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RESEARCH ARTICLE

Characteristics of the Association Some Asian Equity Markets with the New York and London Equity Market

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Abstract

We compare Equity Markets (Hong Kong and one market in China, PRC) with the New York and London Equity Markets (two mature Western markets), with respect to volatility and rates of return. The purpose is to improve and increase our knowledge of the covariation of these markets. Utilization of exploratory data analysis, cross-correlation analysis and identification of the auto-regressive integrated moving-average (ARIMA) models for analysis and possible model predication. No previous research is as current and definitive as accomplished in this study on data collected over long periods of time from the sources utilized. The analysis indicates that use of data analytical methods provides evidence as to the cointegration of financial markets.

Keywords: *Exploratory Data Analysis, Cross Correlation Analysis, ARIMA modeling.*

Introduction

Previous studies of comparisons of Asian equity markets Western equity markets include Chow, et al. [1], Chen [2], Cheung and Ng [3], Liaw [3], and Jarrett and Sun [4]. These studies focused on describing China (PRC) as a new opportunity as a new opportunity for Western investment and growing returns to outside investors.

They utilized criteria for analyzing for analyzing Western equity markets [5-8]. Furthermore, Chow and Lawler [9]; (Data up to 2002) and later Jarrett and Sun using a newer data set 2012, analyzed the price indexes for the Shanghai equity market in comparison with the New York (NYSE) equity market. The last study divided the very lengthy time period into three sub periods to achieve a temporal analysis as well. Other studies including Baily et al. 2009, Jarrett and Sun 2009A and 2009B focused on other issues in Chinese equity markets due to huge and development of the Shenzhen and Shanghai equity markets of China (PRC). Last, Jarrett, Klein and Kyper [10] studied New York, London, and the two large China (PRC) equity markets doing both a study of temporal activity and how they effectively correlate with each other.

Another question relates to the equity market of Hong Kong (a.k.a., Hang Seng market). Previously, Pan, Li and Jarrett [11] studied the relationship of high frequency interactions between China A-shares and Hong Kong H-shares of dual-listed firms. This special study indicated the correlation of these two types of shares. Since Hong Kong and China have strong economic and market relationships, we wish to determine how these special relationships

In the next section, we intend to show exploratory graphical data to explain the variation in characteristics in characteristics of the distribution of price index data and the distribution of volume for the same equity markets. In turn, we explain by auto-regressive modeling the relation between volume and lagged variables of order 1 and 2 for three exchanges. Not enough data was available for the fourth equity market (Shanghai).

The ***VOL*** variable is the logarithm of the current period and so forth. After that, we do the same for the closing price and its lagged variables. In the next analysis**,** we investigate the cross-correlation of the three equity markets (New Yoke, London and Hong Kong) and last, we determine the ARIMA model for each variable studied. The conclusions will indicate covariation, temporal analysis and results for both closing prices and volume.

The Analysis of Volume

To begin, we observe the cross-correlation among the volume of shares denoted by **HKvol** (Hong Kong), **LTvol** (London) and **NYvol** (New York) in Table 1. These data begin with descriptive statistics of the size of data sets, mean and standard of values along with their minimum and maximum values. Most important, the measure of variation (standard deviation) of volume and its span (maximum minus minimum surpasses the same statistics for LT vol and NYvol. There is (indirect) negative association between **LTvol** and **NYvol** (-0.48434). Finally, **HKvol** and **NYvol** have positive (direct) association of 0.92481. Such a large coefficient indicates great strength in this relationship. Next, we investigate to find further evidence of this phenomenon.

Observe Figure 1, the **Scatter Plot Matrix** of the Volume Cross-Correlation among exchanges. The bottom left plot for association between **HKvol** and **NYvol** appears to have best plot of positive linear relationship, that is, as volume increases in one exchange, the send exchange increase at a pace similar to the first. The top right hand graph shows the same outcome because it shows the plot of the same data.

