TESTING WEAK-FORM EFFICIENCY IN CHINESE STOCK MARKET

By

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ABSTRACT

This study aims to test weak-form efficiency in the Chinese stock market. The data of the Shanghai Composite Index and the Shenzhen Composite Index from Sohu Securities were collected during January 2000 to October 2016 including the daily, weekly and monthly closing price to test weak-form efficiency by employing statistical methods, including Autocorrelation test, Variance Ratio testing and Unit Root testing. The results from three of these tests indicate the presence of positive autocorrelation in the daily return series in all index series indicats that stock returns in the Chinese stock market do not behave in a manner consistent with the weak-form of the efficient market hypothesis.

The findings of this research are attributed to investors making more sensible investment decisions regarding market efficiency level, also is helpful for policymakers to regulate the stock market.

Keywords: Efficiency Market Hypothesis, Weak-form Efficiency Market, Chinese Stock Market, Shanghai Composite Index, Shenzhen Composite Index, Random Walk, Stationary Time Series

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CHAPTER Ⅰ

GENERALITIES OF THE STUDY

China's stock market's rapid development is accompanied by a series of problems due to its special historical environment and institutional environment. These issues are not only new issues for Chinese economists, but also for all scholars over the world. How to evaluate China's stock market efficiency objectively is crucial for Chinese stock market development. This chapter introduces the background of the establishment and development of China's securities market. The problem statement points out the asymmetry of information and the manipulation of stock price in China's stock market. These problems affect the efficiency of China's stock market. This paper attempts to explore the efficiency of China's securities market from the empirical analysis, and according to the history and reality of China's securities market to proposed suggestions for improvement of stock market efficiency, which is of fundamental significance to this research.

1.1 Introduction of the Study

The opening of the Shanghai stock exchange (SSE) on November 26, 1990 and the establishment of the Shenzhen stock exchange (SZSE) on December 1, 1990 signified the birth of the Chinese stock market. As a rapidly growing financial market, the Chinese stock market has developed a system with a corresponding scale in the last 25 years. China's stock market is mainly composed of a government bond market, stock market, bond market and corporate bond market. China's stock market divides trading stocks into two categories. Class A shares are denominated in Renminbi only for Chinese citizens, and Class B shares that are traded in US dollars or Hong Kong dollars only for foreign investors. In the number and market value of listed companies, the A-share market is much larger than the B-share market. These two markets are effective segments of the market and can be studied separately (Bailey, 1994). In

China, the securities exchange mainly takes place on the SSE & SZSE, and the securities trading and settlement network covers all the country. At the end of 2015, the Shanghai Stock Exchange has 1,081 quoted companies, 3,023.6 billion shares, with a total market value achieved 29,519.4 billion yuan. Shenzhen has 1,746 listed companies, the total market value of 23,611 billion yuan (Source: China Securities Regulatory Commission).

The Chinese stock market plays an important role on its economy. It facilitated the sustainable development of the Chinese real economy. In recent years, the Chinese economy has significantly improved on the impacting the global economy, the Chinese stock market also has been the focus all over the world. The development of Chinese securities market has become one of the hottest topics and there is still an argument with the structure and function of China's stock market. Research on the efficiency of the Chinese stock market is significant for learning more about the stock market of China and contributes to how to improve its market effectiveness towards future reforms and development.

It is of great significance to study the effectiveness of the market. From the investor's point of view, it means that the information transmission of the securities market is timely, fair, transparent and complete. An efficient market hypothesis is considered an essential tool for investment purposes. Emerging economies attract large investors for their high volatility and high returns (Pervaiz Akhtar & Zaheer Khan, 2016). Investors use the application of trading strategies for investment decisions. Understanding market efficiency is necessary for investors because it helps them make more informed decisions about portfolio choices. Theoretically, if a market is a strong-form efficiency market, investors cannot get an abnormal return. However, in a low efficiency stock market, investors are able to get abnormal returns by using different investment strategies. Therefore, understanding the efficiency of the market situation is crucial to investors. Learning about market efficiency also helps investors build trust in capital market. Since the market has became larger, it is more difficult to beat the market for individual investors by taking advantage of an underdeveloped market structure. To avoid unfair treatment by the market, investors need to know the situation of market efficiency. Consequently, it is worth examining efficiency of the

Chinese stock market in order to provide a good tool for predicting share prices and investments decisions. From the company point of view, an effective market can accurately and reasonably reflect the company's value, promote the company's further development, increase the supply of securities. From the perspective of regulators, it is of great significance to improve the effectiveness of the securities market to protect the interests of investors, to eliminate unfair competition and to maintain the healthy development of the securities market.

It’s no doubt that improving the efficiency of the market is conducive to the sustained and healthy development of the securities market. The efficiency of the securities market has become a sign of the maturity of securities market. Consequently, it is worth examining efficiency of Chinese stock market in order to provide a good tool for investments decision and market regulation.

1.2 Statement of the Problem

It is generally believed that developed markets are more efficient compared to emerging markets, as they are equipped with mature institutions, higher liquidity, active trading, and low information asymmetry. The Chinese stock market has been developing within short time period which is only 26 years old. It is still in the primary stage of the stock market. Therefore, there must be many defects in Chinese stock market as an emerging market.

The Chinese stock market exists information asymmetry, this phenomenon is mainly reflected between the retail investor and listed companies, as well as between retail investors and institutional investors (Sugato Chakravarty, Asani Sarkar & Lifan Wu, 1998). In 2015, the scale of China's stock trading is huge. The World Federation of Exchanges recently released annual data that shows that in 2015, Chinese mainland stock trading was more than 1/3 of total global stock trading; global total stock trading rose by 41%, increasing to $114 trillion. Among them, China's stock trading volume rose by 186%, increased to 10.1 billion, the value of stock trading rose by 218%, increasing to $43 trillion. The robust buying and selling in mainland China made the global stock trading volume soar, growing by 55%, increasing to 27.3 billion of a trading record in 2015, even exceeding the level in the financial crisis (Source: The World Federation of Exchanges).

The World Federation of Exchange released data showing that both the Chinese stock market trading value and trading volume soared in last year. The root of this phenomenon is “retail investor fever” in Chinese stock market. Until January 28, 2016, the Chinese stock market has a total of 100.4 million investors, 100.1 million natural persons and 287.3 thousand non-natural persons are included – around 1 person of per 14 Chinese people are investors. Over the last years, the Shanghai Stock Exchange statistics show that above an 80% transaction amount of stock was made by retail investors while institutional investors only take up a 15% proportion, the general artificial person is only 2%.

However, in the United States, the three major stock exchanges' daily transaction volume of retail investors was only 11% of the total transaction volume; more than 90% of 10 thousand large scale transactions are exchanged between investment institutions and institutional investors. Where did U.S. stock investors go? After experiencing the several bear markets in the history of the stock market, retail investors of U.S. had a lesson and wake up, they realized that due to the lack of market information and risk control ability, they are too weak to against with institutional investors. Therefore, most of them transform into the clients of investment institutions. Actually, over the last 70 years, the proportion of retail investment in the United States has dropped from 93% to 11% (Source: Conference Board, Institutional Investment Report 2008).

While making a huge transaction amount, "retail investor fever" has maked the Chinese stock market become an irrational and emotional market, and exacerbated the stock market turmoil. The Chinese stock market transaction amount in 2015 has exceeded the U.S. stock market, and China has the highest trading volume in the world. By contrast, the market value of stock transactions in U.S. is more than two times that of China. China's retail market is incompatible with mature "institutional market".

At the beginning of 2015, the China Securities Regulation Commission placed a case on file for the investigation of 18 companies and institutions who were suspected to be involved in price manipulation. The Chinese people were shocked by the loopholes in the stock market. In the history of Chinese stock market, such events are not rare (Source: China Securities Regulatory Commission).

China's stock market is faced with problems such as information asymmetry and poor supervision which may lead to a reduction in market efficiency. Since the size of the market is becoming larger and larger, market efficiency is not a stationary process, we need to know the current situation of market efficiency in China. Such research has contribution to market efficiency and has important implications for trading strategies of investors, and also help policymakers towards optimum policy making for market efficiency.

1.3 Research Questions

The aforementioned statement of problems leading to the main question that this study answered is "Is the Chinese stock market an efficient market?" To answer this, this study attempted to answer the following questions in detail:

1. Is the Shanghai stock market a weak-form efficiency market?
2. Is the Shenzhen stock market a weak-form efficiency market?
3. Whether the market efficiency of Chinese stock market is rising?

1.4 Research Objectives

The main purpose of this research is to test the weak-form efficiency market in the Chinese stock market. To achieve the main objective of this study, three specific objectives are outlined as follows:

1. To test weak-form efficiency market in the Shanghai stock market.

2. To test weak-form efficiency market in the Shenzhen stock market.
3. To test weak-form efficiency market in three time panels.

1.5 Scope of the Research

This study is based on the Efficiency Market Hypothesis (EMH), employing statistical methods to test the weak-form efficiency of the Chinese securities market. The reason why only the weak-form efficiency is examined is that in the theory of EMH, the weak-form efficient market test is the premise for the semi-strong efficient market test and strong-form efficient market test. And because the Chinese securities market is still in the primary stage of development, the first step is to test the weak-form efficiency.

Testing the weak-form efficiency is mainly to test the stationarity nature of time series and random walk. The data of Shanghai Composite Index and Shenzhen Composite Index from the Sohu Securities collected the daily, weekly and monthly closing price during January 2000 to October 2016.

1.6 Limitations of the Research

There are some limitations to this study. Firstly, this paper only studied the Shanghai Composite Index and Shenzhen Composite Index of Chinese securities market, but did not analyze the time series stationary of individual stock.

Secondly, this paper only investigated the Shanghai Composite Index and Shenzhen Composite Index of the Chinese securities market, but does not investigate the Class A shares market and the Class B shares market separately. The Chinese markets trade Class A shares and Class B shares. Class A shares are denominated in Renminbi, only for Chinese citizens, and Class B shares are traded in US dollars or Hong Kong dollars only for foreign investors. These two markets are effective segments of the market and can be studied separately (David Bailey, 1994).

Thirdly, this paper has selected the autocorrelation test and unit root test to examine the weak-form effectiveness in the Chinese stock market, but for the market which has reached the weak-form efficiency, there is no further process to semi-strong efficiency.

1.7 Significance of the Study

This research aims to examine whether the Chinese stock market achieved weak-form an efficient market by employing econometric and statistical methods. The findings of research are of interest to academics, investors and policy makers, since the application and development of the Efficient Market Hypothesis in the Chinese securities market is important to improve the efficiency of stock market.

