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Inter-temporal Stability of the International Stock Market Relationships: The Case of Malaysian Stock Market in Relation to World's Major Stock Markets

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ABSTRACT

Most of the past studies regarding the co-movements of the international stock markets dealt with the potential gains to investors from international portfolio diversification. In general, these studies suggested that considerable gains were available to those investors willing to diversify internationally due to usually low positive or negative correlations between national stock markets (i.e., the unsystematic risk is reduced). Emphasis was not given to the possibility of using the movement in one market to predict the movement in another. This study, on the other hand, found that the information of the past movements in one market (referring to world's major markets) is not useful in predicting the movement in another market (referring to the Malaysian market) as shown by generally insignificant lagged correlations. Furthermore, inter-temporal instability of the correlations over time makes it difficult to select an efficient investment strategy due to a continuously changing efficient frontier.

ABSTRAK

Kebanyakan kajian yang lepas mengenai pergerakan bersama pasaran saham antarabangsa bertumpu kepada kemungkinan mendapat untung hasil daripada pempelbagaian portfolio antarabangsa. Secara amnya, kajian-kajian ini mencadangkan bahawa keuntungan boleh didapati bagi mereka yang sanggup mempelbagaikan portfolio secara antarabangsa disebabkan nilai korelasi yang selalunya rendah ataupun negatif di antara bursa-bursa saham ini (yakni, risiko tidak sistematik dikurangkan). Tumpuan tidak diberikan terhadap penggunaan pergerakan saham suatu bursa untuk meramalkan pergerakan saham di bursa saham yang lain. Kajian yang dilakukan ini, sebaliknya, mendapati bahawa pergerakan saham di satu bursa (merujuk kepada bursa-bursa utama dunia) tidak boleh digunakan untuk membuat ramalan tentang pergerakan saham pada bursa yang lain (merujuk kepada bursa saham Malaysia) sebagaimana yang ditunjukkan oleh nilai korelasi berlat yang rata-rata tidak ketara. Di

samping itu, ketidakstabilan korelasi daripada satu tempoh masa kepada satu tempoh masa yang lain menjadikan satu keadaan yang sukar untuk pemilihan strategi pelaburan yang efisien disebabkan perubahan pada sempadan efisien yang berlaku secara berterusan.

INTRODUCTION

The semi-strong form (Fama 1970) of the efficient market hypothesis (EMH) indicates that the price of a stock at any given point in time reflects all available public information (past prices included) concerning the stock. This means that when a new information (such as news on upward movement on the Wall Street) emerges, that information will instantaneously be reflected in the stock concerned, and no investor can gain excess profit from the new information. If there is a delay in the absorption of the new information into the market, then the market is said to be lagging behind (in this case lagging behind the movement on the Wall Street),and an investor can gain from this lagged new information. What it means is, the Malaysian stock market might be highly influenced by overseas markets, but it can only be exploited if there exists a time lag between the news of the movements in the foreign markets and the reflection of that news in the Malaysian market. An instantaneous reflection of that news is not that useful from an investor's point of view because no prediction model can be constructed based on past data.

The potential gains from diversification are dependent upon the degree of correlations between the returns from assets in the portfolio. When the returns from assets are negatively correlated, diversification can theoretically eliminate risk completely. For positive correlation of less than 1, the risk can be reduced but not entirely. By diversifying as widely as possible an investor can eliminate the risk that is unique to individual firms. Through international diversification it would appear possible for an investor to eliminate that part of his portfolio risk associated with the economics of a particular country, and as a result, the investor is left with only the risk associated with world wide economic conditions (Watson 1978).

For the purpose of profitable investment strategy,the stability of the correlation structure is very important (Maldonado and Saunders 1981). Inter-temporal instability of the correlation structure will result in a continuously changing efficient frontier which makes the selection of an optimal investment strategy very difficult to identify. This means, instability in the correlation matrix increases the size of the set of possible outcomes even if the investor can generate good forecasts of the next period's expected returns and variances on domestic and foreign markets.

The purpose of this paper is to determine whether the performance of the Malaysian stock market is highly influenced by major stock markets overseas, specifically the markets of Hong Kong, Tokyo, Sydney, London and New York. This paper will also investigate the possibility of using past movements in these major markets to predict future movements in the Malaysian market. Finally, this paper will try to determine whether or not the correlations are stable over time.

