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ASSOCIATION BETWEEN NEW YORK AND SHANGHAI MARKETS: EVIDENCE FROM THE STOCK PRICE INDICES

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Abstract. This paper examines the time series characteristics of stock price indices for New York and Shanghai during the period of 1991 to 2009. Specifically, we calculate the rate of return and the volatility of return for two markets and estimate the serial correlation and co-movement of the two markets. We find that the average rate of return in Shanghai is much higher than that in New York while Shanghai stock prices are more volatile than New York stock prices. Further, we find that Shanghai stock prices are positively serially correlated while New York stock prices are negatively serially correlated in terms of auto regression of the rate of return. In the multivariate regressions, we find that there is little evidence to show that either the rate of return in Shanghai would affect the rate of return in New York or the rate of return in New York would affect the rate of return in Shanghai. It suggests that the two markets are not integrated. Last, we studied and made conclusion concerning the volatility of the New York and Shanghai indices relate to each other.

Keywords: Shanghai Stock Exchange, comparison of equity markets New York Stock Exchange, volatility.

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JEL Classification: G12, G14.

1. Introduction

Our purpose is to study three sets of weekly price indices: Shanghai Stock Composite Index, NYSE Composite Index, and Hang Seng Composite Index provided by DataStream during the period of 1991–2009. Studies of these indices are important because of the rapid growth and influence of the Chinese economy on world, balance of trade and growth of Asian and other economies throughout the world (Chow *et al.* 1999). Previous studies (Chen 1991; Cheung, Ng 1998; Liaw 2007) described China as an economic power offering tremendous opportunities for investment and growing business returns. Their financial markets for the earlier years in their development were thought to be not fully developed when analyzed by the criteria developed by financial economists using criteria for analyzing Western equity markets (Fama 1990, 1991; Wei, Wong 1992; Zhong *et al.* 1999). Chow and Lawler (2003) analyzed the price index for the Shanghai Stock Exchange in comparison with the New York Stock Exchange Index in terms of its rate of return, volatility and structural changes in the movement of the index up until 2002. In this study, we propose to study the entire period from January 1991 to December 2009 and dividing period into sub periods (sub samples) to analyze change associated with time. The comparisons have the purpose of revealing the behavior of stock movements in an emerging market in comparison with an established Western market.

Another question relates to whether there is some integration between the New York and Shanghai markets as seen by studying the co-movement of stock prices in these exchanges. This will enable one to assess the degree of integration of the Chinese economy with that of the rest of the World as represented by the movement of prices in the New York Stock Exchange (NYSE). We will also look at the correlations among the Shanghai, NYSE and Hong Kong markets (Hang Seng Index) to examine their integration as well. Last, one notes that the Chinese financial markets are not open in the Western sense of the term but our study should yield some observations about the relative openness of the Chinese financial markets.

We examine both the rate of return and the volatility of the price indexes. The rate of return is the change in the natural logarithm of the price index for a given time period. We follow Chow and Lawler (2003, heretofore CL) and measure the volatility by the absolute value of the change rather by its variance. The absolute value is less sensitive to extreme value as compared with ARCH-type models to study the residual variance of a time series model. Stated differently, we study the volatility of the rate of return itself and not the residual in the time series model of the rate of return. Following CL, (1) the volatility in the rate of return and not the time series regression model residual is the subject of interest in financial research and (2), "since log stock price behaves approximately like a random walk, …, the rate of return itself and the residual of an autoregression of this rate are almost the same" (CL, p. 18). The data for this study include three sets of weekly price indices: Shanghai Stock Composite Index, NYSE Composite Index, and Hang Seng Composite Index provided by Datastream during the period of 1991–2009. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. We further divide our sample into three subsamples: before 1997, after 1997 and before 2007, and after 2007. The entire sample period is from January 1991 to December 2009. Again, we follow CL in choosing the weekly data as the best choice among daily, weekly and monthly data.

To begin, we examine the characteristics of the equity markets in Shanghai and New York. We calculate the mean and variance of the rate of return and the mean and variance of the measure of volatility. Recall, that both the variance in the rate of return and mean of the absolute change in the log- price are measures of volatility. If one believes that these measures reflect uncertainty then Shanghai stock prices should be more volatile that those in New York. To study the co-movements of the price in the two markets, we calculate simple correlations and multiple regressions. The multiple regressions include auto regressions as well as ordinary multiple regressions.

