Evaluation the Weak-Form Efficient Exhibiting in Chinese Stock Market

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Abstract: Capital markets in developing economies have expanded quickly, while efficient market hypothesis (EMH) continues to be the foundation of current financial economics despite receiving a lot of criticism, and in particular the EMH's weak form has received the majority of attention throughout empirical testing. Importantly, the Chinese stock market is one of the quickly expanding and emerging market in world, and it shows unique characteristics compared with American and some European markets, such as retail accounts for the higher proportion than institutional investors and special monitoring and political rules issued by Chinese government. So it is valuable for investor to test this powerful decision method for the Chinese capital market. The study uses the CSI300 of the Chinese securities market, which is an index stock weighted by the market value of free float share capital, 300 stocks chosen for its largest market value, the best liquidity and the most representative from Shanghai and Shenzhen stock markets. Based on the daily data of the CSI300 Index from the year 2005 to 2022 that contains a total of 4340 observations, and further developed by drawing on international indexing techniques as a cross-market index for the rich experience in index preparation and publication, this paper uses five quantitative techniques, including the Breush-Godfrey LM test, the Ljungbox test to test serial correlation, the runs test, the Augment Dickey-Fuller (ADF) test, and the Phillips-Perron (PP) test to evaluate the weak-form efficient exhibits in Chinese stock market, which reveals the strength of administrative gradually reduced and the stock market greatly entering a new era where the market will play a leading role.

Keywords: Chinese Stock Market; Efficient Market Hypothesis; Weak-Form Efficient

DOI: 10.57237/j.wjmst.2023.04.005

1. Literature Review

The concept of the efficient market hypothesis (EMH) was introduced by Fama in 1970. Later, he proposed that EMH may be divided into three categories: weak form efficiency, semi-strong form efficiency, and strong form efficiency. The EMH continues to be "the foundation of current financial economics" despite receiving a lot of criticism [1]. In particular, the EMH's weak form has received the majority of attention throughout empirical testing. According to this hypothesis, investors cannot achieve abnormal returns since the existing price of any stock already takes into account all newly available information [2].

The premise of this hypothesis is controversial, which is investors must be rational enough to enable them to efficiently make appropriate choices when information in the market changes. Besides, this hypothesis holds that all historical price information about security can be reflected by the market price. In terms of the studies about this hypothesis, different experts have come to their own conclusions by studying the data of different markets.

Ananzeh [3] studied the efficiency of the Amman stock market and noticed the daily return changes of ASE are not normal, and performed inefficiently in weak form, so he believed that the ASE stock market is inefficient at the

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Received: November 4, 2023; Accepted: December 20, 2023; Published Online: December 27, 2023 http://www.wjmst.net

weak form level. Elango and Husse [4] went into the markets of the GCC countries and studied their stock performance through the daily indices data from October 2001 to October 2006. they made this survey for randomness, then drew a conclusion that performance was not satisfactory in weak form. As for Kashif et al. [5], they studied the stock market efficiency among 14 Asian countries. He used the auto-correlation, runs test, Unit root test and the Variance ratio to analyze the data and the change of monthly prices was not random, so the stock markets are inefficient at the weak form. Moustafa [6] studied the performance among 43 stock prices in the UAE stock market under the weak form efficiency through the non-parametric running test, found the result about stocks were abnormal, so the conclusion about market was negative.

A large literature exists that tests the weak-form EMH in developed countries or markets [7], while in more recent times, capital markets in growing economies have expanded quickly. Importantly, the Chinese stock market is one of the quickly expanding and emerging market in world. And it shows unique characteristics compared with American and some European markets, such as retail accounts for the higher proportion than institutional investors and special monitoring and political rules issued by Chinese government. Therefore, it is valuable to evaluate whether the weak-form efficient exhibits in Chinese stock market. In the previous study, the scholars did not make a consensus on whether the Chinese stock market are weak efficient or not, and the researches can be divided into two parts: the overall stock market and sectorial stock market. For the overall stock market, Liu and Hou [8], Gong and Hu [9] proved that the overall stock market is weak form efficient but not semi-strong efficient. However, the result presented by Tang and Zheng [10], Zhang and Zhou [11] showed that the Chinese stock market is not efficient. For the sectorial stock market, Gao and Chen [12], Xu [13], Wang and Chen [14] proved that the Sci-Tech stocks market are weak efficient. The real estate stock market to be weak efficient by Zhang et al [15], and the carbon market is also confirmed to be weak efficient by Yao and Zeng [16], Wang and Du [17].