REVIEW OF PREVIOUS STUDIES

Most of the past studies dealt with the potential gains to investors from international portfolio diversification (see for example, Agmon 1972; Bertoneche 1979; Grubel 1968; Grubel and Fadner 1971; Saunders and Woodward 1977). Emphasis was not given to the possibility of using the movement in one market to predict the future movement in another market. Most of these studies suggested that considerable gains were available to those investors willing to diversify internationally due to usually low positive or negative correlations between national stock markets (i.e., the unsystematic risk is reduced). The usual approach of these studies with respect to the sample period has been to divide the sample in two, which is a poor test of inter-temporal correlation stability because only two sample observations are drawn from the whole possible distribution of correlation coefficients. The stability of the international correlation matrix is a necessary condition for profitable international investment.

Gruber and Fadner (1971) studied the correlation among pairs of US and foreign assets (the UK and West Germany) over different lengths of holding periods. The authors also studied the influence exchange rate variations have on the stability of earnings from foreign assets. The results of the study indicated that the correlation among all pairs of assets was an increasing function of holding period length, and the average levels of correlation for any given length of holding period was greater for intra-country pairs than it was for inter-country pairs of assets. This study also found that the standard deviation of returns from holding foreign assets with and without exchange rate adjustments were statistically not different. Furthermore, the correlation of returns between the US and foreign assets with and without the exchange rate adjustment were statistically not different and failed to show a consistent pattern of change.

Agmon (1972) studied the monthly share price co-movements in the United States, the United Kingdom, Germany, and Japan for the period January, 1955 to October, 1966. The author concluded that despite the seeming barriers in the multinational equity market, there was a substantial amount of relationship among the four equity markets. In fact, many of the German shares were indistinguishable, in terms of heir price move-

ment, from the majority of the American shares. In addition, changes in share prices in the three non-US countries responded immediately (i.e. within one period) to price changes in the US market index.

Makridakis and Wheelwright (1974) studied the returns of 14 national stock indexes and found that the inter-country correlations were always less than one, which is an important criterion for diversification feasibility. However, they found that the correlations were generally unstable over time.

Watson (1978) studied the correlation coefficients of the monthly returns (net of dividends) for the period from January, 1970 to December, 1977 between the share market indices (adjusted for exchange rate fluctuations) for Australia, Japan, New Zealand, South Africa, the UK, the US, and West Germany. The results showed that, on the average, the inter-country correlation coefficients were in the vicinity of +0.55. The author concluded that the fact that the inter-country correlations were substantially less than +1 support the belief that international diversification can offer significant benefits beyond those offered by diversification within a single country. Another study by Watson (1980) on the stationarity of the inter-country correlation coefficients between the monthly returns of the share market indices from eight countries (Australia, Denmark, Germany, Japan, New Zealand, South Africa, the United Kingdom, and the United States) from January, 1970 to December, 1977 showed that the inter-country correlation coefficients, in general, did not vary significantly with time.

Maldonado and Saunders (1981) studied the inter-temporal stability of correlations between monthly returns on a United States stock index and four foreign stock market indices (Japan, Germany, Canada, and the United Kingdom) from the point of view of United States investors over different time horizons for a period between 1957 and 1978. These countries were chosen because of their relatively broad capital markets and because the authors felt their well developed economies are likely to be highly integrated with the United States economy through trade and other international factors such as capital movements and homogeneous economic and political objectives. The authors found that in the very short-term (up to two quarters), there was a relatively predictable relationship between inter-country correlations. Beyond two quarters, however, inter-country correlations were generally unstable. The results of this study questioned the stability of the so-called "international"factors (which were widely believed to be present in national stock market returns, and strengthened over time through international trade and investment), and thus casted some doubts on the potential size of gains from international portfolio investment for the US investor.

Schollhammer and Sand (1985) studied the co-movement of stock market indices of the major European countries and the US over a period of 30 months. Countries chosen were the UK, Germany, Italy, and the Netherlands as European Communities (EC) member countries, Switzerland as a non-EC country, and the US. Autoregressive integrated moving average time series analysis was used to determine possible interdependence of stock price development in each of these countries along with possible lead or lag relationships. Contrary to findings of previous research, a significant degree of interdependence was found between the stock price development of Germany, the UK, the Netherlands, and Switzerland. Surprisingly, the stock price developments of France and Italy were unaffected by such developments in other major European countries. In addition, a change in the US stock price index contributed to a change in the same direction of all the European markets except Italy. Farragher and Hui (1985) examined the correlation coefficients of the weekly returns (using price indices) of the US market and six Asia-Pacific markets, and found that the correlation coefficients were less than one and fairly stable over time. However, another study on the potential of the international diversification among the US and the Asia-Pacific countries by Hui and Kwan (1988) indicated that the correlation coefficients were unstable.