The remainder of this paper is organized as follows: (1) the characteristics of the rate of return and the volatility of return; (2) correlation coefficients; (3) regressions of the rate of return; (4) regressions of the volatility of return; and (5) conclusions.

2. Rate of return and volatility of Shanghai and New York price indices

Table 1 shows the information for the Shanghai and New York stock price indices including the market capitalization and the number of listed stocks. The sizes of these two financial markets indicate the New York stock exchange is much larger than the Shanghai stock exchange in terms of both the market capitalization and the number of stocks. Jarrett, Pan and Chen (2009) indicated the relatively small influence on the Shanghai Exchange on the movement in the aggregate Chinese economy during a period similar to the earlier CL study.

Table 1. Size and the number of stocks in the Shanghai and New York Stock Exchanges

The table shows the market capitalization and the number of total listed stocks in the two Stock Exchanges, Shanghai Stock Exchange (SSE) and New York Stock Exchange (NYSE), as of December 2009. The data source is *World Federation Exchanges – Statistics/Monthly.* The sample period is from January 1991 to December 2009

	Shanghai Stock Exchange (SSE)	New York Stock Exchange (NYSE)
Market capitalization (in US$ trillion)	27.0	118.3
Number of total listed stocks	870	2.327

Table 2 shows the mean and variance of the rates of return for the New York and Shanghai while Table 3 presents the mean and variance of the volatility of returns for New York and Shanghai.

The average rate of return for Shanghai (0.00426) is about two and half times larger than the average rate of return for New York (0.00168). Thus, the average rate of return for China is growing at a rate much larger than for the New York exchange. If we were to consider change in price levels for the two nations by examining the *China Statistical Yearbook, 2009* and the consumer price index for the United States (although not a perfect comparison), the changes in prices would not account for the major portion of the differences in the average rates of return. This leads to a conclusion that the higher rate of return for Shanghai Stock Index is not attributable to factors other than the investment opportunities in its market.

Volatility (as noted before) as measured by both the variance of the rate of return and by the mean absolute value of the rate of return is again larger for the Shanghai stock market than for the New York Stock market. Table 2 shows a much larger variance for the Shanghai stock index than for the New York shock index and Table 3 concurs by

Table 2. Means and variances of the rate of return

The table shows the means and variances of the rate of return for Shanghai Composite Index (SSE) and the NYSE Composite Index (NYSE). The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. The sample period is from January 1991 to December 2009

	SSE rate of return	NYSE rate of return
Mean	0.00426	0.00168
Variance	0.00431	0.00056

Table 3. Means and variances of volatility of returns

The table shows the means and variances of the volatility of returns for Shanghai Composite Index (SSE) and the NYSE Composite Index (NYSE). The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. The sample period is from January 1991 to December 2009

	SSE volatility of return	NYSE volatility of return
Mean	0.03690	0.01605
Variance	0.00296	0.00030

showing a much large average volatility of return for Shanghai as well. This suggests a great deal of uncertainty in the Shanghai market in comparison to the New York market. Furthermore, the variance of the measure in Table 3 is also much greater than for Shanghai then it is for New York. These results are not a revelation and are similar as those of CL. This would lead one to observe that the volatility is subject to a greater degree of variations, that is, the spread in the distribution in Shanghai than in New York. This is not to say that volatility does not exist or is even small in New York, but only to say that a risk-averse investor is better served by the New York exchange in comparison to that of Shanghai.

In order to test how the two equity markets behave during extreme event, we sort sample period to three economic periods and examine the mean and volatility of the rate of return during these periods: (1) 1991 through the last week of 1996; (2) 1997 to the end of 2007; and (3) after 2007 until the end of the sample data period. By studying these three periods, one may determine if severe economic changes occurring in 1997 and 2007 affect the two markets and whether the changes are different.

We find that the dramatic change in the average rate of return for Shanghai from period 1 to period 2 and the negative average rate of return in period 3 reported in Table 4. The average rate of return for New York decreases from period 1 to period 2. This decline is large but not nearly as dramatic as the change for Shanghai. In addition, the average rate of return became negative in period 3 but not nearly as negative as in Shanghai. For periods 1 through period 2, both measure of volatility were greatly diminished for Shanghai. In period 3, both measures of volatility increase, especially for the average volatility of return. The average rate of return for New York is smaller and for period

3 even becomes negative but the degree of negativity is very small. The variance in the rate of return for New York increases in each of the periods. The average volatility of return increases also from period to period over the entire time period under study. The variance in the volatility of return for Shanghai decreases from period 1 to period 2 but increases in period 3. Last, the variance in the volatility of return increases from period 1 to period 2 and then increases more to period 3. Hence, the volatility in Shanghai remains greater than New York throughout the three time periods. After 2007, the Shanghai market also had a greater period of difficulty than the level of difficulty in New York.