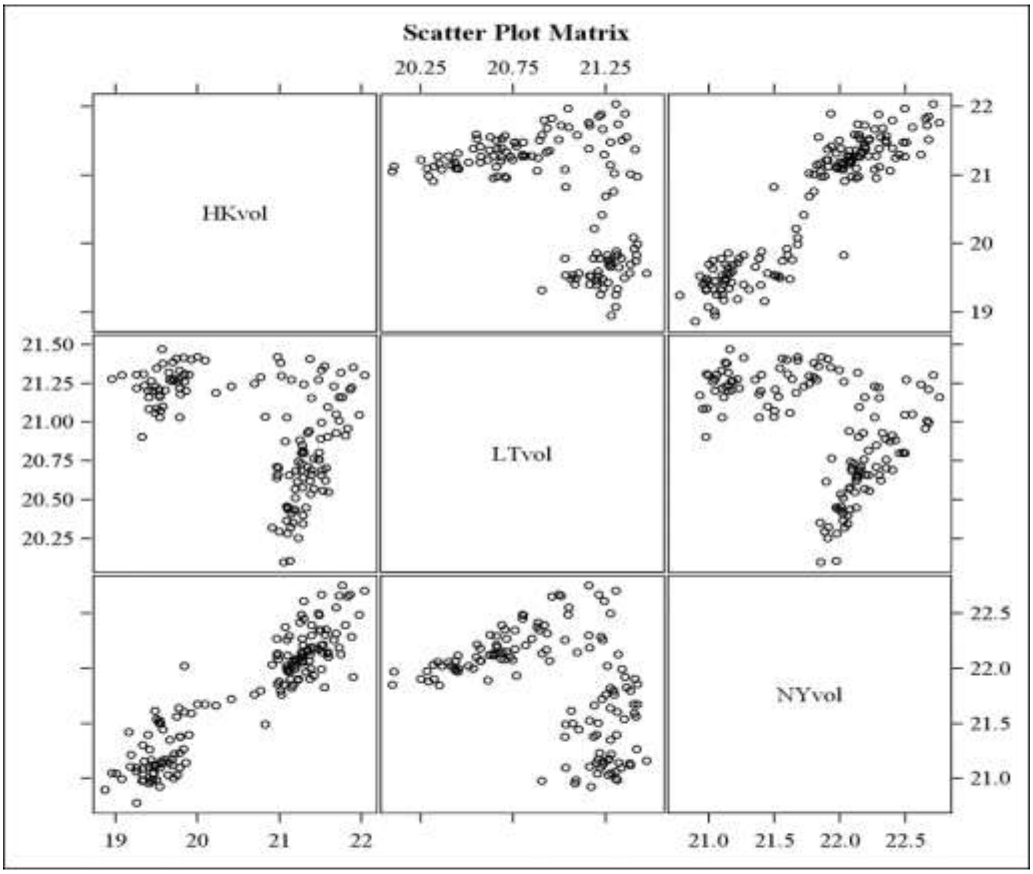

Figure 1: Scatter plot matrix volume cross-correlations among exchanges

For the price data, we observe data on four exchanges by including Shanghai (The largest equity market in China, PRC.) to add additional evidence to the observed relationship evidence to the observed relationships among them. The mean closing pricing price for Hong Kong (**HK15pre**) is greatest and the Shanghai mean closing price is last. The standard deviation of closing prices is largest for Hong Kong (**HK15pre**) and least for Shanghai (**SHpre**); the Western markets are in the middle. This phenomenon continues with the spread between maximum and minimum with

Shanghai having the largest spread, Hong Kong the smallest spread ND London and New York in the middle. Finally, observing the correlations among the closing price for each equity market yield for each equity market yield a different picture than for volume. The correlation coefficients for all two-by-two comparisons ranged from 0.78945 for **LTprc – SHprc** to 0.94814 for **NYprc – SHprc**. These large values for the one-by-one comparison indicate the strong association of closing prices among the equity markets to another with London and Shanghai markets most correlated with each other.

Table 1: Regression results for Hong Kong, London and New York stock exchange

Hong Kong (Hang Seng) Exchange

Parameter Estimates				
Variable	**Parameter** Estimate	**Standard Error**	**t-statistic**	**P-value**
Intercept 1	-77281	5423.799	-14.25 .0001	
vol 1 2111.140	1070.762	1.97	.0505	
vol1 1	1286.042	1295.059	0.99 .3223	
Vol2 1	1214.615	1058.466	1.15 .2530	

Root MSE	2932.634	R-square	0.6779
Dependent Mean	1	Adj R-square	0.6713
Coeff Var	16.585		

London Exchange

Parameter Estimates				
Variable	**Parameter** Estimate	**Standard Error**	**t-statistic**	**P-value**
Intercept 1	26396	4022.606	--3.49 .0001	
vol 1 -441.416	396.817	-1.11	.0206	
vol1 1	-372.327	442.483	-0.84 .4017	
Vol2 1	-186.722	394.545	-0.47 .6368	

Root MSE	739.597	R-square	0.1498
Dependent	5430.490	Adj R-square	0.1566
Coefficient of Variation	13.619		

New York Stock Exchange (NYSE)

Parameter Estimates				
Variable of Parameter	**Estimate**	**Standard Error**	**t-statistic**	**P-value**
Intercept 1	-15822	4532.583	-3.49 .0006	
vol 1 951.492	749.618	1.27	.2063	
vol1 1	113.687	868.948	0.13 .8961	
Vol2 1 4.707	746.511	0.01	.9950	

Root MSE	1358.221	R-square	0.1498
Dependent	7448.398	Adj R-square	0.1330
Coefficient of Variation VVVariationVar	18.235		

By observing Figure 2, the Scatter Plot Matrix of the Indexes of Cross-Correlations among the equity markets under study. All the plots indicate the linear correlation of each of the one-by-one associations.

