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Normality and Homoscedasticity of Stock Market Returns: The Case of Malaysian and Some Major Stock Markets

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ABSTRACT

Many prior studies regarding the behavior of stock prices have shown that the stock prices are not normally distributed. Some offer stable Paretian to be the distribution, while some others offer the mixture of normals distribution. In this study of Malaysian and five major stock markets, it is shown that stock prices (as reperesented by indices) do exhibit normal distributions, but within short time spans. Longer time spans result in stock prices behave not according to normal distribution. In addition, the differing variances found between periods, indicate that the variances are not constant over time. In conclusion, the results of this study support the hypothesis that stock price movements are mixtures of normals with differing variances as proposed by Hall, Brorsen, and Irwin (1989) in their study regarding the behavior of futures prices.

ABSTRAK

Banyak kajian lampau mengenai gelagat harga saham menunjukkan yang harga-harga saham tidak bertaburan normal. Sesetengah pengkaji mencadangkan taburan Paretian stabil, manakala sebahagian lagi mencadangkan gabungan beberapa taburan normal. Dalam kajian ini, yang meliputi pasaran saham Malaysia dan 5 pasaran utama dunia, adalah didapati bahawa harga-harga saham (sebagaimana yang diwakili oleh indeks saham) bertaburan normal, tetapi dalam temph-tempoh masa yang pendek. Jangka masa yang lebih panjang menghasilkan taburan yang tidak normal. Juga, varians yang berbeza-beza mengikut tempoh masa, menunjukkan yang varians adalah tidak konstan sepanjang masa. Sebagai rumusan, keputusan kajian ini menyokong hipotesis yang pergerakan harga saham adalah gabungan beberapa taburan normal dengan varians yang berbeza-beza sebagaimana yang dicadangkan oleh Hall, Brorsen, dan Irwin (1989) dalam kajian mereka mengenai harga-harga di pasaran masa hadapan.

INTRODUCTION

As mentioned by Hsu (1984), empirical studies of the behavior of stock returns are important for several reasons. First, the nature of stock return behavior is fundamental to the formulation of the concept of risk. Second, the measurement of risk depends on properties (such as the stationarity, finiteness of variances, skewness, and kurtosis) of empirical stock return distributions. Third, statistical tests (with the exception of non-parametric tests) for the empirical validity of financial models rely on the constancy of stock return distributions over time. Lastly, several important pricing models for stock options, warrants, convertible debentures, and other similar financial instruments usually require explicit estimates of stock return variances, in which the usefulness of such models depends largely on the finiteness and the stationarity of the variance measurements.

Statistical tests of the efficient market hypothesis regarding price changes are mostly (with the exception of a few non-parametric tests used, such as runs test) based on the assumptions that the price changes are normally distributed with a constant variance. If price movements are not normally distributed, variance may not be an appropriate measure of dispersion, and statistical tests based on finite variance are likely to give misleading results (Fama 1965). If the distribution is normal, but variance is nonconstant, then an adjustment for heteroscedasticity must be made before conducting tests (Taylor 1985). Research on stock prices (such as Fama 1965; Solnik 1973; Ang and Pohlman 1978; Laurence 1986) has found that the distribution of stock prices is leptokurtic (i.e., having more values near the mean and in the extreme tails). Two hypotheses frequently proposed to explain the obseved departures from normality are the stable Paretian and the mixture of normal distributions (Hall, Brosersen, and Irwin 1989). Under the stable Paretian hypothesis, distributions conform to nonnormal members of the stable Paretian family with infinite variance (Mandelbrot 1963), while under the mixture of normality hypothesis, distributions are combinations of normal distribution with different variances (Fama 1965).

This paper will discuss an empirical study regarding the normality and the homoscedasticity nature of stock price distributions over time, performed on Malaysian and various major world's stock markets. This paper will try to conclude whether nonnormality and heteroscedasticity are a worldwide phenomenon, occurring both in the actively traded stock markets (such as New York Stock Exchange) and in the thinly traded markets (such as Malaysian stock market).

