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Case Study

Global Financial Crisis: Chinese Stock Market Efficiency

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ABSTRACT

This study endeavors to examine the efficiency of Chinese stock market and how the global financial crisis influences the efficiency of Chinese stock market. In order to determine the efficiency of Chinese stock market we apply efficient market hypothesis of random walk and divide our data sample into two periods: one is before global financial crisis and other one is during crisis. Here we apply ADF, DF-GLS, PP and KPSS tests on stock market returns in order to check the unit root in data series for both Shenzhen and Shanghai stock exchanges separately. The results of the study shows that Chinese stock market is weak form efficient and past data of stock market movements may not be very useable in order to make excess returns and the global financial crisis has no significant impact on the efficiency of Chinese stock market.

1. Introduction

The term market efficiency is broadly used in capital markets to explain the degree to which the present asset price or stock price reflects all available information in the market place and thus relying upon this information one can buy or sell the stocks which should, on average return investors only a fair measure of return after deducting transaction costs for the associated risk. Samuelson (1965) provides the concept of efficient market hypothesis (EMH) according to which the prices of an asset fluctuate randomly and further this concept is revised by Fama (1970,1991) in which he evidenced for market efficiency on the basis of development in research. For making investment policies both in emerging and developed markets, the concept of market efficiency has important implications. Different investment strategies could be adopted after deciding whether the market is efficient or inefficient. For example, in an efficient market the best strategy to make optimal profit is to concentrate on risk and return feature of an asset or portfolio, because when the market is efficient the price of an asset reflect the market, so the best way to estimate the risk and expected return of the asset, taking into account what is known about the asset at that time. Therefore, in such case there will be no undervalued assets offering higher than expected return or overvalued assets offering lower than the expected return. In contrast, if the market is not efficient the best way to make investment is to spot winners and losers in the market and correct identification of miss-priced assets could help to enhance or optimize the performance of overall investment (Rutterford; 1993). The factor of globalization and rapid growth in technology innovation enhance integration of financial markets world over, so the understanding of market efficiency even in emerging markets is becoming more important as a consequence of integration with more developed markets and free movement of investments across national boundaries. In developing countries like China, the contribution of equity

markets in the process of development is less as compare to developed markets and the equity markets of western developed world considered more efficient than developing nations. Due to factor of integration and reform process to open economies in emerging markets provide chances of getting heavy capital inflows from developed markets to developing markets and make this possible for investor to diversify their investments and risks across boundaries.

China is one of the fastest growing emerging economies in the world and rapidly growing from last 30 years since its opening in 1979. The two stock exchanges in Shanghai and Shenzhen were established in early 1990s and different reform process were initiated as a result demand for investment funds still growing significantly and capital market growth expected to play an increasingly important role in the process of development. At this transitional stage to development, it is very important to access the level of efficiency of the Chinese equity market in order to establish its long-term role in the process of economic development. The purpose of this study is to test whether Chinese stock market is weak form efficient or not in normal circumstances and what impact global financial crisis has on the efficiency of Chinese stock market. Under Efficient Market Hypothesis (EMH) to predict future expected prices or returns, we could use past actual prices or returns. The behavior of share price changes could tested for serial independence and random walk theory for equities prices show an equities market in which new information is quickly discounted into prices and abnormal or excess returns cannot be made from observing past prices.

In order to identify principle process and behavior of market return generation the pattern of short-term movements of combined market return is the key through which we could measure the historical market efficiency. The concept of market efficiency based on the theory of random walk process through which we determine underlying market is efficient or inefficient. If the market is efficient then it follows a random walk process and model will fail to identify any pattern, in such case historical data cannot be useful to determine expected returns. On other hand if market is not efficient then it means market is not following a random walk process and the model used will identify the pattern of market movement, in this case data series is considered to be stationary and historical data can be useful to identify future returns. Here from above discussion it is clear that identification of pattern in time series data is the main key to determine that market is efficient or inefficient. Eugene Fama (1970) identified three levels of market efficiency:

- **Weak-form efficiency:** The market said to be weak-form efficient when prices of the securities instantly and fully reflect all information of the past prices, so the future price movements cannot be predicted by using past prices.
- **Semi-strong efficiency:** In such case, the prices of securities or assets fully reflect all the publicly available information. Therefore, only investors with additional inside information could have advantage in the market.
- **Strong-form efficiency:** In this category, the prices of securities fully reflect all the publicly available information along with private information (inside information). Therefore, in such a case, no one can have advantage in predicting returns in the market, because there is no data that would provide additional value to the investors.

