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Inter-relationship Between Malaysian and Selected Stock Markets in the Far East and New York: Parametric Versus Nonparametric Approach Revisited

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ABSTRACT

Most of the past studies suggested that considerable gains were available to investors who diversify their investment portfolio internationally due to the usually low positive or negative correlations among world's stock markets. This study looks at the issue of stock market co-movement from a nonparametric approach as well as the commonly used parametric approach. This study uses daily and weekly indices of the markets of Malaysia, Hong Kong, Australia, Japan, and the United States for a period from January 1984 to December 1988. In general, the results of both techniques are not totally in agreement with each other However, both techniques suggest that the co-movements among these markets are not stable with time which means that it is difficult to construct an optimal investment strategy based on the co-movements.

ABSTRAK

Kebanyakan kajian lepas mencadangkan bahawa keuntungan yang ketara boleh didapati oleh pelabur yang mempelbagaikan portfolio pelaburan mereka secara antarabangsa disebabkan nilai korelasi yang selalunya rendah atau negatif antara pasaran-pasaran saham dunia. Kajian ini meneliti isu pergerakan bersama pasaran saham daripada perspektif kaedah bukan parametrik dan juga kaedah parametrik yang selalu digunakan. Kajian ini menggunakan indek mingguan dan harian pasaran-pasaran saham Malaysia, Hong Kong, Australia, Jepun dan Amerika Syarikat untuk tempoh dari Januari 1984 hingga Disember 1988. Secara keseluruhannya, keputusan kedua-dua kaedah ini tidak sepenuhnya menyetujui antara satu sama lain. Walau bagaimanapun, kedua-dua kaedah mencadangkan bahawa pergerakan bersama antara pasaran-pasaran ini tidak stabil mengikut masa, yang membawa maksud bahawa adalah sukar untuk membentuk strategi pelaburan optimum berdasarkan pergerakan bersama.

INTRODUCTION

Diversification can reduce or eliminate risk depending on the values of the correlation coefficients between the assets in the portfolio. If the returns

between the assets are negatively correlated, then diversification can theoretically eliminate risk completely If the correlations are positive and less than 1, then diversification can reduce risk eventhough not entirely. It is commonly believed that international diversification will enable an investor to eliminate the part of his portfolio risk associated with the economics of a particular country but not the one associated with the world wide economic conditions. In addition, the stability of the correlation structure is important for a profitable investment strategy (Maldonado & Saunders 1981). Instability of the correlation structure will result in a continuously changing efficient frontier which makes it difficult to identify an optimal investment strategy

Most of the past studies dealt with the potential gains to investors from international portfolio diversification (Agmon 1972; Bertoneche 1979; Grubel 1968; Grubel & Fadner 1971, Saunders & Woodward 1977). 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[1] 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.

Makridakis and Wheelwright (1974) studied the co-movements of 14 stock indices and found that the inter-country correlations were always less than one. However, this study concluded that the correlations between these markets were generally unstable over time.

Watson (1978) studied the correlation coefficients of the monthly returns for the period from January, 1970 to December, 1977 among stock market indices of 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. 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. The results showed 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.

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, the Netherlands, Switzerland, and the US. 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. However, 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.

In the case of co-movement between Malaysian and other markets, two studies are worth mentioned here. The first study is by Chuan, Alhabshi and Kiew (1981). This study examined the correlation between the Malaysian stock market and those of New York, London, Hong Kong, Tokyo, Sydney, and Johannesburg, for the period between May 1974 and December 1978. The results indicated the correlation coefficients, with the exception of New York market, were very high (correlation coefficients between 0.68 and 0.85). The lagged correlations (for day 1 up to day 25) were also very high. The second study by Yong (1987/88) examined the weekly correlations between the Malaysian market and those of Hong Kong, Tokyo, Singapore, and New York, for a period between January 1983 and December 1987 However, the correlations were not as high as those found in the first study, and the lagged correlations were mostly not significant. Both of these studies did not examine the stability of correlations over time.

