

## International Financial Market Integration: An Examination of Six Stock Markets

**Omar Marashdeh**

### ABSTRACT

*The recent daily data (Jan. 1, 1990 - July, 22, 1992) of six stock markets namely, Japan, Hong Kong, Malaysia, Australia, the US, and the UK were used in this study to examine the degree of integration of these markets by using simple correlation and multiple regression analysis. The study found that Hong Kong has a higher degree of integration with all markets. The US market has a low degree of integration with all markets. UK is influenced by informational flow from the US, Japan, and Hong Kong. Malaysian market is influenced by informational flow from the US, Japan, and Hong Kong. Japan is influenced by informational flow from Australia, the UK, Malaysia, and Hong Kong. Australia is affected by informational flow from the US, the UK, Japan, and Hong Kong. Hong Kong and Japan influence all these six markets except the US. The US market leads the four Asian-Pacific markets (Malaysia, Japan, Hong Kong, and Australia) and contemporarily influences the UK. Asian-Pacific markets do not influence the US market. Asian-Pacific markets show a higher degree of integration with each other. The relationship between the six stock markets are stable as shown by the Chow test.*

### ABSTRAK

*Data harian terkini (1 Januari 1990 hingga 22 Julai 1992) enam pasaran saham iaitu Jepun, Hong Kong, Malaysia, Australia, US dan UK digunakan dalam kajian ini untuk meneliti darjah integrasi antara pasaran-pasaran ini dengan menggunakan kaedah korelasi ringkas dan analisis regresi berbilang. Kajian ini mendapati Hong Kong mempunyai darjah integrasi yang tinggi dengan pasaran yang lain. Pasaran Amerika mempunyai darjah integrasi yang rendah dengan kesemua pasaran. Pasaran UK dipengaruhi oleh aliran maklumat dari US, Jepun, dan Hong Kong. Pasaran Malaysia dipengaruhi oleh aliran maklumat dari US, Jepun, dan Hong Kong. Jepun dipengaruhi oleh aliran maklumat dari Australia, UK, Malaysia dan Hong Kong. Australia dipengaruhi oleh aliran maklumat dari US, UK, Jepun dan Hong Kong. Hong Kong dan Jepun mempengaruhi kesemua enam pasaran kecuali US. Pasaran US mendahului empat pasaran Asia-Pasifik (Malaysia, Jepun, Hong Kong dan Australia) dan mempengaruhi UK secara sama masa. Pasaran Asia-Pasifik tidak mempengaruhi pasaran US. Pasaran Asia-Pasifik menunjukkan darjah integrasi yang tinggi antara satu sama lain. Perhubungan antara*

*enam pasaran saham didapati stabil mengikut ujian Chow*

## INTRODUCTION

The deregulation and openness of the capital markets across markets in the 1980s may lead eventually to financial market integration. The level of integration, however, of the world financial markets bears on an empirical question. With the rapid automation of the financial markets, the informational advantages of domestic investors over others appear gradually disappearing. Indeed, what is happening in one financial market is transmitted instantly to other markets; thus, lending support to the argument that financial markets are moving towards integration. In line with such an argument, does the closing of the stock market in country A lead to lower volatility elsewhere? This study tries to answer this question by looking at the behavior of the Malaysia, Japan, Hong Kong, Australia, the UK, and the US stock markets as well as their interactions. That is, the study examines the role of public information, i.e., the closing of stock market in country A, in the transmission of volatility differential across international markets.

Several studies have investigated the movements of stock markets across countries, e.g., by Makridakis and Wheelwright (1974), Hillard (1979), Le (1991), Nam Jeon and Furstenberg (1990), Bhoocha-oom and Stansell (1990), Cheung and Ho (1991), Cheung and Mak (1992), and Cheung and Kwan (1992). Early studies have concluded that the movements of stock markets in the 1970s across countries are characterized by a random process, that is, markets are not integrated (Makridakis & Wheelwright 1974; Hillard 1979). However, recent studies suggest that the relationship between capital markets is becoming more stable and they move in unison, that is, moving in the same direction, especially after the October, 1987 crash.

