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Comovement of International Stock Market from the Perspective of a Nonparametric Approach

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ABSTRAK

Kebanyakan kajian lepas tentang pergerakan bersama pasaran-pasaran saham antarabangsa adalah berkenaan dengan potensi laba kepada para pelabur daripada pempelbagaian portfolio antarabangsa. Secara amnya, kajian-kajian ini mencadangkan bahawa laba yang agak besar boleh didapati oleh pelabur yang mempelbagaikan pelaburan secara antarabangsa disebabkan oleh korelasi positif atau negatif yang rendah antara pasaran-pasaran saham dunia. Sebaliknya, kajian ini melihat kepada isu ini daripada perspektif kaedah bukan parametrik, iaitu berlawanan dengan kaedah parametrik yang selalu digunakan oleh kajian-kajian masa lepas, kerana adanya masalah ketidak-normalan pada data yang dikaji. Kajian ini menggunakan indeks mingguan pasaran-pasaran saham Malaysia, Hong Kong, Australia, Jepun, United Kingdom dan Amerika Syarikat bagi satu tempoh di antara bulan Januari 1984 hingga bulan Disember 1988. Keputusan kajian ini mendapati bahawa pergerakan bersama antara pasaran-pasaran ini adalah tidak stabil mengikut masa, yang bermakna bahawa adalah sukar untuk membentuk strategi pelaburan optimum berdasarkan pergerakan bersama pasaran-pasaran ini.

ABSTRACT

Most of the past studies regarding the comovement of the international stock markets deal with the potential gains to investors from international portfolio diversification. In general, these studies suggested that considerable gains were available to investors who diversify internationally due to the usually low positive or negative correlations between national stock markets. This study, on the other hand, looks at this issue from the perspective of a nonparametric approach as apposed to the commonly used parametric approach in the past studies, due to the problem of nonnormality with data under study. This study uses weekly indices of the markets of the Malaysia, Hong Kong, Australia, Japan, the United Kingdom, and the United States for a period from January 1984 to December 1988. The results of this study indicate that the comovements among these markets are not stable with time, which means that it is difficult to construct an optimal investment strategy based on comovements of these markets.

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 argued (Watson 1978) 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.

Many past studies (Agmon 1972; Bertoneche 1979; Grubel 1968; Gruber & Fadner 1971; Saunders & Woodward 1977) suggested that considerable gains were available to investors who diversify internationally due to low positive or negative correlations between national stock markets. Makridakis & Wheelwright (1974) studied the movement (measured in terms of returns) of 14 national 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 correlations between the monthly indices of Australia, Japan, New Zealand, South Africa, the United Kingdom, the United States and West Germany for a period from January 1970 to December 1977. In general, the correlations between these countries were approximately +0.55, which were substantially less than +1.00, and thus the author concluded that the international diversification can reduce risk. In addition, another study by Watson (1980) showed that inter-country correlations did not vary significantly with time.

Maldonado & Saunders (1981) studied the stability of correlations over time between the stock index (recalculated as monthly returns) of the United States and four major stock indices of Japan, Germany, Canada, and the United Kingdom from the point of view of the United States investors. This study found that in the very short-term (up to two quarters), the correlations were quite stable but beyond two quarters they were generally unstable.

Farragher & Hui (1985) studied the correlations between the index of the United States and six Asia-Pacific indices and concluded that correlations were less than one and fairly stable over time. On the other hand, another study by Hui & Kwan (1988) on the US and Asia-Pacific markets showed that the correlations were not stable over time.

Based on our discussion in the above paragraphs, 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, which is something that these studies seem to neglect. By ignoring this assumption the test results are rendered quite invalid. The current study, on the other hand, looks at the idea of comovement of the national stock markets from a nonparametric approach, an approach which makes no assumption regarding the data under study.

DATA AND METHODOLOGY

The data base consists of weekly closing indices (friday's or recently available trading data during the week) of the KLSE Industrials (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* (a monthly publication of the KLSE) for a period from January 1984 to December 1988. Only the same-date available closing indices were used. The weekly indices were transformed into percentage changes (from here on simply referred to as changes in index) to reflect weekly return, as used by past studies. 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.

There are five tests performed. They are the Kolmogorov-Smirnov test for normality, median test, Kruskal-Wallis one-way ANOVA, Wilcoxon matched-pairs signed-ranks test. As mentioned in the above paragraph, 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. Other tests are the nonparametric procedures that utilize three or more independent samples. In a way, these tests cannot be used to identify which pairs are significatly different from each other; therefore, 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

$$\underset{\text{all } x}{\text{Sup}} \, [S(x) - F(x)] \qquad (1)$$

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 is rejected if $D > 1.36/N^{1/2}$ at the 5 percent significance level, and if $D > 1.63/N^{1/2}$ at the 1 percent significance level (Daniel 1978:267-76).

With the median test, the null hypothesis is that all 6 populations of the samples under study have the same median, against the alternative hypothesis that at least one population has a median different from the other. The statistic is chi-square which is calculated as

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

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

The null hypothesis is rejected if $\chi^2 >$ tabulated χ^2 for c-1 (in our case 6-1=5) degrees of freedom at a stated level of significance.