Table 4. Rate of return and volatility in three sub-samples

The table shows the means and variances of the rate of return and the volatility of return for Shanghai Composite Index and the NYSE Composite Index in three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. Panel A presents the means and variance of the rate of return for two indices while Panel B provides the means and variance of the volatility of return for two indices. The sample period is from January 1991 to December 2009

Panel A: *rate of return*

	Shanghai			New York		
	Before 1997	1997–2007	After 2007	Before 1997	1997–2007	After 2007
Mean	0.01034	0.00268	–0.00519	0.00267	0.00159	–0.00081
Variance	0.01061	0.00112	0.00298	0.00019	0.00046	0.00221

Panel B: *volatility of return*

	Shanghai			New York		
	Before 1997	1997–2007	After 2007	Before 1997	1997–2007	After 2007
Mean	0.05784	0.02452	0.04271	0.01086	0.01626	0.03035
Variance	0.00736	0.00052	0.00117	0.00008	0.00019	0.00128

The economic change occurring in the World during the three time period kept the Shanghai market more volatile and less profitable than the one in New York. Risk-averse investors were better off in New York after 2007 because of the smaller level of volatility and smaller negative in the average rate of return. The differences in the sample statistics for the three time periods suggest that the rates of return and volatility in stock prices in nominal terms for the entire time period studied were not covariate stationary time series. This is the same conclusion for a much large time period than observed by CL. Their conclusions at this point are not disputed but only enhance by the study of the new data.

3. The correlation in price movements

Following CL, we arrive at a preliminary view of the level of integration between the Shanghai and New York Exchanges by examining the simple (Pearson) correlation coefficients. Table 5 contains the Person Product Moment correlation coefficients of the Shanghai, New York and Hong Kong Exchanges. Noted before, all of these data came from the same source available DataStream. Note that the New York and Hong Kong market for the rate of return (Panel A) have a correlation of .4795, indicating that slightly less than 25% of variation in the two markets is associated with each other. The same Pearson Product Moment Correlation coefficients for the Shanghai-New York and Shanghai-Kong Kong are 0.0220 and 0.0961. Hence, the association between prices these markets are less than one percent. The correlation between the volatility of return in New York and Hong Kong is 0.3060. The calculated correlations between (1) Shanghai and New York and (2) Shanghai and Hong Kong are –0.0404 and 0.0812 respectively. This suggests that there is little correlation between these pairs of exchanges.

Table 5 indicates that at first glance that the Shanghai and New York exchanges are neither covariate or related to each other over the time period studied. Whereas the Hong Kong and New York markets do show some covariance, therefore they are often influenced by the same economic factors. Near zero and slightly negative correlation coefficients for the rate of return and volatility of return for the Shanghai-New York exchanges suggest that these equity markets operative largely independent of each other.

Table 5. Correlation matrices

The table shows the correlation matrices of the rate of return and the volatility of returns for Shanghai Composite Index, the NYSE Composite Index, and Hong Kong index (Hang Seng Index) in three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. Panel A presents the correlation of the rate of return for three indices while Panel B provides the correlation of the volatility of return for three indices. The sample period is from January 1991 to December 2009

Panel A: *rate of return*

	Shanghai	New York	Hong Kong
Shanghai	1.0000		
New York	0.0220	1.0000	
Hong Kong	0.0961	0.4795	1.0000

Panel B: *volatility of return*

	Shanghai	New York	Hong Kong
Shanghai	1.0000		
New York	–0.0404	1.0000	
Hong Kong	0.0812	0.3060	1.0000

A negative coefficient for the volatility of returns for these two markets indicates that economic fundamentals operate differently in opposite directions in each market. However, since the coefficient is so small, one may conclude that economic factors are unrelated in these two markets. CL (p. 22) earlier concluded that "negative correlation between the volatility measures for the two markets are driven by two different sets of economic fundamentals in the two nations". Our analysis can add little or detract much from this conclusion since the coefficients are so small and like to be unimportant. We must not forget that a significance test at this level may result in the rejection of a null hypothesis but if the coefficient is so small it still may not be important.