Based on the above, it seems that the results of these studies do indicate some potential gains from the international diversification due to low (substantially less than one) correlations between the markets chosen. However, the results regarding the stability of correlations are mixed; some do indicate stability, while others do not. It should be noted here that most of the tests employed by these studies are parametric in nature. That is, these tests assume normality with the data under study, eventhough this is not necessarily true. If the data under study were nonnormal, then the test results were invalid. The current study, on the other hand, looks at the issue of comovement of the national stock markets from both parametric and nonparametric approaches, and to see whether the results of these two methods are consistent with each other.

DATA AND METHODOLOGY

The data base consists of daily and weekly (friday's) closing indices of the KLSE Industrial (Malaysia), and some selected Far East and New York stock indices, i.e., Hang Seng (Hong Kong), Nikkei Dow Jones (Tokyo), Dow Jones Industrial Average (New York), and Australian All Ordinaries (Sydney) as reported by the *Investors Digest* (a publication of the KLSE) for a period from January, 1984 to December 1988.[2] For consistency, only the same-day available closing indices are used. This means that if there is no trading (usually due to holidays) on a given day on any one of these markets, then that day will be dropped, or in the case of weekly data the most recently available data will be used.

The above-mentioned indices were chosen because they are widely referred to and considered to be representative of the respective markets.[3] These indices were transformed into percentage changes in indices (from here on simply referred to as changes in index) to reflect daily and weekly return, as used by past studies. 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. These transformed data were first tested using the Kolmogorov-Smirnov test for normality to determine the distributional nature of the data. For other tests employed, the transformed data were readjusted according to the requirement of the respective tests. The tests were performed according to period/subperiods, namely, year 1984, year 1985, year 1986, year 1987, year 1988, and period 1984-1988. The purpose of looking at the results of the sub-periods is to find out whether or not there exists stationarity or stability in the results from one subperiod to another. For parametric tests, daily data are used because these tests work better with large observations. As for the nonparametric tests, daily data are not used for the opposite reason. For comparative purposes, weekly data are used both in the parametric and nonparametric tests.

In prior studies (Gruber & Fadner 1971, Watson 1978; Maldonado & Saunders 1981), the percentage changes in indices (or returns) were usually 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 influence 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.[4]

The correlation coefficient 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 the correlations are equal between two sub-periods is tested using the Z-statistic (Maldonado & Saunders 1981)

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

where, $X_{ij}(k)$ = $\ln \{\{[1 + r_{ij}(k)]/[1 - r_{ij}(k)]\}^{1/2}\}$, 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.

In addition to the Kolmogorov-Smirnov test for normality, three other nonparametric tests are performed, namely, Wilcoxon matched-pairs signed-ranks test, median test and Kruskall-Wallis (K-W) one-way analysis of variance. As mentioned before, the Kolmogorov-Smirnov test is used to test the conformity of the data to the normal distribution. The Wilcoxon matched-pairs signed-ranks test is used to determine whether two samples are different

in terms of their pairs of observations as well as the direction of the difference. The Wilcoxon test (due to its nature of testing in pairs) can be used to actually determine which pairs are significantly different.

The null hypothesis for the Kolmogorov-Smirnov test for normality is that the population of the data under study is normally distributed. The statistic calculated is the D statistic which is

$$\text{Sup}_{\text{all } x} [S(x) - F(x)]$$

where x is the weekly change in index,

S(x) is the proportion of sample observations less than x or equal to x, and

F(x) is the proportion according to a normal distribution.

The null hypothesis in the case of the median test is that all 5 populations of the samples under study have the same median, or put it another way, they are closely related. The test statistic is chi-square which is calculated as

$$\sum_{i=1}^{n} \sum_{j=1}^{c} [(O_{ij} - E_{ij})^2/E_{ij}]$$

where O_{ij} is the observed value in each cell,
and E_{ij} is the expected value for each cell.

