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Co-movement Behaviour of Stock Prices in Shanghai Stock Exchange

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This paper analyses the Shanghai Stock Exchange (SSE) co-movement behaviour from January 2001 till December 2011. The study used 699 listed companies from the SSE and compares its co-movement behaviour during and after the global financial crisis. It is found that stocks in the SSE were highly synchronous during the global financial crisis; though this tendency is not visible before the GFC.The study also used the NYSE time-series data and compare with the SSE and, found evidence that time-series variables of these stock markets are negatively correlated. However, there are no statistically significant macroeconomics events to support the tendency of the Shanghai Stock Exchange synchronous behaviour during the sample period. It seems the global financial event is one of the denominators for this co-movement behaviour of the SSE.

JEL Codes: F34, G21 and G24

1. Introduction

Stock markets around the world suffered significantly during the Global Financial Crisis in 2007. Although, the GFC started late 2007 the after effects of the GFC are still visible and, several developed and emerging economies are still suffering from post the GFC crisis. The World Bank also warned the G20 nations that a new economic meltdown is coming, and it will be more devastating in nature(Lowrey, 2012).

This paper analyses the Shanghai Stock Exchange (SSE) co-movement behaviour during and after the global financial crisis. The study used the R-square metrics for the co-movement analysis suggested by various scholars and academics. For example, Alves et al. (2010) used the stock return co-movement as a measure of the quality of the country's information environment. Morck et al. (2000) and Khandaker and Heaney (2009) used the R-square measure to analyse stock price synchronicity for their sample countries. While the Shanghai Stock Exchange (SSE) has been well addressed in many ways, there is very little empirical analysis on its co-movement behaviour during and after the global financial crisis.There is evidence that the SSE was volatile during the global financial crisis and its market capitalisation dropped to its lowest level in recent years due to the GFC.

These sudden changes in market capitalisation and higher stock price co-movement behaviour raise a question about the market integrity and information effectiveness in emerging stock markets, such as China. Academics used the R-square measure to analyse the stock market co-movement tendency and its information effectiveness. Studies found that stock exchanges with higher stock price co-movement behaviour generally cannot provide sufficient protection to its investors and market wide share price swings can push the market value of stocks from its

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fundamental value (Pistor et al. 2000). Therefore, the R-square metrics is an important market model for information efficiencies in emerging stock markets. The study finds evidence that the Shanghai Stock Exchange (SSE) was volatile during the global financial crisis and its stocks exhibit higher stock price co-movement behaviour during the study period. It is also found that the co-movement measures are stationary over the period for the SSE. The study also could not establish a positive correlation coefficient between the SSE and the NYSE time-series variables.

The remainder of the paper is organised as follows: The next section reviews some recent literatures. Section three discusses research methodology. A description of the sample data included in section four and section five provided a section for data analysis. Conclusions and limitations appear in the final section.

2. Literature Review

Co-movement refers to the tendency of a stock market prices to move in the same direction in a given day/week. It is argued that stock prices in the emerging countries move closely together than that of the developed economies, due to several factors; such as poor corporate governance mechanisms, poor investor protection rights, corruption and low GDP per capita. Morck et al. (2000) argued that stock prices move more closely together in poor GDP per capita economies than that of the high GDP per capita economies. The authors used the R-square model to measure the stock price co-movement behaviour for their sample countries. They argued that emerging countries tend to have synchronous stock price behaviour. They also found that developed economies stock price changes are associated with firm-specific information with stronger investor protection rights, whereas emerging economies share price fluctuation influenced by the market wide share price swings and poor investor protection rights (Roll 1988; Jensen et al. 1992).

Campbell et al. (2001) argued that large investors are exposed to greater risk as stock price co-movement increases in emerging economies. He also asserted that larger stocks can manipulate the financial market and in a country where few stocks are listed in a stock exchange are more volatile in nature due to the size of the market. He argued that stock market co-movement behaviour is an important phenomenon for developed economies as well as for the emerging market economies.

Durnev et al. (2003) suggested that a higher firm-specific stock price variation is associated with higher information content about future earnings. It should be noted that all information about the future earning is not always publicly traded but private information can play a vital role in emerging economics and that’s why stock synchronicity is higher in more corrupted economies.