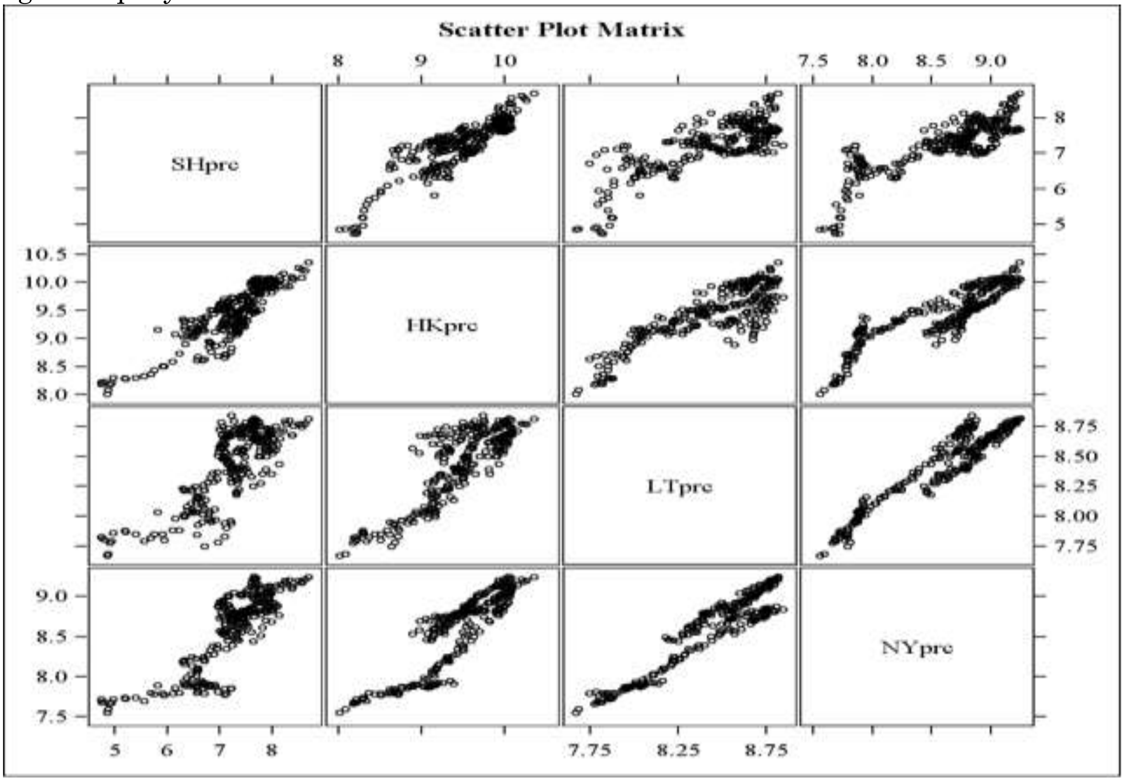

Figure 2: Scatter plot matrix volume cross-correlations among exchanges

Cross-Correlation among Exchanges

We study the cross-correlation among exchanges to determine the fit by conditional least-squares is expressed by the following:

$$LnHK_{price,\,t} = \alpha + LnHK_{price,\,t-1} + \text{lag } HKVol_{t-1} + \text{lag } HKVol_{t-2} + LTvol_{t} + NYvol_{t}$$

Observe the results presented in Table 2.

Table 2: Index Cross-correlation Among Exchanges

Descriptive Statistics

Variable	N	Mean	Std. Dev	Sum	Minimum	Maximum
SHprc	279	7.222	0.721	2015	4.736	8.692
HKprc	279	9.456	0.479	2638	8.014	10.353
LTprc	279	8.440	0.301	2.355	7.670	8.844
NYpre	279	8.605	0.455	2401	7.554	9.250

Pearson Correlation Coefficient, N=279 (P-value under Ho: p=O)

	SHprc	HKprc	LTprc	NYprc
SHprc	1.000	0.874 (.000)	0.789 (.000)	0.840 (.000)
HKprc	0.874 (.000)	1.000	0.848 (.000)	.886 (.000)
LTprc	0.789 (.000)	0.848 (.000)	1.000	0.984 (.000)
NYpre	0.840 (.000)	0.886 (0.000)	0.948 (.000)	1.000

These results indicate the estimated coefficients, the standard error of the coefficients, the t-statistics and associated p-values. Other data in Table 2 are descriptive of the parameter estimates. The two most important are the ones for the constant, (mu) and the auto-regressive coefficient (AR, 1, 1 model) since they have p-values of less than 0.0001. These p-values indicate that here is less than a 0.0001 chance of rejecting a TRUE null hypothesis. The model for

$LnHK_{price,\, t}$ contains a constant and an auto-regressive predictor variable. The constant is 11.3806 (t = 7.63) and the AR (1, 1) is 1.00 (t = 53.25). Hence, the predictive model for the LnHK apparently is an ARIMA (1.1) model. We observe additional evidence in the next table showing the AIC and SBC values of -355.419 and -332.296 which provide evidence as to the validity of the estimated model.

