	17	0.0068	0.0061	0.0088	0.0125
Maximum	18	0.0042	0.0099	0.0093	0.0101
Maximum	26	0.0065	0.0065	0.0065	0.0087
Maximum	27	0.0060	0.0110	0.0061	0.0083
Maximum	28	0.0074	0.0084	0.0135	0.0126
Maximum	29	0.0203	0.0179	0.0103	0.0125
Maximum	30	0.0053	0.0207	0.0184	0.0141
Maximum	31	0.0106	0.0114	0.0207	0.0184
Maximum	32	0.0091	0.0094	0.0103	0.0205
Minimum	9	-0.0227			
Minimum	10	-0.0084	0.0158		
Minimum	11	-0.0135	0.0105	0.0144	
Minimum	12	-0.0035	0.0113	0.0098	0.0124
Minimum	13	-0.0036	0.0064	0.0115	0.0106
Minimum	14	-0.0028	0.0050	0.0079	0.0090
Minimum	15	-0.0037	0.0042	0.0059	0.0074
Minimum	16	-0.0211	0.0226	0.0231	0.0226
Minimum	17	-0.0089	0.0278	0.0315	0.0320
Minimum	18	-0.0165	0.0254	0.0443	0.0480
Minimum	26	-0.0092	0.0072	0.0066	0.0074
Minimum	27	-0.0226	0.0238	0.0241	0.0247
Minimum	28	-0.0101	0.0312	0.0260	0.0264
Minimum	29	-0.0099	0.0200	0.0412	0.0347
Minimum	30	-0.0040	0.0075	0.0176	0.0387
Minimum	31	-0.0044	0.0042	0.0075	0.0176
Minimum	32	-0.0154	0.0154	0.0157	0.0157

Table 4 Regression Results for the Impact of TSE Returns on TWNSE Returns

Panel A

Dependent Variables	Independent Variables						Adjusted R-square
	Constant	TWN15	TSE-LA	TSE-E	TSE-CC	TSE15	
TWN-CC	-0.000 (-0.281)				0.062 (0.866)		0.004
TWN15	0.003* (3.486)		0.060 (0.776)				0.003
TWN15	0.003* (3.554)			0.096 (1.447)			0.012
TWN15	0.003* (3.609)		0.070 (0.904)	0.101 (1.518)			0.005
TWN16-C	-0.003* (-3.289)			0.002 (0.026)			0.000
TWN16-C	-0.003* (-3.258)			0.008 (0.095)		-0.11 (-0.290)	-0.011
TWN16-C	-0.003* (-3.195)	0.010 (0.104)		0.001 (0.014)			-0.011
TWN16-60	-0.002* (-2.910)			0.041 (0.811)			0.004
TWN16-60	-0.002* (-2.846)			0.054 (1.029)		-0.230 (-0.999)	-0.002
TWN16-60	-0.002* (-3.097)	0.063 (1.096)		0.035 (0.688)			-0.001

* significant at 5% level

Table 4 Regression Results for the Impact of TSE Returns on TWNSE Returns - continued

Panel B

Dependent Variables	Independent Variables						Adjusted R-square
	Constant	TWN(t-1)	TSE(t)	TSE(t-1)	TSE(T-1)	TSE(T-2)	
TWN(t)	0.000 (1.072)		0.016 (0.193)				0.000
TWN(t)	0.000 (1.089)			-0.018 (-0.224)			0.000
TWN(t)	0.000 (1.187)				0.044* (1.967)		0.005
TWN(t)	0.000 (1.234)					0.050* (2.136)	0.006
TWN(t)	0.000 (1.249)		-0.026 (-0.318)			0.050* (2.147)	0.003
TWN(t)	0.000 (0.051)	-0.128* (-3.709)				0.056* (2.389)	0.021

* significant at 5% level

Table 5 Regression Results for the Impact of HKSE Returns on TWNSE Returns

Panel A

Dependent Variables	Independent Variables			Adjusted R-square
	Constant	TWN15	HK-LA	
TWN15	0.003* (4.215)		0.594* (4.092)	0.088
TWN16-C	-0.003* (-3.481)		-0.113 (-0.633)	0.002
TWN16-C	-0.003* (-3.434)	0.039 (0.416)	-0.136 (-0.728)	-0.008