With the Kruskall-Wallis (K-W) one-way analysis of variance, the null hypothesis is that the 5 population distribution functions are identical (or having the same median), or put it another way, they are closely related. The Kruskal-Wallis test statistic can be calculated as

$$H = [12/(N(N+1))][\sum_{i=1}^{k} R_i^2/n_i] - 3(n+1)$$

where R_i is the sum of the ranks assigned to observations in the ith sample,
n_i is the number of observations in the ith sample,
and N is the total number of observations in the k samples.

If the calculated value of H is greater than the tabulated chi-square value, then we reject the null hypothesis at the stated level of significance. If there are a substantial number of ties, we should adjust the test statistic H to

$$H_c = H/[1 - T/(N^3 - N)]$$

where T equals t^3 - t,
and t is the number of tied observations in a group of tied scores.

With the Wilcoxon matched-pairs signed-ranks test, the null hypothesis is that the median of the population of differences is zero, or put it another way, the two markets are correlated. The test statistic T is the smaller of the T_+ or T_- where T_+ is the sum of the ranks with positive signs, and T_- is the sum of the ranks with negative signs. For matched-pairs of $n > 20$, we can recalculate T as

$$Z = \frac{T - [n(n+1)]/4}{[n(n+1)(2n+1)/24]^{1/2}}$$

RESULTS AND DISCUSSION

Table 1 and 2 show 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 significantly less than +1 (the highest value is 0.5582 for daily data and 0.6308 for weekly data, between Australian All Ordinaries and Hang Seng) which means that international diversification can offer significant benefits beyond those offered by diversification within a single country. The KLSE Industrial has the highest correlation (a value of 0.5051 for daily data and a value of 0.5795 for weekly data) with the Australian All Ordinaries. Lagged serial correlations for the daily data (from lag 1 to lag 55) between the Malaysian market and other markets were also calculated (the full results are presented in appendices Table A1 through Table A6). Special attention is given to the DJIA because of its very significant time difference with Malaysian and other markets. Specifically, we would like to know whether there exists a significant correlation at lag 1 between the KLSE Industrial and the DJIA. The results indicate that even with big time difference between the NYSE and the Malaysian market, the correlations are still not significant at lag 1 for all subperiods. Overall, except for one or two significant correlations at various lags, the lagged correlations between Malaysian and other markets are not significant.

Tables 3 and 4 show the correlation coefficients between the KLSE Industrial Index and other indices according to sub-period. Correlation coefficients for both daily and weekly data are generally high in 1987, and generally low in 1985 and 1986. The high correlations in 1987 are possibly due to the October 1987 crash where all the markets used in this study fell within the same percentage or magnitude. For year 1984 and year 1988, the

TABLE 1. Correlation coefficients among the selected stock indices 1984-1988, using daily data

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Nikkei
KLSE Ind	1.0000	0.4609*	0.5051*	0.3157*	0.3680*
Hang Seng		1.0000	0.5582*	0.3375*	0.4284*
Aust. Ord.			1.0000	0.3605*	0.4725*
DJIA				1.0000	0.3253*

Note: * Significant at the 5 percent level.

TABLE 2. Correlation coefficients among the selected stock indices 1984-1988, using weekly data

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Nikkei
KLSE Ind	1.0000	0.4928*	0.5795*	0.3590*	0.3382*
Hang Seng		1.0000	0.6308*	0.3953*	0.3768*
Aust. Ord.			1.0000	0.4387*	0.4832*
DJIA				1.0000	0.4401*

Note: * Significant at the 5 percent level.

