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Has Stock Market Efficiency Improved? Evidence from China

Thian Cheng Lim[1], Wan Huang[2], Jessica Lim Xiu Yun[3*] and Dan Zhao[1]

[1]Xi'an Jiaotong-Liverpool University, China

[2]Imperial College, London

[3]National University of Singapore, Singapore

*Correspondence: Jessica Lim Xiu Yun, Kent Ridge Hall, National University of Singapore, 10 Hen Mui Keng Terrace, 119617, Singapore. Tel: +6594695437; E-mail: a0099278@nus.edu.sg.

Abstract: Stock market has been associated with economic growth through its role as a source of new private capital. On the other hand, economic growth may be the catalyst for stock market growth. The purpose of this paper is to investigate the efficiency of the two official stock markets in China. The sample includes the daily closing prices of A-share and B-share indexes in both the Shanghai and Shenzhen stock exchanges for the period of January 1st, 2006 to December 31st, 2010. Three different approaches are employed; namely, serial correlation test, runs test and variance ratio test. Statistical evidence from serial correlation test shows that returns are correlated in both Shanghai and Shenzhen indexes and therefore the markets are weak-form efficiency.

JEL Classification: G15

Keywords: stock market; efficient market hypothesis, weak form, inefficient

Abbreviations:

EMH: Efficient Market Hypothesis

BPQ: Box Pierce Q

1. Introduction

Understanding the stock market efficiency is very important in helping investors make well informed investment decisions. In finance theory, the efficiency market hypothesis is important due to the theoretical assumption of a perfect capital market and the rational behavior of investors. The importance of the efficient market theory is also required in the "separation theory" proposed by Fisher (1961). Fisher's separation theorem asserts that the objective of a corporation will be the maximization of its present value, regardless of the preferences of its shareholders. The theorem therefore separates management's "productive opportunities" from the entrepreneur's "market opportunities". A firm's value is not affected by how its investments are financed or how the distributions (dividends) are made to the owner (Fisher, 1930).

In the agent-principal relationship, the task of management is to reduce cost and improve productivity in order to maximize shareholder wealth. Since the capital market is assumed to be efficient, the cost of finance is the same for everyone. In an efficient stock market, management do not have to spend time on "Guanxi" and building relationships with banks or financiers because eventually all borrowers will be given the same treatment in their efforts to raise capital. Transparency and efficient flow of information ensure that all borrowers are aware of the lowest interest rates for their funds. The weak form efficiency of China stock markets means those who have political connections with banks will enjoy better borrowing rates.

Ever since Fama (1965, 1970), empirical evidence had been divided. Some supported efficiency theory (Su and Fleisher, 1998; Abdel-Khalik et al., 1999; Chow et al., 1999; Mookerjee and Yu, 1999; Ma, 2004; Kang, et al., 2002; Groenewold et al., 2004a; Chen and Li, 2006; Balsara et al., 2007; Chen et al., 2010) while others proved that market is not efficient (Bailey, 1994; Cai et al., 1997; Liu et al., 1997; Long et al, 1999; Xu, 2000; Darrat and Zhong, 2000; Chen and Li, 2006).

Theoretically an efficient market is ideal and much desired but empirically a perfect stock market cannot be proven and does not exist (Malkiel, 2007). If this is so, why then is EMH still important to finance theory and application? The efficient market theory facilitates the proposal of other finance theories. The efficient market hypothesis is a benchmark for measuring the performance of the agents. Since financing and investment decision can be separated, this allows management performance to be measured objectively in a theoretical setting. Although the real business world is full of corruptions and distortion, a theoretical framework provides us with a platform to begin our scientific observation.

There has been a large body of empirical research concerning the validity of the efficient market hypothesis with respect to stock markets in both developed and developing countries. Empirical research on testing the efficient market hypothesis has produced mixed results (Fama, 1995).

Most early research is supportive of the weak and semi-strong forms of the efficient market hypothesis in capital markets (Osborne, 1959; Granger and Morgenstern, 1963; Fama, 1965; Ball and Brown, 1968). Recent research however, has reported that stock market returns are predictable (Poterba and Summers, 1986; Fama and French, 1988; Lo and MacKinlay, 1988).

Groenewold et al. (2004) documented that the Chinese stock market is inefficient. On the other extreme, some studies report market efficiency (Liu et al., 1997; Laurence et al., 1997; Lima and Tabak, 2004; Long et al., 1999). Most research find the Chinese stock market to have weak form efficiency. We agree that China stock market display a weak form efficiency (Wu, 2004; Zeng, 2006; Massey, 2007).

The purpose of this study is to test the efficiency of both the Shanghai and Shenzhen stock markets. This paper utilizes three econometric models to test the efficiency of the two stock markets. Three different approaches are employed; the serial correlation test, runs test and variance ratio test.