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). For uniformity, 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 returns in each market. In other words, the daily rate of return in each market at time period t is

$$\{[I_t - I_{t-1}]/I_{t-1}\} \times 100\%,$$

where I_t and I_{t-1} are the index of a given market at time period t and time period t-1, respectively.

In prior studies (for example, Gruber and Fadner 1971; Watson 1978; Maldonado and Saunders 1981), the percentage 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 the following 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 exchnge 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. Second, 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. 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 analyses are first made for the period 1984-1988, and followed by analyses of the sub-periods, namely, before crash, after crash, 1984, 1985, 1986, 1987, and 1988. The purpose of looking at the results of the differing sub-periods is to find out whether or not there exists stationarity or stability in statistical properties, especially the normality property and variances, over time.

The statistical properties calculated are the mean, standard deviation, variance, mode, kurtosis, and skewness (see, for example, Francis 1986, for discussion on these statistics). Kolmogorov-Smirnov test for normal distribution is also performed to see the conformity of the stock returns to the normal distribution.

STATISTICAL TESTS

TEST FOR NORMAL DISTRIBUTION

Let x be the percentage change in the stock price (or index change), then, S(x) can be defined as the proportion of sample observations less than or equal to x. The test statistic D can be calculated as

$$\sup_{\text{all } x} [S(x) - F(x)],$$

which is read "D equals the supremum, over all x, of the obsolute value of the difference S(x) - F(x)". If the two functions are represented graphically, D is the greatest vertical distance between S(x) and F(x), the normal distribution.

The null hypotheses, which states that the cumulative probability distribution of the index changes is normal, is rejected if $D > 1.36/N^{1/2}$ at the 5 percent level of significance, of if $D > 1.63/N^{1/2}$ at the 1 percent level of significance (see Daniel 1978: 267-276).

The null hypothesis can also be tested (as proposed by the SPSS-X procedures) using the formula

$$K - S\ Z = D(1/n)^{-1/2}$$

TEST FOR HOMOSCEDASTICITY

A well known test developed by Hartley (see Berenson, Levine, and Goldstein 1983: 66-67) called F_{max} can be used to test the null hypothesis that all variances are equal. F_{max} statistic is the ratio of the largest of the c sample variances to that the smallest. That is,

$$F_{max} = \frac{S^2 \text{ (largest)}}{S^2 \text{ (smallest)}}$$

If, for a specified level of significance, the computed F_{max} equals or exceeds F_{table} value, the upper-tail critical value of Hartley's F_{max} distribution based on c and r-1 degrees of freedom, (c refers to number of samples, and r refers to number of observations in each sample) the null hypothesis is rejected. It is important to note that the Hartley test was devised for c equal-sized samples. In the case of differing sample sizes, r can be approximated by the average observation of all the samples, rounded to the lower whole number (not to the nearest whole number).

STATISTICAL MEASURES OF THE DISTRIBUTION

Let r_1 be the percentage change in index, or rate of return, at time period i, P_1 as the probability of r_1, and E(r) as the expected mean for r_1, then we can discuss these terms in terms of four different statistical moments (see Francis 1986: 910-912).

The first moment, $M_1 = \sum_{i=1}^{n} P_i\,[r_1 - E(r)]$,

is always equivalent to zero. The expected mean, E(r), is equivalent to

$$\sum_{i=1}^{n} P_i r_1$$

The second moment, $M_2 = \sum_{i=1}^{n} P_i[r_1 - E(r)]^2$,

which is another name for variance, measures the distribution's dispersion or wideness. Its square root is the standard deviation, which measures the variability of price changes.