TABLE 3. Correlation coefficients between the KLSE industrial index and the selected major stock indices according to sub-period, using daily data

	1984 N=213	1985 N=210	1986 N=213	1987 N=214	1988 N=212	1984-1988 N=1066
Hang Seng	.1808*	.1251	.0171	.7224*	.3658*	4609*
Aust. Ord.	.2598*	.0560	.0432	.7343*	.3716*	.5051*
Dow Jones	.1101	.0321	- .0757	.6241*	.0550	.3157*
Nikkei	.1904*	.0272	.0804	.5800*	.1900*	.3680*

Note: * Significant at the 5 percent level.

TABLE 4. Correlation coefficients between the KLSE industrial index and the selected major stock indices according to sub-period, using weekly data

	1984 N=49	1985 N=52	1986 N=51	1987 N=49	1988 N=51	1984-1988 N=252
Hang Seng	4162*	.0867	-.0974	.8328*	.1926	4928*
Aust. Ord.	.0492	.2159	.1536	.8024*	.5261*	.5795*
Dow Jones	.2481	-.0434	.1470	.6538*	-.0169	.3590*
Nikkei	.2858*	.1125	.0036	.5630*	.2790*	.3382*

Note: * Significant at the 5 percent level.

results are mixed. Overall, the correlation coefficients are not quite stable from one sub-period to another.

Tables 5 and 6 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 for both daily and weekly data 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 one exception, i.e., between KLSE Ind. and Hang Seng for subperiod 1988, in the daily data) can also be said about the period 1984-1988 compared to other sub-periods. For other sub-periods, the results are mixed for the daily data, but not quite so for the weekly data where the correlations for most subperiods are significantly different among themselves.

Table 7 shows the results of the Kolmogorov-Smirnov test of the weekly index changes for each market for the entire period 1984-1988 and of the daily index changes for the subperiods selected. For the entire period 1984-1988, only the index of New York exhibits normal distribution. Other indices do not exihibit normality in their weekly changes. With the daily data for each subperiod, at the 5 percent level of significance, the American, Australian and Malaysian markets exhibited nonnormality in their daily returns in year 1984; all markets, year 1987; the American and Malaysian markets, year 1988; and no market, years 1985 and 1986. This means that, in general, we are right in assuming that the data under study are not normally distributed and thus reinforcing the need to use the nonparametric tests in dealing with data on changes in stock indices.

The results of the median test are shown in Table 8. The results show highly insignificant values (that is, close association) of the test statistic for the years 1987 and 1986. On the other hand, the result is significant in year 1984 at the 1 percent level, and quite insignificant at the 5 percent level in years 1985 and 1988. For the entire period 1984-1988, the result shows significant difference in median among these five markets at the 5 percent level. The highly insignificant values for the years 1987 and 1986 can imply that these markets are highly interrelated, which means that international diversification in these markets for both years might not reduce risk substantially The risk might be reduced tremendously in year 1984, and quite substantially reduced in other years. In general, these results indicate that the associations or correlations between the national stock markets are not quite stable with time.

The results of the Kruskal-Wallis one-way ANOVA as shown in Table 9 are consistent with the results of the median test in terms of highly insignificant values of the test statistic for the years 1987 and 1986. In year 1984, the result is significant at the 5 percent level. Again, as in the case of the median test, we can see that the test results are not consistent from one period to another.

TABLE 5. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the selected index, using daily data