We can still learn more about the level of integration in these two markets by studying through multiple regressions, in doing so to exclude the influence the delayed effects of lagged explanatory variables.

4. Regressions of the rate of return

We define the rate of return now to be the change in the natural logarithm of the stock price in period t. According to the efficient markets hypothesis, the rate of return is difficult to predict with any reasonable level of accuracy. Hence, we wish to determine if there is validity in this hypothesis and whether rates of return in the two markets (New York and Shanghai) are correlated after excluding the influence of their own lagged values.

We construct a model to explain the Shanghai rate of return by its own past values. By constructing a model with many lagged values of the rate of return and calculate the Akaike Information Criterion (AIC), we find that AIC is minimized at a lag of one. In turn, we find the first-order auto regression which appears in column (2) of Table 6. The coefficient (S1) is 0.042 with a *t*-statistic of 2.34 which is significant at the reasonable level of $\alpha = 0.05$ or less (the p-value being than 0.05). According to this result the weak form of the efficient markets hypothesis does not hold for the entire time period studied. Similarly, we construct an auto regression model with one lagged value for the rate of return in the New York exchange. In column (6) (All Data), we find a negative (–0.085) coefficient for the first lagged value. The *t*-statistic is –2.71 and again would be significant at $\alpha = 0.05$ or less (the p-value being than 0.05). Next, we will further investigate this phenomenon by dividing the time series data into the same three sub-periods analyzed previously.

For both Shanghai and New York, we subdivided the data into the three time periods used previously. In all three time periods the lagged variable of one resulted in coefficients of 0.043, 0.019 and 0.020, but none had sufficiently large enough *t*-statistics to reject the null hypothesis of the parameter equaling zero. Thus, one has no evidence to conclude that the rate of return is predictable and thus, the efficient market hypothesis holds. For the auto regression of New York, we find the N1 coefficient to be –0.082, –0.043 and –0.137. However, only the coefficient for period 1 is significant at $\alpha = 0.05$ or less. Change occurred after 1997 and was enough to change any conclusion about the predictability of the rate of return in New York. For periods 2 and 3, the efficient markets hypothesis holds. These results are not entirely the same as those of CL, but do indicate that change occurred among the three sample sub-periods studied.

Table 6. Auto regressions of rate of return of Shanghai and New York stock prices

The table presents the auto regressions of rate the return of Shanghai and New York stock prices in total sample and three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. S1 represents the one-lag of the rate of return of Shanghai stock prices while N1 represents the one-lag of the rate of return of New York stock prices. We also report R-squared and Root MSE. *T*-statistics are provided in the parentheses. The sample period is from January 1991 to December 2009

	Shanghai				New York			
	All Data (1056 obs)	Before 1997 (327 obs)	1997–2007 (621 obs)	After 2007 (108 obs)	All Data (1056 obs)	Before 1997 (327 obs)	1997–2007 (621 obs)	After 2007 (108 obs)
Intercept	0.004	0.010	0.002	–0.004	0.002	0.003	0.002	–0.002
	(1.98)	(1.70)	(1.76)	(–0.73)	(2.25)	(3.33)	(2.03)	(–0.51)
S1	0.042	0.043	0.019	0.020				
	(2.34)	(1.76)	(0.48)	(0.21)				
N1					–0.085	–0.082	–0.043	–0.137
					(–2.71)	(–2.46)	(–1.06)	(–1.42)
R-squared	0.002	0.002	0.001	0.001	0.007	0.007	0.002	0.019
Root MSE	0.065	0.103	0.034	0.055	0.024	0.014	0.021	0.046

CL observed that lack of strong correlation between the equity markets of New York and Shanghai which corroborate an earlier and similar study of Bekaert and Harvey (1997). With the continued and dynamic development of the of the Shanghai equity market, we should now observe the more recent analysis of their co integration exhibited in Table 7. In column 2, Table 7, we note the value of SI and its related *t*-statistic of 0.041 and 2.32. The values indicate that the current Shanghai rate of return (the response variable) associated with the lagged New York rate of return (the explanatory variable) is small but significant at the same criterion previously used. Further, with a *t*-statistic of 0.98 (for N0), we find that the coefficient of the contemporaneous New York rate has no effect of the Shanghai rate of return for the entire time period studied. Under columns 2 and 5 (All Data), one observes very small and not significant *t*-statistics. This supports the notion that the two markets are integrated and have no effect on each other during the entire time period studied.