In the academic's perspective, this research differs from previous research mainly on the data sample. The Closing price index from the Shanghai and Shenzhen stock market during January 2000 to October 2016 is collected to do empirical research in this paper. In the investors' perspective, knowledge about market efficiency is crucial for investors, it facilitates them to make more sensible decisions regarding their portfolio choices. In the policy makers' perspective, this research examined market efficiency in the Chinese stock market and it offers evidence for China's market efficiency and some suggestions on improving it.

1.8 Definition of Terms

Efficient Market Hypothesis - If the information that investors can obtain is fully reflected by the price of securities, then the stock market is regarded as an efficient market. In the efficient market, investors are unable to obtain the abnormal return by holding any kind of securities. (Eugene Fama, 1970).

Random Walk - The Random Walk theory suggests that stock price changes are independent of each other and have the same distribution, therefore the past stock price is unable to predict its future price (Gregory F. Lawler & Vlada Limic, 2010).

Stationary time-series - A time series, if there is no systematic change in mean (no trend), the variance has no systematic change, and strictly eliminates the cyclical changes, it is called a stationary time-series (Maurice B. Priestley, 1981).

Autocorrelation test - Autocorrelation coefficient method calculates the correlation between two trading week periods (usually a trading cycle and lag a number of cycles) the correlation coefficient of yield to test their relevance.

Information Asymmetric - Information asymmetry refers to the phenomenon in the market economy in which the buyer or seller cannot completely occupy the opposite party's information, this information asymmetry will lead to information owners damaging the benefit of the opposite party for their own greater benefit (Orleans S. Martins & Edilson Paulo, 2014).

Three types of random walk - John Y. Cambell, Andrew W. Lo and A. Craig MacKinlay (1997) classified the random walk to three types by the properties of random disturbance.

Random walk 1 (RW1): increments εt are independent and identically distributed (IID);

Random walk 2 (RW2): increments εt are independent but not identically distributed;

Random walk 3 (RW3): increments εt are serial uncorrelated.

CHAPTER Ⅱ

REVIEW OF RELATED LITERATURE AND STUDIES

The effective market hypothesis is the theoretical basis of a finance and modern capital market, which has an important influence on financial theory research and securities investment practice. Since the beginning of the literature of Eugene Fama in 1965, the research results in this field have been endless, and the effective market theory is one of the most influential and controversial theories in the study of the law of the capital market in the western market.

2.1 The Development of EMH and Related Studies

The beginning of the study of the stock market efficiency is the study of random walk behavior. The description of Efficient Markets Hypothesis by George Gibson (1889) in "*The Stock Exchanges of London Paris and New York: A Comparison*" is the embryonic development of EMH. Inspired by the Efficient Market Hypothesis, the French economist Louis Bachelier (1900) used statistical methods on the research to analyze the stock price and yield. He firstly proposed and tested the Random Walk Model, and used random walk model on research of stock market effectiveness based on the stock price and yield. And made the conclusion of "market return is the random variable of independent and identically distributed" from "*The Theory of Speculation*".

British statistician Maurice G. Kendall (1953) studied the serial correlation of the successive changes of stock price on the basis of stock price fluctuation, and "*The Analysis of Economic Time-Series-Part Ⅰ: Prices*" proposed that "stock prices follow the random walk". Paul A. Samuelson (1965) and Benoit B. Mandelbrot (1966) meticulously studied the random walk theory, and shows the theory of Fair Game in the expected return model of EMH. Paul A. Samuelson (1965) and Benoit B. Mandelbrot (1966) on the basic of the study of random walk proposed that if the information flow is not impeded, and there is no transaction costs, then the next day's price changes of the securities market will just reflect the next day's news, and not be related to the price changes today. The random fluctuation of securities price is consistent with the stock price which fully reflects the information transmission in the stock market.

In 1970, American economist Eugene Fama made significant contribution to the study on security market effectiveness. In the article of "*Efficient Capital Markets: A Review of Theory and Empirical Work*", Eugene Fama reviewed theory and empirical literature since the 19th Century which is related to market efficiency and made a comprehensive summary, including the basic connotation, hypothesis, theory, and model design of EMH, giving a complete framework of EMH, the Efficient Market Hypothesis was born in formal. In the later studies, Fama put competitive equilibrium and ideal investment into the Efficient Market Hypothesis, and employed a series of statistic models to confirm the EMH related propositions, for improving the reliability and influence of EMH.

With the forward development of capital and financial markets, some assumptions of EMH are difficult to achieve in the real security market. As making the EMH theory becomes more practical, Michael C. Jensen (1978) EMH innovated the assumption on costs of transaction. He pointed out that information obtainment and processing costs are involved in the transaction costs. Therefore, return of securities investment not only should make up the corresponding risk adjustment, but also should deduct the transaction cost. The lower information obtainment and processing costs, the more effective the market is. Mark Rubinstein (1975), John Latham (1986) made a stricter definition of an effective market structure on the trading volume perspectives, they believed that the most effective market is both the trading volume and market prices are not affected by the market information.

Sanford J. Grossman & Joseph E. Stiglitz (1980) based on the previous research gave a strict definition of EMH: If the costs of a transaction and information is equal to zero, then the stock price is considered to fully reflect all the available information. Burton G. Malkiel (1992) made a summary about the effectiveness of securities market on three aspects, he proposed that the stock market efficiency is reflected by the price of stock which is accurately reflects all the related information in market, the price of a complete and accurate to reflect all relevant information. Therefore, this research estimate whether the stock market is an effective stock market by the size of yields that investors obtained by using the relevant information to trade securities in stock market. The method is basic, but it offers a foundation for the empirical analysis of stock market efficiency.

The research literatures above are assumed that the investors in security market are rational, but after 1970s, with the information economics enter in the study field, people gradually realized that even with the existence of irrational investors in the market, efficient market theory still is accepted. The scholars who studied the EMH based on the rational exception began to transform to use sufficient conditions of an effective capital market of Fama as the kernel of study, and adding the assumption conditions of EMH, Andrei Shleifer (2000) is a representative. Andrei Shleifer concluded three assumptions that EMH can be accepted: the rational investors; random transactions and effective arbitrage. These three hypotheses are more consistent with the conditions in the real securities market which plays a significant role in testing the securities market efficiency.

The establishment and development of EMH not only promoted the development of the system of modern economics theory; but also offered a foundation for the establishment of option pricing model (OPT), the Capital Asset Pricing Model (CAPM), and Arbitrage Pricing Theory (APT).

2.2 Contents of Efficient Market Hypothesis

The Efficient Markets Hypothesis (EMH) is put forward for the relationship which between stock price and information that affects stock prices. The relationship is market prices fully reflect the market information. Eugene Fama systematically and concretely proposed the Efficient Markets Hypothesis in 1970. Eugene Fama (1970) defined the efficient market as that a specific stock market, in which the stock price is able to reflect all available information completely, and any new arrival information will lead to rapid and complete changes to the stock price; then, we regard the market as efficient market and it is impossible for investors to “beat the market”, the market is called the effective market. Burton G. Malkiel (1992) also believes that when the capital market which fully and correctly reflects all the information related regarding to price of the securities in the market, the market is considered to be effective.

2.2.1 Three forms of EMH

Harry V. Roberts (1967) firstly put forward three forms of the efficient market, the market is flooded with varied information, including historical information, public information and insider information. Accordingly, the stock prices have different degree and scale of reactions with relevant information, the stock market is classified as three forms: weak-form efficient market, semi-strong efficient market and strong-form effective market. Eugene Fama (1970) described three forms concretely, and made it can be widely applied. The information that each level of efficient market reflected can be expressed as follows:

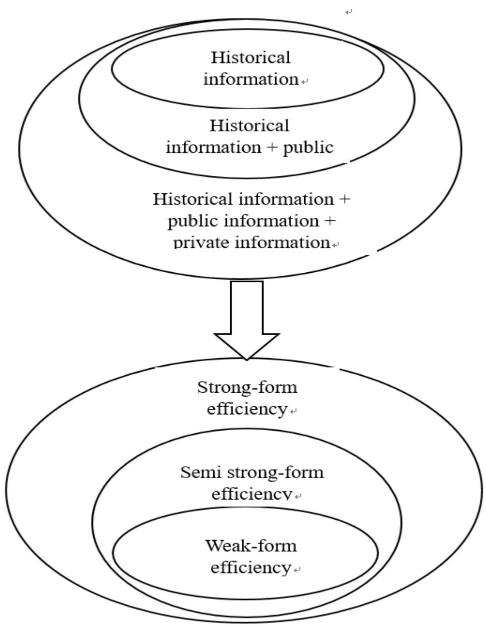

Figure 2.1 Classification of Stock Market Information and Stock Market Efficiency (Source: MengTing Yang, 2014)

2.2.1.1 Weak-form efficient market

The stock market is considered as weak-form efficient market if all historical price information is reflected by the current price of the stock (Eugene Fama, 1970). In a weak-form efficient market, all the historical returns and any other information in the securities market have been fully reflected in the real price, meaning that the information which excluded historical information is the decisive factor affecting stock prices in future. Therefore, the price trend forecasting based on historical price information is useless; in other words, the verification of a weak-form efficient market is the rejection of the technical analysis based on the historical price information not being able to get abnormal return. Since the historical price information generally released in public stock market, the cost of information acquisition is low, therefore, weak-form efficient market is a low effectiveness stock market (Stephen F. LeRoy, 1976).

2.2.1.2 Semi-strong efficient market

The stock market that all historical price and public information are reflected in current price is called the semi-strong efficient market (Eugene Fama, 1970). The public and available information includes not only the company information, such as company personnel changes, mergers and other news; but also the tax policy adjustment, monetary policy changes, inflation and so on. Because all the historical price information and public information is reflected by the current price of the stock, using public information to forecast the future stock price trend is useless, no one could benefit from the balance sheet, income statement or other public information (Jrffrey F. Jaffe, 1974). In other words, fundamental analysis is unable to help investors obtain an abnormal return. Semi-strong efficient market contains weak-form efficient market, because all the historical information that weak-form efficient market considered is contained by the public information.