	1984	1985	1986	1987	1988	1984-1988
KLSE Ind. and Hang Seng						
1984	0.00	0.58	1.70	-7 49*	-2.05*	-4.21*
1985		0.00	1.11	-8.04*	-2.63*	-4.94*
1986			0.00	-9.19*	-3.75*	-6.41*
1987				0.00	5.42*	5.46*
1988					0.00	-1.55
1984-1988						0.00
KLSE Ind. and Aust. All Ord.						
1984	0.00	2.14*	2.28*	-6.90*	-1.27	-3.86*
1985		0.00	0.13	-9.02*	-3.41*	-6.60*
1986			0.00	-9.18*	-3.55*	-6.81*
1987				0.00	5.61*	5.05*
1988					0.00	-2.21*
1984-1988						0.00
KLSE Ind. and DJIA						
1984	0.00	0.80	1.91	-6.37*	0.57	-2.87*
1985		0.00	1.10	-7.15*	-0.23	-3.88*
1986			0.00	-8.28*	-1.34	-5.34*
1987				0.00	6.93*	5.37*
1988					0.00	-3.60*
1984-1988						0.00
KLSE Ind. and Nikkei						
1984	0.00	1.69	1.15	-4.82*	0.00	-2.56*
1985		0.00	-0.54	-6.49*	-1.68	-4.73*
1986			0.00	-5.97*	-1.14	-4.05*
1987				0.00	4.82*	3.67*
1988					0.00	-2.56*
1984-1988						0.00

Note: * Significant at the 5 percent level.

TABLE 6. Calculated Z statistics for significant difference of the correlation coefficients among sub-periods between the KLSE industrial index and the selected index, using weekly data

	1984	1985	1986	1987	1988	1984-1988
KLSE Ind. and Hang Seng						
1984	0.00	8.45*	12.70*	-17.34*	5.83*	-3.75*
1985		0.00	4.48*	-26.34*	-2.62*	-18.54*
1986			0.00	-30.42*	-7.03*	-25.65*
1987				0.00	23.54*	25.53*
1988					0.00	-13.87*
1984-1988						0.00
KLSE Ind. and Aust. All Ord.						
1984	0.00	-4.04*	-2.48*	-24.29*	-12.58*	-23.78*
1985		0.00	1.56	-21.02*	- 8.86*	-18.11*
1986			0.00	-22.33*	-10.32*	-20.40*
1987				0.00	12.23*	17.22*
1988					0.00	-3.10*
1984-1988						0.00
KLSE Ind. and DJIA						
1984	0.00	7.04*	2.47*	-12.16*	6.35*	- 4.75*
1985		0.00	-4.64*	-19.58*	-0.64	-17.16*
1986			0.00	-14.89*	3.96*	- 9.16*
1987				0.00	18.76*	15.77*
1988					0.00	-15.80*
1984-1988						0.00
KLSE Ind. and Nikkei						
1984	0.00	4.29*	6.82*	- 7.89*	0.17	- 2.25*
1985		0.00	2.65*	-12.44*	-4.21*	- 9.79*
1986			0.00	-14.88*	-6.79*	-14.02*
1987				0.00	8.24*	11.07*
1988					0.00	-2.63*
1984-1988						0.00

Note: * Significant at the 5 percent level.

TABLE 7 Results of Kolmogorov-Smirnov test for normality (D statistics) by period

Year	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Nikkei
1984 (daily data)	0.09864* (P=.032)	0.08726 (P=.078)	0.10113* (P=.026)	0.15672** (P=.000)	0.06190 (P=.388)
1985 (daily data)	0.06384 (P=.359)	0.07147 (P=.234)	0.04858 (P=.705)	0.07322 (P=.210)	0.09156 (P=.059)
1986 (daily data)	0.07922 (P=.138)	0.05355 (P=.574)	0.09272 (P=.051)	0.07930 (P=.137)	0.06004 (P= 426)
1987 (daily data)	0.16669** (P=.000)	0.22097** (P=.000)	0.23723** (P=.000)	0.17356** (P=.000)	0.14571** (P=.000)
1988 (daily data)	0.10689* (P=.016)	0.09087 (P=.060)	0.05415 (P=.563)	0.10888* (P=.013)	0.07859 (P=.146)
1984-1988 (weekly data)	0.08591* (P=0.048)	0.12223** (P=0.001)	0.13869** (P=0.000)	0.07510 (P=0.117)	0.09331* (P=0.025)

Notes: 1) P refers to two-tailed significance values.
2) * Significant at the 5 percent level.
3) ** Significant at the 1 percent level.