By examining the three sub periods (e.g. before 1997, 1997–2007 and after 2007) one continues to observe the small and not significant *t*-statistics with one exception. NI before 1997, the *t*-statistic is 2.45 indicating a significant relationship for the earliest period. The latter two sub periods the *t*-statistics were not significant. This is the only noticeable change associated with change in time period. Hence, only the period starting in 1997 did the relationship change between the index number studied for the two stock exchanges. Additional tests such as the Chow test based on the *F*-distribution do not reject the hypothesis that the coefficients of the three sub sample time periods are the same.

Table 7. Regressions of rate of return of Shanghai and New York stock prices

The table presents the regressions of rate the return of shanghai and New York stock prices on the one-lag return and the return and one-lag return of the other stock exchange in total sample and three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. S0 represents the raw rate of return of Shanghai stock prices while N0 represents the raw rate of return of New York stock prices. S1 represents the one-lag of the rate of return of Shanghai stock prices while N1 represents the one-lag of the rate of return of New York stock prices. We also report R-squared and Root MSE. *T*-statistics are provided in the parentheses. The sample period is from January 1991 to December 2009

	Shanghai				New York			
	All Data	Before 1997	1997–2007	After 2007	All Data	Before 1997	1997–2007	After 2007
Intercept	0.004	0.009	0.002	–0.004	0.002	0.003	0.002	–0.002
	(1.74)	(1.59)	(1.61)	(–0.71)	(2.23)	(3.28)	(2.06)	(–0.47)
S0					0.011	–0.002	0.008	0.151
					(0.98)	(–0.25)	(0.30)	(1.42)
S1	0.041	0.043	0.020	0.004	–0.009	0.003	–0.027	–0.099
	(2.32)	(1.77)	(0.51)	(0.04)	(–0.083)	(0.36)	(–1.06)	(–1.22)
N0	0.085	–0.102	0.019	0.198				
	(0.98)	(–0.25)	(0.30)	(0.78)				
N1	0.228	0.227	0.125	0.349	–0.086	–0.082	–0.045	–0.171
	(1.63)	(0.54)	(1.06)	(1.17)	(–2.77)	(–2.45)	(–1.09)	(–1.71)
R-squared	0.009	0.003	0.007	0.105	0.009	0.007	0.004	0.062
Root MSE	0.065	0.103	0.033	0.053	0.024	0.014	0.021	0.046

5. Regressions of the volatility of return

We construct a regression model with the purpose to explain the volatility in the Shanghai and New markets. First, we account for the effects of their own volatility associated with their past values. Following CL, the appropriate number of lagged explanatory variables to include in the respective models is determined by (1) the significance of individual parameter estimates; (2) by minimizing the AIC value; and (3) the presence or absence of serial correlation in the residual. By including one lagged response variable at a time, we follow CL and observe the three criteria to construct a model explaining the current volatility in the two stock exchanges.

In Table 8, we find for Shanghai (All Data) that S1 and S3 have significant *t*-statistics (2.41 and 4.40). The AIC values for models including one through eight lags had a minimum at four lags. Last, tests for serial correlation applied to the model having four lagged values yield a small and not significant *t*-statistics. Column 2 (All Data) and

Column (5) of Table 8 show the results for the Shanghai and New York stock exchanges. New York (All Data) had large significant coefficients for lags 1 and 2 but had not significant but marginal coefficients for lagged values 3 and 5. Hence, for New York, there tends to be a determination by employing criteria 2 and 3 to include 5 lagged values in the New York regression.

Table 8 shows that significant auto regressive coefficients for both markets indicate an association with its own lagged variables. It is a well know observation from previous studies including CL. The Root MSE for New York (All Data, 0.020) is much small (percentage wise) than the ROOT MSE for Shanghai (All Data, 0.063).This suggest that volatility is more predictable for the New York exchange than it is for the Shanghai exchange. Last, iif we compare the residual variances of volatility agrees with the conclusions from comparing the unconditional variances that the volatility in Shanghai has more variation and is less predictable.

As before, we test for structural change in each stock exchange, by dividing our time period into three sub periods. Columns 3, 4 and 5 of Table 8 contain the auto regressions for Shanghai and Columns 7, 8 and 9 of Table 8 contain the auto regressions for New York. Chow tests of equality among columns 3, 4 and 5 suggest equality among the coefficients even for S3 in columns 3 an 4 have significant coefficients. Another test for equality among the three sub periods for the New York exchange also strongly suggested the hypothesis of parameter stability in the explanation of New York volatility. One should not that for N1 (before 1997) and N5 for (before 1997 and after 2007) contained significant *t*-statistics.