The rest of this article is organized as follows. In Chapter 2, we define and investigate the origin of EMH. Chapter 3 is Literature review of EMH. Chapter 4 discusses the data used for the research. In chapter 5, the Methodology and Run tests are detailed. Chapter 6 discusses the empirical results and chapter 7 is the conclusion.

2. Efficient Market Hypothesis

The original idea of market efficiency was proposed by Bachelier in his PhD thesis in 1890. The original paper by Bachelier demonstrated that the market prices incorporate past, present and even discounted future events although no obvious relationship between the events and price changes is shown. Bachelier presented a clear definition of market efficiency. However, the initial conception did not draw much attention until it was reinvestigated by Savage in 1955. In early empirical studies by Working in 1934, Cowles and Jones in 1937, Kendall in 1953, Osborne in 1959, Cootner in 1962, Granger and Morgenstern in 1963, examined randomness of stock prices and revealed supportive evidence (Sewell, 2011).

In 1965, an 'efficient' market was formally defined by Fama for the first time in the landmark empirical study in which he concluded that stock market prices conforms to random walk hypothesis. In the same period, Samuelson developed the theoretical framework for the random walk. With numerous empirical findings, Roberts created the term “efficient market hypothesis”. Meanwhile, he compared the differences between weak and strong form tests in 1967. Fama (1970) reviewed the theoretical and empirical literature on efficient market hypothesis to that date. He defined the efficient market as a market in which prices always "fully reflect" available information. Fama (1970) also categorized EMH into three levels, which include weak form, semi-strong form and the strong form market efficiency, according to the definition of available information set.

3. Literature Review of China EMH

Most past research on China stock market has found it having a weak form efficiency (Malkiel, 2007; Charles and Darne, 2007; Liu, 2010) or inefficient (Liu et al., 1997; Darrat and Zhong, 2000; Seddighi and Nian, 2004). Lima and Tabak (2004) studied the daily returns of A-share and B-share indices from the Shanghai and Shenzhen stock exchanges over the period of June 1992 to December 2000. They found that random walk hypothesis is strongly rejected for B-shares in both the Shanghai and Shenzhen stock exchanges. However, A-shares in both of the exchanges conform to weak-form efficiency. The distinctive results in A-share and B-share markets suggest that liquidity and market capitalization may have influence on the market efficiency. It is worth noting that B-share markets, which consist of less than 5 percent of total market capitalization than A-share markets, are less liquid and active.[1]

4. Data

To test the weak-form efficiency of Chinese stock markets, the data used in the research are the time series of daily closing prices of Shanghai A-share index, Shanghai B-share index, Shenzhen A-share index and Shenzhen B-share index. All the data are collected from the database of Huaan Securities Corporation and the sample period starts from January 4, 2006 to December 31, 2010. Excluding the weekends, the sample of this study yields 1212 daily observations for both Shanghai A-share and B-share indices and 1214 observations for Shenzhen A-share and B-share indices.

5. Methodology

5.1 Runs Test

Runs test is a non-parametric test designed to check whether successive stock price changes are independent (randomness of the series). However, it does not require the availability of normal distribution criteria in the data, compared to serial correlation test. In the runs test, a run is viewed as a sequence of subsequent price movement with the same sign. The sign of the run can be positive, negative or zero. Each change in return is classified according to its position with respect to the mean return. More precisely, it is positive change when return is larger than the mean return, negative when return is smaller than mean return, zero when return equals to mean return (Worthington and Higgs, 2005).

Runs test indicates that the stock price changes conform to random walk when the observed number of runs equals to the expected number of runs. A lower than expected number of runs suggests

[1] A-Shares are specialized shares of the Renminbi currency that are purchased and traded on the Shanghai and Shenzhen stock exchanges.This is contrast to Renminbi B shares which are owned by foreigners who cannot purchase A-shares due to Chinese government restrictions.

market overreaction to information, subsequently reversed. On the contrary, if the number of runs is higher than expected, then a lagged response to information is present. In either case, there would be an opportunity to make abnormal returns (Mobarek and Keasey, 2000).

Under the null hypothesis that observed number of runs equals to expected, the total expected number of runs is distributed as normal with the following mean:

$$\mu = \frac{N(N+1) - \sum_{i=1}^{3} n_i^2}{N} \quad (1)$$

And following standard deviation

$$\sigma_\mu = \left[\frac{\sum_{i=1}^{3} n_i^2 [\sum_{i=1}^{3} n_i^2 + N(N+1)] - 2N(\sum_{i=1}^{3} n_i^3 - N^3)}{N^2(N-1)}\right]^{\frac{1}{2}} \quad (2)$$

Where n_i is the number of type i, i is the sign of plus, minus and no change. N is the number of observations.