DATA AND METHODOLOGY

The data base consists of daily closing indices of the KLSE Industrial (Malaysia), Hang Seng (Hong Kong), Nikkei Dow Jones (Tokyo), Dow Jones Industrial Average (New York), Australian All Ordinaries (Sydney), and Financial Times Industrial Ordinaries (London) as reported by the *Investors Digest* for a period from January 1984 to December 1988. A Singaporean based index, such as the SES Industrial Index, is not used in this study due to its similarity (in terms of composition of the stocks) with the Malaysian based index (KLSE Industrial Index). Only the same-day available closing indices are used. This means that if there is no trading (for whatever reason) on a given day on any one of these markets, then that day will be dropped. Altogether, there were 1066 observations covering a period of 5 years.

The above-mentioned indices were chosen because they are widely referred to and considered to be representative of the respective markets. These indices were transformed into percentage changes in indices. Percentage changes reflect the relative changes rather than the actual changes, and for the purpose of making comparison a relative change is more meaningful than an actual change. In prior studies (for example, Gruber and Fadner 1971; Watson 1978; Maldonado and Saunders 1981), the percen-

tage changes in indices (or returns) are normally adjusted for exchange rate changes to reflect returns received by a United States investor. In this study this adjustment is not made due to a few reasons. First, as indicated by Gruber and Fadner (1971), the effect of exchange rates on the stability of the value of foreign assets is theoretically indeterminate. Furthermore, they found in their study that the standard deviation of returns from holding foreign assets with and without exchange rate adjustments are statistically not different. In fact, they found the correlation of returns between US and foreign assets with and without the exchange rate adjustment are statistically not different and fail to show a consistent pattern of change. Secondly, adjustment for exchange rate alone is not enough because other factors such as dividends, taxes (both on dividends and capital gains), transaction costs, and inflation rates (in respective countries) are equally important in determining the returns received by an investor. However, by excluding all of these factors, the purpose of this study is still valid since we are interested in finding out whether or not the movements in foreign markets can be used to predict the Malaysian market. Finally, an investor will normally convert his income from foreign investment at the end of his investment period (i.e., not throughout his investment period). This means that the adjustment made by those prior studies is not realistic.

The statistical analysis is first made for the period 1984-1988, and followed by analysis of the sub-periods, namely, before crash, after crash, 1984, 1985, 1986, 1987, and 1988. The purpose of looking at the results of the sub-periods is to find out whether or not there exists stationarity or stability in correlations.

The correlation coefficient (see, for example, Johnson and Siskin 1980) between two variables X and Y is computed as

$$\frac{\text{Cov}\ (X,Y)}{[\text{Var}(X)\text{Var}(Y)]^{1/2}}$$

where, X represents the series of percentage changes in market 1, and, Y represents the series of percentage changes in market 2. In the case of a lagged correlation coefficient, X represents the series of lagged percentage changes in market 1. If the two markets are perfectly and positively correlated then the coefficient correlation is $+1$, and -1,if they are perfectly and negatively correlated. A zero coefficient correlation value indicates no correlation. For the movements of the two markets to be closely interrelated, one would expect a very high positive correlation coefficient between the two.

The null hypothesis that states the population correlation coefficient between X and Y is zero will be accepted if the calculated or observed

correlation coefficient is within plus or minus r-table value at a given level of significance with N-2 degrees of freedom, where N is the number of observations. For example, at the 5 percent level of significance with 100 degrees of freedom (N-2 = 100), the r-table value is plus or minus 0.195 (see Johnson and Siskin 1980). For large degrees of freedom (greater than 100), the r-table value at the 5 percent level of significance can be estimated by 2 standard error of correlation (see Fama 1965), where the standard error of correlation at lag k is calculated as $1/(N\text{-}k)^{1/2}$. The relationship between variables X and Y are statistically insignificant if correlation coefficient is within plus or minus 2 standard error of correlation at the 5 percent level. However, a statistically significant correlation coefficient does not necessarily mean a very high correlation coefficient which can be meaningful in the construction of a forecasting model. As indicated in the above paragraph, the two markets are considered to be closely related if the positive correlation coefficient is very high. In addition, a meaningful prediction model can be constructed if the lagged correlation coefficients are also very high.