At this point, we introduce lagged values of the other market to ascertain whether the volatility in the former market indicates *granger causality* (Granger 1969). To determine *granger causality* in Shanghai volatility, we choose the number of lagged values of New York volatility accord to the criteria noted before (e.g. AIC and the absence of serial correlation in the residuals). Our results for (All Data), reported in column 2 of Table 9, do not coincide with CL when we have two lagged New York variables, N1 and N2. N1 is positive and significant but N2 is almost zero and not significant. However, CL's conclusion was based on an $\alpha = 0.053$ and 0.061 (CL, p. 28) and was therefore suspect due to this relatively high probability of a Type 1 Error. Statistically, for the entire time period, we cannot conclude the New York volatility caused *grange caused* Shanghai volatility in any direction. Hence, this indicates that the volatility in the markets for the entire time period were likely independent of each other. Unlike CL, we did not observe negative coefficients for N1 and N2 in the entire time period studied.

In consistent with the finding of CL, we observed only the S1 (lag of 1) and this time the coefficient was not significant (at $\alpha = .05$ or less). The AIC value suggested not including any lagged values of the Shanghai variables. In addition, the Breusch-Godfrey test revealed the absence of serial correlation in the autoregressive model. The model with one Shanghai lagged variable (S1) is contained in column 7 of Table 9. The negative coefficient corroborates the results of CL but in this study this coefficient is not significant. Hence, by *granger causality*, the Shanghai volatility and New York volatility

Table 8. Auto regressions of volatility of Shanghai and New York stock prices

The table presents the auto regressions of the volatility of return of shanghai and New York stock prices in total sample and three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. S1 (S2, S3, S4) represents the one-lagged (two-lagged, three-lagged, four-lagged) of the rate of return of Shanghai stock prices while N1 (N2, N3, N4, N5) represents the one lagged (two-lagged, three-lagged, four-lagged, five-lagged) of the rate of return of New York stock prices. We also report R-squared and Root MSE. *T*-statistics are provided in the parentheses. The sample period is from January 1991 to December 2009

	Shanghai				New York			
	All Data	Before 1997	1997–2007	After 2007	All Data	Before 1997	1997–2007	After 2007
Intercept	0.004	0.010	0.002	–0.004	0.002	0.003	0.002	–0.005
	(1.86)	(1.81)	(1.34)	(–0.84)	(2.08)	(3.90)	(2.56)	(–1.24)
S1	0.074	0.091	0.013	0.024				
	(2.41)	(1.63)	(0.34)	(0.24)				
S2	–0.028	–0.057	0.040	–0.019				
	(–0.92)	(–1.04)	(1.10)	(–0.20)				
S3	0.129	0.141	0.122	–0.042				
	(4.40)	(2.63)	(3.50)	(–0.43)				
S4	–0.022	–0.038	–0.036	0.127				
	(–0.74)	(–0.70)	(–1.04)	(1.31)				
N1					–0.091	–0.121	–0.027	–0.178
					(–2.94)	(–2.18)	(–0.68)	(–1.85)
N2					0.065	–0.068	0.033	0.099
					(2.11)	(–1.23)	(0.82)	(1.00)
N3					–0.055	0.011	–0.039	–0.115
					(–1.79)	(0.19)	(–0.98)	(–1.16)
N4					0.011	–0.081	–0.042	0.101
					(0.38)	(–1.46)	(–1.06)	(1.11)
N5					0.049	–0.136	0.001	0.175
					(1.72)	(–2.45)	(0.01)	(2.09)
R-squared	0.023	0.030	0.023	0.019	0.020	0.039	0.005	0.106
Root MSE	0.063	0.098	0.032	0.054	0.023	0.014	0.021	0.044

do not have a granger cause relationship. Last, when we compare the Root MSE of the Shanghai and New York models, we not that the small residual variation in the New York regression and hence, it is more predictable than Shanghai volatility.