The third moment, $M_3 = \sum_{i=1}^{n} P_i[r_1 - E(r)]^3$,

measures the lopsidedness of the distribution. It is normalized by dividing it by the standard deviation cubed. This puts the third moments of different distribution in terms of a relative measure of lopsidedness which is called "skewness,"

$$sk(r) = M_3/\sigma^3.$$

The Fourth moment, $M_4 = \sum_{i=1}^{n} P_i[r_i - E(r)]^4$,

measures the peakedness of a probability distribution. The fourth moment is also called kurtosis. The measure of kurtosis is normalized using the formula M_4/σ^4 In the SPSS-X procedure, the formula for kurtosis is modified to $[M_4/\sigma^4]$ - 3. Based on this SPSS-X procedure, a distribution is normal if the kurtosis is zero; a leptokurtic, if kurtosis is greater than 0; and a platykurtic, if the kurtosis is less than 0. It should be noted here that, if observations within a distribution cluster more around a central point than those in the normal distribution (i.e., the distribution is more peaked), the distribution is called leptokurtic. A leptokurtic distribution also tends to have more observations spread in the extreme tails than does a normal distribution. If observations cluster less than in the normal distribution (i.e., distribution is flatter), the distribution is called platykurtic.

Although examination of a histogram provides some indication of possible skewness and kurtosis, it is often desirable to compute formal indexes that measure these properties (Norusis 1983). In the SPSS-X procedure, values for skewness and kurtosis are zero if the observed distribution is exactly normal. Positive values for skewness indicate a positive skew, while positive values for kurtosis indicate a distribution that is more peaked than normal. Norusis (1983) also mentioned that for samples from a normal distribution, measures of skewness and kurtosis typically will not be exactly zero but will fluctuate about zero because of sampling variation.

RESULTS AND DISCUSSIONS

Tables 1 through 8 show the summary statistics for the percentage changes in indices (or daily returns) of the stock markets selected for this study according to sub-period. For the period 1984-1988, as shown in Table 1, the average daily return ranges from 0.023 percent for the Malaysian market to 0.124 percent for the Hong Kong market. The standard deviation ranges from 1.070 percent for the Japanese market to 2.149 percent for the Hong Kong market. The overwhelming values of kurtosis greater than 0 indicate that the daily returns of these markets are not normally distributed. A distribution with kurtosis greater than 0 is a leptokurtic.

TABLE 1. Summary statistics (in percent) of the selected indices
1984-1988

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.023	0.124	0.075	0.078	0.064	0.111
Std. Dev.	1.639	2.149	1.537	1.437	1.363	1.070
Variance	2.687	4.620	2.363	2.064	1.857	1.146
Mode	0.000	0.000	0.000	0.000	0.000	0.000
Kurtosis*	102.550	132.816	231.594	90.114	165.857	49.504
Skewness*	– 29.702	– 6.737	– 10.490	– 2.888	– 8.173	– 3.287
K-S Z*	3.303	3.837	4.407	4.076	2.741	3.335
	(P = .000)	(P = .000)	(P = .000)	(P = .000)	(P = .000)	(P = .000)

Notes: 1. The figures above are based on N = 1066.
2. All values of the Kolmogorov-Smirnov goodness-of-fit test for normal distribution indicate that none of the indices exhibited normal distribution at the 1 percent significance level.
3. *The Figures are not in percent.

TABLE 2. Summary statistics (in percent) of the selected indices
January 1984 to October 15, 1987

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.038	0.195	0.129	0.104	0.109	0.130
Std. Dev.	1.279	1.707	0.970	1.155	1.053	0.919
Variance	1.635	2.914	0.941	1.335	1.108	0.844
Mode	0.000	−0.486	0.000	0.000	0.000	0.000
Kurtosis*	3.909	4.804	6.941	57.076	0.183	2.755
Skewness*	0.294	0.314	0.330	3.749	−0.167	−0.391
K-S Z*	2.016	1.905	1.520	2.485	0.919	1.991
	(P = .001)	(P = .001)	(P = .020)	(P = .000)	(P = .367)	(P = .001)

Notes: 1 The figures above are based on N = 812
2. P refers to two-tailed significance values.
3. *The Figures are not in percent.

TABLE 3. Summary statistics (in percent) of the selected indices
October 26, 1987 to December 1988

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.092	0.059	0.038	0.089	0.031	0.114
Std. Dev.	1.607	1.808	1.518	1.469	1.083	1.047
Variance	2.582	3.269	2.305	2.157	1.172	1.097
Mode	−8.031	2.136	0.000	2.016	0.601	0.000
Kurtosis*	3.986	8.012	6.398	2.954	3.158	5.462
Skewness*	−0.396	−0.594	−0.928	−0.279	−0.163	0.320
K-S Z*	1.703	1.981	1.531	1.618	1.132	1.677
	(P = .006)	(P = .001)	(P = .018)	(P = .011)	(P = .154)	(P = .007)

Notes: 1. The figures above are based on N = 253
2 P refers to two-tailed significance values
3. * The Figures are not in percent.