To test the EMH hypothesis, this paper uses five quantitative techniques, including the Breush-Godfrey LM test, the Ljungbox test to test serial correlation, the runs test, the Augment Dickey-Fuller (ADF) test, and the Phillips-Perron (PP) test to test the unit root. Based on the daily data of the CSI 300 Index from 2005 to 2022. Although we conclude that the Chinese stock market is not efficient, these tests show mixed results. When testing the ADF test the EMH can be accepted, while the rest of tests present opposite results as ADF test.

The structure of this paper is as follows: the second section is brief data descriptions of the price and daily return of CSI300 and core methodology used in this paper; the third is the results of empirical studies; the fourth is a brief explanation of the mixed results of our paper and some possible causes of inefficient market in China.

2 Data Construction with Methodology

2.1 Data Construction

This study uses the CSI300 of the Chinese securities market. The CSI300 is an index stock weighted by the market value of free float share capital, including 300 stocks with the largest market value, the best liquidity and the most representative in Shanghai and Shenzhen stock markets. The index has a base year of 2005 and a base value of 1,000. Using the market value weighting method, CSI300 reflects the comprehensive change of the stock price of the representative companies listed in China's liquid market. The CSI300 is chosen as the research target because it is a cross-market index that has been studied by the Shanghai and Shenzhen Stock Exchanges since 1998, and is further developed by drawing on international indexing techniques based on the rich experience in index preparation and publication. In order to test the weak-form efficient market hypothesis for the Chinese stock market, we use the daily closing prices of the CSI300 from January 4, 2005 to November 14, 2022 as our sample, which contains a total of 4340 observations.

Figure 1 shows the line chart of CSI300 stock price changes over time during the whole sample period. This indicates that the price of CSI300 has shown a significant upward or downward trend in some periods. For example, from 2006 to 2008 there was a strong uptrend in the price of CSI300 with the Chinese economy continuing to grow rapidly. However, after mid-2008 there was an obvious declining, which may be due to the financial crisis that occurred in 2008.

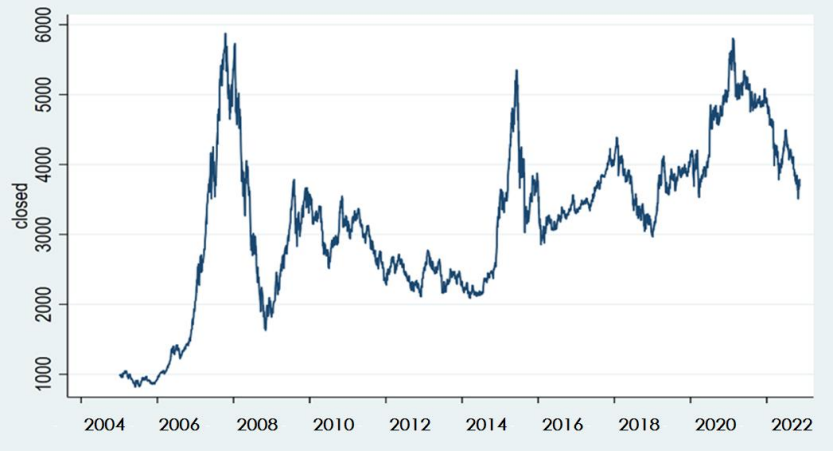

Figure 1 Time Series Plots of Daily CSI300 Prices

The return time series of CSI300 during the whole sample period is shown in Figure 2. In calculating the daily returns of CSI300, we used the continuous compounding formula: R_t=ln(P_t⁄P_(t-1)), where P_t and P_(t-1) indicate the closing prices of CSI300 on day t and day t-1, and R_t indicates the daily return of CSI300 on day t. As shown in Figure 2, the CSI300 daily return time series exhibits a high degree of variability within the range of ±0.05%. Prior to 2010, it was possible to observe a high volatility in the variation of returns. In recent years, excluding a few outliers, the degree of volatility seems to have diminished.

The core idea of testing the market efficiency is to evaluate the random walk method. The null hypothesis of the randomness of stock price state that stock price's movements do not show any trend or mode. Hence stocks' future performance cannot be predicted using past information, the people cannot gain an abnormal return from it. Thus, this paper utilizes five quantitative techniques to analyze the above null hypothesis. The Breush-Godfrey LM test, Ljungbox test are used to test the serial correlation, runs test, unit root can be tested by Augment Dickey-Fuller (ADF) test and Phillips-Perron (PP) test.