Piotroski and Roulstone (2004) stated that stock price co-movement increases with analyst coverage and poor information disclosure policy. They argued that greater industry coverage by the stock brokers and industry analysts; and higher information (publicly traded information) disclosure requirements confronted share price volatility and co-movement behavior of emerging stock markets. In addition, Dasgupta et al. (2006) argued that corporate transparency and stock price co-movement are strongly correlated. They found that greater transparency indicates early and timely disclosure of firm specific information. So, stock co-movement decreases as corporate disclosure and greater transparency increase.

In contrast, Alves et al. (2010) argued that R-square measure is not a reliable model for the quality of the information disclosure for country level data. They found that the R-square measure is based on the implicit assumptions, such as the stability of a country, strength of corporate governance mechanisms and superior investor protection rights, which cannot be always accessible to investors.

Chan and Hameed (2006) used the trading volume of stocks as a descriptive variable to explain stock price co-movement for individual firms. They found that the size of a firm has strong impact on market wide share price swings, and also when the number of stocks within a stock market is small a few large companies tend to dominate overall market movements. Thus, there is evidence of two approaches in the literature. While the first focuses on country level analysis, the second looks more closely at individual share based effects.

Xing and Anderson (2011) argued that the R-square measure is not a reliable measure for stock market correlation and co-movement analysis. They focused on several foreign capital markets and found that the R-square measure could be positively or negatively correlated to their sample countries. They found conflicting results in their sample countries using the R-square metrics and argued that the R-square measure provide valuable stock price information but in limited extent.

Finally, there is sufficient evidence that the R-square metrics is a reliable measure for the stock market co-movement analysis. Though, there are some other market models available to analyse the stock market synchronous behaviour, the R-square measure is the most widely accepted model in academic literature and time series analysis.

3. Data

The study uses the Shanghai Stock Exchange (SSE) adjusted stock price data to analyse its share price co-movement behaviours for the sample periods (2001-2011). The study selected all available stocks from the SSE and then analysed the share market trends. It should be noted that the Shanghai Stock Exchange (SSE) listed 932 firms in its stock exchange and to avoid the survivorship bias problem, the study considered all available stocks listed to this stock market. In addition, the NYSE return index data collected from the Yahoo finance database.

It should be noted that, the research could only collect 699 complete firm level data from the SSE using the DataStream database[i]. The study uses weekly individual stock return data (adjusted) for the analysis and then converted these data series in a monthly data set. The study used the R-square metrics to determine the correlation between the individual firm's returns and the share market index on monthly basis. The study period includes 132 monthly (11x12) observations for each firm to calculate the R-square metrics for the sample period.

4. Methodology

The study uses the following model to analyse the Shanghai Stock Exchange (SSE) co-movement behaviour.

$$R_{i,t} = \alpha_i + \beta_i R_{m,\,it} + \varepsilon_{i,t} \qquad \text{(i)}$$

In this given market model, share return can be expressed as a fraction of share market return. Where $R_{i,t}$ is the firm i return for period t, $R_{m,\,it}$ is the market return of firm i for t period, $\varepsilon_{i,t}$ is the error term and α_1 and β_i are estimated parameters. The R^2 measure is the percentage of variation in monthly return of stock i in country j explained by variations in country j 's market return, or:

$$R_{it}^2 = \left(\frac{Cov(R_i\ R_m)}{\sigma_i\ \sigma_m} \right)^2 \qquad \text{(ii)}$$

Where, Cov($R_i R_m$) is the covariance between the share returns and share market returns and σ_i is the standard deviation for asset i. A high R-square indicates a high degree of stock return co-movement.