TABLE 4. Summary statistics (in percent) of the selected indices
Year 1984

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	−0.117	0.166	− 0.029	0.063	0.099	0.073
Std. Dev.	0.963	2.225	1.080	1.523	1.126	0.855
Variance	0.928	4.951	1.166	2.319	1.267	0.731
Mode	−2.449	−8.046	− 5.219	− 3.791	−3.219	0.081
Kurtosis*	3.176	2.427	15.147	72.858	0.240	1.629
Skewness*	1.048	−0.074	1.480	6.665	−0.119	−0.048
K-S Z*	1.440	1.274	1.476	2.287	0.688	0.903
	(P = .032)	(P = .078)	(P = .026)	(P = .000)	(P = .731)	(P = .388)

Notes: 1. The figures above are based on N = 213.
2. P refers to two-tailed significance values.
3. *The Figures are not in percent.

TABLE 5. Summary statistics (in percent) of the selected indices
Year 1985

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	−0.107	0.162	0.155	0.124	0.089	0.061
Std. Dev.	1.306	1.564	0.777	0.694	1.010	0.645
Variance	1.704	2.446	0.604	0.482	1.021	0.415
Mode	−8.568	−5.336	0.000	−1.639	−3.419	0.000
Kurtosis*	8.551	8.906	1.231	0.886	0.794	4.952
Skewness*	−0.764	1.139	0.095	0.517	−0.238	−1.103
K-S Z*	0.925	1.036	0.704	1.061	0.715	1.327
	(P = .359)	(P = .234)	(P = .705)	(P = .210)	(P = .685)	(P = .059)

Notes: 1. The figures above are based on N = 210.
2. P refers to two-tailed significance values.
3. *The Figures are not in percent.

TABLE 6. Summary statistics (in percent) of the selected indices
Year 1986

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.079	0.169	0.172	0.118	0.069	0.192
Std. Dev.	1.398	1.317	1.019	1.063	1.010	0.980
Variance	1.955	1.735	1.039	1.129	1.019	0.961
Mode	−3.624	−5.160	−3.786	0.000	−2.536	−3.521
Kurtosis*	1.564	2.453	2.807	2.061	−0.182	1.581
Skewness*	0.637	0.231	−0.583	−0.676	−0.247	−0.365
K-S Z*	1.156	0.782	1.353	1.157	0.715	0.876
	(P = .138)	(P = .574)	(P = .051)	(P = .137)	(P = .686)	(P = .426)

Notes: 1. The figures above are based on N = 213.
2. P refers to two-tailed significance values
3. *The Figures are not in percent.

TABLE 7. Summary statistics (in percent) of the selected indices
Year 1987

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.094	0.000	− 0.015	0.012	0.061	0.085
Std. Dev.	2.651	3.504	2.788	2.188	2.295	1.714
Variance	7.028	12.278	7.774	4.789	5.266	2.937
Mode	0.000	− 0.486	− 34.122	0.000	0.000	0.000
Kurtosis*	74.957	92.572	106.023	65.728	103.783	35.960
Skewness*	− 6.809	− 7.880	− 8.807	− 6.098	− 8.551	− 4.023
K-S Z*	2.438	3.233	3.470	2.539	2.676	2.132
	(P = .000)	(P = .000)	(P = .000)	(P = .000)	(P = .000)	(P = .000)

Notes: 1 The figures above are based on N = 214.
2. Prefers to two-tailed significance values.
3. *The Figures are not in percent.