The test of serial dependence is conducted by comparing the observed number of runs to expected number. Thereby, the sub-hypotheses of the research are:

$$H_0 : E(runs) = \mu$$

$$H_1 : E(runs) \neq \mu$$

Then the number of runs is converted into a standard normal Z-statistic as follows:

$$Z = \frac{R - \mu \pm (\frac{1}{2})}{\sigma_\mu}, \; Z \sim N(0,1) \quad (3)$$

Where R is the actual number of runs, correction factor for continuity adjustment is 1/2. The sign of continuity adjustment is positive when $R \leq \mu$, negative when $R \geq \mu$. If the Z value is greater than or equal to $\pm$ 1.96, the null hypothesis that the sequence is random is rejected at 5% level of significance (Sharma and Kennedy, 1977).

5.2 Serial Correlation Test (Liu, 2010)

Serial correlation can be used to verify whether or not the returns and the lagged returns in the same time series are correlated. In a more precise way, serial coefficients appropriately measure the relationship between value of random variable R, in time t and its value in the prior k-period. It indicates whether daily price changes in the period t depend on price changes occurring k-period earlier, where k=1, 2, 3....n.

The correlation coefficient can be defined as

$$\rho_k = \frac{\sum_{t=1}^{n-k}(R_t - \overline{R})(R_{t+k} - \overline{R})}{\sum_{t=1}^{n}(R_t - \overline{R})^2} = \frac{Cov(R_t, R_{t+k})}{Var(R_t)} \tag{4}$$

Where k is the number of lags and R_t represents the individual rate of return. $\overline{R}$ is the mean of time series of stock returns. $Cov(r_t, r_{t-k})$ is the covariance between the return over period (t-1,t) and its lagged return in the prior t-k period and $Var(r_t)$ represents the variance on the return over time period (t-1,t).

5.3 Variance Ratio Test

Variance ratio test, which exploits the fact that the variance of random walk increments is linear in all sampling interval, examines the random walk hypothesis against stationary alternatives. Variance ratio test is defined as the ratio of 1/k times the variance of k-period to that of one-period. The calculation of Variance ratio test is

$$VR(k) = \frac{\frac{1}{k}Var(p_t - p_{t-k})}{Var(p_t - p_{t-1})} = \frac{\sigma^2(k)}{\sigma^2(1)} \tag{5}$$

Where k is any positive number, p represents the indices, $\sigma^2(1)$ is the variance of the first differences of stock prices and $\sigma^2(k)$ is the one kth of the variance of the k-differences. More precisely,

$$\sigma^2(k) = \frac{1}{m}\sum_{t=k}^{nk}(p_t - p_{t-k} - k\hat{\mu})^2 \tag{6}$$

Where $m = k(nk - k + 1)(1 - \frac{k}{nk})$, $n = \frac{T-1}{k}$

And $\sigma^2(1) = \frac{1}{(nk-1)}\sum_{t=1}^{nk}(p_t - p_{t-1} - \hat{\mu})^2$ (7)

Where $\hat{\mu} = \frac{1}{nk}(p_{nk} - p_0)$ is the mean of return

6. Empirical Results

6.1 Runs Test

Table 6.1

Full Period							
	Total Cases	Cases ≥ Mean	Cases<Mean	Act. runs	Exp. runs	Std.	Z-statistic
Shanghai							
A Index	1211	546	665	592	600.65	17.2244	-0.5022
B Index	1211	559	652	588	602.93	17.2899	-0.8635
A Index	1213	567	646	590	604.93	17.3330	-0.8614
B Index	1213	560	653	570	603.93	17.3045	-1.9608**

** indicates statistical significance at 5% level

Table 6.1 summarizes the full-period results of these four indexes. A remarkable aspect of runs of all periods is that the observed number of runs is slightly less than the expected number of runs.

The results for return series of all the indexes except for Shenzhen B index accept the null hypothesis of weak-form efficiency. The Z values of the B index in the Shenzhen stock market significantly reject the hypothesis of randomness at 5% level from the year 2006 to 2010, indicating a positive correlation of stock prices.

The five-year data in the table above is not sufficient to verify the EMH. Therefore, the detailed results of each index are presented and discussed below.