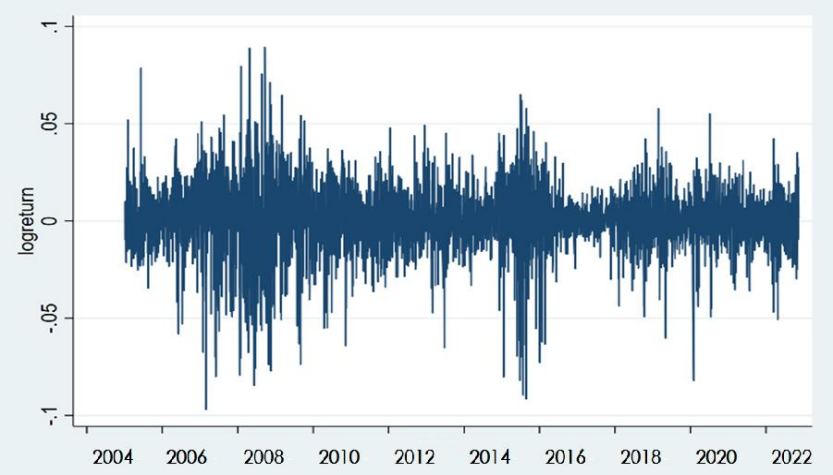

Figure 2 Time Series Plots of Daily CSI300 Returns

2.2 Serial Correlation Test

The serial correlation test examines the correlation between stock prices and returns for the current and previous cycle [18] The existence of serial correlation in returns can be determined by testing whether the correlation is significantly different from zero between a given series of returns and its lagged returns. We will use the Ljung-Box Q test and the Breusch-Godfrey LM test to determine the serial correlation of the price and return

for CSI 300. The Ljung-Box Q test can be used to test the applicability of the time series model, and the Breusch-Godfrey LM test is used to test the degree of autocorrelation among the errors in the regression model.

2.3 Runs Test

Unlike the autocorrelation test, using the runs test to check the EMH does not require that the return series of stocks are normally distributed. According to Abraham et al. [19], runs test examines whether a set of data has continuous variations with the same sign to determine the randomness of the data. The number of runs that appear in the series is supposed to be similar to the expected number if the run test assumes a series of variations is random.

2.4 Unit Root Test

We can use Augment Dickey-Fuller (ADF) test and Phillips-Perron (PP) test to determine the stationarity of stock prices to test the efficient market hypothesis. The ADF test can determine whether a unit root exists in the series, if it exists, the series will perform as a random walk; if the series is stationary, then there will be no unit root. The PP test is a nonparametric unit root test. It corrects on the basis of the ADF test, mainly to resolve the effects of potential serial correlation and heteroskedasticity problems in the residual term on its asymptotic distribution, and can be used as a complement for the ADF test.

3 Empirical Results

3.1 Descriptive Data

Table 1 is the summary description of the daily return of 000300 from 2015 to 2022, indicating that the stock's mean return is positive and its standard deviation is 0.01668, which shows high volatility. It can be seen that the skewness is negative and kurtosis is around 7, which implies the serial daily return of 000300 is not normally distributed and skewed to right.

Table 1 Descriptive Statistics for the Daily 000300 returns

Sample period	**05.01.2005-14.11.2022**
Number of observations	4339
Median	0.0003113
Standard deviation	0.016838
Mean	0.0002784
Skewness	-5.083049
Kurtosis	7.000275

Source: Estimation based on data source described in the data descriptive part

3.2 Result of the Serial Correlation Test

3.2.1 Ljung-Box Q Test

The Ljung-Box Q table presents that the p-value is smaller than 0.01 at lag 1, 3, 6, 9, 12, which rejected the null hypothesis of the Ljung-Box test, hence the daily return of 000300 is highly auto-correlated even at 1% significance level at lag 1, 3, 6, 9, 12. This infers the stock's return is stationary, which is opposite the random walk hypothesis.

Table 2 Ljung-Box Q table of 000300's daily return

Lags	**P-value**
1	0.0005
3	0.0004
6	0.0002
9	0.0001
12	0.0004

Source: Estimation based on data source described in the data section

Table 3 illustrates the result of Breush-Godfrey LM test, which is normally utilized to test the serial correlation and the result is as same as the Ljung-Box Q test. The P-values of lag 1, 3, 6, 9 is smaller than 0.05 which accepts the alternative hypothesis at a 95% significance level, indicating that the daily return on 000300 does not exhibit properties of the random walk. In this case, the EMH is rejected based on the Breush-Godfrey LM test results.

Table 3 Breush-Godfrey LM test of 000300's daily return

Lags	**P-value**
1	0.0368
3	0.0000
6	0.0000
9	0.0000

Source: Estimation based on data source described in the data section

3.2.2 Results of the Runs Test

Table 4 represents the runs test's result, because the variable need to be divided into two groups on a basis of the cut point, in this paper the mean of the 000300 daily return is considered as the cut point. The core idea of runs test is to compare the number of actual runs is whether

equivalent to the number of expected runs, and if they are not identical, then the null hypothesis of return is independence cannot be accepted.