TABLE 8. Summary statistics (in percent) of the selected indices
Year 1988

	KLSE Ind	Hang Seng	Aust. Ord.	DJIA	Fin. Times	Nikkei
Mean	0.173	0.071	0.077	0.055	0.001	0.155
Std. Dev.	1.345	1.225	1.069	1.237	0.834	0.823
Variance	1.809	1.501	1.142	1.531	0.695	0.677
Mode	−5.149	2.136	0.000	2.016	0.601	0.000
Kurtosis*	4.128	2.547	0.602	5.901	0.653	9.239
Skewness*	0.466	0.105	−0.415	−0.695	−0.382	1.233
K-S Z*	1.556	1.323	0.788	1.585	0.833	1.144
	(P = .016)	(P = .060)	(P = .563)	(P = .013)	(P = .492)	(P = .146)

Notes: 1 The figures above are based on N = 212.
2. P refers to two-tailed significance values.
3. *The Figures are not in percent.

All indices exhibit negative skewness, which implies that the daily returns of these markets are skewed to the left. This may be explained by the sudden and major drop in the indices during the October Crash of 1987. Results of the Kolmogorov-Smirnov test for normal distribution show that none of daily returns of these markets are normally distributed at the 1 percent significance level.

For shorter time periods, there is a tendency for the observations to move towards normal distribution as shown by the smaller values of K-S Z scores. In fact, with the exception of period Year 1987, the Financial Times Index always exhibit a normal distribution at the 5 percent level. of significance. For the sub-periods Year 1985 and Year 1986, all indices exhibit normal distribution at the 5 percent level of significance. For sub-period Year 1984, all except Dow Jones Industrial Average, exhibit normal distribution at the 1 percent level of significance. For sub-period Year 1988, all indices have a normal distribution. For sub-period Year 1987, no index has normal distribution due to large drop in indices during the October 1987 crash. A reexamination of the percentage changes in the indices shows close relationship between nonnormality and a big and sudden change (up or down) in index.

Tables 9 through 11 show the results of Hartley's F_{max} according to index. No index seems to have constant variance over time. Also, year 1987 always exhibit the largest variance compared to other sub-periods. When year 1987 is excluded, the F_{max} values still indicate heteroscedasticity, but the values become smaller. When period 1984-1988 is also excluded (for the reason of observations of year 1987 being in there), there is some further improvement in the values of F_{max}.

Table 12 shows the results of Hartley's F_{max} test according to period. As indicated by the significant F_{max} values, no period exhibits equal variances among the different indices at the 1 percent level of significance. This can imply no similarity in terms of risks in these differing markets.

CONCLUSIONS AND IMPLICATIONS

Many prior studies regarding the behavior of stock prices have shown that the stock prices are not normally distributed. Some offer stable Paretian to be the distribution, while some others offer the mixture of normals distribution. In this study it is shown that stock prices (as reperesented by indices) do exhibit normal distributions, but within short time spans. Longer time spans result in stock prices behave not according to normal distribution. This implies that in a long time period, the distribution of the stock prices consists of a few normal distributions of shorter time periods. In other words, this study substantiates the mixture of normals

TABLE 9. Results of Hartley's F_{max} test according to index

Index	$S^2_{largest}$	Period of $S^2_{largest}$	$S^2_{smallest}$	Period of $S^2_{smallest}$	F_{max}	Decision*
KLSE Ind	7.028	Year 1987	0.928	Year 1984	7.573	Reject
Hang Seng	12.278	Year 1987	1.501	Year 1988	8.180	Reject
Aust. Ord	7.774	Year 1987	0.604	Year 1985	12.871	Reject
DJIA	4.789	Year 1987	0.482	Year 1985	9.936	Reject
Fin. Times	5.266	Year 1987	0.695	Year 1988	7.577	Reject
Nikkei	2.937	Year 1987	0.415	Year 1985	7.077	Reject

Notes: 1. *This refers to the decision whether to reject the null hypothesis that the variances for all time periods are equal, at the 1 percent level of significance.

2. The critical value of the Hartley's F_{max} Test at the 1 percent significance level with $c = 8$ and $r-1 = 388$ degrees of freedom is 1.00.