Table 3: The arima procedure

Conditional Least Squares Estimation

Parameter	Estimate	Standard Error	t-statistic	p-value	Lag	Variable	Shift
MU	11.3807	1.4919	7.63	>.0001	0	HKprc	0
MA 1,1	-0.1144	0.0923	-1.24	0.2175	1	HKprc	0
AR 1,1	1.0000	0.1878	53.25	>.0001	1	HKprc	0
NUM1	0.0068	.02721	0.25	0.8020	0	HKvol	0
NUM2	0.0257	0.02635	0.97	0.3315	0	LagHKvol	0
NUM3	0.0055	0.02398	0.23	0.8196	0	Lag2HKvol	0
NUM4	-0.0414	0.03753	-1.10	0.2727	0	LTvol	0
NUM5	0.0604	0.04580	-1.32	0.1897	0	NYvol	0

Constant Estimate	2.577E-7
Variance Estimate	0.003816
St. Error of Estimate	0.061777
AIC	-355.419
SBC	-332.296
Number of Residuals	133

*AIC and SBC do not include logarithmic determinant.

The ARIMA Procedure

Next, we observe the Index of cross-correlations of parameter estimates in Table. These correlations ranged from a low of -0.023 (LTvol 4 – Lag HKvol 2) to a high of 0.780 (Lagvol2 – LKprc

Table 4 (A): The arima procedure

Correlations of Parameter Estimates

Variable Parameter	HKprc MU	HKprc MA1,1	HKprc AR1,1	HKvol NUM1	LagHKvol NUM2	Lag2HKvol NUM3	LTvol Num4	NYvol NUM5
HKprc MU	1.000	0.100	0.148	-0.218	-0.780	-0.637	-0.162	-0.475
HKprc MA1,1	.100	1.000	0.202	0.143	-0.056	-0.035	-0.108	-0.100
HKprc AR1,1	0.148	0.202	1.000	-0.26	-.126	-.115	-.028	-.055
HKvol NUM1	-0.218	0.143	-0.26	1.000	0.238	0.159	-0.263	-0.264
LagHKvol Num2	-0.780	-0.056	-.126	0.238	1.000	0.429	0.092	0.176
Lag2HKvol NUM3	-0.637	-0.035	-.115	0.159	0.429	1.000	-0.023	0.120
LTvol NUM4	-0.162	-0.108	-.028	-0.263	0.092	-0.023	1.000	-0.400
NYvol NUM5	-0.475	-0.100	-.055	-0.264	0.176	0.120	-0.400	1.000

Table 4 (B): Autocorrelation check of residuals

Correlations of Parameter Estimates

To Lag	Chi-Square`	Degrees of Freedom	p-value
6	4.82	4	0.3063
12	9.96	10	0.4439
18	16.44	16	0.4229
24	17.91	22	0.7113

Autocorrelations

To Lag						
6	-0.007	0.145	0.067	0.002	0.025	0.093
12	-0.071	0.106	0.114	0.028	0.057	0.047
18	-.065	0.111	0.059	0.135	0.035	0.055
24	0.072	0.042	0.044	0.002	0.014	0.014

The constant for Hong Kong price and lag HKvol 2 had the largest correlation follow by lag2HKvol 3 (-0.637) and NYvol (-0.475). Hence, the associations of Hong Kong prices and Hong Kong volume with a smaller negative association with New York volume.

One last table (Table 4) checks for the autocorrelation check of residuals from the ARIMA (1, 1) model. Note that the check procedure referred to as the Ljung-Box (chi-square) statistics of 4.28, 8.96, 16.44, and 17.91 for lags of 6, 12, 18 and 24. The p-values for these statistics are 0.3063, 0.4439, 0.4229 and 0.7113. None are significant at p-values less than or equal 0.05 or any other useful criterion. Hence, the ARIMA (1, 1) model satisfies the testing common to Box-Jenkins modeling methods. The autocorrelation function of the residual correlation diagnostics for the HK prices. Examine the histogram of residuals which appears close to "Normal" in Figures 3A and 3B.