5. Hypothesis

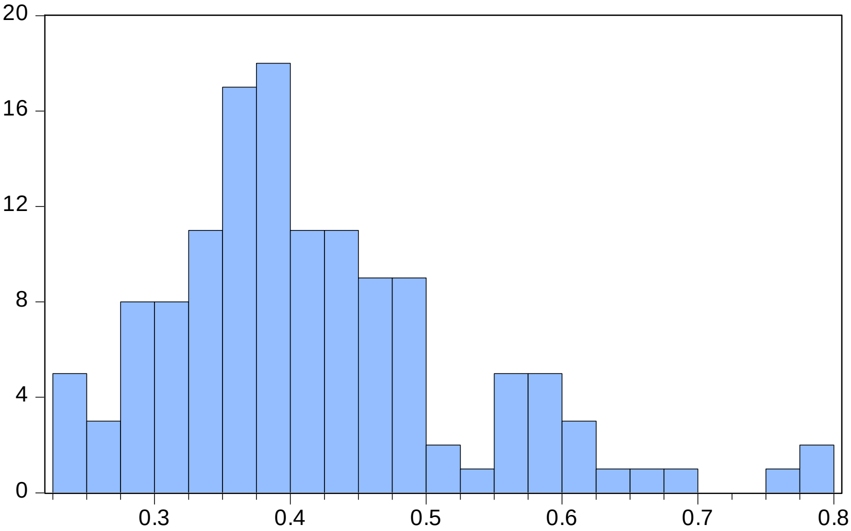
The hypotheses of this study are the following:

H_1 = The time-series distribution of the SSE is normal.
H_2 = Stock market co-movement behaviour of the SSE increased during the GFC.
H_3 = The SSE and the NYSE are positively correlated.

6. Data Analysis

Table 1 illustrates descriptive statistics of the full dataset for the sample 699 listed companies. The data span the period from January 2001 till December 2011. It is found from the analysis that the R-square values for the sample firms are 0.4179 with standard deviation of 0.1118. This suggests higher stock price co-movement behaviour for the SSE with small spread in the R-square values. There is evidence from the time-series analysis that the R-square values of the sample stock exchange could be up to 79.6 per cent in a given week or month during the sample period. This is not a surprising result, as previous literature suggests that the Chinse stock market can move up to 99 per cent in the same direction in a given day of the week. For example, Morck et al. (2000) found that Chinese, Turkish and Malaysian stock exchange exhibit higher stock price synchronicity in their sample period.

Table 1: Descriptive statistics of the full dataset



Series: ALL	
Sample 1 132	
Observations 132	
Mean	0.417856
Median	0.394500
Maximum	0.796000
Minimum	0.230000
Std. Dev.	0.111868
Skewness	1.027172
Kurtosis	4.224612
Jarque-Bera	31.46000
Probability	0.000000

Table-A1 exhibits the R-square values of the sample 699 firms from 2001 till 2011 on monthly basis. It is found that the R-square values of the SSE reached to its highest level during the global financial crisis (GFC). The sample stock exchange exhibits the R-square value of 0.4667 in 2008, 0.4958 in 2009, 0.4997 in 2010 and 0.5360 in 2011.

In addition, to understand the normality of the SSE times-series data collected from the DataStream database the study also run Kolmogorov–Smirnov test statistic.This is a very useful statistical test with reference to the probability distribution. The Kolmogorov–Smirnov statistic quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution. The result suggests that time-series data of the SSE is not normally distributed with mean of 41.7 and standard deviation of 21.11. Therefore, the study rejects the first null hypothesis and suggests that the stock market index of the SSE is not normally distributed.

Table 2: Kolmogorov–Smirnov test statistic

Null Hypothesis	Test	Sig	Decision
The distribution of China is normal with mean 41.7 and standard deviation 21.11	One-sample Kolmogorov-Smirnov Test	0.000	Reject the null hypothesis

To understand the time-series behaviour of the SSE more clearly, the study uses 15 weeks moving average model (MA). MA is a very popular technical analysis that illustrates the average value of a stock price over a specific period of time. It also helps to smooth-out the series data and define areas of possible support and resistance.

Figure 1: The 15 Weeks Moving Average Model for the SSE

Figure 1 illustrates the variation of 15 weeks moving average model for the sample stock market from January 2001 till December 2011. It is found that the SSE stocks exhibit higher co-movement behaviour during and after the global financial crisis. There is evidence that the SSE stocks move up to 90 per cent in the same direction in week 353, which is during 2007. It also shows that the SSE remains volatile during 2011 as an after effect of the crisis.