TABLE 10. Results of Hartley's F_{max} test with sub-period year 1987 excluded according to index

Index	S^2 largest	Period of $S^2_{largest}$	$S^2_{smallest}$	Period of $S^2_{smallest}$	F_{max}	Decision*
KLSE Ind	2.687	1984-1988	0.928	Year 1984	2.895	Reject
Hang Seng	4.951	Year 1984	1.501	Year 1988	3.298	Reject
Aust. Ord	2.363	1984-1988	0.604	Year 1985	3.912	Reject
DJIA	2.319	Year 1984	0.482	Year 1985	4.811	Reject
Fin. Times	1.857	1984-1988	0.695	Year 1988	2.672	Reject
Nikkei	1.146	1984-1988	0.415	Year 1985	2.761	Reject

Notes: 1. *This refers to the decision whether to reject the null hypothesis that the variances for all time periods are equal, at the 1 percent level of significance.

2. The critical value of the Hartley's F_{max} Test at the 1 percent significance level with c = 7 and r-1 = 424 degrees of freedom is 1.00.

TABLE 11. Results of Hartley's F_{max} test with exclusion of period 1984-1988 and sub-period Year 1987 according to index

Index	$S^2_{largest}$	Period of $S^2_{largest}$	$S^2_{smallest}$	Period of $S^2_{smallest}$	F_{max}	Decision*
KLSE Ind	2.582	After Crash	0.928	Year 1984	2.782	Reject
Hang Seng	4.951	Year 1984	1.501	Year 1988	3.298	Reject
Aust. Ord	2.305	After Crash	0.604	Year 1985	3.816	Reject
DJIA	2.319	Year 1984	0.482	Year 1985	4.811	Reject
Fin. Times	1.267	Year 1984	0.695	Year 1988	1.823	Reject
Nikkei	1.097	After Crash	0.415	Year 1985	2.643	Reject

Notes: 1. *This refers to the decision whether to reject the null hypothesis that the variances for all time periods are equal, at the 1 percent level of significance.

2. The critical value of the Hartley's F_{max} Test at the 1 percent significance level with $c = 6$ and $r\text{-}1 = 317$ degrees of freedom is 1.00.

TABLE 12. Results of Hartley'S F_{max}test according to period

Period	S^2largest	Index with S^2 largest	S^2 smallest	Index with S^2 smallest	F_{max}	Decision*
1984-1988	4.620	Hang Seng	1.146	Nikkei	4.031	Reject
Before Crash	2.914	Hang Seng	0.844	Nikkei	3.453	Reject
After Crash	3.269	Hang Seng	1.097	Nikkei	2.980	Reject
Year 1984	4.951	Hang Seng	0.731	Nikkei	6.773	Reject
Year 1985	2.446	Hang Seng	0.415	Nikkei	5.894	Reject
Year 1986	1.955	KLSE Ind	0.961	Nikkei	2.034	Reject
Year 1987	12.278	Hang Seng	2.937	Nikkei	4.180	Reject
Year 1988	1.809	KLSE Ind	0.677	Nikkei	2.672	Reject

Notes: 1. *This refers to the decision whether to reject the null hypothesis that the variances for all indices in a given time period are equal, at the 1 percent level of significance.

2. The critical value of the Hartley's F_{max} Test at the 1 percent significance level with c = 6 and r-1 degrees of freedom is 1.00. The values of r-1 are 1065 for period 1984-1988; 811, Before Crash; 252, After Crash; 212, Year 1984; 209, Year 1985; 212, Year 1986; 213, Year 1987; and 211, Year 1988.

hypothesis. In addition, the differing variances found between periods, indicate that the variances are not constant over time. In conclusion, the results of this study support the hypothesis that stock price movements are mixtures of normals with differing variances as proposed by Hall, Brorsen, and Irwin (1989) in their study regarding the behavior of futures prices. The nonconstancy in variance and multiple normality can be explained by major changes in market forces, such as seasonal effects, structural shifts in demand and/or supply parameters, and major political/ economic events. This means, any statistical model to be developed should take into consideration the nonnormality that might exists if time period taken is quite long. Attempts should be made to ensure the distribution of stock price changes during the time period under study is normal, and if nonnormality exists, transformation should be made to normalize the data, or nonparametric statistical analysis should be used instead.

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