Indeed, the movement of information between the world financial markets appears to be increasing, that is stock markets are becoming integrated (Le 1991, Nam Jeon & Furstenberg 1990; Bhoocha-oom & Stansell 1990; Cheung & Ho 1991, Cheung & Mak 1992; Cheung & Kwan 1992). Although the major stock markets are showing a higher degree of integration, some markets which appear to be not affected by this trend stand alone, especially thin stock markets and highly closed ones. For example, Cheung and Mak (1992) find that the US leads most of the Asian-Pacific markets with the exception of Korea, Taiwan, and Thailand which are relatively closed markets, whereas the Japanese stock market has less influence on the Asian-Pacific stock markets. Malkamaki et al (1991) find that thin stock markets (Finland and Mexico) behaves differently from major ones.

## DATA

The data consist of daily closing prices for the following major equity market indexes: New York Dow Jones Industrial Average, Tokyo Nikkei, London Financial Times 30-Industrial, Hong Kong Hang Seng, Australian All Ordinaries, and Malaysian Composite index. The prices have been collected from the *Investors Digest* for the period from the beginning of the split between the Singapore and Kuala Lumpur stock markets, January 1, 1990 to the extension of the trading hours on the Kuala Lumpur stock exchange, July 22, 1992. These markets are open Monday to Friday of each week, except for holidays and holiday-eves.

With daily data available for the six national exchanges, daily returns are defined as:

$$R_t = \text{Log}(P_t/P_{t-1})$$

where  $P_t$  and  $P_{t-1}$  are the closing price index at time  $t$  and  $t-1$ , respectively

Table 1 shows the trading hours of the national stock markets in Greenwich Mean Time, Local Time, and New York Time. The last column shows that in any given trading day, the closing prices for all foreign exchanges analyzed in our sample are known by the time the NYSE closes for the day. The table clearly shows that there is overlapping between the Sydney, Tokyo, Hong Kong, and Kuala Lumpur Stock exchanges and between London and New York markets, whereas there is no overlapping between the Asian-Pacific, London, and New York stock exchanges. That is, information contained in the Asian-Pacific markets indexes makes a serial impact, e.g., on each others, the London and New York indexes at the same day, whereas New York and London indexes on Asian-Pacific indexes the following day.

### STOCK INDEX VOLATILITY

Comparison of stock returns volatility during the sample period is provided in Table 2. The table shows annualized means and standard deviations, number of daily returns, minimum and maximum in one day. There were 675 calendar dates during the sample period that were trading days in at least some markets, but due to holidays the maximum number of observations for a given country was 647 for the US. The minimum was 629 for Malaysia and Hong Kong. Large differences in volatilities of country index return exist during the sample period. Japan has the highest volatility (27.17% standard deviation of annualized rate of return) followed by Malaysia (24.73%), while the US has the lowest (14.55%). Australia, the UK and Hong Kong had lower volatilities (annualized standard deviation below 20%).

Across the six countries, the average of the largest single day return during the sample period is 10.17% and the largest single day return for a country was 17.96% (Malaysia). The average of the largest negative single day return was -9.22%, and the largest negative single day return for a given country was -15.98% for Malaysia.