* significant at 5% level
** significant at 10% level

Table 5 Regression Results for the Impact of HKSE Returns on TWNSE Returns - continued

Panel B

Dependent Variables	Independent Variables						Adjusted R-square
	Constant	TWN(t-1)	HK(t)	HK(t-1)	HK(T-1)	HK(T-2)	
TWN(t)	-0.000** (-1.931)		0.074 (1.288)				0.002
TWN(t)	-0.000* (-1.984)			0.048 (1.277)			0.002
TWN(t)	-0.000** (-1.803)				-0.004 (-0.299)		0.000
TWN(t)	-0.000** (-1.713)					-0.009 (-0.742)	0.001
TWN(t)	-0.000** (-1.791)			0.045 (1.210)		-0.008 (-0.621)	0.000
TWN(t)	-0.000** (-1.761)	-0.057** (-1.766)				-0.010 (-0.822)	0.002

* significant at 5% level
** significant at 10% level

Table 6 Regression Results for the Impact of TWNSE Returns on TSE Returns

Panel A

Dependent Variables	Independent Variables: Constant	TSE-L15	TWN-CC	Adjusted R-square
TSE-L15	0.000 (0.029)		-0.000 (-0.013)	0.000
TSE-L16-C	-0.001 (-1.413)		-0.001 (-0.025)	0.000
TSE-L16-C	-0.001 (-1.412)	-0.155 (-1.280)	-0.001 (-0.026)	-0.002

Table 6 Regression Results for the Impact of TWNSE Returns on TSE Returns - continued

Panel B

Dependent Variables	Independent Variables: Constant	TSE(t-1)	TWN(t)	TWN(t-1)	TWN(T-1)	TWN(T-2)	Adjusted R-square
TSE(t)	-0.000 (-0.198)		-0.267 (-0.618)				0.001
TSE(t)	-0.000 (-0.158)			0.020 (0.046)			0.000
TSE(t)	-0.000 (-0.176)				0.035 (0.260)		0.000
TSE(t)	-0.000 (-0.186)					0.035 (0.254)	0.000
TSE(t)	-0.000 (-0.177)			0.026 (0.060)		0.036 (0.257)	-0.003
TSE(t)	-0.000 (-0.270)	-0.501* (-16.02)				0.052 (0.434)	0.249

* significant at 5% level

Table 7 Regression Results for the Impact of TWNSE Returns on HKSE Returns

Panel A

Dependent Variables	Constant	TWN-CC	HK15	TWN-E	HK-L15	TWN15	Adjusted R-square
	Independent Variables						
HK-CC	0.001 (1.516)	0.120* (2.292)					0.029
HK15	0.002* (3.001)			-0.021 (-0.516)			0.002
HK16-C	-0.001 (-0.716)			0.080 (1.482)			0.012
HK16-C	-0.001 (-0.890)			0.081 (1.512)		-0.286 (-1.568)	0.015
HK16-C	-0.001 (-0.336)		-0.164 (-1.652)	0.077 (1.424)			0.018
HK16-60	-0.000 (-0.383)			0.065* (2.050)			0.038
HK16-60	-0.000 (-0.563)			0.066* (2.083)		-0.173 (-1.609)	0.194
HK16-60	0.000 (0.972)		-0.333* (-6.259)	0.058* (2.017)			-0.003
HK-L15	0.000 (1.352)	-0.004 (-0.687)					0.003
HK-L16-C	-0.000 (-0.905)	0.024 (0.995)					0.006
HK-L16-C	-0.000 (-0.908)	0.024 (0.996)			0.030 (0.099)		-0.006

* significant at 5% level
** significant at 10% level

Table 7 Regression Results for the Impact of TWNSE Returns on HKSE Returns - continued