An additional question relates to whether or not there is significant co-variation of volatility in a multivariate setting. To incorporate instantaneously causality in explaining Shanghai volatility, one adds the current value of the variable in the other market in the auto regression. One observes the result for Shanghai in column 3 of Table 9 and the results for New York in column 8 of Table 9. The coefficients for the New York variables (All Data) show positive coefficients but only N1 is significant. This result differs from CL in that they found negative coefficients but none were significant. This would indicate that extended time period in this study resulted in some Shanghai volatility being related to New York volatility. A wholly different interpretation than CL and would indicate that the relationship of the two markets changed in the lengthier time period. For N0, all three sub periods yield small and not significant coefficients. For the sub period (Before 1997) in column 4 of Table 9, we observe small and not significant coefficients for N1 and N2. However, in columns 5 and 6, coefficients for lagged variable of one N1 are now significant and positive. This would indicate that during these sub periods New York volatility had an effect on Shanghai volatility. For N2 in columns 5 and 6, the coefficients were negative but not significant. In summary, we do find some differences the effect of New York volatility on Shanghai volatility depending on the time period. However, much of the time the market volatilities remain separate or at least not dependent on each other.

To explain New York volatility by including the current Shanghai volatility, we observe, in column 8 of Table 9, the coefficient 0.02 with a t-statistic is not significant using the criterion of $\alpha = 0.05$ or less. For S1, we observe the coefficient –0.02 with a t-statistic of –1.44 indicating no significance at any reasonable level of α. In column 8, only the value for the intercept is significant, but its value is only 0.01. For the variable S1, the coefficients in each column are not significant except the column 11 of Table 9, (After 2007) where the coefficient is negative and having significant t-statistic (–2.05). Obviously after 2007, the in New York was negatively influenced by the volatility in Shanghai. Hence, the volatility in New York was negatively related to that in Shanghai but likely unrelated during the earlier two sub periods of this study. In summary, there appears to be some difference in the relationship of New York volatility explained by Shanghai volatility relating to which sub period that we observe. Hence, there like differential effects during the three sub periods studied.

At this point, we observed some structural change occurring in the relationships of volatility in the two stock exchanges. The estimated auto regressions of volatility indicate that the parameters of the model are not stable over the entire length of the study period. Chow tests of equality of all coefficients for the regressions during all three time period indicated that the temporal instability existed for the coefficients. Hence, given temporal instability, one may question whether the model is stable over the entire length of the study period. E agrees with the results of CL, that the analysis yields a thorough examination by statistics of the relationship during the entire period and its three sub period, but may not lead to the conclusion that we have a perfectly predictive for the behavior of the stock exchanges into the future.

Furthermore, the results for the model for New York volatility, we find the effect of the Shanghai variables leading to the same for of temporal instability of the parameters. Results of the Chow test on the data lead to the same conclusion noted before for the other models in Table 9. Simply stated the addition of Shanghai variable does not result in a stable throughout the three sub periods. There are observed structural changes related to time period, we conclude that we should question the concept of temporal stability.

Table 9. Regressions of volatility of Shanghai and New York stock prices

The table presents the regressions of the volatility of return of Shanghai and New York stock prices in total sample and three subsamples: before 1997, after 1997 and before 2007, and after 2007. The rate of return is calculated as the change in the natural logarithm of the price index in a given period. The volatility of returns is calculated as the absolute value of the change in the natural logarithm of the price index in a given period. The price index is obtained from DataStream Equity Indices. S0 represents the raw rate of return of Shanghai stock prices while N0 represents the raw rate of return of New York stock prices. S1 (S2, S3, S4) represents the one-lagged (two-lagged, three-lagged, four-lagged) of the rate of return of Shanghai stock prices while N1 (N2, N3, N4, N5) represents the one lagged (two-lagged, three-lagged, four-lagged, five-lagged) of the rate of return of New York stock prices. We also report R-squared and Root MSE. *T*-statistics are provided in the parentheses. The sample period is from January 1991 to December 2009

	Shanghai					New York				
	All Data	All Data	Before 1997	1997–2007	After 2007	All Data	All Data	Before 1997	1997–2007	After 2007
Intercept	0.01	0.01	0.01	0.01	–0.01	0.01	0.01	0.01	0.01	–0.01
	(1.64)	(1.57)	(1.28)	(1.07)	(–0.55)	(2.14)	(2.07)	(3.85)	(2.52)	(–1.26)
S0							0.02	0.01	0.04	0.10
							(1.35)	(0.34)	(1.35)	(1.18)
S1	0.07	0.07	0.09	0.01	0.04	–0.02	–0.02	–0.01	–0.02	–0.16
	(2.27)	(2.32)	(1.57)	(0.36)	(0.35)	(–1.36)	(–1.44)	(–0.06)	(–0.92)	(–2.05)
S2	–0.03	–0.03	–0.06	0.04	0.03					
	(–0.85)	(–0.84)	(–1.05)	(1.14)	(0.29)					
S3	0.13	0.13	0.14	0.12	–0.09					
	(4.42)	(4.35)	(2.64)	(3.39)	(–0.85)					
S4	–0.02	–0.02	–0.04	–0.03	0.07					
	(–0.86)	(–0.85)	(–0.65)	(–1.01)	(0.71)					
N0		0.09	0.01	0.08	0.20					
		(1.12)	(0.02)	(1.30)	(1.58)					