2.2.1.3 Strong-form efficient market

All the historical price, public information and private information are reflected in the current price of the securities market, then the market is known as a strong-form efficient market (Eugene Fama, 1970). Private information here refers to information that is available only to the company's internal staff, such as the not released information of company's merger and statistic data, and so on. Because the market price contains all the information and insider information, the stock price changes is impossible to predict (Eugene Fama, 1970). Individual investors are unable to acquire private information including insider information, therefore, they cannot obtain abnormal return in a strong-form efficient market. As the most effective market, a strong-form efficient market generally difficult to achieve, it is an idealized stock market condition. At the same time, it is hard to confirm whether the stock market achieved strong-form efficient market (Ahmet Kara & Karen C. Denning, 1998).

Depending on the division of efficient market, it is obviously that different market information corresponding to different levels of market efficiency. The relationship between information and efficient market forms is illustrated as figure 2.2:

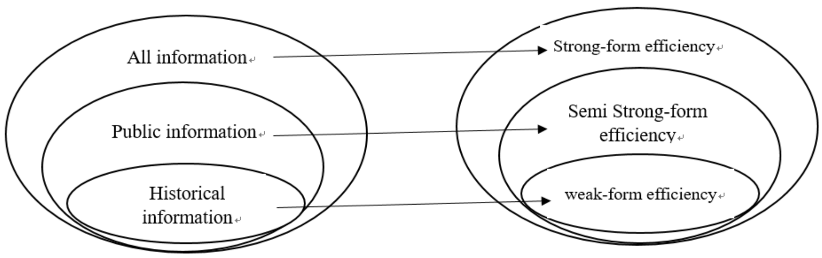

Figure 2.2 Three Efficient Market Forms and Corresponding Information (Source: Guan Lei, 2015)

Figure 2.2 shows that all the information contains public information and historical information, and their relationship is also corresponding to the three forms of efficient market. Weak-form market effectiveness is the primary stage of market efficiency, semi-strong market effectiveness is middle stage, strong-form market effectiveness is the topmost stage (Burton G. Malkiel, 1992). If a market has achieved weak-form efficient market, it is not ensured that the market is semi-strong efficient or strong-form; if the market is semi-strong effective market, then the market must be weak-form effective market, but not ensuring the strong-form market effectiveness; if the market is strong-form efficient market, then it must be weak-form effective and semi-strong effective market. Therefore, to determine the effectiveness of a market, usually testing by the order that from weak-form efficient to strong-form efficient market.

Therefore, the first step of testing securities market efficiency is to investigate that whether the market achieved weak-form efficiency. According to China's securities market is still in the initial stage of development, this research verifies whether the securities market of China has reached the weak efficiency. Weak-form efficient market is the first step on the process of further and healthy development of Chinese stock market.

2.2.2 The basis of EMH

As one of the foundations of economic theory, the essence of EMH is an assumption, its establishment is based on some specific conditions.

1. Information and transaction costs are zero

Information cost is zero means that the participants are free to attain information, any fees are needed to pay in the market (Michael C. Jensen, 1978). It also means that the information is fully and evenly distributed, the information that all market participants have is symmetrical, and arrived at the same time, and there is no friction in the market.

2. Investors are rational and independent, they can rationally analyze the price of the securities, they can independently analyze the value of stock and make decisions of investment. There may be non-rational investors, but the randomness of their trading makes the impact to be offsets, the price will not be affected (Andrei Shleifer, 2000).

3. The releasing of information in the market is random, and there is no specific time and notice in advance (Andrei Shleifer, 2000). Prices for each price of information after the announcement of the adjustment is also independent of each other.

2.3 Previous Studies About Market Efficiency

Since Eugene Fama (1970) proposed the Efficient Markets Hypothesis, there is a large number of studies about stock market efficiency and effectiveness. Different studies have different research objectives and methods, therefore, the conclusions of each study is not identical. It also a lot of research about study on the Chinese stock market efficiency, and most of the literature concerns the Chinese stock market weak-form market efficiency, but the methods and sample data used are different, the conclusions for whether the stock market of China has reached the weak-form efficiency are also different.

2.3.1 Previous studies in Chinese Stock Market

In the Chinese academic studies, the study on Chinese stock market efficiency mainly focus on the examining weak-form market efficiency in China's securities market. Research methods and tools are mainly including Random Walk model, Vector Auto Regressive (VAR) model, the Autocorrelation test and Run test, Unit Root test, Non-parametric test, Variance Ratio test, Normality test and other methods. The conclusions about the effectiveness of the Chinese stock market are not identical in different literatures.

Lin Ling, Ceng Yong, Tang Xiaowo (2000) take a total of 800 Shanghai Composite Index from January 1996 to March 1999 as a research object, made the statistical analysis and hypothesis testing for the profitability and predictability of moving average Y line trading in Shanghai stock exchange market. The result shows that the stock return has significant predictability, and employing the moving average line trading strategy can obviously obtain higher yields than employ buy and hold strategy. So the Shanghai stock exchange market has not reached the weak-form effective market.

Hu Bo, Song Wenli, Zhang Yuguang (2002) take the Shenzhen Composite Index and Shanghai Composite Index from February 12, 1996 to July 9, 2001 as the research sample, employed a unit root test and random walk test and weekend effect, concluded that the China's securities market has not reached the weak-form efficiency market.

Xie Baohua, Gao Rongxing, Ma Zheng (2002) used the Shenzhen Composite Index during the period from December 21, 1990 to March 2, 2001and the Shenzhen Component Index during December 1, 1995 to March 2, 2001 closing price as a sample, employed the unit root test, variance ratio test and second-order correlation test to examine whether the Chinese stock market accords with the random walk process. The result shows that the Chinese stock market has not achieved the weak-form effective market.

Li Xingxu, Zheng Shuming (2004) used the unit root test, Q-statistic, and autocorrelation test to test the random walk in the Shanghai Composite Index, concluded that the Shanghai stock exchange market has not achieved the weak-form efficiency yet.

Chen Chunhui and Li Zhenghui (2005) believe that the Shanghai stock market's cyclical characteristics are obviously observed by the Released Range Analysis (R/S analysis), the Shanghai stock market has not reached the weak-form efficient market.

Wang Zhigang, Zeng Yong, Li Ping (2007) used the Shanghai Composite Index from January 2, 1996 to December 30, 2005 as data sample to investigate the moving average trading strategy's rate of return and standard deviation on buying day and selling day. They found that the moving average trading strategy's average return rate moved higher but the variance is lower on buying day; the average return rate is significantly negative at the same time the standard deviation is large on selling day; the stock price index rising trend stronger on buying day than it on selling day, it shows that the moving average trading strategy has a significant predictability; through the bootstrap method for further testing and analysis, the moving average trading strategy still have significant forecasting ability, so the stock market of China has not attained the weak-form efficiency.

Sun Bibo (2005) take the Shanghai Composite Index from December 19, 1990 to December 31, 2003 as the data sample, estimated whether the moving average trading strategy have significant profitability and predictability than the buy and hold strategy in Chinese stock market. It found that the holding period variable moving average trading strategy can obtain abnormal return in significant, after considering the asynchronous transaction and costs of transactions, the abnormal return still exists and is significant; through bootstrap method, they found that the expected return time-varying model of the AR model and GARCH model hypothesis still cannot explain why the moving average trading strategy is significant predictability and profitability, so the stock market of China has not attained the weak-form efficiency.

Xu Peng (2008) used the Shanghai Composite Index from March 1, 2000 to March 1, 2008 as sample, through the method of statistical analysis and hypothesis tests the rate of return and significance of the moving average trading strategy in the Shanghai stock exchange market. He found that in the holding period the moving average trading strategy is able to obtain significantly higher average returns than that buy and hold strategy obtained, it concluded that the Shanghai stock exchange market has not attained the weak-form effectiveness.

Wang Xiao, Li Jia (2010) sampled data from April 8, 2005 to November 29, 2007 of the Shanghai and Shenzhen 300 Index and Jin Xin Securities Investment Fund closing price from November 26, 1999 to November 29, 2007 as a research object, using the variance ratio test, and found that the Shanghai and Shenzhen 300 Index yield is unpredictable in the short term, but in the long term it has significant predictability. They concluded that Chinese stock market in short term is weak-form effective market, but in long term it has not reached weak-form effective market.

Zhao Yongliang, Zhang Jiwei (2010) used the Shanghai Composite Index from December 19, 1990 to June 27, 2008 as a research object, using the program trading method to compare the steadiness of moving average trading strategy to buy and hold strategy, and concluded that the Shanghai stock exchange market has not attained weak-form effectiveness.

Liu Hua (2012) used the Shanghai Composite Index, Shenzhen stock index and the CSI 300 index in 2004, 2007, 2010 three representative years, as a sample, using the autoregression model and unit root test to investigate the stock market of China. He it concluded that the stock exchange market of China has not attained weak-form effectiveness.

There are also amount of studies believe that the stock market of China has already achieved the weak-form efficiency.

Song Songxing and Jin Weigen (1995) select 29 stocks total 845 data from December 19, 1990 to April 28, 1994 in Shanghai stock exchange market as the research sample. It divided the development stage of Shanghai stock market into two stages by December of 1992, through the analysis of the autocorrelation test, normality test, run test and the small firm effect. It concluded that the SSE has almost achieved the weak-form effectiveness after 1993.

Chen Xiaoyue, Chen Xiao, Gu Bin (1997) take stocks' daily price from January 1991 to November 1996 in Shanghai stock market, and stocks' weekly price from January 1993 to November 1996 in Shenzhen stock exchange market as the sample to have the Dickey-Fuller test respectively. By testing the Chinese stock index and the stock price behavior consistency with a random walk test, they conclude that the Shenzhen stock exchange market has reached a weak-form efficient market; the Shanghai stock exchange market had not reached a weak-form effective market before 1993, however, since the year of 1993, it gradually reached the weak-form effective market; The Shenzhen stock exchange market reached the weak-form effective market earlier than Shanghai stock exchange market; therefore, the stock market of China has achieved the weak-form efficiency.

Fan Longzhen, Zhang Zigang (1998) used 5 stocks' closing prices in the Shenzhen stock market during July to October in 1995, the stock price is tested by Unit Root test to detect the random walk. The result reveals that the Shenzhen stock exchange market has effective responses to market information. Therefore, the Shenzhen stock market reached a weak form efficient market conclusion.

Sun Jianbo, Jin Xianglan (1999) had the empirical analysis by employing the dynamic runs test to investigate the daily and weekly data of Shanghai composite index and Shenzhen composite index. The results show that both the two indexes are consistent with general rules of random walk process, Shanghai and Shenzhen Stock Exchange Market has reached the weak-form effective market after year of 1993.