The null hypothesis that the correlations are equal between two sub-periods is tested using the Z-statistic (see Maldonado and Saunders 1981)

$$Z_{ij} = [X_{ij}(1) - X_{ij}(2)]/\{[1/(N_1 - 3) + 1/N_2 - 3)]\}^{1/2},$$

where, $X_{ij}(k) =$ In $\{[1 + r_{ij}(k)]/[1 - r_{ij}(k)]\}^{1/2}$ which is a Fisher transformation of the correlation coefficients in sub-period k,

$r_{ij}(k) =$ correlation coefficient of market i and market j for sub-period k,

and $N_k =$ number of observations in sub-period k.

The oneway analysis of variance or the F-test (see Berenson, Levine and Goldstein 1983; Johnson and Siskin 1980) is used to test the null hypothesis that all sub-periods' correlation coefficients for selected lags 1 through 55 (between the KLSE Industrial Index and other indices) are the same. The observed value of the test statistic, F-Observed, can be calculated as

$$\text{F-Observed} = \frac{\text{Between Groups Mean Square}}{\text{Within Groups Mean Square}}$$

The null hypothesis is rejected if the F-Observed is greater than the F-table value at the 5 percent significance level. Degrees of freedom for

F-table value are C-1 and N-C, where C is the number of groups, and N is the number of observations in each group.

RESULTS AND DISCUSSION

Table 1 shows the correlation coefficients for the period 1984-1988 among the stock markets selected for this study. All correlation coefficients are statistically significant at the 5 percent level. However, these correlation coefficients are not big enough (the highest value is 0.5582, between Australian All Ordinaries and Hang Seng) to conclude a highly close relationship among these stock markets. The KLSE Industrial has the highest correlation (a value of 0.5051) with the Australian All Ordinaries.

TABLE 1. Correlation coefficients among the selected stock indices 1984-1988

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
KLSE Ind	1.0000	0.4609	0.5051	0.3157	0.4063	0.3680
Hang Seng		1.0000	0.5582	0.3375	0.4151	0.4284
Aust. Ord.			1.0000	0.3605	0.5014	0.4725
DJIA				1.0000	0.4694	0.3253
Fin. Times					1.0000	0.4179

Note: All correlation coefficients are significant at the 5 percent level.

Table 2 shows the correlation coefficients for the period 1984-1988 between the Malaysian market and the other markets at selected lags. Except for a few lags, the correlation coefficients are not statistically significant at the 5 percent level. This indicates that the Malaysian market is quite efficient in incorporating the public information (i.e., the movements in the foreign stock markets) into its stocks.

Tables 3 through 9 show that correlation coefficients between the KLSE Industrial Index and other indices at selected lags 1 through 55 for sub-periods before 1987 crash, after 1987 crash, year 1984, year 1985, year 1986, year 1987, and year 1988. Excepts for a few lags, most of the correlation coefficients are not significant at the 5 percent level (coefficient correlation is twice its standard error).

Table 10 shows the correlation coefficients between the KLSE Industrial Index and other indices according to sub-period.Correlation coefficients are generally high in 1987, and generally low in 1985, 1986, and the period before the 1987 crash. For other sub-periods, the results are mixed. Overall, the correlation coefficients are not quite stable from one sub-period to another.

TABLE 2. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags 1984-1988

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
1	−0.0263	0.0528	−0.0490	0.0147	−0.0049
2	0.0059	0.0790*	−0.0387	0.0206	−0.0118
3	0.0681*	0.0429	−0.1017*	0.0054	−0.0203
4	0.0229	0.0451	−0.0340	−0.0234	−0.0525
5	−0.0400	−0.0563	−0.0342	0.0142	−0.0571
10	0.0018	0.0320	0.0296	−0.0475	0.0478
15	−0.0271	−0.0238	−0.0172	−0.0171	−0.0070
20	0.0272	0.0159	0.0465	0.0220	0.0400
25	−0.0167	−0.0039	−0.0502	−0.0469	−0.0129
30	0.0065	0.0420	−0.0149	−0.0522	0.0199
35	0.0064	0.0336	0.0237	−0.0009	0.0222
40	0.0508	0.0411	0.0409	0.0222	0.0714*
45	0.0283	0.0538	0.0678*	0.0016	0.0054
50	0.0075	−0.0184	0.0681*	0.0365	0.0116
55	−0.0016	0.0277	0.0135	0.0029	−0.0320