6.2 Serial Correlation Test

Table 6.2

Full-period	SH (A)	SH (B)	SZ (A)	SZ (B)		Full-period	SH (A)	SH (B)	SZ (A)	SZ (B)
ρ_1	0.01239	0.1108**	0.0534*	0.0667**		ρ_7	0.01525	0.0607**	0.0382	0.0280
ρ_2	-0.0208	-0.0119	-0.0392	-0.0161		ρ_8	-0.01876	-0.0279	-0.0206	-0.0202
ρ_3	0.0439	0.0372	0.0381	0.0223		ρ_9	-0.01076	-0.0236	-0.0114	-0.0395
ρ_4	0.0779***	0.0628**	0.0754***	0.0424		ρ_{10}	0.0087	-0.0101	0.0308	0.0103
ρ_5	0.0001	0.0151	-0.0190	0.0055		ρ_{11}	0.0479*	0.0289	0.0357	0.0463
ρ_6	-0.0538*	0.0378	-0.0373	0.0053		ρ_{12}	0.0470	0.0405	0.0345	0.01664

***, ** and * indicate statistical significance at the 1%, 5% and 10% levels

The autocorrelation coefficient at lag one is the lowest for Shanghai A index (0.01239), and highest for Shanghai B index. Except for the return series of Shanghai A index, those of Shenzhen A index and B indexes in both markets are indicated to have a significant positive autocorrelation. More precisely, Shanghai B index, Shenzhen A index and B index are rejected at 1%, 10% and 5% level respectively. The coefficient at lag two and lag three for the four indexes, however, cannot be rejected at any given level. For higher-order autocorrelation, lag 4, all the returns series except Shenzhen B index that conforms to the null hypothesis of random walk, are all consistent with a positive autocorrelation. Overall, the daily returns in market indexes of both stock exchanges follow a random walk process as lag length increases despite a few exceptions in the Shanghai stock exchange. In detail, the serial correlation coefficients for A-share index in lag six and eleven are non-zero at 10% significance level while one for B-share index in lag seven is non-zero at 5% significance level; the results all exhibit positive correlated return patterns. On the whole, the autocorrelation coefficients for all indexes are accepted, suggesting that the daily returns for A-share and B-share indexes in both stock exchanges are weak-form efficient.

6.3 Variance Ratio Test

Table 6.3

	Obs.		K= 2	K= 4	K= 6	K= 8	K=10	K=12	K=14	K=16
SH (A)	1211	VR(k)	1.0174	1.0232	1.0846	1.0937	1.0755	1.0594	1.1062	1.1203
		Z(k)	0.6056	0.4304	1.1880	1.0937	0.7782	0.5485	0.8360	0.8387
SH (B)	1211	VR(k)	1.1213	1.1673	1.2049	1.2518	1.2399	1.1818	1.0719	0.9368
		Z(k)	4.2188***	3.1090***	2.8789***	2.9587***	2.4717***	1.6794*	0.5657	-0.4403
SZ (A)	1213	VR(k)	1.0568	1.0559	1.0832	1.0637	1.0367	1.0122	0.9565	0.8871
		Z(k)	1.9784**	1.0397	1.1716	0.7486	0.3779	0.1136	-0.3426	-0.7866
SZ (B)	1213	VR(k)	1.0702	1.0863	1.0848	1.0436	0.9841	0.9101	0.7319	0.6033
		Z(k)	0.6056	1.6057	1.1949	0.5125	-0.1642	-0.8345	-2.1098**	-2.7653***

***, ** and * indicate statistical significance at the 1%, 5% and 10% levels

Table 6.3 reports the variance ratios and homoscedasticity test statistic Z (k) for daily observation respectively. The results of all the indexes presented here are for the same period from 4/1/2006 to 31/12/2010. The sample size for the daily data varies across the indexes in accordance with the number of working days in each exchange during the full period.

The variance ratios surpass one for all the cases in the daily returns. In the Shanghai A-share index panel, variance ratios fluctuate as the length of interval k increases. More precise, the variance ratio of daily returns grows from 1.0174 for interval of 2 to 1.0937 for interval of 8 and then drops continuously to 1.0594 for interval of 12. In the interval of 14, the variance ratio becomes 1.1062, followed by a further increase to 1.1203 for interval of 16. Accordingly, the test statistic Z (k) fluctuates as well. When the interval equals two, the statistic is 0.6056 and fall slightly to 0.4304, after which the ratio climbs to 1.18 for interval of 6. Afterwards, the variance ratio continuously decreases to 0.5485 for interval of 12 and remain stable through interval 14 to 16. According to the estimates of variance ratio, null hypothesis of random walk cannot be rejected at any given ratio.

7. Conclusion

The theoretical and empirical studies of the efficient market hypothesis have played an important role in the understanding of stock market. We have found mixed results and concluded that China's stock market is still has a weak form efficiency. The results from runs test and variance test consistently imply that the null hypothesis of random walk cannot be rejected for A-share indexes, while serial correlation test provides negative evidence. In B-share index markets, past information can be used to predict future return changes based on the empirical evidence from variance ratio test and serial correlation test. The findings of runs test also accept the random walk hypothesis in B-share index of Shenzhen stock exchange but showed insignificant correlation in daily returns in Shenzhen B-share market.

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