From the statistical viewpoint, the null hypothesis of random walk of the stock's return can be rejected at a 5% significance level when Z-value is not displayed in (-1.96, +1.96). It can be seen from table 4 that the z value is even significant at the 1% level and the sign of Z is negative, which means it follows a positive serial-correlation. Therefore, it shows a negative serial correlation and does not follow the non-stationary pattern.

Table 4 Runs Test for Daily returns on 000300-Mean Approach

Number of total observations	4339
N (logreturn <=.0003113116023378)	2093
N (logreturn >.0003113116023378)	2264
N (runs)	2175
Z-value	-63.23***
P-value	0.000

Source: Estimation based on data source described in the data section
Notes: ***1%, **5%, *10%, levels of significance.

3.3 Results of Unit Root Test

3.3.1 Augment Dickey-Fuller (ADF) Test

The ADF test has three features including intercept, intercept with time trend, and without time trend and intercept. This paper considers these three situations and the results can be found in table 5, which shows that the alternative hypothesis can be accepted, in other words, the daily prices of 000300 are at a non-stationary pattern. And results are inconsistent with Ljung-Box Test and Brush-Godfrey LM, but the sole uniformity test would not convince that the existent weakly-form efficient of CSI300. Hence to ensure the accuracy of the unit root test, the Phillips-Perron (PP) test is considered.

Table 5 Results of the ADF test for 000300 price

Variable	**Number of lags**	**ADF statics**	**Stationary**
000300 None	02	-1.502	Non-Stationary
000300 (Intercept)	02	-2.245	Non-Stationary
000300 (intercept & trend)	02	-2.639	Non-Stationary
Level of significance	None	Intercept	Intercept & trend
1%***	-2.5661	-3.4346	-3.9652
5%**	-1.9394	-2.8626	-3.4133
10%*	-1.6156	-2.5673	-3.1283

Source: Estimation based on data source described in the data section
Notes: ***1%, **5%, *10%, levels of significance.

3.3.2 Phillips-Perron (PP) Test

Table 6 exhibits the consequences of the PP test on the daily 000300 price series from 2015-2022. The Newey-West method indicates that the optimal lag length is 8. Because the Mackinnon equivalent critical values are larger than the PP test statics, the hypothesis of 000300 prices exists unit root can be rejected at 1% significance level in three options. Therefore, it can be asserted that the 000300stock price does not follow a random pattern, which means the pattern of 000300's price shows a particular pattern in certain periods, so the market is inefficient according to the PP test.

Table 6 Results of the PP test for 000300 price

Variable	**Number of lags**	**PP statics**	**Stationary**
000300 None	08	-1.093	Non-Stationary
000300 (Intercept)	08	-7.111***	Stationary
000300 (intercept & trend)	08	-11.951***	Stationary
Level of significance	None	Intercept	Intercept & trend

Variable	Number of lags	PP statics	Stationary
1%***	-2.5661	-3.4346	-3.9652
5%**	-1.9394	-2.8626	-3.4133
10%*	-1.6156	-2.5673	-3.1283

Source: Estimation based on data source described in the data section
Notes: ***1%, **5%, *10%, levels of significance.

4 Conclusion

After testing we have mixed results: the results of L-M test; Ljung-box test, runs test and P-P test reject the random walk pattern of the stock price, but the ADF test cannot reject the random walk theory even at 10% significant level.

However, the mixed result can still give us the conclusion that Chinese market does not obey the stochastic wandering process, the future stock price cannot be predicted from its historical price. The reasons below can explain:

a) The structure of investors is unreasonable: the institutional investors hold the majority of the market shares and have great influence on the stock price.
b) Most of the investors are not well-educated and would like to do speculation and irrational investment decision rather than long-term investment.
c) Inadequate regulation led to financial fraud, information asymmetry in the market, so the stock price could not reflect its intrinsic value.

But since we got mixed results that ADF test accepts the random walk pattern, we could contribute it to the recent policy and changes in the stock market.

a) In recent years, the structure of the investors optimizes a lot and the portion took by professional investment institution continue to grow, so the rights of the minority investors can be strongly protected.
b) The well-educated adults are becoming the mainstay of investors and the professional investment institution hold the voice, investors are becoming rational and start turn to long-term investment.
c) In the past 10 years, the strength of administrative will be gradually reduced and the stock market will gradually enter an era where the market will play a leading role.

Acknowledgments

I would thank the professor Xiaogang Bi for providing the idea of this thesis, and he is also really helpful during the teaching time. I would also thank my supervisor Paolo Bianchi for giving me a lot of encouragement.

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