Hu Wei, Fan Zhenlong (2000) collected 15 stocks' weekly returns of the Shanghai Composite Index and A-shares index from February 17, 1995 to November 19, 1999 which is selected from 5 industry categories as the research sample, to test whether the sample is consistent with random walk process by using the unit root test and incremental correlation test. It found that Shanghai Composite Index, A-shares index and most of the stock prices changed in accordance with the unit root process, except a few small firms' stock price behavior, it can be regarded as a random walk, therefore, the stock market of China is weak-form effective.

Huang Jisheng, Cheng Yiming (2001) collected the data of the Shanghai Composite Index from 1992 to 1999 as the research sample, to instigate the market efficiency of the Shanghai stock market by employing the run test, correlation test and normality test three methods. It found that the Shanghai stock exchange market had not achieved an effective market before 1996; but after1996, it gradually achieved weak-form effectiveness.

Ma Xiangqian, Ren Ruoen (2002) used the Shanghai Composite Index from December 1990 to December 2000 as the data sample, using unit root test on index sequence, the AR model of return series, the result shows that the stock price of the Shanghai stock market fluctuations accorded with random walk, so the stock market has been attained weak-form efficient market.

Xu Dilong, Lyu Zhongwei (2003) collected the closing price of the Shenzhen stock market from January 2, 1998 to December 31, 2001 as a research sample, using a unit root test, CAPM, and random walk test to investigate the effectiveness of the Shenzhen stock market with different perspectives, and having regression analysis, hypothesis testing by employing the TSP analysis. The result shows that the Shenzhen stock market is weak-form efficient market.

Dai Xiaofeng, Yang Jun, Zhang Qinghai (2005) used the Shanghai Composite Index and the Shenzhen Composite Index from December 19, 1990 to June 18, 2004 as sample, investigated the weak-form effective market of Chinese stock market by employing unit root test and run test. It found that stock price index has passed the tests except the Shanghai Composite Index, and the Chinese stock market has attained the weak-form efficient market.

Li Xiaojing (2006) investigated the Shanghai Composite Index by using unit root test, variance ratio, run test; it found that Chinese stock market showed characteristics of weak-form efficient market obviously.

Gao Shutang, Zhou Xuemei (2009) investigated the Shanghai and the Shenzhen stock markets by employed the unit root test, residual serial correlation and run test, it concluded that stock market of China has attained weak-form efficient market.

Xu Mi (2012) take the Shanghai Composite Index and the Shenzhen Composite Index from 2005 to 2008 as sample, according to the result of variance ratio test, the Chinese stock market has attained weak-form efficient market.

It should be noted that although most scholars have empirical tests on the Chinese stock market efficiency by using research methods that were used in the foreign securities market combined with the actual data in China's stock market, some Chinese scholars believe that the current Chinese stock market is not standardized, and has asymmetric information. They also view that the stock market is controlled by the government, and can not have completely free development. There is a gap between the foreign developed stock market, just copy and paste the foreign theory in China that cannot explain the problem well, the results also cannot be regarded as a substantive basis for the analysis of the Chinese stock market efficiency.

2.3.2 Previous studies in other Stock Markets

The origin of the inspection on the market efficiency is born of the random walk model. There is a large volume of literature in the foreign stock market on testing the weak-form effective market. The representative literature such as Robert J. Shiller (1959) had used the U.S. stock market data test, and the result shows that stock price changes are random, it verified that the American stock market is a weak-form effective market; Clive W. J. Granger & Oskar Morgenstern (1963) collected the U.S. stock market transaction price, and it found no indications showing the price change exists in any specific model. They verified the hypothesis of the weak-form market effectiveness in American Stock market; Eugene Fama and Marrshall E. Blume (1966) investigated the U.S. stock market rules of technical trading, it found that technical analysis is not helpful in obtaining abnormal return, and it verified the assumption of a weak-form efficient market in the U.S.; Kenneth French (1980) found the weekend effect on stock price changes in U.S. stock market, it rejects the weak-form efficient market hypothesis in U.S.; Peter Klein (1983) found that the United States stock market exists January effect, it rejects the weak-form efficient market assumption; Mustafa N. Gultekin (1983) found "seasonal effect" on U.S. stock market, it indicated that weak-form efficient market is not accepted in U.S.; Peter Lehmann (1988) found the “reversal effect” on United States stock market, it indicated that weak-form efficient market is not accepted.

For the Europe and the United States market developed stock market, Andrew W. Lo and A. Craig MacKinlay (1988) tested the variance ratio of the CRSP index, portfolio and individual stocks of the US stock market. The results show that the RW3 assumption is not rejected by the value-weighted index for the index and portfolio. For the individual stocks, it’s difficult to find predictable parts of the market. Iwaisako (2003) took the Tokyo Stock Price Index and size-based combinations form January 1, 1968 to August 15, 2001 by employing autocorrelation and co-autocorrelations to conclude a similar conclusion: The Tokyo stock market index and portfolio does not reject the RW3 assumption, the Tokyo stock market is a weak-form efficient one. However, Terence C. Mills (1991, 1995) tested the UK Actuaries All Share Index by a variance ratio test showing that the UK stock market rejected the RW3 assumption; it means that UK stock market is not weak-form efficient.

In the developing and emerging markets, weak-form efficiency is controversial. Most of developing and emerging markets have smaller trading volumes than developed markets, while in the small markets the larger traders are easier to manipulate the market.

Alam et al. (1999) used data from November 1986 to December 1995 to test the effectiveness of five emerging markets in Asia, including Hong Kong, Bangladesh, Malaysia, Taiwan and Sri Lanka. The variance ratio test showed that, the markets sample index series are subject to random walk except Sri Lanka market. Cheng F. Lee et al. (2001) examined the stock market of China, and its variance ratio test rejects the assumption that stock returns follow a random walk. Lima et al. (2004) use daily returns data to test the effectiveness of China (including A-share and B-share), the Singapore and the Hong Kong stock markets. The market does not refuse random walk hypothesis except China's B-share market and Singapore market.

Jorge L. Urrutia (1995) employed the monthly price index of Chile, Argentina, Mexico and Brazil for the period the December 1975 to March 1991 to test whether the prices of emerging market securities in Latin American were subject to random walk. The variance ratio test result rejects this hypothesis, while the run test shows that the Latin American market is a weak-form efficiency market. Terrance Grieb & Mario G. Reyes (1999) tested whether the Brazilian and Mexican stock index and stock price are subject to random walk. The variance ratio test showed that the Mexican market index and individual stocks, the Brazil stock market exist the phenomenon of mean reversion, while the Brazilian index showed a strong random walk trend.

Graham Smith et al. (2003) employed a multiple variance ratio test towards testing five Europe emerging market price indices, including Greek, Hungarian, Polish, Portuguese and Turkish. Greek, Hungarian, Polish, Portuguese markets reject the RW3 hypothesis; the Istanbul market in Turkey in the 1990s had higher trading volume than the other four stock markets, its stock index follows random walk.

CHAPTER Ⅲ

RESEARCH FRAMWORKS

Testing weak-form efficiency market includes two aspects: Firstly, to test whether the current stock returns are related to historical stock returns; Secondly, to examine whether the stock returns are independent of each other. Therefore, whether the stock price conforms to the random walk is an important criterion to estimate the effectiveness of the stock market. This study employs an autocorrelation test, variance ratio test and unit root test to estimate the effective of the Chinese stock market. The autocorrelation test and unit root test are employed for validating the stationary of series, the variance ratio test is employed for test random walk.

3.1 Models

The examination of weak-form efficient market is mainly examine whether the stock price exist a rule that is able to predict the future price trend and employing it to obtain abnormal return. If the rule does not exist, it means that investors cannot obtain an abnormal return by technical analysis, and the securities market has achieved a weak-form efficient market.

3.1.1 Stationary Time-Series

In time series, if there is no systematic change in the mean (no trend), the variance has no systematic change, and has strictly eliminated the cyclical changes, it is called a stationary time-series (Maurice B. Priestley, 1981).

It is assumed that a time-series is generated by a stochastic process, in other words, each value of the time-series $\{X_t\}$ (t = 1,2,...) can be attained from a probability distribution, then for the X_t :

(1) $E(X_t) = \mu$ is a constant which is independent of time t.

(2) $Var(Xt) = \sigma^2$ is a constant which is independent of time t.

(3) $Cov(Xt\ Xt+k) = \gamma_k$ is a constant which is only related to the time interval k, but independent of time t.

If X_t is satisfied with above terms, it is said that the stochastic time-series X_t is stationary time-series (Maurice B. Priestley, 1981).

3.1.2 White Noise

In the random variable $X(t)$ (t = 1, 2, 3, ...), if it is a component of a sequence of unrelated random variables, and its expected value and variance will be a constant, then it is regarded as white noise process. The White Noise is the sample of White Noise process.

Random time-series X_t is independent distribution series which with zero mean and homoscedasticity:

$X_t = \mu_t$, $\mu_t \sim N(0, \sigma^2)$,

This time-series refers to white noise, which is a stationary series.

3.1.3 Random Walk

The random walk of financial price refers to the random change of market price (Gregory F. Lawler & Vlada Limic, 2010). The Random Walk theory suggests that the change in stock price are independent of each other and have the same probability distributions. If a stock market follows a random walk, the time-series of the security price will be stochastic, it means that the historical stock price is unable to predict its future price (Gregory F. Lawler & Vlada Limic, 2010).

Eugene Fama (1970) pointed out that the price of securities that follows the random walk model completely reflects the available information, which means that the continuous changes in prices or yields are independent of each other. It also shows that the change is same distribution. Then, under the random walk model, the information prices can be expressed as:

$f(r_{j,t+1} \mid \Phi_t) = f(r_{j,t+1})$

Where $f(r_{j,t+1} \mid \Phi_t)$ is the probability density of the return of the security j at time

$t + 1$ that estimated by the current information, $f(r_{j,\,t+1})$ is the probability density of the unconditional return.

If the series is generated by random process as follows:

$X_t = X_{t-1} + \mu_t$

μ_t is a white noise.

The means of this series are identical, $E(X_t) = E(X_{t-1})$. In order to test whether the series is homoscedasticity, it can be assumed that the initial value of X_t is X_0, then it can be concluded that:

$X_1 = X_0 + \mu_1$

$X_2 = X_1 + \mu_2 = X_0 + \mu_1 + \mu_2$

… … … …

$X_t = X_0 + \mu_1 + \mu_2 + \ldots + \mu_t$

Assume that the initial value of X0 is a constant, t is a white noise, $Var(X_t) = t\sigma^2$, then the variance of X_t is related to time t, and it is a non-constant, therefore, the series X_t is non-stationary series.