Further, to understand the co-movement behaviour of the sample stock exchange in various sub-periods, the full dataset further divided into three sub sets. Subset-1span the period from January 2001 till December 2003 (post-9/11 crisis), subset-2 is from January 2004 to December 2007(pre-GFC crisis) and subset-3 includes data from January 2008 till December 2011(during and post GFC crisis).

Table 3 illustrates the R-square values of stock market co-movement behaviour for the three sub-sets. The R-square values for the subset one includes 36 monthly observations for the sample stock exchange. It is found that the SSE exhibits the R-square value of 0.3792 during 2001-2003, which is slightly higher than the pre-Global Financial Crisis R-square values (0.3651) in sub-period two.

Table 3: R-square descriptive statistics for the sub-periods

		Sub-Period 1	Sub-Period 2	Sub-Period 3
	ALL	2001-2003	2004-2007	2008-2011
Mean	0.4179	0.3792	0.3651	0.4995
Median	0.3945	0.3675	0.3610	0.4905
Maximum	0.7960	0.7960	0.4930	0.7910
Minimum	0.2300	0.2300	0.2390	0.2860
Std. Dev.	0.1118	0.1176	0.0573	0.1025
Skewness	1.027	1.9951	0.1749	0.3336
Kurtosis	4.222	8.0040	2.6508	3.0604
Observations	132	36	48	48

The average R-square value for sub-period three is 0.4995; which is significantly higher than the previous two sub-periods. The result is not surprising as there is evidence that the higher R-square value associated with higher stock price co-movement behaviour. During the global financial crisis stock exchanges around the world suffered significantly and the Chinse stock exchange is one of them. It lost a large proportion of its market capitalisation during the GFC and, the higher stock price co-movement behaviour probably caused by the crisis (GFC). It is also found that the R-square standard deviation and kurtosis is also high in sub-period three than sub-period two.

The study also includes the ANOVA test statistics to determine, whether there are significant mean differences between the series variables (in different sub periods and pre and post GFC). Table 4 illustrates the ANOVA test statistics results for the analysis, which is statistically significant at 1 per cent level. It suggests there is significant difference in mean variance of the sample data series. Therefore, the study accepts the second null hypothesis which states, '*Stock market co-movement behaviour of the SSE increase during the GFC*'.

Table 4: ANOVA test statistics for the R-square co-movement analysis

	Sum of squares	Degrees of freedom	Mean square	F	Sig.
Between groups	0.5073	2	0.2536	31.5133	0.000
Within groups	1.1320	129	0.0087		
Total		131			

The study also runs an Augmented Dickey Fuller test (model includes intercept, no time frame) to determine whether the R-square values are stationary over the study period. The ADF test is an important test statistics for determining the quality of the data.

Table 5 reports the ADF test statistics which are statistically significant, and consistent with the co-movement measures being stationary over the period of the study. This suggests that the time series data has a constant mean variance.

Table 5: ADF test Statistics

Augmented Dickey-Fuller test statistic			t-Statistic	Probability
			-3.926093	0.0025
MacKinnon (1996) one-sided p-values.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ALL(-1)	-0.414542	0.105586	-3.926093	0.0001
D(ALL(-1))	-0.301832	0.095333	-3.166076	0.0019
D(ALL(-2))	-0.253355	0.083699	-3.026965	0.0030
C	0.161169	0.041934	3.843362	0.0002
R-squared	0.383523	Sum squared residual		1.018726
Adjusted R-squared	0.368727	F-statistic		25.92166
S.E. of regression	0.090276	Probability (F-statistic)		0.000000

In addition, the study also report Granger-Causality test in table 6. G-causality is normally tested in the context of linear regression models. It is a statistical concept of causality that is based on prediction. For example, if 'A' does not granger-cause 'B', then it does not necessarily suggest that 'B' is independent. It is found from the analysis that the NYSE, USA does not Granger-cause the SSE, China and, the SSE, China also does not Granger-cause the NYSE, USA. It suggests that the lead-lags[ii] of the NYSE, USA could not be used to forecast the SSE behaviour.