2. Literature Review

The essence of efficient market theory was taken from the concept of random walk theory. Bachelier in 1900 introduces the idea that asset prices may follow a random walk pattern. The future path of the price level of a security is no more predictable than the path of a series of accumulated random numbers or in statistical terms successive price changes are independent and identically distributed random variables Fama(1965). In contrast to this theory Andrew W. Lo (1988) totally reject the theory of random walk by taking the data into sample period from 1962-1985 and concluded that the past prices data cannot be attribute completely to the effects of infrequent trading or time varying volatilities. In following to these earlier studies some other researchers conduct same random walk concept hypothesis to test its implication on financial data of different countries markets which can be grouped into developed and emerging markets e.tc. Korea (Ryoo and Smith (2002) use a variance ratio test and find that the market follow random walk pattern, if the price limits are relaxed. China, (lee et al 2001) uses GRAPH and EGRAPH models and found that the volatility is highly persistent and predictable. Hong Kong (Cheung and Coutts 2001) by using variance ratio test found that the index on Hong Kong stock market follow a random walk. Spain (Regulez and Zarraga, 2002), Africa (Smith et al. 2002; Appiah-kusi and Menyah, 2003), and Middle East (Abraham et al. 2002) they all use variance ratio tests and runs test on the financial data of different countries for testing random walk hypothesis and found week form efficient these markets are and follow a random walk. The concept of efficient market hypothesis was firstly introduced by Samuelson (1965) that properly anticipated price of an asset fluctuate randomly. Fama (1970) presented a formal review of theory and evidence for market efficiency. To prove the theory in his empirical work he divided security prices into three information subsets first one was" week form test", second is " semi strong form test" and third one was " strong form test". He characterized an efficient capital market in which security prices fully reflect all available information and further revised his theory on the basis development research in 1991.In his revised work he hypothesize on information and trading costs, the costs of getting prices to reflect information (Fama 1991). Upon the connection information and market efficiency Bernard and Thomas (1990) present a robust testing model in which they conclude that prices may partially reflect the information regarding future earnings, but not reflect all available information by focusing on abnormal returns at the time of earnings announcements, and also argue that these can be predicted from the unexploited information in past earnings. They also demonstrate that the signs of average abnormal returns at quarterly earnings announcement dates agree with those predicted by a model that exploits the (+,+,+,-) signs of the serial correlation. Burton G. Malkiel (2003) examines the attacks on the efficient market hypothesis and believe that the stock prices are partially predictable by focusing on statistical findings of relationship between predictability and efficiency, crash of 1987 and internet bubble, he conclude that our stock markets are far more efficient and far less predictable. In his point of view an efficient market do not allow investors to earn above average returns without accepting above average risks and sports the view that stock market has no memory and the way past prices changed cannot be use in divining how it will behave in future, same survey and empirical results were concluded in the study of cootner (1964). Balvers et al(1990) argue on predictability of returns, intertemporal asset pricing, and macroeconomic fluctuations by using a simple equilibrium model with relation to consumption opportunities and output. Consumption opportunities vary along with variations in aggregate output, investors are forced with a less smooth consumption pattern. Investors adjust their

required rate of return on stock in order to smooth consumption. This linkage provides a base in which returns could be predictable up to an extant related to the predictability of aggregate output. The change in utility consumptions further result in utility-increasing intertemporal transactions, so under this scenario we could say that predictability is consistent with efficient markets. Rendleman, Jones and Latané (1987) hypothesize that the investors are not fully aware about the serial correlation in earnings which prevail among quarterly earnings changes, so they do not use this information to enhance their earnings.