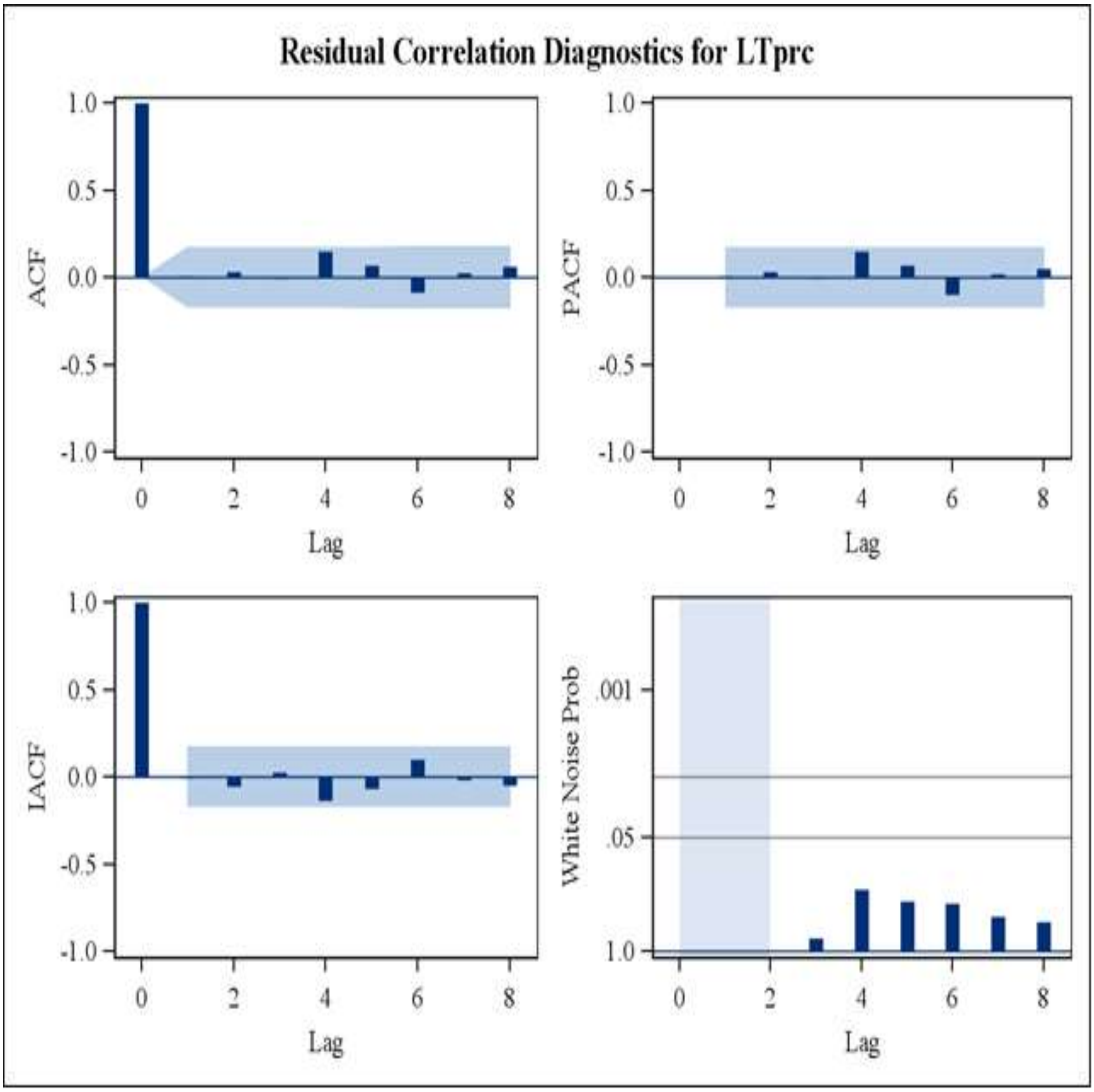

Figure 3: The ARIMA Procedure (SAS) (A) Diagnostics for LTprc

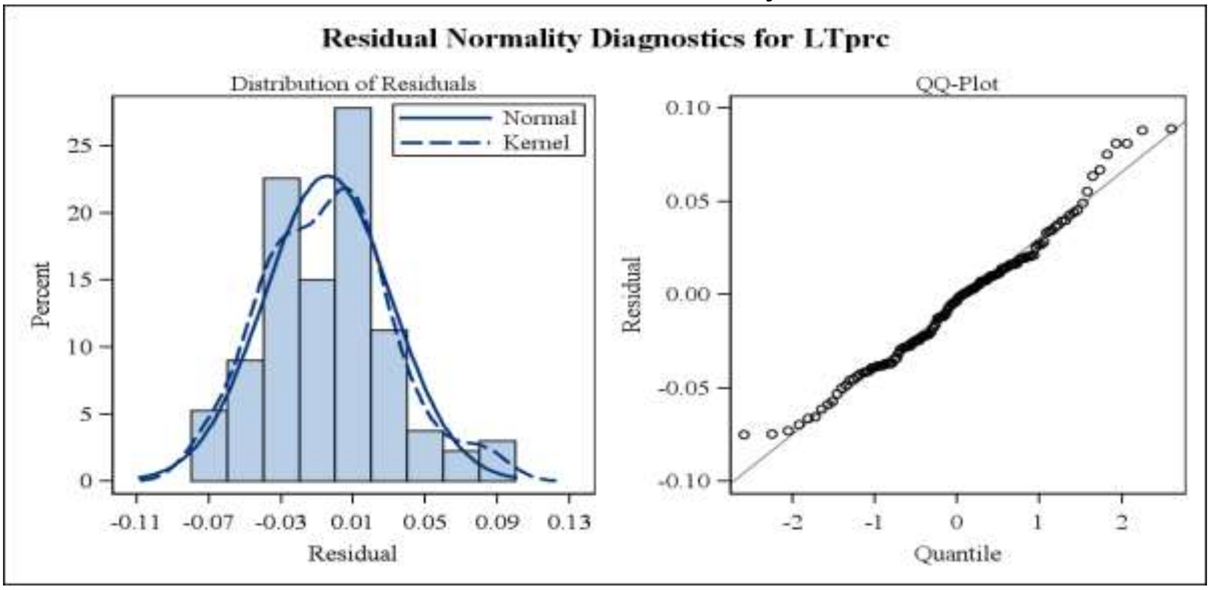

Figure 3 (B):Normality diagnostics for HKPRC

Note, the similarity of the histogram of the residuals which appears close to normal in the plot. In addition, the QQ-Plot shows the observations approaching the 45 degree line indicating normality of the residuals.

Our last analysis concerns the index cross-correlation among exchanges for the closing prices of the Hong King (see Appendix A) denoted HKprc. The estimated intercept is 11.38068. Observe input numbers one through five. The overall regression factor for each are presented. None are very large and range from -0.06039 for NYvol to 0.02569 for lag HKvol. This indicates that the volume of the volume on the New York exchange does have some influence of closing prices on the Hong Kong exchange. This corroborates previous results previously observed.

Further Analysis of Results

In this study, we collected analyzed and interpreted an extensive data bank of stock market index numbers for the equity market of New York, London and Hong Kong and to a lesser extent for Singapore. The data analysis enabled us to draw conclusion concerning the association of these World markets. The analysis included an examination of the mean and volatility in the stock exchanges over a lengthy period of time and also study the relationships within sub-periods of the large length of time. We observed the rates of return and volatility of returns for the equity markets noting the differences in their rates of return and the volatility in the rates of return. Observing that the means and volatility. Investigation into the mean and volatility of the rates of return bring to light the great difficulty in predicting mean and variation in rates of return as well as the volatility in these rates of return. In addition, the temporal analysis indicates the problems of prediction when one looks at the time series characteristics of the market indexes.