Table 6: Granger-Causality Test results

Null Hypothesis:	Observations	F-statistics	Probability
USA does not Granger Cause CHINA	585	0.12031	0.9940
CHINA does not Granger Cause USA		0.56838	0.7556

Table 7 illustrates the results of spearman's rank correlation coefficient matrix for the SSE and the NYSE. The test can also be denoted by ρ. This is a nonparametric measure of statistical dependence between two variables.The test assesses how well the relationship between two variables and analyse the strength of a relationship between two data sets. These can be written as follows:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}. \qquad \text{(iii)}$$

Where, d_i is the difference in the ranks given to the two variable values for each item of data.

Table 7: Spearman's Rank Correlation coefficient for the USA and China

	USA	
	Coefficient	P-Value
China	-0.343	0.000

It is found from the analysis that, there is a negative association between the time-series variables of the New-York Stock Exchange (NYSE) and the Shanghai Stock Exchange (SSE). The test is statistically significant at 1 per cent level, suggesting a strong negative correlation between these two equity markets which is surprising. Therefore, the study rejects the third null hypothesis and accepts the alternative one. The findings are not constant with the previous studies and there is no evidence of recent published literatures in this field of research that deals with the pre and post GFC crisis.

Figure 2: The SSE and the NYSE market movement behaviour during 2001-2011

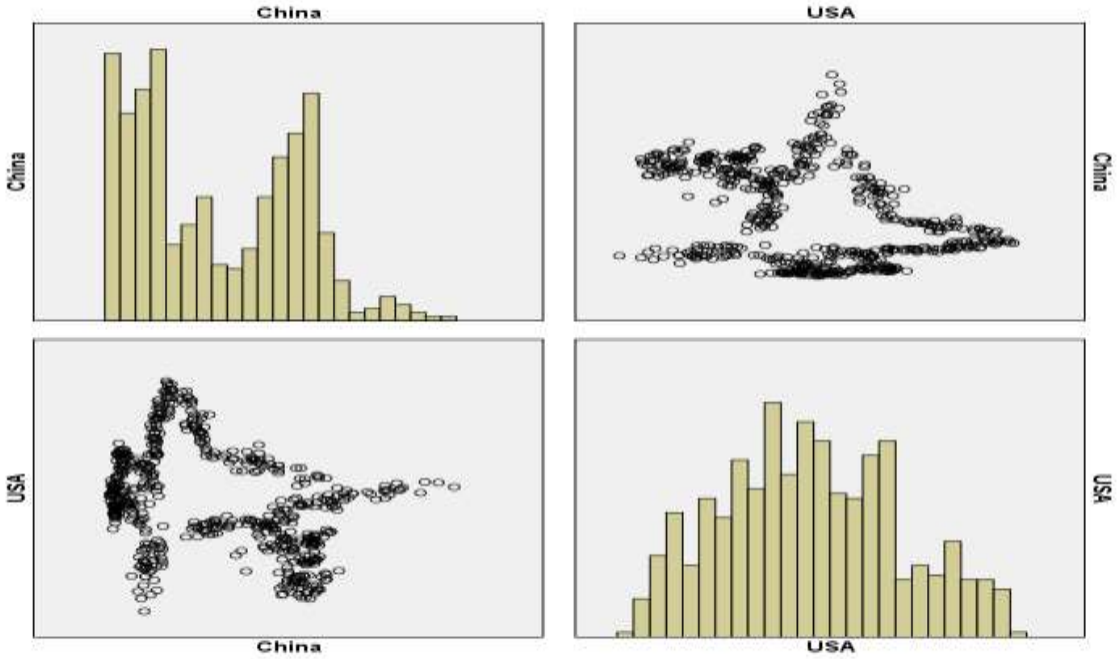


Figure 2 exhibits the SSE and the NYSE behaviors during the sample periods. There is evidence that the SSE stocks were volatile and behave unprecedentedly during the GFC. The SSE stocks were also synchronous and stock price correlations rose to as high as 79.6 during the sample period.

7. Discussion and Conclusion

The study presents empirical evidence of higher stock price co-movement behaviour of the Shanghai Stock Exchange (SSE) using the R-square metrics. It is found from the analysis that the Shanghai Stock Exchange (SSE) exhibits higher R-square values during 2008-2011, suggesting higher stock price co-movement behaviour during and after the global financial crisis (GFC). This result is further supported by Kolmogorov–Smirnov test statistic, which shows that time-series data of the SSE are not normally distributed.