Efficient market hypothesis has a twofold functions firstly it could be use as a theoretical and predictive model for operations in a financial market and secondly it could be use as a technique in impression management campaign to attract more peoples for investment in stock market (Will 2006). Traditionally more developed western equity market are considered to be more efficient and the contribution of equity markets in the process of development in developing countries is less due to restrictions and controls which resulted in a weak markets (Gupta, 2006)
Along with empirical literature on efficient market hypothesis, many other researchers try to explain it through behavioral perspective. Robert J. Shiller (2001) tries to explain efficient market hypothesis through behavioral principles. According to shiller behavioral principles are derived from psychology, sociology and anthropology. In his work, he discussed some behavioral principles, which are relevant in context of efficient market hypothesis. The principles discussed are prospect theory, regret and cognitive dissonance, anchoring, mental compartments, overconfidence, over- and underreaction, representativeness heuristic, the disjunction effect, gambling behavior and speculation, perceived irrelevance of history, magical thinking, quasi-magical thinking, attention anomalies, the availability heuristic, culture and social contagion, and global culture. Joseph E. Finnerty (1974) on the topic of insider's access to information and market efficiency conclude that market is not strong-form efficient and insiders are able to outperform the market because they can identify profitable as well as unprofitable situations within their corporations.

3. Data and Methodology

Number of techniques can be used to identify pattern in a series of data and all have their own merits and demerits. In order to measure the stock market efficiency, this study will use the stock market return of Shanghai and Shenzhen stock exchanges. Different studies have used different methods to measure the stock market efficiency. Etc:

3.1 Runs Test (Bradley 1968)

It's a non-parametric statistical test through which we could check randomness hypothesis for a two-valued data sequence. Through run test we find that the underlying series of data is of increasing values or decreasing values. The number of increasing or decreasing values considered as the length of the run. The probability that the (I+1)th value is larger or smaller than the Ith value follows a binomial distribution, which forms the basis of the runs test. As it's a non-parametric test so not require the returns to be normally distributed. The null hypothesis could determine by the same sign in price changes as it observes the sequence of successive price changes with the same sign. The main drawback of using run test that it could not detect the amount of change from mean because it only looks at the number of positive or negative changes.

3.2 LOMAC variance ratio test

Lo and MacKinlay (1988) proposed a test for checking the randomness of hypothesis for a value data sequence, along with other criticism the main flaw in using this test is the selection of maximum order of a serial correlation(faust,1992).

3.3 Durbin-Watson test (1951)

Durbin and Watson is one among the serial correlation tests used for finding market efficiency in previous studies. This test is only for first order autocorrelation, because it could only detect the relationship between an error and its immediately preceding value. The best way to use this test is to regress the error of time t with its previous value.

$$u_t = \rho u_{t-1} + v_t$$

$$\text{where } v_t \sim N(0, \sigma_v^2)$$

Another major drawback of using DW test is that, it could not detect residual correlations for example if $\text{corr}(u_t, u_{t-1}) = 0$ but $\text{corr}(u_t, u_{t-2}) \neq 0$ in such case the DW test will not find the autocorrelation. Here are some ways to remove the autocorrelation. One possible way is to remove the error from all possible combinations one by one, but it's a hectic job and practically not possible to do this lengthy exercise. The second and best alternative is to use a test for autocorrelation in a form of equation, in which relationship between u_t and several of its lagged values at the same time could be checked. Breusch- Godfrey test is among the tests widely used for testing autocorrelation of the lags up to r'th order

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \rho_3 u_{t-3} + \ldots\ldots + \rho_r u_{t-r} + v_t$$

$$v_t \sim N(0, \sigma_v^2)$$

After considering the above mentioned weakness of different models this study will use Augmented Dickey Fuller test (ADF test) to detect the pattern in time series data.