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 3. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags January 1984 to October 15, 1987

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.0947*	0.0888*	0.0167	0.0295	0.0542
1	−0.0157	0.0494	0.0392	0.0377	−0.0299
2	0.0279	0.0511	−0.0264	0.0418	−0.0013
3	0.0466	−0.0192	−0.0551	0.0272	−0.0141
4	−0.0460	0.0229	−0.0212	0.0232	−0.0394
5	−0.0465	0.0119	0.0107	0.0271	−0.0038
10	0.0379	0.0165	0.0586	0.0069	0.0161
15	−0.0169	−0.0099	−0.0151	−0.0108	0.0376
20	−0.0037	−0.0477	−0.0286	−0.0062	0.0141
25	0.0189	−0.0037	−0.0266	−0.0105	−0.0007
30	0.0108	0.0319	−0.0421	−0.0485	−0.0236
35	0.0040	0.0337	0.0578	−0.0235	0.0261
40	0.0399	0.0460	−0.0206	0.0185	−0.0099
45	0.0185	0.0758*	0.0039	−0.0144	0.0324
50	−0.0019	0.0020	0.0430	0.0454	0.0284
55	−0.0024	0.0254	−0.0373	−0.0175	−0.0253

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 4. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags October 26, 1987 to December 1988

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.5599*	0.4322*	0.0778	0.1790*	0.3609*
1	0.0911	0.1241*	−0.1370*	0.0413	0.0941
2	0.0043	−0.0418	−0.0896	−0.0882	−0.1223
3	−0.1620*	−0.1108	−0.0991	0.0096	−0.2852*
4	−0.0882	−0.0111	0.0134	0.0487	−0.0498
5	−0.0666	−0.0398	−0.0973	−0.0582	−0.0376
10	−0.0729	−0.1027	0.0538	−0.0288	−0.0427
15	−0.0422	−0.0733	0.0744	0.0618	0.1119
20	0.0392	0.1073	0.0048	−0.0625	0.0466
25	0.1204	0.0257	0.0514	0.0692	0.0148
30	0.0749	0.0368	0.0662	−0.0595	0.0311
35	0.0566	0.0570	0.0006	−0.0585	−0.0311
40	0.0869	0.0873	−0.0031	0.0180	0.0017
45	0.1238	0.1043	0.0081	0.0719	−0.0632
50	−0.0458	0.0044	0.1472*	−0.0074	−0.0567
55	0.0172	0.0973	0.0345	−0.0061	−0.0801

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 5. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags Year 1984

Lag	Hang Seng	Aust.All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.1808*	0.2598*	0.1101	0.0835	0.1904*
1	0.0245	−0.0179	0.0654	0.0725	−0.0243
2.	0.0917	0.0646	−0.0914	0.0827	0.0274
3.	0.1078	−0.0513	−0.0391	0.0192	−0.0124
4	0.0903	0.0747	−0.0097	0.0400	−0.0394
5	0.0314	0.0649	0.0048	0.0878	0.0822
10	0.1680*	0.0271	0.1392*	−0.0776	−0.0540
15	0.0236	0.0729	0.0851	0.0933	0.0722
20	0.0439	−0.1287	−0.0733	0.0160	−0.0569
25	0.0489	−0.0955	0.0284	−0.1537*	−0.0151
30	0.0887	−0.0134	0.0031	−0.0104	0.0502
35	−0.1187	0.0340	0.0920	−0.0616	−0.0471
40	−0.0039	−0.0079	−0.0027	0.0570	−0.0209
45	−0.0213	0.2080*	0.0064	−0.1260	0.1864*
50	−0.1233	−0.0270	0.0074	−0.0122	−0.0052
55	0.0302	0.1466	−0.0047	0.0182	0.0442

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 6. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags
Year 1985