However, if we take the first order difference of X_t

$\Delta X_t = X_t - X_{t-1} = \mu_t$

μ_t is a white noise, then the series $\{\Delta X_t\}$ is stationary. Therefore, if a series is stationary, it generally can be constructed by finite difference method to generate a stationary series.

3.2 Data Used in This Study

There are a lot of index that measured stock price in China's stock market, including the Shanghai Composite Index, Shenzhen Composite Index, Shanghai & Shenzhen 300 index, Shanghai 180 index and so on. The Shanghai and Shenzhen 300 index and Shanghai 180 index latter two contain only a part of information in the stock market. Shanghai and Shenzhen 300 index is compiled by 300 of selected A shares in SSE & SZSE; the Shanghai 180 index mainly including the blue chips stocks, it selects 180 of stocks which is large scale, strong representativeness, and good liquidity stocks to compile the index.

This paper chooses the Shanghai Composite Index and Shenzhen composite index. Shanghai Composite Index covers all stocks that listed on the Shanghai stock exchange, it reflects the overall stock price trend of Shanghai stock market. Similarly, the Shenzhen Composite Index covers all stocks that listed on the Shenzhen stock exchange, it reflects the overall stock price trend of Shenzhen stock market. Therefore, the data of this paper is able to reflect the listed companies' stock price in China.

The sample data of research is the Shanghai Composite Index and Shenzhen Composite Index closing price from January 2000 to October 2016 source Sohu Securities. The stock index returns are calculated to de the Autocorrelation test and Variance Ratio test. This study collects the daily, weekly and monthly closing price of this period, to compare the difference of Chinese stock market efficiency in short-run and long-run.

This data sample is large, and it covers a long period; for the quality of sample data, the sample is able to reflect the overall conditions of listed companies in the Chinese stock market, it is a comprehensive sample; for the research method, this paper employs autocorrelation test, unit root test, and the variance ratio test to analysis the weak-form efficiency in the Chinese stock market from different perspectives.

3.3 Research Hypothesis

This study aims to examine the stock market of China has achieved weak-form efficiency market or not, in other words, whether it follows the random walk. Accordingly, the hypothesis of this study is as follows:

H_0: *The Chinese stock market follows the random walk, it is a weak-form efficiency market.*

H_1: *The Chinese stock market does not follow the random walk, it is not a weak-form efficiency market.*

3.4 Methods

In the weak-form effective market, stock price completely reflects all the historical information, the volatility of return is completely random and not related to historical price. There are no profitable trading rules to follow.

Overall, testing weak-form efficient market includes two aspects: Firstly, to test whether the current stock returns are related to historical stock returns; Secondly, to examine whether the stock return is independent of each other. Therefore, whether the stock price conforms to the random walk is an important criterion to estimate the effectiveness of the stock market. This study employs Autocorrelation test, Variance Ratio test and Unit Root test to estimate the effective of Chinese stock market.

3.4.1 Autocorrelation test

Autocorrelation is also known as serial correlation. An autocorrelation coefficient test calculates the correlation coefficient of yields between two trading periods (usually one trading cycle and one lag of cycles) to detect their relevance and non-randomness (George Box & Gwilym Jenkins, 1976).

Eugene Fama (1965) proposed that the most straightforward way to test whether a time-series conforms to random walk is to a test its serial dependency. The autocorrelation correlation test is based on the fact that if the stock price series follows the random walk, then the stock yield series is no correlation. In a weak efficient market, the yield on the stock price fluctuates around its mean, and the yield series is stationary, with no correlation or correlation coefficient close to zero.

For a time series R_t, if $COV(R_t, R_i) = 0$, and $t \neq i$, t, $i = 1, 2, 3, \ldots, T$, and T is the number of observed value, then the time series R_t is not serial correlation; if $COV(R_t, R_i) \neq 0$, and $t \neq i, t, i = 1, 2, 3, \ldots, T$, then there is serial correlation. The degree of serial correlation can be measured by correlation coefficient ρ:

$$\rho(k) = \frac{\text{cov}(R_t, R_{t-1})}{\sqrt{\text{var}(R_t)}\sqrt{\text{var}(R_{t-1})}} = \frac{\text{cov}(R_t, R_{t-1})}{\text{var}(R_t)}$$

Where k is the lag order and $\rho(k)$ is the correlation coefficient of the time series. As k increases, the autocorrelation coefficient of stationary series decreases rapidly and tends to zero. Here the null hypothesis is that there is no k-order serial correlation, the market is weak-form efficient.

The Q statistic of autocorrelation test:

$$Q = n(n+2)\sum_{k=1}^{m} \frac{r_k^2}{n-k}$$

Q is similar to the chi-square distribution, where m is the lag length, that is, the maximum lag order, where we can write:

$$Q = T\sum_{k=1}^{m} \rho_k^2$$

where, T is the total number of sample, m is the length of lag, after transferring:

$$Q = T(T+2)\sum_{k=1}^{m} \frac{\rho_k^2}{T-k} \sim x^2(m)$$

The Q statistic and p value are calculated. Assuming that the significance level is α, when the degree of freedom is k, the corresponding p value of Q statistic is less than the significance level, then reject the null hypothesis, the stock yield serial exists k-order serial correlation; on the contrary, the null hypothesis cannot be rejected, the serial does not exist serial correlation.

3.4.2 Unit root test

The primary problem in time-series analysis is the stationary problem of time-series data in that, it is accurate to use statistics to test it, unit root test is available to be employed. David A. Dickey and Wayne A. Fuller (1979) published the unit root autoregressive time series estimator distribution in which, the literature is usually called the Dickey-Fuller (DF) test. In statistic, the unit root test is a test that examines whether a time-series variable is non-stationary and possesses a unit root (David A. Dickey & Wayne A. Fuller, 1979).

So, how to examine whether a time series is stationary? First of all, we can see the time series of the Figure, if it is stationary, the line fluctuation should be around a mean point, vice versa, it is non-stationary. Then, it is possible to determine whether or not to include the intercept term or the trend item, or both, in the model when test it. The Figure of Shanghai and Shenzhen stock market closing price series as follows:

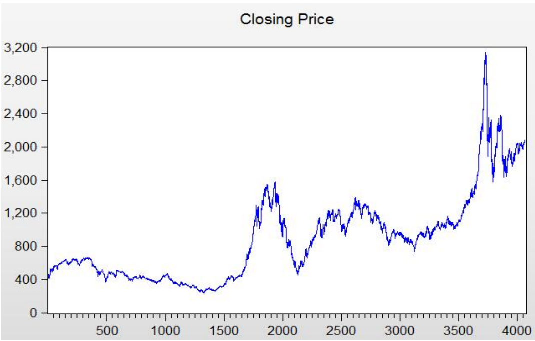

Figure 3.1 The trends of Shanghai daily closing price fluctuation

Figure 3.2 The trends of Shenzhen daily closing price fluctuation

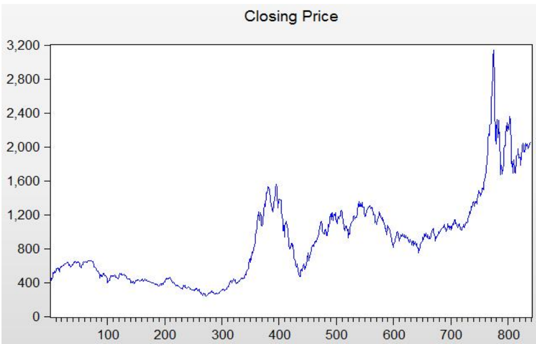

Figure 3.3 The trends of Shanghai weekly closing price fluctuation

Figure 3.4 The trends of Shenzhen weekly closing price fluctuation

Figure 3.5 The trends of Shanghai monthly closing price fluctuation

Figure 3.6 The trends of Shenzhen monthly closing price fluctuation

As the Figure shows, the stock price time series is not stationary; therefore, this research uses the model with intercept items and trend items to do the ADF test. Firstly, setting up a first order autoregressive model AR (1):

$$P_t = \alpha + \delta_t + \rho P_{t-1} + \varepsilon_t$$

Where α is a constant and δ_t is a linear function, ε_t is a random distribution, it follows the standard a normal distribution, which means the value is 0 and the standard deviation is σ.

If $-1 < \rho < 1$, then the P_t is stationary;

If $\rho = 1$, P_t is non-stationary;

If $| \rho | > 1$, P_t is non-linear.

Therefore, we can determine whether the ρ is less than 1 to determine the stationary time series.

$$H_0: \rho = 1 \qquad H_1: \rho < 1$$

Using the first-order difference method, the first-order autoregressive model is subtracted Pt-1 on both sides of the equation at the same time, then we get

$$\Delta P_t = (\rho - 1)P_{t-1} + \alpha + \delta_t + \varepsilon_t$$

Let $\gamma = \rho - 1$, then the null hypothesis and alternative hypothesis can be converted to

$$H_0: \gamma = 0 \qquad H_1: \gamma < 0$$

Then the estimated value of γ can be calculated by the least squares method. According to the t-statistic obtained from the test and the *t*-critical value at the corresponding significance level, if *t*-statistic is larger than *t*-critical value, the H_0 is not rejected, and the series processes is a unit root and it is non-stationary; if *t*-statistic less than *t*-critical value, the H_0 is rejected. The series does not exist a unit root and it is stationary.

3.4.3 Variance ratio test

Andrew W. Lo and A. Craig MacKinlay (1988) proposed using random variance to test random walk. The variance ratio test shows that the return of financial assets is predictable to some extent. The microstructure of the stock market and the friction in the process of transaction can lead to predictability in returns. It also can be predicted by the expected return changes as a result of changes in business conditions. At the same time, a certain degree of predictability of return on assets is necessary to compensate investors for the risks they are exposed.

Since the traditional random walk test methods is based on strict assumptions, the variance ratio test overcomes the shortcomings of autocorrelation test and unit root test. It allows the time series does not follow the normal distribution, and the existence of disturbance term heteroscedasticity. The basic idea of this test is that it is a linear function of time under the assumption of random walk.

The variance ratio test implies that the increased variance is linear in the sampling interval and the variance of its q differences equals q times the variance of its first order differences when the return series pursues a random walk.