With the Kruskal-Wallis (K-W) one-way analysis of variance by ranks, the null hypothesis is that the 6 population distribution functions are idential (or having the same median). The Kruskal-Wallis test statistic can be calculated as

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

where R_i = sum of the ranks assigned to observations in the ith sample,
n_i = number of observations in the ith sample,

and $N = \sum_{i=1}^{k} n_i$ = total number of observations in the k samples.

If the calculated value of H is greater then the tabulated chi-square value with k-1 (in our case 6-1=5) degrees of freedom, then we reject the null hypothesis at the stated level of significance. If there are a substantial number of ties, me way want to adjust the test statistic H to

$$H_c = H/(1 - \sum T/(N^3 - N)) \qquad (4)$$

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

The null hypothesis in the case of the Kendall's coefficient of concordance is that the m sets of rankings are not associated (independent). The test statistic is

$$W = [12 \sum_{j=1}^{n} R_j^2 - 3m^2n(n+1)^2]/[m^2n(n^2-1)] \quad (5)$$

where m is the number of sets of rankings,
n is the number of objects that are ranked in each set,
and R_j is the sum of the ranks assigned to the jth object.

For $n > 7$, the W statistic can be adjusted to the chi-square statistic as

$$\chi^2 = m(n-1)W. \quad (6)$$

We reject the null hypothesis if χ^2 is greater than the tabulated chi-square with (n-1) degrees of freedom.

With the Wilcoxon matched-pairs signed-ranks test, the null hypothesis is that the median of the population of differences is zero. 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 or $n > 20$, we can recalculate T as

$$Z = \frac{T - [n(n+1)]/4}{[n(n+1)(2n+1)/24]^{1/2}} \quad (7)$$

We reject the null hypothesis if $Z < -1.96$ or if $Z > +1.96$ at the 5 percent significance level, and if $Z < -2.576$ or $Z > +2.576$ at the 1 percent significance level.

RESULTS AND DISCUSSION

Table 1 shows the results of the Kolmogorov-Smirnov test of the weekly index changes for each market for the entire period 1984-1988. As we can see only the index of New York exhibits normal distribution. Other indices do not exihibit normality in their weekly changes. This means that 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 by period are shown in Table 2. The results vary from being highly significant test statistic in year 1984 to being highly insignificant test statistic in year 1987. For the entire period 1984-1988 the result still shows insignificant difference in terms of the median or distribution of the weekly changes in the indices at the 5 percent level. The highly insignificant difference in median for the years 1987 and 1986 can imply that all the markets in those two year are highly interrelated in terms of their movement. This means that international diversification (in these 6 markets) might not reduce risk. The risk might be tremendously reduced in year 1984, and substantially reduced in other periods.

TABLE 1. Results of the Kolmogorov-Smirnov test for normality for period 1984 - 1988

Index	D-statistic	Two-tailed P-value
KLSE Ind.	0.08591*	0.048
Hang Seng	0.12223**	0.001
Aust. Ord.	0.13869**	0.000
DJIA	0.07510	0.117
Fin. Times	0.10289**	0.010
Nikkei	0.09331*	0.025

Notes: * significant at the 5 percent level.
** significant at the 1 percent level.

TABLE 2. Results of the median test by period

Period	Chi-square	P-value
1984	18.5714**	0.0023
1985	6.9875	0.2216
1986	1.3725	0.9273
1987	0.6122	0.9874
1988	7.0068	0.2201
1984 - 1988	10.5609	0.0608

Note: ** significant at the 1 percent level.

The results of the Kruskal-Wallis one-way ANOVA as shown in Table 3, and the Kendall's coefficient of concordance as shown in Table 4 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 addition, the results are significant in year 1984 as in the case of the median test.

The Kendall's coefficient of concordance is an association test as apposed to the Kruskal-Wallis one-way ANOVA and median test which are tests for equal median or identical distribution. Any how, identical distribution can also mean close association; thus, these tests are more or less reinforce each other or substitute for each other. Therefore, it is not unexpected that these tests produced, more or less, the same results. All these results indicate that the associations or correlations between the national stock markets are not quite stable with time.

TABLE 3. Results of the Kruskal-Wallis one-way ANOVA, by period

Period	H-value**	P-value
1984	13.7648*	0.0172
1985	11.1229*	0.0490
1986	2.2944	0.8071
1987	1.3392	0.9308
1988	6.8249	0.2340
1984 - 1988	7.5180	0.1849

Notes: * significant at the 5 percent level.
** adjusted for ties.

TABLE 4. Results of the Kendall's coefficient of concordance, by period

Period	W-statistic	Chi-square	P-value
1984	0.0607	14.8659*	0.0110
1985	0.0378	9.8379	0.0800
1986	0.0045	1.1539	0.9492
1987	0.0013	0.3237	0.9972
1988	0.0284	7.2447	0.2031
1984 - 1988	0.0038	4.7703	0.4446

Note: * significant at the 5 percent level.