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin.Times	Nikkei
0	0.1251	0.0560	0.0321	0.0521	0.0272
1	−0.0650	0.0980	−0.0216	−0.0131	0.0956
2	0.0066	0.1012	−0.0831	−0.0280	0.0156
3	0.0029	0.0558	0.0616	0.0183	0.0062
4	−0.1150	0.0048	−0.0758	0.0528	−0.0530
5	−0.0429	0.0277	0.0478	0.0541	−0.0836
10	−0.0046	0.0957	−0.0065	−0.0706	0.0239
15	−0.1194	−0.0835	−0.0093	−0.0498	0.0622
20	−0.0361	−0.0945	0.0025	0.0637	0.1060
25	−0.0318	0.0267	−0.0517	0.0347	0.0008
30	−0.0319	0.0771	0.1078	−0.0082	−0.0759
35	−0.0259	−0.0880	0.0290	0.0349	0.1175
40	−0.0005	0.0550	−0.1246	−0.0153	0.1693*
45	0.0599	−0.0545	−0.0065	0.1079	−0.1342
50	−0.0170	0.1070	0.0102	−0.0307	0.1334
55	−0.0331	−0.0936	−0.1486	−0.0331	−0.0163

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 7. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags
Year 1986

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.0171	0.0432	−0.0757	−0.0258	0.0804
1	−0.0886	0.0269	0.1285	0.0066	−0.0700
2	−0.0677	0.0275	0.0451	0.0553	−0.0579
3	0.0357	−0.0529	−0.1072	−0.0208	−0.0173
4	−0.0722	0.0164	−0.0046	0.0543	−0.0880
5	−0.0434	−0.0832	0.0767	−0.0210	−0.0589
10	−0.0950	−0.0466	−0.0530	0.0496	−0.0285
15	−0.0201	−0.0416	−0.0900	−0.0445	−0.0349
20	0.0184	0.0079	−0.0308	0.0399	0.0249
25	0.0409	−0.0827	−0.1287	−0.0890	−0.0349
30	−0.0138	0.0083	−0.0911	−0.1805*	−0.0789
35	0.1716*	0.0858	0.0719	0.0245	0.0343
40	0.0147	0.0875	0.1060	0.0268	−0.0349
45	−0.0925	−0.0233	0.0896	−0.0617	0.0403
50	0.0269	−0.0023	0.0442	0.1866*	0.0559
55	0.0174	−0.0897	0.0302	−0.0664	−0.0897

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 8. Correlation coefficients between the KLSE Industrial index and the selected major stock indices at selected lags
Year 1987

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.7224*	0.7343*	0.6241*	0.7106*	0.5800*
1	−0.0336	0.0499	−0.1241	−0.0039	−0.0410
2	0.0040	0.1047	−0.0313	0.0533	−0.0198
3	0.1510*	0.1120	−0.0990	0.0170	0.0197
4	0.0671	0.0775	−0.0846	−0.0780	−0.0617
5	−0.0309	−0.0914	−0.1024	0.0061	−0.1187
10	−0.0121	0.0425	0.0424	−0.0872	0.0625
15	−0.0060	−0.0194	0.0039	−0.0219	−0.0508
20	0.0548	0.0482	0.1478*	0.0423	0.0441
25	−0.0384	−0.0026	−0.0596	−0.0382	−0.0234
30	0.0060	0.0654	−0.0281	−0.0650	0.0726
35	0.0235	0.0378	0.0289	0.0382	0.0260
40	0.1076	0.0305	0.1024	0.0149	0.1516*
45	0.0760	0.0611	−0.0821	−0.0231	0.0273
50	−0.0325	−0.0327	0.0836	0.0008	−0.0067
55	0.0272	0.0770	0.0095	0.0867	0.0408

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 9. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags
Year 1988

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Fin. Times	Nikkei
0	0.3658*	0.3716*	0.0550	0.1738*	0.1900*
1	0.1183	0.1389*	0.0079	0.0821	0.1032
2	−0.0293	0.0938	−0.0550	−0.0829	−0.0033
3	−0.2256*	−0.0802	−0.1837*	−0.0576	−0.2048*
4	0.0190	−0.0203	0.0470	0.1233	−0.0388
5	−0.0591	−0.0295	−0.1501*	−0.0095	0.0921
10	−0.0139	0.0731	0.0229	0.0416	0.1228
15	−0.1184	−0.1612	−0.0682	−0.0453	−0.0509
20	−0.0448	0.0210	−0.0526	−0.1300	0.0094
25	−0.0701	0.0226	−0.2105	−0.0652	−0.0776
30	0.0174	0.0396	0.0855	0.0093	−0.0150
35	−0.1092	0.0075	−0.0870	−0.0963	−0.0488
40	0.0514	0.0991	0.0397	0.0941	0.0253
45	0.0278	0.0341	0.0132	−0.0189	−0.0068
50	−0.1775*	−0.0695	0.0848	−0.0394	−0.1101
55	0.0334	0.0066	0.0954	0.0891	−0.0688

Note: * Correlation Coefficient is significant at the 5 percent level.