Suppose the price is subject to the following random walk model with drift:

$p_t = \mu + p_{t-1} + e_t \in (0, \delta^2)$

Obviously,

$p_t - p_{t-1} - \mu = e_t$

$p_t - p_{t-1} - \mu + p_{t-1} - p_{t-2} - \mu = p_t - p_{t-2} - 2\mu = e_t + e_{t-1}$

In the assumption of $e_t \in (0, \delta^2)$, the variance of $p_t - p_{t-2} - 2\mu$ equals 2 times of the variance of $p_t - p_{t-1} - \mu$. In general, the variance of $p_t - p_{t-q} - q\mu$ equals the variance of $p_t - p_{t-1} - \mu$ times q. In other words, if we sample the logarithmic price time series every q points, the variance of the resulting sequence is q times the variance of the original logarithmic price time series. The variance ratio statistic just uses this feature to construct the test statistic. Assuming that there is a logarithmic price time series which length is $nq+1$, and the first of logarithmic price is p_0, the following notation should be adopted:

$$\hat{\mu} \equiv \frac{1}{nq}\sum_{k=1}^{nq}(p_k - p_{k-1}) = \frac{1}{nq}(p_{nq} - p_0)$$

$$\delta^2 \equiv \frac{1}{nq}\sum_{k=1}^{nq}(p_k - p_{k-1} - \hat{\mu})^2$$

$$\delta^2(q) \equiv \frac{n}{(n-1)(nq-q+1)}\sum_{k=q}^{nq}(p_k - p_{k-q} - q\hat{\mu})^2$$

Under the assumption of et is a normal distribution, Andrew W. Lo and A. Craig MacKinlay (1988) provide a method of checking the random walk by calculating the variance ratio. They define a variance of the proportional variable, the statistic *VR*.

$$VR(q) = \frac{\delta^2(q)}{q\delta^2} = 1 + 2\sum_{t=1}^{q-1}(1 - \frac{t}{q})\rho_{(k)}$$

VR(q) is the value of variance ratio which interval equals *q*. If the series follow random walk, then the value of *VR(q)* should close to 1.

Furthermore, they also provide the asymptotic distribution of statistic variable *M(q)*.

$$M(q) \equiv \frac{\delta^2(q)}{q\delta^2} - 1$$

$$\sqrt{nq}M(q) \in N\left(0, \frac{2(2q-1)(q-1)}{3q}\right)$$

For the convenience of testing, they also provide a variance ratio *Z(Z*)* test. In the case of homoscedasticity, the standard normal *Z* statistic is calculated as follows:

$Z(q) = M(q) / \sqrt{V} \sim N(0,1)$

Where,

$$V = \frac{2(2q-1)(q-1)}{3q(nq)}$$

Under the loose assumption of et normality, et it is allowed to not be a normal distribution, and it is also allowed to have heteroscedasticity, but the variance must exist. There are the following asymptotic results:

$$Z(q)^* \equiv \sqrt{nq}M(q)/\sqrt{\hat{\theta}(q)}$$

Where,

$$\hat{\theta}(q) \equiv \sum_{j=1}^{q-1}[\frac{2(q-j)}{q}]^2\hat{\delta}_{(j)}$$

$$\hat{\delta}_{(j)} = \frac{nq\sum_{k=j+1}^{nq}(p_k - p_{k-1} - \hat{\mu})^2(p_{k-j} - p_{k-j-1} - \hat{\mu})^2}{[\sum_{k=1}^{nq}(p_k - p_{k-1} - \hat{\mu})^2]^2}$$

$\hat{\delta}_{(j)}$ is variance of the j order autocorrelation. Based on these asymptotic results, we can carry out random walk tests on these logarithmic stock time series.

CHAPTER Ⅳ

EMPIRICAL RESULTS

4.1 Descriptive Statistics

The summary of descriptive statistic for all stock closing price series in both the Shanghai and Shenzhen stock markets for the entire sample period of January, 2000 to October, 2016 are presented in Table 4.1 and 4.2.

Table 4.1: Descriptive statistics for the closing price in Shanghai and Shenzhen stock market

Time series	Market	N	Mean	Maximum	Minimum	Standard deviation
Daily	Shanghai	4069	2350.60	6092.06	1011.50	919.61
	Shenzhen	4069	898.05	3140.66	237.18	519.21
Weekly	Shanghai	840	2348.08	5903.26	1013.64	910.64
	Shenzhen	840	895.56	3140.66	241.63	513.39
Monthly	Shanghai	197	2317.44	5954.77	1060.74	910.86
	Shenzhen	197	864.82	2793.25	254.47	487.68

The table presents descriptive statistics for daily, weekly, monthly the Shanghai and Shenzhen markets stock closing price. These include mean, maximum, minimum value and standard deviation. N is the number of observations. Estimates are given for full sample period January, 2000 to October, 2016.

From the Table 4.1, it can be seen that the mean value of the Shanghai market is higher than Shenzhen market in daily, weekly, and monthly time series. Similarly, the standard deviation value of the Shanghai stock market is higher than the Shenzhen stock market. It indicated that the fluctuations in Shanghai market are wide.

Table 4.2: Descriptive statistics for the closing price in three time periods

Market	Time series	N	Mean	Maximum	Minimum	Standard deviation
Shanghai	S1: 2000 - 2005	1442	1583.89	2242.42	1011.50	303.65
	S2: 2006 - 2011	1459	2861.38	6092.06	1180.96	991.21
	S3: 2012 - 2016	1168	2659.12	5166.35	1950.01	677.81
Shenzhen	S1: 2000 - 2005	1442	446.54	664.85	237.18	116.30
	S2: 2006 - 2011	1459	946.36	1576.50	283.48	332.48
	S3: 2012 - 2016	1168	1395.54	3140.66	734.28	531.83

Table 4.2 reports the closing price of the Shanghai and Shenzhen stock markets in three time periods. For observing the changing of market efficiency in the Chinese stock market with time, the sample is divided into three stages. S1 from 2000 to 2005, S2 from 2006 to 2011, S3 from 2012 to 2016.

The Chinese government and policies it carries out has significant effects on promotion and innovation of the Chinese stock market. Therefore, the sample is divided into three time periods according to the Chinese government policies issuing.

S1 (2000 - 2005): In 1999, the Securities Law began to be implemented in China. Since the beginning of 2000, the government started to carry out a series of new policies which were aimed at improving efficiency of the market. This process was called “re-regulation”. In 2004, a variety of trading products were explored. On May 9, 2005, the non-tradable shares reform was started, and the capital market was further opened. The Chinese stock market began to enter the stage of rapid development.

S2 (2006 - 2011): In 2006, the Chinese government amended the Company Law and Securities Law. It regulated the securities market and made the Chinese stock market more standardized and international.

S3 (2012 - 2016): In October 2011, Guo served as Chairman of the SFC. Since 2012, Guo had issued more than 70 new policies.

As Table 4.2 shows, the mean value of the Shanghai stock market in three time periods are higher than the Shenzhen market. The greater value of the standard deviation in the Shanghai market also indicated a wider fluctuation in the Shanghai market than the Shenzhen market. And both the Shanghai and Shenzhen market’s stock closing price increased comparing with the previous periods.

Table 4.3: Descriptive statistics for the closing price in Shanghai and Shenzhen stock market

Time series	Skewness	Kurtosis	Jarque-Bera	Jarque-Bera *p*-value
Shanghai				
Daily	1.2032	4.6818	1461.29	<0.001
Weekly	1.1831	4.6279	288.37	<0.001
Monthly	1.2979	5.0660	90.35	<0.001
Shenzhen				
Daily	1.0945	4.1360	1031.01	<0.001
Weekly	1.0932	4.1827	216.27	<0.001
Monthly	1.0887	4.1954	50.65	<0.001

The table reports the tests of normality for daily, weekly, and monthly stock closing prices on the Shanghai and Shenzhen stock markets. Skewness, Kurtosis and Jarque-Bera are calculated for the full sample period January, 2000 to October, 2016.

As the Table 4.3 illustrates, the values of skewness and kurtosis show that the closing price of all indexes are not to distribute in a normal. The closing price of all indexes are positively skewed or skewed to the right, indicating higher probability of large rises in closing price than decreases. The monthly closing price on Shanghai stock market has the largest value of skewness, while the monthly closing price on the Shenzhen stock market has the lowest.

The kurtosis of all index returns is also higher than 3, but not very large. A high positive value of kurtosis signified that the distributions of these variables are centered. The evidence of a high kurtosis value is also consistent with the previous findings in emerging markets, see e.g., Huang (1995), Asma Mobarek & Keavin Keasey (2002), Claire G. Gilmore & Ginette M. Mcmanus (2003), and Hassan et al. (2006). The findings also consistent with previous research on China's stock markets. All *p*-values of Jarque-Bera statistics and corresponding *p*-values in Table 4.3 are less than the 0.01 level of significance, indicating that the null hypothesis the daily, weekly, monthly distribution of Shanghai and Shenzhen markets returns is to distribute in a normal can be rejected. Therefore, all of these return series are not a normal distribution.

Table 4.4: Descriptive statistics for the closing price in three time periods

Time series	Skewness	Kurtosis	Jarque-Bera	Jarque-Bera *p*-value
Shanghai				
S1	0.2704	2.2968	47.29	<0.001
S2	0.9610	3.9785	282.78	<0.001
S3	1.2886	4.2409	398.17	<0.001
Shenzhen				
S1	0.2151	2.0537	64.92	<0.001
S2	-0.4467	2.0588	102.37	<0.001
S3	0.8348	2.7098	139.64	<0.001

Table 4.4 shows the tests of normality for the Shanghai and Shenzhen markets in three time periods. Skewness, Kurtosis and Jarque-Bera are calculated for S1: 2000 – 2005, S2: 2006 – 2011 and S3: 2012 – 2016. Table 4.4, the skewness and kurtosis suggests that the closing price index of all three time periods in the Shanghai and Shenzhen markets are not distribute normally. The kurtosis increases with time period. All *p*-values are less than the 0.01 level of significance, thus the null hypothesis can be rejected. Therefore, none of these closing price index series is a normal distribution.

4.2 Autocorrelation Test

The stock index returns are employed to do the Autocorrelation test. All index series returns are calculated using the continuously compounded formula:

$$R_t = \ln\left(\frac{p_t}{p_{t-1}}\right)$$

where p_t and p_{t-1} represent the closing prices of an index at time t and $t\text{-}1$ respectively, and ln is natural logarithm (Brooks 2004, 7).