End of Table 9

	Shanghai					New York				
	All Data	All Data	Before 1997	1997–2007	After 2007	All Data	All Data	Before 1997	1997–2007	After 2007
N1	0.21	0.22	0.41	0.13	0.28	–0.09	–0.09	–0.12	–0.03	–0.18
	(2.55)	(2.64)	(1.00)	(2.05)	(2.28)	(–2.89)	(–2.98)	(–2.19)	(–0.76)	(–1.79)
N2	0.07	0.07	0.64	–0.02	–0.03	0.07	0.07	–0.07	0.04	0.14
	(0.87)	(0.78)	(1.59)	(–0.34)	(–0.23)	(2.21)	(2.17)	(–1.25)	(0.93)	(1.43)
N3						–0.05	–0.06	0.01	–0.04	–0.10
						(–1.76)	(–1.79)	(0.18)	(–1.07)	(–1.02)
N4						0.01	0.01	–0.08	–0.04	0.11
						(0.42)	(0.44)	(–1.46)	(–1.04)	(1.22)
N5						0.05	0.05	–0.14	0.01	0.10
						(1.73)	(1.69)	(–2.45)	(0.04)	(1.87)
R-squared	0.03	0.03	0.04	0.03	0.08	0.02	0.02	0.04	0.01	0.15
Root MSE	0.06	0.06	0.09	0.03	0.05	0.02	0.02	0.01	0.02	0.04

6. Conclusions

We collected, analyzed and interpreted an extensive database of the stock market indices for New York and Shanghai. Our purpose is to draw conclusions concerning the relationships of the two stock exchange expressed by an analysis of the mean and volatility of rates of return in the two stock exchanges over a lengthy period of time and during three sub periods. We first examine the time series characteristics of stock price indices for New York and Shanghai during the period of 1991 to 2009. Specifically, we calculate the rate of return and the volatility of return for two markets and estimate the serial correlation and co-movement of the two markets. We find that the rate of return in Shanghai is much higher than that in New York while Shanghai stock prices are more volatile than New York stock prices. Further, we find that Shanghai stock prices are positively serially correlated while New York stock prices are negatively serially correlated in terms of auto regression of the rate of return. In the multivariate regressions, we find that there is little evidence to show that the rate of return in Shanghai would affect the rate of return in New York and the rate of return in New York would affect the rate of return in Shanghai. It suggests that the two markets are not integrated. In additional, the volatility in one market cannot be said to influence the volatility in the second market in the same manner throughout the time period studied. Last, for econometrics modeling, we do not suggest that our models should be used in predicting the future volatility of these markets since they are subject to structural changes. The use of multivariate time series analysis may provide further evidence as the lack of co-integration in these stock exchanges.

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NIUJORKO IR ŠANCHAJAUS RINKOS: AKCIJŲ KAINŲ INDEKSAI

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Santrauka

Šis tyrimas apima akcijų kainų indeksų analizę Niujorko ir Šanchajaus biržose nuo 1991 m. iki 2009 m. Atlikus tyrimus nustatyta, kad vidutinė grąžos norma Šanchajuje yra daug didesnė nei Niujorke, o Šanchajaus akcijų kainos kinta daug sparčiau nei Niujorko vertybinių popierių kainos. Be to, pastebėta, kad Niujorko akcijų kainos turi teigiamą koreliaciją, o Šanchajaus akcijų kainos – neigiamą (lyginant grąžos normą). Atlikę daugiakriterinės regresijos analizę, autoriai pastebėjo, kad Šanchajaus biržose vykstantys grąžos normos pasikeitimai neturi įtakos Niujorko biržoms ir, atvirkščiai, Niujorke vykstantys pasikeitimai neturi įtakos Šanchajaus biržoms. Tai rodo, kad šios dvi rinkos nėra integruotos.

Reikšminiai žodžiai: indekso skaičius, kintamumas, koreliacija, Šanchajus vertybinių popierių birža, Niujorko vertybinių popierių birža.

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