TABLE 10. Correlation coefficients between the KLSE industrial index and the selected major stock indices according to sub-period

	1984	1985	1986	1987	1988	Before Crash*	After Crash*	1984-1988
	N=213	N=210	N=213	N=214	N=212	N=812	N=253	N=1066
Hang Seng	0.1808a	0.1251	0.0171	0.7224a	0.3658a	0.0947a	0.5599a	0.4628a
Aust. Ord.	0.2598a	0.0560	0.0432	0.7343a	0.3716a	0.0888a	0.4322a	0.5059a
Dow Jones	0.1101	0.0321	−0.0757	0.6241a	0.0550	0.0167	0.0778	0.3159a
Fin. Times	0.0835	0.0521	−0.0258	0.7106a	0.1738a	0.0295	0.1790a	0.4062a
Nikkei	0.1904a	0.0272	0.0804	0.5800a	0.1900a	0.0542	0.3609a	0.3681a

Notes: 1. * Before Crash refers to a period from January 1984 to October 15, 1987 inclusive. After Crash refers to a period from October 26, 1987 to December 1988 inclusive.

2. a Correlation coefficient is significant at the 5 percent level.

TABLE 11. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the Hang Seng index

	1984	1985	1986	1987	1988	Before Crash	After Crash	1984-1988
1984	0.00	0.58	1.70	−7.49*	−2.05*	1.13	−4.81*	−4.21*
1985		0.00	1.11	−8.04*	−2.63*	0.40	−5.39*	−4.94*
1986			0.00	−9.19*	−3.75*	− 1.01	−6.58*	−6.41*
1987				0.00	5.42*	10.58*	2.99*	5.46*
1988					0.00	3.72*	−2.66*	−1.55
Before Crash						0.00	−7.43*	−8.70*
After Crash							0.00	1.88
1984-1988								0.00

Note: * Significant at the 5 percent level.

TABLE 12. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the Australian all ordinaries index

	1984	1985	1986	1987	1988	Before Crash	After Crash	1984-1988
1984	0.00	2.14*	2 28*	−6.90*	−1.27	2 28*	−2.10*	− 3.86*
1985		0.00	0.13	−9.02*	−3.41*	− 0.42	−4.33*	− 6.60*
1986			0.00	−9 18*	−3 55*	− 0.59	−4.48*	− 6.81*
1987				0.00	5 61*	10.98*	5.09*	5.05*
1988					0.00	3.88*	−0.77	− 2.21*
Before Crash						0.00	−5.16*	−10.03*
After Crash							0.00	− 1.35
1984-1988								0.00

Note * Significant at the 5 percent level

TABLE 13. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the Dow Jones industrial average

	1984	1985	1986	1987	1988	Before Crash	After Crash	1984-1988
1984	0 00	0.80	1.91	−6.37*	0.57	1.21	0.35	−2.87*
1985		0.00	1.10	−7.15*	−0.23	0.20	−0.49	−3.88*
1986			0.00	−8.28*	−1.34	−1.19	−1.64	−5.34*
1987				0.00	6.93*	9.25*	6.99*	5.37*
1988					0.00	0.49	−0.24	−3.60*
Before Crash						0.00	−0.85	−6.65*
After Crash							0.00	−3.54*
1984-1988								0.00

Note * Significant at the 5 percent level

TABLE 14. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the financial times index

	1984	1985	1986	1987	1988	Before Crash	After Crash	1984-1988
1984	0.00	0.32	1.12	−8.26*	−0.94	0.70	−1.04	−4.60*
1985		0.00	0.80	−8.55*	−1.26	0.29	−1.37	−4.99*
1986			0.00	−9.38*	−2.06*	− 0.71	−2.21*	−6.05*
1987				0.00	7.30*	11.11*	7.57*	6.07*
1988					0.00	1.88	−0.06	−3.38*
Before Crash						0.00	−2.09*	−8.61*
After Crash							0.00	−3.56*
1984-1988								0.00