TABLE 1. Market time table

Stock Market	Hours(Greenwich Mean Time)	Hours(local Time)	Hours(New York time)
Sydney	Midnight-2:15 a.m/ 4:00 a.m.-5:15 a.m	10:00 a.m.-12:15 p.m./ 2:00 p.m.-3:15 p.m.	7:00 p.m.-9:15 p.m/ 11:00 p.m.-0:15 a.m.
Tokyo	Midnight-2:00 a.m/ 4:00 a.m.-6:00 a.m	9:00 a.m.-11:00 a.m./ 1:00 p.m.-3:00 p.m.	7:00 p.m.-9:00 p.m/ 11:00 p.m.-1:00 a.m.
Hong kong	2:00 a.m-4:30 a.m/ 6:30 a.m.-7:30 a.m	10:00 a.m.-12:30 p.m./ 2:30 p.m.-3:30 p.m.	9:00 p.m.-11.30 p.m/ 1.30 p.m.-2:30 a.m.
Kuala Lumpur	2:00 a.m-4:30 a.m/ 6:30 a.m.-8:00 a.m	10:00 a.m.-12:30 p.m./ 2:30 p.m.-4:00 p.m.	9:00 p.m.-11.30 p.m/ 1.30 a.m.-3:00 a.m.
London	9:00 a.m-5:00 p.m/ 9:00 a.m-5:00 p.m	9:00 a.m.-5:00 p.m.	4:00 a.m.-12:00 noon
New York	2:30 p.m-9:00 p.m/ 9:30 a.m.-4:00 p.m./	9:30 a.m.-4:00 p.m./	9:30 a.m.-4:00 p.m

Source: Directory of World Stock Exchanges.

TABLE 2. National stock market indexes return (in percentage)  
(January 2, 1990 to July 22, 1992)

Stock	Number of Daily Return	Mean	Standard Deviation	Minimum (in one day)	Maximum
Malaysia	629	3.61	24.73	-15.98	17.96
Australia	644	-0.18	17.30	-15.81	15.37
USA	647	5.70	14.55	-4.01	4.47
UK	646	2.13	15.16	-3.9	5.44
Japan	629	-3.38	27.17	-6.85	12.43
Hong Kong	632	27.79	17.75	-8.75	5.37
Cross Country Mean	638	7.10	19.44	-9.22	10.17

CORRELATIONS

The intercountry correlations of the six stock markets are presented in table 3. The table (3) shows that intercountry correlations are small. Only 8 of the 15 correlations are above 0.3, and these mainly for Asian countries and major trading partners: Malaysia/Hong Kong, Japan/Hong Kong, Japan/Malaysia, Japan/Australia, Hong Kong/ Australia, the UK/ Japan, the UK/the US, and the UK/Hong Kong. One possible reason for the low correlation between Asian markets and the UK and the US markets would be due to time zone differences as seen from Table 1. That is, events taking place in the US and the UK on any given day will be reflected on Asian-Pacific markets the following day. The results for the subperiods: January 2, 1990-March 30, 1991 and April 1, 1991-July 22, 1992 are similar to those of the whole period.

TABLE 3. Correlation coefficients of daily index returns

	January 2, 1990 to July 22, 1992				
	Australia				
USA	0.0323*	U.S.A			
UK	0.1714	0.3745	U.K.		
Japan	0.3281	0.2014	0.3620	Japan	
Malaysia	0.2146	0.1353	0.2481	0.3748	Malaysia
Hong Kong	0.3188	0.1832	0.3344	0.5041	0.4504
	January 2, 1990 to March 30, 1992				
USA	-0.0092*				
UK	0.1236*	0.3689			
Japan	0.3048	0.1692	0.3352		
Malaysia	0.2454	0.2105	0.3162	0.5609	
Hong Kong	0.3191	0.2258	0.3465	0.5575	0.6045
	April 1, 1991 to July 22, 1992				
USA	0.1336*				
UK	0.2563	0.3817			
Japan	0.4304	0.2119	0.3627		
Malaysia	0.3025	0.1436*	0.2496	0.3567	
Hong Kong	0.4235	0.1997	0.3458	0.5126	0.4458

Note: \* Not significant at the 1 percent level.

To test for the possibility that time zone differences are affecting observed correlations, a multiple regression of the following form was calculated for each pair of countries, *i* and *j*:

$$R_{j,t} = a_0 + a_1R_{i,t-1} + a_2R_{i,t} + a_3R_{i,t+1}$$

and the square root of the multiple correlation of determination (adjusted for degrees of freedom was taken as an indicator of the total correlation).

The results of this regression are reported in Table 4. The results show a marked improvement in the correlation between Asian-Pacific markets and the American and British markets. The US and the UK, now, have all coefficients with Asian-Pacific countries above 0.2.