TABLE 8. Results of the median test, by period, using weekly data

Period	Chi-square	P-value
1984	18.3538**	0.0011
1985	7.0769	0.1319
1986	1.3490	0.8530
1987	0.5878	0.9644
1988	4.1417	0.3872
1984-1988	10.5588*	0.0320

Notes: 1) * Significant at the 5 percent level.
2) ** Significant at the 1 percent level.

TABLE 9. Results of the Kruskall-Wallis one-way ANOVA, by period, using weekly data

Period	H-value@	P-value
1984	12.0412*	0.0170
1985	11.0368*	0.0262
1986	2.2761	0.6851
1987	0.8911	0.9258
1988	5.1019	0.2770
1984-1988	7 4704	0.1130

Notes: 1) * Significant at the 5 percent level.
2) @ Adjusted for ties.

TABLE 10. Results (Z-observed) of the Wilcoxon matched-pairs signed-ranks test between Malaysian and the selected markets, by period, using weekly data

	Hang Seng	Aust. Ord.	DJIA	Nikkei
1984	-2.4271*	-1.6612	-1.5070	-2.2978*
	(0.0152)	(0.0967)	(0.1318)	(0.0216)
1985	-2.1310*	-2.8550**	-2.1037*	-2.0126*
	(0.0331)	(0.0043)	(0.0354)	(0.0442)
1986	-0.9373	-0.8061	-0.2343	-0.9514
	(0.3486)	(0.4202)	(0.8147)	(0.3414)
1987	-0.4078	-0.7063	-0.6615	-0.1144
	(0.6834)	(0.4800)	(0.5083)	(0.9089)
1988	-1.6122	-1.9028	-1.2935	-1.0812
	(0.1069)	(0.0571)	(0.1958)	(0.2796)
1984-1988	-2.2068*	-1.4315	-0.9454	-2.1343*
	(0.0273)	(0.1523)	(0.3445)	(0.0328)

Notes: 1) Two-tailed p-values are shown in the parentheses.
2) * Significant at the 5 percent level.
3) ** Significant at the 1 percent level.

Table 10 shows the results of the Wilcoxon matched-pairs signed-ranks test according to subperiods. The *highly* insignificant Z-values in years 1986 and 1987 indicate that there is close association between the Malaysian market and other markets in these two years. The results of the parametric test as shown in Table 4, however, indicate that close associations only took place in year 1987 but not in year 1986. In year 1988, the results are not significant at the 5 percent level, which means that the Malaysian market is quite correlated with those 4 markets. However, the results of the parametric test shown in Table 4 are mixed for year 1988. In year 1985, the results are

significant at the 5 percent level, which means that the Malaysian market is not correlated with those 4 markets. The results in year 1985 are somewhat consistent with the results of the parametric test shown in Table 4, which show that the correlations are not significant at the 5 percent level for that year. In year 1984 and for the entire period of 1984-1988, the results are mixed, whereas the results of the parametric test (as shown in Table 4) are slightly different, with all significant correlations in period 1984-1988 and mixed results in year 1984. In general, we can see that the correlations between the Malaysian market and other markets are not consistent from one period to another.

CONCLUSION AND IMPLICATION

In this study, both the nonparametric approach as well as the commonly used parametric approach are applied to examine the issue of co-movements among world's stock markets. Statistically significant correlation coefficients between the Malaysian market and those of other major markets indicated that there is some validity in the claim of interdependency between stock markets. However, these correlation coefficients are substantially less than +1.

The results of the nonparametric tests indicate that in some years there seems to be close association in the co-movements of the stock markets, while in some other periods they do not seem to be so. In fact, the nonparametric tests show that the relationship between these markets are not stable over time as in the case of parametric tests.