Note * Significant at the 5 percent level

TABLE 15. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the Nikkei index

	1984	1985	1986	1987	1988	Before Crash	After Crash	1984-1988
1984	0.00	1.69	1.15	−4.82*	0.00	1.79	−1.98	−2.56*
1985		0.00	−0.54	−6.49*	−1.68	−0.35	−3.73*	−4.73*
1986			0.00	−5.97*	−1.14	0.34	−3.18*	−4.05*
1987				0.00	4.82*	7.87*	3.04*	3.67*
1988					0.00	1.78	−1.98	−2.56*
Before Crash						0.00	−4.47*	−7.12*
After Crash							0.00	−0.12
1984-1988								0.00

Note * Significant at the 5 percent level

Tables 11 through 15 show the Z-values for significant difference of the correlation coefficients among sub-periods between the KLSE Industrial Index and other indices. In general, the correlation coefficients of the sub-period 1987 are significantly different from other sub-periods at the 5 percent level. In fact, the high Z-values also indicate that the differences are significant at the 1 percent level. The same (with a few exception) can also be said about the period 1984-1988 compared to other sub-periods. For other sub-periods, the results are mixed.

Table 16 shows the results of the analysis of variance of the sub-periods' correlation coefficients (for the selected lags 1 through 55) between the KLSE Industrial Index and other indices. The F-statistic of 2.6580 and the P-value of 0.0140 indicate that the sub-periods' selected lagged correlation coefficients between the KLSE Industrial Index and the Hang Seng Index are not significantly different at the 1 percent level. For other indices, the sub-periods'correlation coefficients (for selected lags 1 through 55) are not significantly different at the 5 percent level. In addition, the results of the Scheffe technique for multiple comparison indicate that no two sub-periods are significantly different at the 5 percent level. Furthermore, the results of the independent t-test indicate that no sub-period is significantly different from the period 1984-1988 in terms of correlation coefficients (for selected lags 1 through 55) at the 1 percent level. This means that lagged coefficient correlations are quite stable from one sub-period to another.

TABLE 16. Oneway analysis of variance of the sub-periods' correlation coefficients for the selected lags 1 through 55 between the KLSE industrial index and other indices

KLSE Index and	MS (Between)	MS (Within)	F-Statistic	P-Value
Hang Seng	0.0108	0.0041	2.6580	0.0140
Aust. All Ord.	0.0029	0.0043	0.6619	0.7037
DJIA	0.0031	0.0052	0.5971	0.7571
Fin. Times	0.0010	0.0035	0.2713	0.9639
Nikkei	0.0060	0.0046	1.3024	0.2557

Notes: 1. Degrees of freedom for between groups and within groups are 7 and 112, respectively.

2. Results of the Scheffe Technique for multiple comparison indicate that no two groups (classification according to sub-periods) are significantly different at the 0.05 level.

3. Results of the t-test indicate that no sub-period is significantly different from the period 1984-1988 in terms of selected lagged correlation coefficients at the 0.01 level.

CONCLUSIONS AND IMPLICATIONS

Statistically significant correlation coefficients between price movements of stocks in the Malaysian market and those of other major markets indicated that there is some validity in the claim of interdependency between stock markets. This can be explained by the globalization of information flow, in which no stock market can escape from being slightly affected by the events in the major stock exchanges. Furthermore, these countries have trade relations with each other, and therefore any factor affecting the economy of any of these countries (which in turn will be reflected in the country's stock market) will also affect the other stock markets. However, these correlation coefficients are not as high as commonly thought of, which means that there are other factors affecting the price movements in these stock markets.

Statistically insignificant correlation coefficients for both longer and shorter sub-periods between price movements, at different lags, of stocks in the Malaysian stock market and those of other markets indicated that the information on the past movements of stock prices in other stock markets is not useful in predicting the future price movements in the Malaysian stock market. This means that the Malaysian market is quite efficient in absorbing the past and public information concerning the movement of the foreign stock markets, and hence, conforming to the semi-strong form of the efficient market hypothesis.

The relatively high positive correlation coefficients among these markets for the period 1984-1988 indicate that the risk can only be reduced slightly through international diversification. In addition, the instability in the correlations over time further complicate the selection of an optimal investment strategy. Furthermore, as indicated by the insignificant lagged correlations, the prediction model based on past changes in indices is difficult to construct.

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