Tokyo volatility according AIC and the absence of serial correlation in the residuals for the entire sample period reported in column 2 of Appendix B Table 2, we have only lag 0 for Nikkei and 0 lag for Singapore. The *t-statistic* for these are significant at a very small probability (less than 0.01). This indicates that the volatility in the Hang Seng equity market is associated with the value in Nikkei. Since the *t-statistics* are only significant for Singapore, we can draw the same conclusion. Chow, and Lawler [9] and Jarrett and Sun [11] comparisons were for Hang Seng, thus these results are similar. Hence, we conclude that Hang Seng volatility at zero lag is associated with Nikkei and Singapore for the entire time period. Thus a *Granger Causality* [12] may exist between Hang Seng and Nikkei and Singapore. Hence, this indicates that the volatility in the markets for the entire period were not likely completely independent of each other. Unlike CL, we did not observe negative coefficients in the entire time period studied. Results of

Tables 1, 2 and 3 in Appendix B do result in very similar results.

To be consistent with the findings of CL, we observe only the H1, H3 and STI0 are significant (at α= to 0.05 or less) in 9a. In 9 b, the coefficients ***t-statistics*** are significant for H0 and STI0. Tables summarizing the relationships of the three markets may differ for the two or three predictor variables and the direction of the causality (i.e. signs of the coefficients). The differences in time periods should yield different results.