According to the analysis of the Shanghai and Shenzhen markets' closing price index returns by Eviews6.0, the results as follows:

Table 4.5: Shanghai Composite Index Daily Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.024	0.024	2.2659	0.132
2	-0.023	-0.024	4.4708	0.107
3	0.022	0.023	6.4898	0.090
4	0.059	0.057	20.4480	0.000
5	-0.002	-0.004	20.4720	0.001
6	-0.049	-0.047	30.4540	0.000
7	0.028	0.028	33.6610	0.000
8	0.011	0.004	34.1150	0.000
9	0.001	0.005	34.1230	0.000
10	-0.003	0.002	34.1500	0.000
11	0.015	0.012	35.1240	0.000
12	0.022	0.018	37.0980	0.000

Table 4.6 Shanghai Composite Index Weekly Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.066	0.066	3.6909	0.055
2	0.071	0.067	7.9298	0.019
3	0.072	0.063	12.2480	0.007
4	0.010	-0.003	12.3370	0.015
5	0.003	-0.006	12.3450	0.030
6	0.018	0.013	12.6100	0.050
7	0.021	0.019	12.9770	0.073
8	0.091	0.089	20.0600	0.010
9	0.056	0.042	22.7120	0.007
10	0.011	-0.009	22.8190	0.011
11	0.026	0.007	23.3780	0.016
12	0.051	0.043	25.5900	0.012

Table 4.7 Shanghai Composite Index Monthly Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.130	0.130	3.3407	0.068
2	0.193	0.179	10.7760	0.005
3	0.069	0.027	11.7370	0.008
4	0.216	0.181	21.2050	0.000
5	0.071	0.017	22.2400	0.000
6	-0.092	-0.182	23.9800	0.001
7	0.073	0.080	25.0870	0.001
8	-0.040	-0.057	25.4150	0.001
9	0.015	-0.011	25.4620	0.003
10	-0.011	0.066	25.4890	0.004
11	-0.030	-0.060	25.6750	0.007
12	-0.103	-0.120	27.9310	0.006

Table 4.8 Shenzhen Composite Index Daily Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.072	0.072	21.3280	0.000
2	-0.020	-0.025	22.9680	0.000
3	0.032	0.036	27.2550	0.000
4	0.047	0.042	36.2310	0.000
5	-0.006	-0.011	36.3680	0.000
6	-0.019	-0.017	37.8880	0.000
7	0.037	0.037	43.5970	0.000
8	0.015	0.007	44.4640	0.000
9	-0.003	-0.001	44.4930	0.000
10	0.004	0.004	44.5660	0.000
11	0.032	0.027	48.7100	0.000
12	0.019	0.014	50.1410	0.000

Table 4.9 Shenzhen Composite Index Weekly Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.103	0.103	8.9465	0.003
2	0.080	0.070	14.3870	0.001
3	0.062	0.047	17.5850	0.001
4	-0.002	-0.018	17.5880	0.001
5	-0.043	-0.050	19.1720	0.002
6	-0.021	-0.014	19.5500	0.003
7	0.033	0.045	20.4740	0.005
8	0.100	0.103	28.9310	0.000
9	0.065	0.044	32.5100	0.000
10	0.013	-0.020	32.6490	0.000
11	0.043	0.022	34.2350	0.000
12	0.015	0.007	34.4190	0.001

Table 4.10 Shenzhen Composite Index Monthly Return Q-Statistics

Order	AC	PAC	Q-Stat	Prob
1	0.123	0.123	3.0174	0.082
2	0.178	0.165	9.3410	0.009
3	0.047	0.009	9.7881	0.020
4	0.178	0.150	16.2170	0.003
5	0.038	-0.004	16.5130	0.006
6	-0.096	-0.161	18.4030	0.005
7	0.092	0.117	20.1570	0.005
8	0.028	0.022	20.3250	0.009
9	-0.007	-0.054	20.3350	0.016
10	-0.015	0.031	20.3830	0.026
11	0.020	-0.002	20.4630	0.039
12	-0.026	-0.067	20.6060	0.056

Table 4.5 shows that the p-value of *Q*-statistic of the 1*st*, 2*nd* and 3*rd* orders of the Shanghai Composite daily return is significantly larger than the significance level of 5%, indicating that the statistics are not significant and the null hypothesis is not rejected. The daily return series does not exist first-order correlation, second-order autocorrelation and third-order autocorrelation, but there is a 4-10 order correlation in the 4-10 order statistics.

Table 4.6, for the autocorrelation test of the Shanghai weekly return series, the results show that the p-values of the first-order autocorrelation and the second-order autocorrelation of the *Q*-statistic are greater than 1% at the significance level of 1%, and the statistics are not significant. There is no serial correlation on the first order and the second order, and the 3-10 order exists serial correlation.

Table 4.7 shows that the p-value of the *Q*-statistic of the 1st of the Shanghai Composite monthly return is significantly larger than the significance level of 5%, indicating that the statistics are not significant and the null hypothesis is not rejected. The daily return series does not exist first-order correlation, but there is a 2-10 order correlation in the 2-10 order statistics.

Table 4.8 and Table 4.9 are the autocorrelation test of the Shenzhen daily return series and the autocorrelation test of the Shenzhen weekly return series. The results show that all the *p*-values of daily and weekly return from 1-12 order are less than the significant level at 1%, and the statistics are significant and reject the null hypothesis. There is strong serial correlation on Shenzhen composite daily and weekly returns.

Table 4.10 shows that the *p*-value of the *Q*-statistic of the 1*st* order of the Shanghai Composite monthly return is significantly larger than the significance level of 5%, indicating that the statistics are not significant and the null hypothesis is not rejected, the monthly return series does not exist first-order correlation but there is a 2-10 order correlation in the 2-10 order statistics.

In conclusion, the autocorrelation test of the Shanghai and Shenzhen stock markets shows that there is some degree of serial correlation in both markets, and the markets are not fully weak-form efficient. The results are consistent with the previous findings in emerging markets, e.g., Harvey (1995), Poshakwale (1996), Mobarek and Keasey (2002), Hassan et al. (2006). They find significant presence of strong serial correlation in emerging stock market returns, which indicate these markets are not weak-form effective. However, contrary to what Ma and Barnes (2001) reported, they found that the autocorrelation of daily returns on the indices of each of two markets do not decay gradually as the lag length increases.

4.3 Unit Root Test

The unit root is a crucial condition for examining a random walk, therefore, the Augmented Dickey-Fuller test is employed to test the null hypothesis of a unit root. The results of ADF for a unit root for the Chinese stock price indices are illustrated in Table 4.11. According to the Figure 3.1-3.6 shows, the ADF test model that including intercept and time trend for the whole sample period from January 2000 to October 2016 can be determined.

Table 4.11: Results of the Augmented Dickey-Fuller Unit Root Test for Stock Index Closing Price

		Level		
	t-statistic	***t-critical value***		
Shanghai		**1%**	**5%**	**10%**
Daily Index	**-1.8644**	**-3.9603**	**-3.4109**	**-3.1273**
Weekly Index	**-2.2340**	**-3.9691**	**-3.4152**	**-3.1298**
Monthly Index	**-2.9486**	**-4.0061**	**-3.4332**	**-3.1404**
		First Difference		
Shanghai		**1%**	**5%**	**10%**
Daily Index	**-35.8012**	**-3.9603**	**-3.4109**	**-3.1273**
Weekly Index	**-14.2499**	**-3.9691**	**-3.4152**	**-3.1298**
Monthly Index	**-6.6609**	**-4.0063**	**-3.4333**	**-3.1405**
		Level		
Shenzhen		**1%**	**5%**	**10%**
Daily Index	**-2.1632**	**-3.9603**	**-3.4109**	**-3.1273**

Weekly Index	**-2.7939**	**-3.9691**	**-3.4152**	**-3.1298**
Monthly Index	**-2.7337**	**-4.0061**	**-3.4332**	**-3.1404**
		First Difference		
Shenzhen		**1%**	**5%**	**10%**
Daily Index	**-34.0381**	**-3.9603**	**-3.4109**	**-3.1273**
Weekly Index	**-15.0941**	**-3.9691**	**-3.4152**	**-3.1298**
Monthly Index	**-8.3660**	**-4.0063**	**-3.4333**	**-3.1405**

The ADF test of the Shanghai stock market can be seen from the above table, the test on daily closing price at three significant levels of 1%, 5%, 10%, the critical value is -3.9603, -3.4109, -3.1273, while the t-statistic value of -1.8644, the t-statistic is greater than the three t-critical values on corresponding significance levels; therefore, the null hypothesis H_0 cannot be rejected. That is, the Shanghai stock market daily closing price series exists a unit root, and it is non-stationary. For the ADF test on Shanghai daily closing price of the first order difference series, the t-critical values on corresponding significance level of 1%, 5%, 10% are larger than the *t*-statistic; therefore, the null hypothesis H_0 is rejected. The Shanghai daily closing price of the first order difference series does not exist a unit root, and it is stationary.

The ADF test of Shanghai stock market on the weekly and monthly closing price were also tested. For the weekly closing price series, the *t*-statistic -2.2340 is larger than the *t*-critical values -3.9691, -3.4152, -3.1298of corresponding significance levels of 1%, 5%, 10%; therefore, the null hypothesis H_0 cannot be rejected. That is, the Shanghai stock market weekly closing price series exists unit root, and it is non-stationary. But after first order difference, the *t*-statistic -14.2499 is less than the *t*-critical values -3.9691, -3.4152, -3.1298 of corresponding significance levels of 1%, 5%, 10%, therefore, the null hypothesis H_0 is rejected. The Shanghai weekly closing price of the first order difference series does not exist a unit root, and it is stationary. The monthly closing price series, also cannot reject the null hypothesis H_0 on level. It processes a unit root and is non-stationary. But, after the first order difference, the null hypothesis H_0 is rejected, and there is no unit root exist on the series and it is stationary.

Similarly, the ADF test of the Shenzhen stock market on the daily closing price shows that the *t*-statistic of -2.1632 is larger than the *t*-critical values of -3.9603, -3.4109, -3.1273 at a significance level of 1%, 5%, 10% respectively. Therefore, the null hypothesis H_0 cannot be rejected. That is, the Shenzhen stock market daily closing price series exists unit root, and it is non-stationary. For the ADF test on Shenzhen daily closing price of the first order difference series, the *t*-critical values on corresponding significance level of 1%, 5%, 10% are larger than the t-statistic; therefore, the null hypothesis H_0 is rejected, and the Shenzhen daily closing price of the first order difference series does not exist a unit root, it is stationary.