The study also used several statistical techniques to compare the SSE synchronous behaviour with different sub-periods analysis. For example: the ANOVA test statistic has been employed to compare the R-square values with different sub-periods. It is found that the ANOVA test statistics are statistically significant at 1 per cent significant level for the sample sub-periods. The study also used the ADF test statistics and found that the R-squares measures are stationary over the sample period (2001-2011).

There is no evidence of a positive Granger-causality between the SSE and the NYSE time series data using the Granger-rho test.However, the spearman's rank correlation metrics shows statistically significant negative correlations between stock markets time-series variables.Therefore, it is quite difficult to determine the factors of higher stock price co-movement behaviour of the Shanghai Stock Exchange during the GFC. Morck et al (2000) argued that higher R-square value is associated with higher inflation, corruption and lower GDP per capita. They also suggest that the countrywide corruption can inversely affect the stock market and corruption perception index is also positively correlated with the R-square values for the Chinese stock market (Khandaker 2011).

This research found evidence that the SSE exhibits higher stock price co-movement behaviour during the global financial crisis and its share prices moved from its fundamental value due to this factor. There is also evidence that during the global financial crisis the Shanghai Stock Exchange market capitalisation drop significantly and marginal investors lost confidence on the SSE. However, this research support Morck et al. (2000) and Khandaker (2011) idea at a limited extent for macroeconomics variables, a further analysis is needed to explore the SSE market behaviours during the GFC.

8. Limitations

There are two major limitations of this study.

First, this study used 699 listed firms for the R-square co-movement analysis. A larger sample size or even a cross-country time series analysis would provide a more robust result for the stock markets co-movement behaviour.

Second, there are some other market models available for the stock market volatility and co-movement analysis. A comparison between these market models for the co-movement analysis would provide a clear and robust picture of the stock markets behaviours.

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Appendix

Table A1: Shanghai Stock ExchangeCo-movement Metrics

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
January	0.7540	0.4290	0.4840	0.3610	0.3190	0.3010	0.3150	0.4160	0.6060	0.3990	0.4960
February	0.7960	0.2480	0.4240	0.4110	0.4120	0.3910	0.4720	0.4340	0.6010	0.6190	0.5710
March	0.3320	0.4190	0.2950	0.2390	0.4360	0.3710	0.3900	0.2980	0.4540	0.4420	0.4640
April	0.2450	0.2300	0.4540	0.3420	0.3640	0.3400	0.4040	0.5990	0.4420	0.3910	0.4900
May	0.3500	0.4190	0.3510	0.2730	0.2880	0.3380	0.3980	0.3910	0.4540	0.4910	0.4990
June	0.3350	0.4340	0.3640	0.4550	0.4740	0.3900	0.4410	0.3870	0.3870	0.6450	0.5950
July	0.2990	0.2960	0.3710	0.3460	0.3700	0.3480	0.3530	0.5650	0.3680	0.5780	0.5630
August	0.3330	0.4560	0.3810	0.3050	0.3030	0.4460	0.3520	0.4240	0.2860	0.4580	0.5050
September	0.3560	0.3320	0.2920	0.4930	0.3340	0.3580	0.3460	0.4420	0.5730	0.5170	0.5430
October	0.2330	0.3780	0.4080	0.4160	0.3750	0.2880	0.2670	0.4850	0.6840	0.6590	0.7910
November	0.2660	0.3880	0.3880	0.3210	0.4390	0.3680	0.3710	0.5610	0.5970	0.3980	0.4260
December	0.4090	0.3870	0.3160	0.3610	0.3840	0.3520	0.3060	0.5980	0.4980	0.3990	0.4890
Average	*0.3923*	*0.3680*	*0.3773*	*0.3603*	*0.3748*	*0.3576*	*0.3679*	*0.4667*	*0.4958*	*0.4997*	*0.5360*

Endnotes

[i]The study could not use all available listed firms for the analysis due to the lack of complete data set available in DataStream database.
[ii] The test used 6 lags.