An additional question relates to whether or not there is a significant co-variation of volatility in a multivariate setting. To incorporate instantaneous causality in explaining Hang Seng volatility, one includes the current value of the variable in the other markets in the auto-regression. One observes the result for Hang Seng in column 2 of Appendix B Table 1 and the results in other markets in Appendix B Tables 2 and 3. The coefficients for the variables (all years) show some positive but only H2 and H3 are significant. This would indicate that the extended time period in this study results in some Hang Seng volatility being significant in period 1 for lag 1. A different interpretation of results just not indicated for other sub-time periods. Some may occur randomly and one has difficulty predicting pattern of consistency from period to period in pairwise combinations. Thus, we could conclude that the relationships among the markets change during the sub-periods indicating the dynamic aspects of capital markets studied. Volatility is present and changes the relationships of markets due to economic conditions, law affecting these markets, the growth of emerging markets versus more established markets. At hand, there is little doubt that market volatility is ever changing and the prediction of volatility not easily accomplished.

Without going through the analysis to compare individual coefficients, we observe the different effects of change in time and the pairwise relationship of markets. As long as economic conditions change, the results include temporal instabilities in markets.

Our study is lengthy and exhaustive butmuch of its results are not unnerving since we already know that markets vary in prices and volatility, but these factors have components that are predictable when using modern time series analysis. For example, see Ray, Chen and Jarrett (19970 where the authors demonstrate that firms listed on the Nikkei contain components (permanent and temporary) which may in turn lead to better predictions.

Observing Appendix B Table 2b, N1, N3, N4 and STI0 have estimated coefficients with significant *t-statistics* at αless than or equal to 0.05.This indicates that Nikkei has serial correlation at 1, 3 and 4 lags and contains one additional coefficient with STI0 at zero lag. In period 2, only STI0 contains a coefficient with a significant (t-statistics or p-value) at zero lag. The last sub-period (3), Nikkei contains significant coefficients at N1, H0 and ST0. Hence there no consistency in the three period.

In keeping with the exhaustive analysis, we observe the same lack of consistency in the analysis for Singapore. Lag STI2 contains a significant t-statistic for ST1 lagged values. H0 and N0 have significant t-statistics indicating and corroborating the observations before that Singapore, the smallest equity market is influenced by the larger Nikkei and Hang Sang exchanges. The three periods have different results. No one period is similar to each other and relationships over time will be influence by other factors.

Last, the results of the models for the volatility in equity returns for all the equity markets, we find the effect of the Asian equities leading to the same for temporal instability. Simply stated, the inclusion of the markets do not result in stable relationships throughout the three sub-periods. There are structural changes related to each time period. Hence, we conclude that the concept of temporal stability is not present which agrees with many previous studies done in earlier time periods.

Conclusions

We collected, analyzed and interpreted an extensive data bank of stock market files for the equity markets of New York, Honk Kong and London. Our purpose is to draw conclusions concerning the relationship of the various equity markets expressed by an analysis of the mean and volatility in the stock exchanges over lengthy period of after defining three distinct sub-periods We first examining the time series characteristic of stock price indices for four exchanges during the period from 1987 until 2012 (we included the smaller Asian market of Singapore).

Specifically, we calculated the rate of return and volatility of returns for three major markets and estimated the serial correlation and co-movement of the equity markets. We found that the mean rates of return vary for the equity markets noting all have differences in their rates of return. Volatility in the rates of return also differ among the equity exchanges. Across the three sub-periods defined by time, the relationships among the markets are not stable. This, perhaps, is the most crucial of the general findings of the analysis and similar to JKK in a time series analysis of other stock markets. Relationship across equity markets change. Investigations into the influences of the economic environment in which the markets operate would indicate what some of the causes and associations with the changes in the mean and variability of rates of return. Volatility in the rates of return would add to our knowledges of explaining and predicting relationships among equity markets. This evidence is consistent with other studies of Western and Asian markets.

Furthermore, we find that serial correlation also differs in the equity markets studied. The use of multivariate time series analysis (see Kuvita, [13]; Chen, Finney and Lai [14]; and Juselius, [15] may provide further evidence of the lack of co-integration in these stock exchanges. A more useful and better definition of temporal stability may add to the discussion of emerging markets of Asian and even the ones currently considered emerging. One earlier study noted before [16] suggests an alternative approach h using long memory time series modeling that both permanent and temporary components exist in the time series of Asian markets, i.e. the Japan equity market in their study [17-20].