3.4 Augmented Dickey Fuller test (ADF test)

From the above mentioned weaknesses of models, Augmented dickey fuller (1979) test is used in this study because it is widely used and best fits for measuring market efficiency (Chan 1997, Brooks 2002). This test do not follows the conventional t-distribution. This test can be used to derive asymptotic results and could simulate critical values for various tests and sample sizes. It test has multiple choices for its use. It can be used with a constants, a linear time trend and with regression. For our study we will use the regression model in its standard form, with drift and with drift and trend for testing unit root.

$$SPI_t = \alpha SPI_{t-1} + \varepsilon_t \quad (1)$$

$$SPI_t = u^* + \alpha SPI_{t-1} + \varepsilon_t^* \quad (2)$$

$$SPI_t = u^{**} + \beta(t - T) + \alpha^{**} SPI_{t-1} \varepsilon_t^{**} \quad (3)$$

The denomination of these equations is as follows. Equation (1) is for standard model, (2) is for standard model with drift, (3) for standard model with drift and trend. SPI_t is the logarithm of stock price index at time t. u^* and u^{**} are drift parameters. "T" is the total number of

observations. $\varepsilon, \varepsilon^{*}, \varepsilon^{**}$, are error terms that could be autoregressive moving average process with time dependent variance. U is an arbitrary drift parameter, α is the change in index and ε_t is a random disturbance term.

For checking the non-stationarity of the data the Augmented Dickey-Fuller unit root will be applied in the form of following regression equation in order to check the null hypothesis.

$$y_t = \theta y_{t-1} + u_t$$

If the series will be stationary then θ=1, and against this, if model detect non-stationarity in data series then $\theta < 1$. So the hypotheses of our study are

H_0 : Time series is stationary.

H_1 : Time series is non-stationary.

The null hypothesis of the study will be rejected if the statistical value is lesser than the critical value and data series will be considered as non-stationary (following the random walk). In this study we will calculate daily market return by using daily market returns with the help of following formula for both Shanghai and Shenzhen stock exchanges.

$$R_t = Log \left(\frac{I_t}{I_{t-1}} \right) \quad (4)$$

This study divide sample period into two groups based on crisis period. First one is the period before global financial crisis started from January 1ST 2004 to 30TH June 2007. The second group relates to the period of global financial crisis, started from July 1ST 2007 and ending on December 31ST 2009. In order to check the stationarity of data, daily stock market returns are calculated for both Shanghai and Shenzhen stock exchanges separately for both periods. The daily stock market returns are calculated by applying the formula indicated in equation (4) upon daily stock market index. The sample data is collected from CCER (Chinese centre for economic research) database. Saturday and Sunday are the weekend days in china, so both stock exchanges remain close on these days. According to basic time series requirement the observations should be taken at a regular space interval. The requirement however, is that the frequency be spaced in terms of the processes underlying the series. The underlying process of the series in this case is trading of stocks and generation of stock exchange index based on the stock trading, as such for this study the index values at the end of each business day is appropriate (French 1980).
For robust testing we use DF-GLS, PP and KPSS tests. The data characteristics are mentioned in table1A and 1B and the figures below mentioned depicting the behavior of daily stock market returns before and during the crisis, which is separated by a red line. In order to check the stationarity of data series, study uses Augmented Dicky Fuller (ADF) Test in its standard form with drift and with drift and trend for both periods of time separately and for the sack of robust testing Dicky fuller GLS (DF-GLS) , Phillips Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used.

Table 1A: Data Characteristics – SHZ and SHN – January 2004-June 2007 (Before Crisis)

Index	Obser.	Mean	Median	Minimum	Maximum	Skewness	Kurtosis	Variance
SHZ	843	0.0018	0.0016	-0.0069	0.0117	0.250	-0.316	0.00002
SHN	843	0.0013	0.0012	-0.0052	0.0118	0.469	0.127	0.00001

Table 1B: Data Characteristics – SHZ and SHN – July 2007-December 2009 (During Crisis)

Index	Obser.	Mean	Median	Minimum	Maximum	Skewness	Kurtosis	Variance
SHZ	613	0.0005	0.0025	-0.0124	0.0101	-0.685	-0.646	0.00004
SHN	613	0.00008	0.0024	-0.0137	0.0081	-0.886	-0.450	0.00004