Panel B

Dependent Variables	Constant	HK(t-1)	TWN(t)	TWN(t-1)	TWN(T-1)	TWN(T-2)	Adjusted R-square
	Independent Variables						
HK(t)	0.000* (2.924)		0.081* (3.780)				0.009
HK(t)	0.000* (2.646)			-0.015 (-0.651)			0.000
HK(t)	0.000* (2.363)				0.023* (3.739)		0.008
HK(t)	0.000* (2.263)					0.025* (4.047)	0.010
HK(t)	0.000* (2.229)		-0.013 (-0.585)			0.025* (4.035)	0.009
HK(t)	0.000* (2.206)	0.016 (0.674)				0.025* (4.005)	0.009

* significant at 5% level
** significant at 10% level

Table 8 Reactions of One Market to Large Positive Changes in Another Markets

Panel A

The denominator is the number of observations of one market index that have returns greater than 1%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE > 1% TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					19/29	
HK16-C					17/29	
HK16-60					18/29+	
HK-L15						19/36
HK-L16-C						14/36
HK-CC						18/36
TWN15	16/24		11/18	4/5+		
TWN16-C	9/24		9/18	1/5		
TWN16-60	11/24					
TWN-CC		14/36				
TSE-L15						21/41
TSE-L16-C						15/41

"+" indicates that the correspondent OLS parameter is significant and positive.

Table 8 Reactions of One Market to Large Positive Changes in Another Markets

Panel B

The denominator is the number of observations of one market index that have returns greater than 2%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE > 2% TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					5/8	
HK16-C					5/8	
HK16-60					5/8+	
HK-L15						7/14
HK-L16-C						7/14
HK-CC						6/14
TWN15	5/6		3/4	0/0+		
TWN16-C	2/6		1/3	0/0		
TWN16-60	4/6					
TWN-CC		4/14				
TSE-L15						7/16
TSE-L16C						6/16

"+" indicates that the correspondent OLS parameter is significant and positive.

Table 8 Reactions of One Market to Large Positive Changes in Another Markets

Panel C

The denominator is the number of observations of one market index that have returns greater than 3%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE > 3% TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					2/3	
HK16-C					2/3	
HK16-60					3/3+	
HK-L15						3/4
HK-L16-C						2/4
HK-CC						2/4
TWN15	1/1		2/3	0/0+		
TWN16-C	0/1		1/3	0/0		
TWN-CC		1/5				
TSE-L15						2/5
TSE-L16C						3/5

"+" indicates that the correspondent OLS parameter is significant and positive.

Table 8 Reactions of One Market to Large Positive Changes in Another Markets

The denominator is the number of observations of one market index that have returns greater than 1%, 2% and 3% for Panel D, E and F respectively and the nominator is the number of reaction in the same direction from another market.

Panel D CHANGE > 1%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					6/10	4/6	56/126	59/135				
TWN-t	1/2	1/1	13/24+	44/96+					1/2	6/13	50/136	45/122
HK-t					1/1	1/1	134/271+	131/262+				

Panel E CHANGE > 2%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					0/0	0/0	19/37	16/35				
TWN-t	0/0	0/0	13/24+	44/96+					1/1	0/0	10/21	7/20
HK-t					1/1	1/1	37/76+	35/71+				

Panel F CHANGE > 3%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					0/0	0/0	6/15	4/13				
TWN-t	0/0	0/0	0/0+	1/2+					0/0	0/0	5/11	4/11
HK-t				0/0	0/0	14/28+	14/25+					

"+" indicates that the correspondent OLS parameter is significant and positive.

Table 9 Reactions of One Market to Large Negative Changes in Another Markets

The denominator is the number of observations of one market index that have returns less than -1%, -2% and -3% for Panel D, E and F respectively. and the nominator is the number of reaction in the same direction from another market.

Panel D CHANGE < -1%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					7/12	9/12	61/101	54/92				
TWN-t	0/0	1/1	55/106+	67/125+					0/1	3/4	22/46	18/45
HK-t					9/15	5/11	88/179+	79/162+				

Panel E CHANGE < -2%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					0/0	3/3	17/33	13/29				
TWN-t	0/0	0/0	15/24+	8/17+					0/0	0/0	0/0	0/1
HK-t					1/1	1/2	21/54+	19/45+				

Panel F CHANGE < -3%

Dependent Variables	TSE-t	TSE-t-1	TSE-T-1	TSE-T-2	TWN-t	TWN-t-1	TWN-T-1	TWN-T-2	HK-t	HK-t-1	HK-T-1	HK-T-2
TSE-t					0/0	1/1	9/17	6/15				
TWN-t	0/0	0/0	0/0+	0/0+					0/0	0/0	0/0	0/0
HK-t					0/0	0/0	12/28+	11/26+				

"+" indicates that the correspondent OLS parameter is significant and positive.