Table 5 shows in details the pairs of markets which differ significantly in terms of their median according to period. The results of this test are quite consistent with the results of previous tests. In general the market of Malaysia did not show close relationship (as indicated by the difference in median) with some other markets for almost (except years 1986 and 1987) all periods. All markets seem to have close association in years 1986 and 1987. For all other periods the results are mixed, but the majority still shows close association.

TABLE 5. The results (Z-observed) of the Wilcoxon matched-pairs signed-ranks test between markets, by period

	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
1984					
KLSE	-2.4271*	-1.6612	-1.5070	-1.9646*	-2.2978*
	(0.0152)	(0.0967)	(0.1318)	(0.0495)	(0.0216)
Hang Seng		-1.5468	-1.4026	-0.6466	-0.9649
		(0.1219)	(0.1607)	(0.5179)	(0.3346)
Aust. Ord.			-0.1243	-1.2534	-1.3180
			(0.9010)	(0.2101)	(0.1875)
DJIA				-1.4672	-1.2832
				(0.1423)	(0.1994)
Fin.Times					-0.0149
					(0.9881)
1985					
KLSE	-2.1310*	-2.8550**	-2.1037*	-1.9033	-2.0126*
	(0.0331)	(0.0043)	(0.0354)	(0.0570)	(0.0442)
Hang Seng		-1.1867	-0.3962	-0.4098	-1.0792
		(0.8519)	(0.6920)	(0.6819)	(0.2805)
Aust. Ord.			-0.8469	-0.4781	-1.4981
			(0.3970)	(0.6326)	(0.1341)
DJIA				-0.2231	-1.0154
				(0.8234)	(0.3099)
Fin.Times					-0.3937
					(0.6938)
1986					
KLSE	-0.9373	-0.8061	-0.2343	-0.0328	-0.9514
	(0.3486)	(0.4202)	(0.8147)	(0.9738)	(0.3414)
Hang Seng		-0.3562	-0.3468	-0.6854	-0.0187
		(0.7217)	(0.7287)	(0.4931)	(0.9850)
Aust. Ord.			-0.4734	-0.6902	-0.1734
			(0.6360)	(0.4901)	(0.8623)
DJIA				-0.5165	-0.8014
				(0.6055)	(0.4229)
Fin.Times					-0.9702
					(0.3320)

(continued)

TABLE 5 (*continued*)

1987					
KLSE	-0.4078	-0.7063	-0.6615	-0.2238	-0.1144
	(0.6834)	(0.4800)	(0.5083)	(0.8229)	(0.9089)
Hang Seng		-0.4924	-0.8207	-0.3581	-0.1791
		(0.6224)	(0.4118)	(0.7203)	(0.8579)
Aust. Ord.			-0.5073	-0.5521	-0.1243
			(0.6119)	(0.5809)	(0.9010)
DJIA				-0.7411	-0.6068
				(0.4586)	(0.5440)
Fin.Times					-0.2238
					(0.8229)
1988					
KLSE	-1.6122	-1.9028	-1.2935	-2.3409*	-1.0812
	(0.1069)	(0.0571)	(0.1958)	(0.0192)	(0.2796)
Hang Seng		-0.4312	-0.0797	-0.1312	-1.2115
		(0.6663)	(0.9365)	(0.8956)	(0.2257)
Aust. Ord.			0.0000	-0.3749	-1.1108
			(1.0000)	(0.7077)	(0.2667)
DJIA				-0.0187	-1.1248
				(0.9850)	(0.2607)
Fin.Times					-2.2309*
					(0.0257)
1984-1988					
KLSE	-2.2068*	-1.4315	-0.9454	-0.8314	-2.1343*
	(0.0273)	(0.1523)	(0.3445)	(0.4057)	(0.0328)
Hang Seng		-1.4073	-1.4910	-1.1051	-0.6065
		(0.1593)	(0.1359)	(0.2691)	(0.5442)
Aust. Ord.			-0.7727	-0.0622	-0.5249
			(0.4397)	(0.9504)	(0.5996)
DJIA				-0.6734	-1.4772
				(0.5007)	(0.1396)
Fin.Times					-1.1161
					(0.2644)

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.

CONCLUSION AND IMPLICATION

In this study a nonparametric approach to the issue of relationship of the national stock markets is taken as apposed to the parametric approach used by many earlier studies. The results of this study do indicate that some years (particularly years 1986 and 1987) do exhibit close association between the movements of the national stock markets, while in some other periods they do not. In fact, the relationship between these markets are not stable over time. Eventhough this study does not actually calculate the correlation coefficients, the tests performed do indicate or point to the issue of asscociation or correlation.

We show from the results of the tests that indeed the idea of international diversification is still far from being resolved. The idea of reducing risk through international diversification is not quite acceptable because there are periods which show high association among the national stock markets. Eventhough there exist periods with low association, it is difficult to predict this well in advance. This study, at least, substantiates those earlier studies (such as Maldonado & Saunders 1981) which question the validity of the potential gain hypothesis of the international diversification.

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