We show from the results of all the tests performed, that indeed the idea of international diversification is still far from being resolved. The idea of reducing risk through international diversification does not seem to be totally acceptable due to changing and inconsistent correlations between these national stock markets, plus the fact that there are periods of very high correlations among them. Eventhough there exist periods with low association, it is difficult the predict this well in advance. This study, at least, substantiates those earlier studies, such as that of Maldonado and Saunders (1981), which question the validity of the potential gain hypothesis of the international diversification.

As we can see, the results of the parametric tests and those of the nonparametric tests are not totally in agreement, eventhough there are periods in which the results show otherwise. However, they all conclude that the associations or correlations are not stable over time. This, in a way, suggests that eventhough most prior studies suffer from the problem of nonnormality (and thus resulting in their methods being somewhat invalid), their conclusions are still quite acceptable. However, with the problem of nonnormality,

it is better that future studies use nonparametric tests or other tests adjusted for the distribution of the data under study.

One final note, 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.

Appendices

TABLE A1. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, 1984-1988

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	-0.0263	0.0528	-0.0490	-0.0049
2	.0059	.0790*	- .0387	- .0118
3	.0681*	.0429	- .1017*	- .0203
4	.0229	.0451	- .0340	- .0525
5	- .0400	- .0563	- .0342	- .0571
10	.0018	.0320	.0296	.0478
15	- .0271	- .0238	- .0172	- .0070
20	.0272	.0159	.0465	.0400
25	- .0167	- .0039	- .0502	- .0129
30	.0065	.0420	- .0149	.0199
35	.0064	.0336	.0237	.0222
40	.0508	.0411	.0409	.0714*
45	.0283	.0538	.0678*	.0054
50	- .0075	- .0184	.0681*	.0116
55	- .0016	.0277	.0135	- .0320

Note: * Significant at the 5 percent level.

TABLE A2. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, year 1984

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	.0245	-.0179	.0654	-.0243
2	.0917	.0646	-.0914	.0274
3	.1078	-.0513	-.0391	-.0124
4	.0903	.0747	-.0097	-.0394
5	-.0314	.0649	.0048	.0822
10	.1680*	.0271	.1392*	-.0540
15	-.0236	.0729	.0851	.0722
20	.0439	-.1287	-.0733	-.0569
25	.0489	-.0955	.0284	-.0151
30	.0887	-.0134	.0031	.0502
35	-.1187	.0340	.0920	-.0471
40	-.0039	-.0079	-.0027	-.0209
45	.0213	.2080*	.0064	.1864*
50	-.1233	-.0270	.0074	-.0052
55	.0302	.1466	-.0047	.0442

Note: * Significant at the 5 percent level.

TABLE A3. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, year 1985

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	-.0650	.0980	-.0216	.0956
2	.0066	.1012	-.0831	.0156
3	.0029	.0558	-.0616	-.0062
4	-.1150	.0048	-.0758	-.0530
5	-.0429	.0277	.0478	-.0836
10	-.0046	.0957	-.0065	.0239
15	-.1194	-.0835	-.0093	.0622
20	-.0361	-.0945	.0025	.1060
25	-.0318	.0267	-.0517	.0008
30	-.0319	.0771	.1078	-.0759
35	-.0259	-.0880	.0290	.1175
40	-.0005	.0550	-.1246	.1693*
45	.0599	-.0545	-.0065	-.1342
50	-.0170	.1070	.0102	.1334
55	-.0331	-.0936	-.1486	-.0163

Note: * Significant at the 5 percent level.

TABLE A4. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, year 1986

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	-.0886	.0269	.1285	-.0700
2	-.0677	.0275	.0451	-.0579
3	.0357	-.0529	-.1072	-.0173
4	-.0722	.0164	-.0046	-.0880
5	-.0434	-.0832	.0767	-.0589
10	-.0950	-.0466	-.0530	-.0285
15	-.0201	-.0416	-.0900	-.0349
20	.0184	.0079	-.0308	.0249
25	.0409	-.0827	-.1287	-.0349
30	-.0138	.0083	-.0911	-.0789
35	.1716*	.0858	.0719	.0343
40	.0147	.0875	.1060	-.0349
45	-.0925	-.0233	.0896	.0403
50	.0269	-.0023	.0442	.0559
55	.0174	-.0897	.0302	-.0897

Note: * Significant at the 5 percent level.