Now, does the closing of stock market in other countries affect the volatility of the  $j$ th country stock market? A multiple regression is used to answer this question of the following form:

$$R_{j,t} = a_0 + a_k R_{i,t} + e_t$$

where,  $i \neq j =$  Malaysia, Hong Kong, Australia, Japan, the US, and the UK

To account for the time differences between Asian markets and British and American markets, a lag value of the US and the UK returns is included (in addition to the contemporaneous) in the regression of the stock returns of Malaysia, Hong Kong, Japan, and Australia.

TABLE 4. Correlation coefficients of daily index returns  
(one daily lead, contemporaneous and one daily lag)

	USA	UK
UK	0.4094	
Japan	0.3406	0.3635
Malaysia	0.3307	0.2569
Hong Kong	0.3540	0.3694
Australia	0.3032	0.2604

The results of this regression are reported in Table 5. The results are good as indicated by the R-bar squared, low standard error of estimate (SEE) and absence of autocorrelation in the residual as indicated by D-W test and Box -Pierce Q statistics. The table shows that 37% and 34% of the volatility in the Hong Kong and Japan stock markets, respectively, are explained by the closing index prices in the other five countries. However, it seems that other stock markets are explaining only 14% of the American stock market volatility. The volatility of other markets explains 25% of the Malaysian and British stock markets volatilities, and 19.4% of the Australian stock market volatility.

The regression for the US, shows the UK, only, with the statistically significant coefficient, whereas the Asian-Pacific countries do not influence the US market. On the other hand, the US stock market is significantly

TABLE 5. Regression of stock returns for the period January 2, 1990 to July 22, 1992

	Hong Kong	Malaysia	Japan	UK	USA	Australia
constant	0.0017 (4.14)	-0.0002 (-0.4)*	-0.0021 (-3.3)	-0.0002 (-0.5)*	0.0002 (0.6)*	-0.0004 (-0.94)*
Australia	0.1191 (2.82)	0.0041 (0.1)*	0.2482 (3.76)	0.3723 (0.99)*	-0.0601 (-1.6)	
USA	0.0638 (1.36)*	0.0583 (0.9)*	0.1246 (1.69)	0.3186 (7.9)		-0.0322 (-0.7)*
USA (lag one)	0.1148 (2.31)	0.2106 (3.1)	0.1373 (1.75)			0.2418 (4.9)
UK	0.1337 (2.85)	0.0799 (1.23)*	0.2999 (4.1)		0.3205 (7.86)	0.0313 (0.66)*
UK (lag one)	0.0153 (1.21)*	0.0623 (1.03)*	0.0144 (0.2)*			0.1013 (2.3)
Japan	0.1902 (7.3)	0.1246 (3.35)		0.1058 (4.32)	0.0358 (1.43)*	0.1022 (3.8)
Malaysia	0.1976 (6.6)		0.1631 (3.35)	0.0418 (1.48)*	0.0112 (0.4)*	0.0022 (0.1)*
Hong kong		0.3735 (6.6)	0.4707 (7.3)	0.1177 (3.04)	0.0377 (0.96)*	0.1214 (2.82)
R bar- squared	0.37	0.25	0.34	0.25	0.14	0.194
SEE	0.0093	0.0128	0.0147	0.0086	0.0086	0.0094
D-W	2.035+	1.702+	1.959+	2.065+	2.237+	1.949+
Q(69)	60.55+	59.32+	66.50+	72.35+	58.28+	33.22+

Notes: t-values are shown in parentheses.

\* Statistically not significant at the 10 percent level.

+ Statistically not significant at the 5 percent level.

influencing all stock markets except the Japanese stock market. Indeed, the table shows that the US market is only affected by the closing price on the UK stock market. That is, the far eastern countries do not show an influence on the US stock market. This may be attributable to the causative influence of the US on other markets, e.g., an influence which is not reciprocated by others.