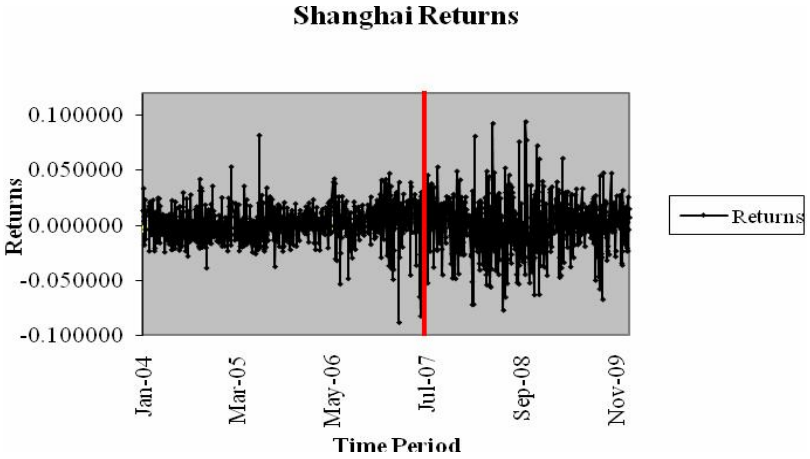

Figure 1: Shanghai stock market return data series

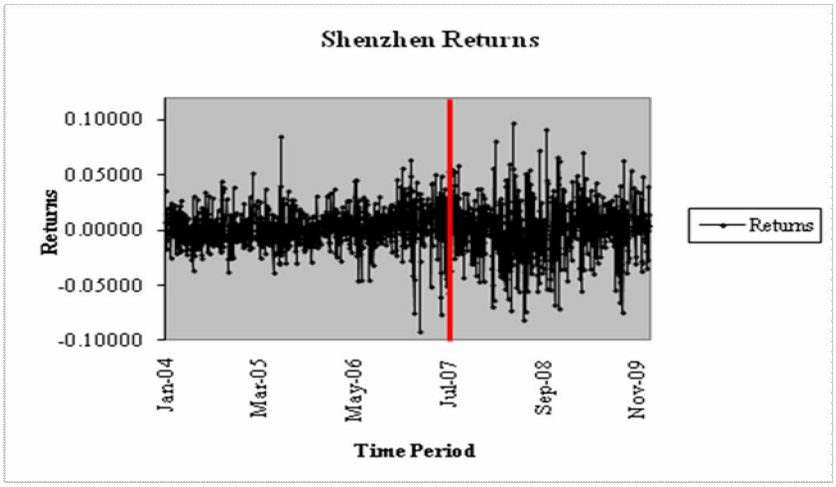

Figure 2: Shenzhen stock market return data series

4. Results and Findings

4.1 Before Crisis Efficiency Tests

Table 2 reports that before the global financial crisis the statistical value of ADF test (with intercept) in Shenzhen stock exchange is -4.301848, which is less than its critical values of -3.600987, -2.935001, -2.605836 at 1%, 5%, and 10% respectively. Therefore, study rejects the null hypothesis and concludes that data series is non-stationary and following the random walk. The statistical values of DF-GLS, PP and KPSS are also lesser than their corresponding critical values and rejecting the null hypothesis of stationarity. The test statistics of Shanghai stock exchange for all ADF, DF-GLS, PP, KPSS are also lesser than their critical values and accepting the alternative hypothesis of non-stationarity. Only the test statistics of KPSS are greater than critical values at 5% and 10% level of significance showing that there is somehow stationarity in data series.

Table 2 (A): Test statistics with intercept and no trend

Index	ADF test Statistics With 5 lags	DF-GLS test Statistics With 5 lags	PP unit root test (Newey-West Bandwith)	KPSS (Newey-West Bandwith)
SHZ	-4.301848	-4.086342	-4.283931	0.630456
SHN	-4.568317	-4.289556	-4.568317	0.621237

Table 2 (B): Critical values

Level	ADF Test	DF-GLS Test	PP unit root test	KPSS Test
1%	-3.600987	-2.62258	-3.600987	0.739000
5%	-2.935001	1.949097	-2.935001	0.463000
10%	-2.605836	1.611824	-2.605836	0.347000

The ADF test statistic (with intercept and trend) in table 3 is also lesser than the critical values in both Shenzhen and Shanghai stock exchange. So again the null hypothesis is rejected, concluding that the data series has unit root. Same statistical conclusion is observed for DF-GLS, PP and KPSS tests here.