TABLE A5. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, year 1987

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	-.0336	.0499	-.1241	-.0410
2	.0040	.1047	-.0313	-.0198
3	.1510*	.1120	-.0990	.0197
4	.0671	.0775	-.0846	-.0617
5	-.0309	-.0914	-.1024	-.1187
10	-.0121	.0425	.0424	.0625
15	-.0060	-.0194	.0039	-.0508
20	.0548	.0482	.1478*	.0441
25	-.0384	-.0026	-.0596	-.0234
30	.0060	.0654	-.0281	.0726
35	.0235	.0378	.0289	.0260
40	.1076	.0305	.1024	.1516*
45	.0760	.0611	-.0821	.0273
50	-.0325	-.0327	.0836	-.0067
55	.0272	.0770	.0095	.0408

Note: * Significant at the 5 percent level.

TABLE A6. Correlation coefficients between the KLSE industrial index and the selected major stock indices at selected lags, daily data, year 1988

Lag	Hang Seng	Aust. All Ord.	Dow Jones	Nikkei
1	.1183	.1389*	.0079	.1032
2	-.0293	.0938	-.0550	-.0033
3	-.2256*	-.0802	-.1837*	-.2048*
4	.0190	-.0203	.0470	-.0388
5	-.0591	-.0295	-.1501*	.0921
10	-.0139	.0731	.0229	.1228
15	-.1184	-.1612	-.0682	-.0509
20	-.0448	.0210	-.0526	.0094
25	-.0701	.0226	-.2105	-.0776
30	.0174	.0396	.0855	-.0150
35	-.1092	.0075	-.0870	-.0488
40	.0514	.0991	.0397	.0253
45	.0278	.0341	.0132	-.0068
50	-.1775*	-.0695	.0848	-.1101
55	.0334	.0066	.0954	-.0688

Note: * Significant at the 5 percent level.

NOTES

1. A good test requires more than two sample observations (or more than two subperiods) so that a more meaningful conclusion regarding the consistency of the results can be made. Also some kind of statistical test should be employed (such as the one used in this paper) in order to find out if there is any significant difference among these subperiods' results.
2. 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) during the period of the study.
3. Some people might object to the use of indices instead of the actual stock prices. They might argue that indices cannot be bought or sold, plus the fact that some of these indices are not similar in terms of measurement due to the omission of dividend yield. To answer this objection, one should look at various aspects of index itself. First, an index is a representative of the general movement of the market it tries to represent and thus should reflect the behavior of the stocks in the respective market. Secondly, annual dividend yields are usually quite small in value, and the daily and weekly observations make them even smaller and insignificant. Even if these indices were to be recomputed with the inclusion of these dividend yields, the results would not be significantly different from the ones that ignore the adjustment. A study by Lee, Pettit & Swankoski (1990) calculated correlations among Asian stock markets both using adjusted data (change in indices adjusted for dividend yields) and unadjusted data. They found that there is no significant difference in terms of results of these two groups of data. Thirdly, in the formula rate of return = change in price

+ dividend yield, the dividend yield portion (or to be more exact, the daily dividend yield or the weekly dividend yield) is constant (usually annual dividend yield is apportioned equally for each transacted day or week) in any given year, and more or less stable from year to year, so "the change in price" portion of that formula is the the one that contributes significantly to the value of correlation (or any other measure) that we try to measure. Finally, many studies cited in this article used indices and they did not adjust the indices for dividend yields.

4. If investors cash in their foreign income throughout their investment period (i.e., on a daily or weekly basis), then the transaction costs will eat up any profit they have. That is why this adjustment is not practical, and thus not realistic.

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