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APPENDIX A

Index of Cross-correlation among exchanges

Model for variable LTprc	
Estimated Intercept	9.952565

Autoregressive Factors	
Factor 1:	1 - 1 B**(1)

Moving Average Factors	
Factor 1:	1 + 0.04402 B**(1)

Input Number 1	
Input Variable	LTvol
Overall Regression Factor	-0.04761

Input Number 2	
Input Variable	lagLTvol
Overall Regression Factor	0.032045

Input Number 3	
Input Variable	lag2LTvol
Overall Regression Factor	0.02401

Input Number 4	
Input Variable	HKvol
Overall Regression Factor	-0.00078
Input Number 5	
Input Variable	NYvol
Overall Regression Factor	-0.06015

APPENDIX A

Volume Cross-correlation among exchanges
(SAS Procedure Output)

Three	**HKvol LTvol**
Variables	**NYvol**

Descriptive Statistics

Variable	**N**	**Mean**	**Std. Dev.**	**Sum**	**Minimum**	**Maximum**
HKvol	152	0.9113	3129	3129	18.8681	22.0307
LTvol	135	0.3520	2829	2829	20.0979	21.4725
NYvol	158	20.774	3435	3435	20.7774	22.0370

Pearson Correlation Coefficients
P-value (r) under H_o: ρ=0
Number of Coefficients

HKvol	**1** **52**	**-0.484** **≤.0000** **1135**	**0.925** **≤.0000** **152**
LTvol	**-0.484** **≤.0000** **135**	**1.000** **135**	**-.432** **≤.0000** **135**

NYvol	**.925** **≤.0000** **152**	**-0.432** **≤.0000** **135**	**1.000** **158**

APPENDIX B

Table 1: Regressions of volatility of equity returns
Hank Seng (Hong Kong)

	All Years	Pre1997	1997-2007	Post 2007
Constant **t**	0.0072	0.0096	0.0078	0.0062
HO **t**				
H1 **t**	0.0181 0.6832	-0.0171 -0.3684	0.0575 1.3687	0.0293 0.5719
H2 **t**	0.0622 2.7874	0.1465 3.2980	0.0258 0.7399	0.0014 0.0399
H3 **t**	0.0570 2.5461	0.0744 1.6759	0.0470 1.3446	0.0463 1.2818
H4 **t**	0.0413 1.8323	0.0552 1.2415	0.0386 1.1003	0.0313 0.8674
N0 **t**	0.1144 4.3082	0.0119 0.2371	0.0903 1.9260	0.1851 4.7361
N1 **t**	-0.0021 -0.0794	0.0146 0.2897	-0.0074 -0.1533	0.0265 0.6597
STI0 **T**	0.5356 20.9238	0.4056 6.7833	0.5290 14.7450	0.6705 14.4441
STI1 **t**	0.0148 0.5044	0.0060 0.0942	0.0229 0.5436	-0.0722 -1.2449

APPENDIX B

Table 2: Regressions of volatility of equity returns

Nikkei (Tokyo)

	All Years	Pre 1997	1997-2007	Post 2007
Constant t	0.0096 8.4516	0.0078 3.8930	0.0158 8.0776	**.0081** **3.8863**
N0 T				
N1 T	0.1240 4.6691	0.1711 3.7345	0.0129 0.3004	0.1364 2.6559
N2 t	0.0447 1.7485	0.0724 1.5780	0.0521 1.2389	-0.0166 -0.3806
N3 t	0.0861 3.3705	0.1113 2.4201	0.0810 1.9249	0.0363 0.8347
N4 t	0.0256 1.0128	0.1796 3.8759	-0.0321 -0.7625	-0.0448 -1.0586
H0 T	0.1146 4.4347	0.0086 0.2077	0.0687 1.8344	0.2975 4.7029
H1 t	-0.109 -0.4201	0.0234 .5659	-0.307 -0.8204	-0.0231 -0.3538
STI0 t	0.1937 6.8208	0.1440 2.5456	0.1150 3.0892	0.3517 4.9835
STI2 t	0.0034 0.1180	-0.0849 -1.4639	0.0325 0.8603	0.0174 0.2361

APPENDIX B

Table 3: Regressions of volatility or equity returns

STI (Singapore)

	All Years	Pre-1997	1997-2007	Post 2007
Constant t	-0.001 -0.617	0.005 2.675	-0.002 -.886	-0.002 -1.865
STI0 t				
STI1 t	0.098 3.695	0.077 1.616	0.077 1.844	0.167 3.277
STI2 t	0.082 3.652	0.123 2.730	0.026 0.762	0.160 4.415
STI3 t	0.079 3.482	0.046 1.022	0.073 2.084	0.086 2.356
STI4 t	0.086 3.814	0.045 0.987	0.120 3.381	-0.018 -0.504
H0 T	0.426 20.639	 6.576	0.508 14.324	0.521 14.527
H1 t	-0.016 -0.681	0.020 0.578	-0.019 -0.450	-0.060 -1.339
N0 t	0.151 6.371	0.100 2.722	0.138 2.973	0.155 4.529
N1 t	-0.009 -0.370	0.015 0.396	0.058 1.223	-0.079 -2.260