The ADF test of the Shenzhen stock market on weekly and monthly closing price are also tested. For the weekly closing price series, the *t*-statistic -2.7939 is larger than the *t*-critical values -3.9691, -3.4152, -3.1298 of corresponding significance levels of 1%, 5%, 10%; therefore, the null hypothesis H_0 cannot be rejected. That is, the Shanghai stock market weekly closing price series exists unit root, and it is non-stationary. But after first order difference, the *t*-statistic -15.0941 is less than the *t*-critical values -3.9691, -3.4152, -3.1298 of corresponding significance levels of 1%, 5%, 10%; therefore, the null hypothesis H_0 is rejected. The Shenzhen weekly closing price of the first order difference series does not exist a unit root, and it is stationary. For the monthly closing price series, it is also cannot reject the null hypothesis H_0 on level. It processes a unit root and is non-stationary. But, after the first order difference, the null hypothesis H0 is rejected, and there is no unit root exist on the series and it is stationary.

In the ADF test on the Shanghai and Shenzhen stock market closing price, according to the SIC to determine the number of lag for the test, it is found that the stock closing price series of the Shanghai and Shenzhen stock markets has a unit root, and it is non-stationary. The first order difference series does not exist a unit root and is a stationary time series. It indicates that according to the stock price of the Shanghai and Shenzhen stock markets follow random walk, the market is weak-form efficient.

4.4 Variance Ratio Test

In reality, stock price series often do not strictly follow the normal distribution, so some of the assumptions based on the normal distribution of stock price series empirical test results are often not very reliable. The variance ratio test proposed by Andrew W. Lo and A. Craig MacKinlay (1988) not only provides a method for testing time series under homoscedasticity assumption, but also provides a method for testing under heteroscedasticity assumption. The stock index returns are employed to do the variance ratio test. The variance ratio test is conducted for various lags of *q* (i.e., 2, 4, 8 and 16 days) for each index. The results of variance ratio tests for the Shanghai and Shenzhen markets for the full sample period are reported in Table 4.12. Z(q) and Z*(q) represent the statistics of the variance ratio under the assumption of homoscedasticity and heteroscedasticity, respectively.

Since Z(q) and Z*(q) are asymptotically conform to thenormal distribution in the large sample, therefore, if | Z(q) | ≥ 1.96, | Z*(q) | ≥ 1.96 or | Z(q) | ≥ 2.56, | Z*(q) | ≥ 2.56, we consider that the two statistics are significant at 5% or 1% significance level, that is, the null hypothesis H0 is rejected, the series not follow the random walk; if Z(q) and Z*(q) are not satisfied with the conditions, then it is not significant, the null hypothesis H0 cannot be rejected, the series follows random walk.

Table 4.12: Result of the Variance Ratio Test

			Numbers of Lag (*q*)			
Market			***q*=2**	***q*=4**	***q*=8**	***q*=16**
Shanghai	**Daily**	***Z(q)***	**-30.3690****	**-25.8770****	**-18.8313****	**-13.5717****
		Z*(q)	**-16.9824****	**-15.5669****	**-12.2622****	**-9.4027****
	Weekly	***Z(q)***	**-14.5154****	**-11.3575****	**-8.5814****	**-6.1595****
		Z*(q)	**-9.5777****	**-8.0153****	**-6.4397****	**-4.8213****
	Monthly	***Z(q)***	**-7.4353****	**-5.7371****	**-3.9649****	**-2.8986****
		Z*(q)	**-4.7477****	**-3.9927****	**-2.9455****	**-2.2126***
Shenzhen	**Daily**	***Z(q)***	**-28.7089****	**-25.3280****	**-18.6910****	**-13.5043****
		Z*(q)	**-17.0686****	**-16.0757****	**-12.8092****	**-9.8134****

	Weekly	***Z(q)***	**-14.0870****	**-11.1459****	**-8.5486****	**-6.1350****
		Z*(q)	**-8.8471****	**-7.3399****	**-6.0389****	**-4.6265****
	Monthly	***Z(q)***	**-7.3663****	**-5.6659****	**-4.0224****	**-2.9072****
		Z*(q)	**-5.2788****	**-4.3951****	**-3.2377****	**-2.3845***
Z(q) **is variance ratio test statistics assuming homoscedasticity;** ***Z*(q)*** **is variance ratio test statistics, heteroscedasticity.**						
**** and * indicate statistical significance at the 1% and 5% level respectively.**						

As the table 4.12 shows, under the homoscedasticity assumption, the Shanghai Composite Index return daily, weekly and monthly series in all the lags are significant at 1% level and rejected the null hypothesis H_0. They do not follow the random walk. The similar results for the Shanghai composite index return daily, weekly and monthly series on the assumption of heteroscedasticity. All the results are significant at 1% level except the monthly return series under the lag of 16. It significant at a 5% level. The results indicate that the Shanghai stock market is not weak-form efficient.

For the Shenzhen Composite Index return under the homoscedasticity assumption, daily, weekly and monthly series in all the lags are significant at a 1% level and rejected the null hypothesis H_0. They do not follow the random walk. The similar results for the Shanghai composite index return daily, weekly and monthly series on the assumption of heteroscedasticity. All the results are significant at 1% level except the monthly return series under the lag of 16, it significant at 5% level. The results indicated that the Shanghai stock market is not weak-form efficient.

Table 4.13: Result of the Variance Ratio Test on three time panels

			Number of Lag (q)			
Time Series	**Market**		***q*=2**	***q*=4**	***q*=8**	***q*=16**
S1	**Shanghai**	***Z(q)***	**-18.2492****	**-15.0746****	**-11.2068****	**-8.0635****
		Z*(q)	**-10.8367****	**-9.6489****	**-7.8007****	**-6.0275****
	Shenzhen	***Z(q)***	**-18.0388****	**-15.0144****	**-11.1953****	**-8.0422****
		Z*(q)	**-11.0542****	**-9.7498****	**-7.7626****	**-5.9306****

S2	**Shanghai**	***Z(q)***	**-18.7175****	**-15.5936****	**-11.2379****	**-8.1146****
		$Z^*(q)$	**-11.4735****	**-10.3359****	**-8.1179****	**-6.2229****
	Shenzhen	***Z(q)***	**-17.1093****	**-15.2408****	**-11.1282****	**-8.0776****
		$Z^*(q)$	**-11.0103****	**-10.5519****	**-8.3842****	**-6.4484****
S3	**Shanghai**	***Z(q)***	**-15.0682****	**-13.8950****	**-10.1024****	**-7.2659****
		$Z^*(q)$	**-7.8330****	**-7.6669****	**-5.9337****	**-4.5415****
	Shenzhen	***Z(q)***	**-14.8002****	**-13.4563****	**-10.0255****	**-7.2194****
		$Z^*(q)$	**-8.5896****	**-8.2479****	**-6.5822****	**-5.0310****
***Z(q)*, variance ratio test statistics assuming homoscedasticity; *Z*(q)*, variance ratio test statistics, heteroscedasticity.**						
**** and * indicate statistical significance at the 1% and 5% level respectively.**						

As table 4.12 shows, under the homoscedasticity assumption, the Shanghai Composite Index return S1, S2 and S3 series in all the lags are significant at 1% level and rejected the null hypothesis H_0. They do not follow the random walk. Under the assumption of heteroscedasticity, all the results are significant at a 1% level. So it rejects the null hypothesis H_0. Therefore, the results indicate that the market effectiveness of the Shanghai stock market has not change from 2000 to 2016, it is still not weak-form efficient.

The similar results for the Shenzhen Composite Index return S1, S2 and S3 series. Under the homoscedasticity assumption, S1, S2 and S3 series in all the lags are significant at a 1% level and rejected the null hypothesis H_0. They do not follow the random walk. Under the assumption of heteroscedasticity, all the results are significant at a 1% level, so it rejects the null hypothesis H_0. Therefore, the results indicate that the market effectiveness of the Shenzhen stock market has not changed from 2000 to 2016, and it is still not weak-form efficient.

The overall findings based on variance ratio test indicate that the Shanghai Composite and Shenzhen Composite markets haven’t become more efficient over time. China’s stock market is not weak-form efficient. The empirical findings coincide with the Ma and Barnes (2001) and Darrat and Zhong (2000) findings of randomness in both the Shanghai and Shenzhen stock markets. However, it contradicts those of Lima and Tabak (2004) who found that both markets exhibit a random walk.

CHAPTER Ⅴ

CONCLUSION AND RECOMMENDATIONS

The empirical results of this study indicate that stock returns in both the Chinese stock markets do not behave in a manner consistent with the weak-form of efficient market hypothesis. The Augmented Dickey-Fuller unit root test shows the existence of a unit root in all of the series. The results obtained from the serial correlation, variance ratio and runs tests show strong evidence of a non-random walk pattern in both Chinese stock markets. The results from three of these tests indicate the presence of positive autocorrelation in the daily return series in all index series.

In emerging markets, such as the Chinese market where securities are less liquid and information is asymmetric, the effects of overconfidence and biased self-attribution can be especially pronounced." In this light, this finding of inefficiency in the Chinese stock market does not appear too surprising.

The rejection of weak form of market efficiency in daily and weekly returns has two important implications for a common investor: Firstly, the investor can earn superior profit by making use of equity research and valuation and discovering and investing in underpriced stocks; Secondly, more value can be added by holding a well-diversified portfolio, proper stock selection, aggressive investment strategies and frequent stock trading. Also, the absence of random walk has economic implication, i.e., it can result in possible distortion in correct pricing of equity and capital, allocation of national resources and movement of foreign capital, and impede overall economic development of a country.

In order to improve the efficiency of the stock market, the Chinese government should strengthen the supervision of the securities market and the supervision of the securities market information disclosure, improve the market supervision and regulations. The liquidity of the securities market information affects the market effectiveness in several ways. At present, China's securities market information distribution is uneven, the circulation speed is slow, the information disclosure of listed companies is not standardized, instant, accurate and complete, which affect the spread of information in China's securities market, reducing the effectiveness of the market.

Therefore, how to improve the quality of information is also an urgent need to solve these problems. The state should establish an authoritative financial information center to issue relevant information to the outside, and reduce the monopoly of certain information to large investors. And improving the structure of China's securities market investors, the developing investor institutions. Institutional investors are more abundant funds, investment philosophy is more advanced, they usually committed to long-term investment, and could attract a large number of social idle funds. It is a potential group. Developing institutional investors is one of the ways to improve the efficiency of the securities market.

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