The UK is influencing the other markets except for Malaysia. The volatility of the Japanese stock market affects all markets except the US market. The Malaysian stock market seems to be affected only by the US, Japan, and Hong Kong stock markets. The Hong Kong stock market is affected by volatility in all other markets. The Australian stock market is

TABLE 6. Regression of stock returns for the period January 2, 1990 to March 30, 1991

	Hong Kong	Malaysia	Japan	UK	USA	Australia
constant	0.0016 (2.85)	-0.0006 (-1.1)*	-0.0019 (-1.95)	-0.0001 (-0.03)*	-0.0001 (-0.03)*	-0.0011 (-1.41)*
Australia	0.1159 (2.51)	-0.0486 (-1.0)*	0.1616 (2.21)	0.0112 (0.24)*	-0.0789 (-1.6)	
USA	0.0823 (1.43)*	0.1038 (1.7)	0.0036 (0.04)*	0.2928 (5.3)		-0.0705 (-0.9)*
USA (lag one)	0.0157 (0.25)*	0.2692 (4.1)	0.1328 (1.24)*			0.2686 (3.3)
UK	0.1158 (1.92)	0.0481 (0.73)*	0.2101 (2.1)		0.3259 (5.24)	0.0013 (0.02)*
UK (lag one)	0.0491 (0.85)*	0.1468 (2.37)	-0.0409 (-0.42)*			0.1357 (1.8)
Japan	0.1584 (4.5)	0.1795 (4.70)		0.0855 (2.29)	-0.0525 (-1.3)*	0.0998 (2.1)
Malaysia	0.3254 (6.1)		0.4541 (4.48)	0.0589 (1.05)*	0.0571 (1.0)*	-0.0734 (-1.0)*
Hong kong		0.3822 (6.1)	0.4382 (4.7)	0.1211 (1.91)	0.0917 (1.36)*	0.2054 (2.51)
R bar- squared	0.45	0.49	0.40	0.22	0.14	0.168
SEE 0.0091	0.0099	0.0154	0.0094	0.0099	0.0121	
D-W	2.154+	1.825+	1.853+	2.016+	2.221+	2.005+
Q(48)	42.99+	48.88+	46.91+	47.61+	33.04+	16.48+

Notes: t-values are shown in parentheses.

\* Statistically not significant at the 10 percent level.

+ Statistically not significant at the 5 percent level.

influenced by the US, the UK, and Hong Kong stock markets. The UK stock market is affected by the US, Japan, and Hong Kong stock market volatilities.

The stability of the model is a prerequisite for sound conclusions to be made about the behavior of the stock markets. Therefore, a Chow test for structural change is conducted to examine whether the relationship remained stable over the period of study. Chow test divides the sample into two samples and compares their variance with overall variance of the sample. The test is calculated as follows:

$$F(k, n_1 + n_2 - 2k) = \frac{(RSSR - SSRI - SSR 2)/k}{(SSR 1 + SSR 2)/(n_1 + n_2 - 2k)}$$



TABLE 7 Regression of stock returns for the period April 1, 1991 to July 22, 1992

	Hong Kong	Malaysia	Japan	UK	USA	Australia
constant	0.0017 (3.12)	0.0001 (0.1)*	-0.0021 (-2.6)	-0.0004 (-0.9)*	0.0005 (1.1)*	-0.0002 (-0.58)*
Australia	0.1623 (1.66)	0.1862 (1.2)*	0.5450 (4.04)	0.1375 (1.84)	-0.0008 (-0.1)*	
USA	-0.0109 (-.13)*	-0.0456 (-4)*	0.2287 (2.00)	0.3502 (5.7)		0.0454 (0.9)*
USA (lag one)	0.2102 (2.54)	0.0526 (0.4)*	-0.0240 (-.21)*			0.2384 (4.8)
UK	0.1530 (2.07)	0.1375 (1.17)*	0.3543 (3.5)		0.2971 (5.67)	0.0703 (1.54)
UK (lag one)	0.0185 (0.28)*	-0.0510 (-48)*	0.0083 (0.1)*			0.0648 (1.6)
Japan	0.1975 (4.8)	0.0241 (3.74)		0.1176 (3.46)	0.0656 (2.07)	0.1028 (4.1)
Malaysia	0.1398 (3.75)		0.3949 (4.82)	0.0385 (1.24)*	-0.0115 (-4)*	0.0283 (1.2)*
Hong kong		0.3475 (3.75)	0.0195 (0.4)*	0.1081 (2.25)	-0.0272 (-.61)*	0.0613 (1.72)
R bar- squared	0.29	0.09	0.31	0.27	0.15	0.29
SEE	0.0095	0.0150	0.0134	0.0077	0.0071	0.0058
D-W	1.925+	1.802+	2.034+	2.141+	2.241+	1.881+
Q(48)	36.37+	34.38+	46.38+	30.83+	32.81+	32.64+