Table 3 (A): Test statistics with intercept and trend

Index	ADF test Statistics With 5 lags	DF-GLS test Statistics With 5 lags	PP unit root test (Newey-West Bandwith)	KPSS (Newey-West Bandwith)
SHZ	-5.532188	-4.719236	-5.843012	0.135360
SHN	-5.742993	-4.765091	-9.147567	0.133356

Table 3 (B): Critical values

Level	ADF Test	DF-GLS Test	PP unit root test	KPSS Test
1%	-4.198503	-3.77000	-4.198503	0.216000
5%	-3.523623	-3.19000	-3.523623	0.146000
10%	-3.192902	-2.89000	-3.192902	0.119000

4.2 During Crisis Efficiency Tests

During the period of crisis the ADF test in Shenzhen and Shanghai stock exchanges are -5.149318, and - 5.522392, which are lesser than their critical values of -3.679322, -2.967767, -2.622989 at 1%, 5%, 10% significance levels respectively. So the null hypothesis is rejected and data series are considered non-stationarity by accepting alternative hypothesis. Same results are obtained by robust testing.

Table 4 (A): Test statistics with intercept and no trend

Index	ADF test Statistics With 5 lags	DF-GLS test Statistics With 5 lags	PP unit root test (Newey-West Bandwith)	KPSS (Newey-West Bandwith)
SHZ	-5.149318	-2.174585	-5.154930	0.180375
SHN	-5.522392	-2.205404	-5.514943	0.186881

Table 4 (B): Critical values

Level	ADF Test	DF-GLS Test	PP unit root test	KPSS Test
1%	-3.679322	-2.65014	-3.679322	0.739000
5%	-2.967767	-1.953381	-2.967767	0.463000
10%	-2.622989	-1.609798	-2.622989	0.347000

The test statistics with intercept and trend for the period of crisis are also not too different. The statistical values of all ADF, DF-GLS, PP and KPSS with drift and trend are lesser than their critical values (Table 5) at all significance levels. So here again the study rejects the null hypothesis and consider that the data series on both exchanges as non-stationary.

Table 5 (A): Test statistics with intercept and trend

Index	ADF test Statistics With 5 lags	DF-GLS test Statistics With 5 lags	PP unit root test (Newey-West Bandwith)	KPSS (Newey-West Bandwith)
SHZ	-5.258361	-2.609317	-5.279356	0.150786
SHN	-5.597081	-2.608892	-5.620397	0.144993

Table 5 (B): Critical values

Level	ADF Test	DF-GLS Test	PP unit root test	KPSS Test
1%	-4.309824	-3.770000	-4.309824	0.216000
5%	-3.574244	-3.190000	-3.574244	0.146000
10%	-3.221728	-2.890000	-3.221728	0.119000

5. Conclusion

Analysis of Market Efficiency is an important concept for the investors who wish to hold internationally diversified portfolios. With increased movement of investments across international boundaries owing to the integration of world economies, the understanding of efficiency of the emerging markets is also gaining greater importance. The results of the study shows that Chinese stock market is weak form efficient and data series are non-stationary, here exist unit root in data series. It means that Chinese stock market is following the random walk process. The investors can not generate excess profits by using and observing past behavior of stock price movements. Here is no significant difference in market efficiency in both periods (before crisis and during crisis). One good possible way to enhance the market efficiency is to introduce financial innovation in the emerging stock markets. New financial products create the opportunities for investors to mobilize their savings and very useful in breaking the relation between origination and ownership. When new financial instruments come into market, this will provide opportunities to the investors to allocate their risks in different securities and in different investor classes. This financial innovation is also very helpful in reducing the cost of capital and allocation of capital at its maximum, which will finally result in maximum utilization of sources and enhance market efficiency at its best. It is observed in major developed world markets that when new financial instruments and technological advancements come into market, it boosts the market efficiency significantly. The most common examples of these innovative advancements are the markets of Europe, USA, and Australia, where these financial innovations contribute a lot in their economic growth. Thus, financial innovations in emerging financial sector in China as whole are beneficial. The recent global financial crisis remind the world that this financial innovations are mixed blessings, not risk free and also has its shortcomings.

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