Table 9 Reactions of One Market to Large Negative Changes in Another Markets

Panel A

The denominator is the number of observations of one market index that have returns less than -1%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE < -1%					
	TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					9/20	
HK16-C					11/20	
HK16-60					14/20+	
HK-L15						19/37
HK-L16-C						21/37
HK-CC						19/37
TWN15	11/35		7/20	1/3+		
TWN16-C	20/35		9/20	3/3		
TWN16-60	29/35					
TWN-CC		33/55				
TSE-L15						22/39
TSE-L16C						16/39

"+" indicates the correspondent OLS parameter is significant and positive.

Table 9 Reactions of One Market to Large Negative Changes in Another Markets

Panel B

The denominator is the number of observations of one market index that have returns less than -2%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE < -2%					
	TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					3/7	
HK16-C					3/7	
HK16-60					5/7+	
HK-L15						7/16
HK-L16-C						6/16
HK-CC						8/16
TWN15	3/12		2/5	1/1+		
TWN16-C	8/12		3/5	1/1		
TWN-CC		18/27				
TSE-L15						9/17
TSE-L16C						8/17

"+" indicates the correspondent OLS parameter is significant and positive.

Table 9 Reactions of One Market to Large Negative Changes in Another Markets

Panel C

The denominator is the number of observations of one market index that have returns less than -3%, and the nominator is the number of reaction in the same direction from another market.

Dependent Variables	CHANGE < -3%					
	TSE-E	TSE-CC	TSE-LA	HK-LA	TWN-E	TWN-CC
HK-15					2/4	
HK16-C					2/4	
HK16-60					2/4+	
HK-L15		5/11				3/7
HK-L16-C		10/11				2/7
HK-CC		8/11				3/7
TWN15	2/4		0/2	1/1+		
TWN16-C	3/4		1/2	1/1		
TWN16-60	3/4					
TWN-CC		9/12				
TSE-L15						4/8
TSE-L16C						5/8

"+" indicates the correspondent OLS parameter is significant and positive.

Table 10 Major Factors That Affect Taiwan, Tokyo and Hong Kong Stock Market Returns - When Absolute Value of Returns Are Greater Than 1%

A. Factors related to foreign issues:	Taiwan	Tokyo	HongKong	Total
1. Large changes of major stock market indexes	6	9	13	28
2. Political issues	3	4	4	11
3. Changes in interest rates		3	1	4
4. Others		1		1
Sub-total	9	17	18	44
B. Factors related to domestic issues:				
1. Economic conditions	8	7	1	16
2. Changes in interest rates	13	17	3	33
3. Political issues	14	4	3	21
4. Market technical adjustments	36	58	20	124
5. Money supply	6	1		7
6. Changes in tax laws	8			8
7. Oversupply of previously government-owned shares	7			7
8. Exchange rates		4		4
9. Others	6	1	6	3
Sub-total	98	92	33	223
Total number of returns with absolute value greater than 1 %	107	109	51	267

台灣股市與主要亞洲股市之即時相互影響

楊朝成

摘　要

本文利用十五分鐘之即時報酬資料 (Intraday returns) 探討台灣股市與主要亞洲股市 (日本與香港) 間之即時相互影響。由於台灣、日本與香港股市開盤及收盤之時間不一，因此，尚未開盤之股市可能受到已開盤股市累積之變化之影響，已開盤之股市亦可能受到剛傳來之其它股市之變化之影響。本文發現三個股市間確有相互影響之情形，亦有輕微之違反股市效率之情形；雖然台灣股市受到日本、香港等亞洲股市之影響，但台灣股市之大幅漲跌主要還是受到國內政治、景氣展望、利率變動及市場因素等之影響。