Notes: t-values are shown in parentheses.

\* Statistically not significant at the 10 percent level.

+ Statistically not significant at the 5 percent level.

where RSSR is restricted sum of squared residuals; SSR1 is sum of squared residuals for the first period, SSR2 is sum of squared residuals for the second period;  $k$  is number of variables;  $n_1$  is the number of observation in the first period, and  $n_2$  is the number of observation in the second period.

The sample is divided into two halves: January 2, 1990 - March 30, 1991 and April 1, 1991-July 22, 1992. The results of OLS regression for the subsamples are presented in Tables 6 and 7. In general, the results of the two subperiods are similar to those obtained by the overall period. This is confirmed by the results of the Chow test. The results of Chow test for stability of the stock returns regression are presented in Table 8. The table shows that all regressions are stable at the one percent level of significance. Therefore, the analysis obtained by the overall sample will be used to make conclusions.

TABLE 8. Test of structural stability

Index	Chow Test
Hong Kong	0.7557*
Malaysia	1.0385*
Japan	1.814*
UK	0.3501*
USA	0.5119*
Australia	0.583*

Note: \* Statistically not significant at the 1 percent level.

## CONCLUSION

By using daily data from January 1, 1990 to July 22, 1992, from six stock markets: the US, the UK, Japan, Malaysia, Hong Kong, and Australia, the informational flow resulting from the closing price of one stock market on the others was examined by using simple correlation and multiple regression.

The simple correlation revealed a moderate but significant degree of correlation among the Asian-Pacific markets but low correlation with the US and the UK. To account for the time zone differences, a multiple regression was run on the one day lead of, contemporaneous, and one day lag of the US and the UK as independent variables and Asian-Pacific dependent variables. The square root of the adjusted R-square was taken to represent the degree of correlation between the US and the UK, and Asian-Pacific markets. This procedure revealed that the correlation between the Asian-Pacific markets, and the US and the UK has improved considerably and become significant.

In addition, a multiple regression was used to account for the informational interaction among the stock markets. The results indicate that the US is leading all Asian Pacific markets and contemporaneously affecting the UK. However, the Asian Pacific markets do not affect the US. The Hong Kong and Japan stock markets are affecting all Asian Pacific and the UK markets. Malaysia and Australia are only affecting the Hong Kong and Japan stock markets.

By all, the Hong Kong stock market is influenced by informational flow from all other markets. This shows that the Hong Kong market is showing a higher degree of integration with the other five markets. The Malaysian stock market is showing integration with the Hong Kong, Japan, and the US markets. Japan is showing integration with Australia, the UK, Malaysia and Hong Kong.<sup>1</sup> That is, informational flow from the US is not playing an important role in the Japanese market as they had done in the 1980s. Australian market is showing integration with the US, the UK, Japan, and

Hong Kong. The UK is showing integration with the US, Japan, and Hong Kong. The relationship between the six stock markets remained stable over the period of study as indicated by Chow test.

#### NOTE

<sup>1</sup> Cheng and Muk (1992) had shown that informational flow from the Japanese market play insignificant role in affecting events in the Asian-Pacific region during 1977-1988, whereas the US market play a dominant role in this region.

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Department of Economics  
International Islamic University  
P.O.Box 70, Jalan Sultan  
46700 Petaling Jaya, Selangor D.E.