

UNIVERSITY OF VAASA
FACULTY OF BUSINESS STUDIES
DEPARTMENT OF ACCOUNTING AND FINANCE

Ran Zhao

**THE EFFECT OF INFORMATION FLOWS ON STOCK MARKET
VOLATILITY: CHINESE EVIDENCE**

Master's Thesis in
Accounting and Finance
Line of Finance

VAASA 2008

Table of Contents	Page
ABSTRACT	5
1. INTRODUCTION	7
1.1. Purpose of the study	11
1.2. Research hypothesis	12
1.3. Previous studies	14
1.3.1 Review of the international research	14
1.3.2 Review of the Chinese research.....	16
1.4. Structure of the thesis	17
2. MARKET MICROSTRUCTURE THEORY.....	19
2.1 Prices behavior and information.....	19
2.2 Information and trading volume	22
2.3 Trading volume and price changes.....	24
3. MIXTURE DISTRIBUTION HYPOTHESIS.....	27
3.1 The assumptions of MDH theory	27
3.2 The model of MDH theory	31
4. DATA AND METHODOLOGY	34
4.1 Data.....	34
4.1.1 Data descriptions	34
4.1.2 The Sample period.....	36
4.1.3 Descriptive Statistics of Returns.....	38
4.1.4 Trading Volumes	42
4.2 Methodology.....	44
4.2.1 Return series	45
4.2.2 GARCH Model.....	46
4.2.3 EGARCH Model	48
5. EMPIRICAL RESULTS AND DISCUSSIONS.....	50
5.1 Results of GARCH model	50
5.2 Results of EGARCH model.....	56

6. CONCLUSIONS	61
REFERENCES	65
APPENDICES	71

UNIVERSITY OF VAASA**Faculty of Business Studies**

Author:	Ran Zhao
Topic of the Thesis:	The Effect of Information Flows on Volatility of Stock Markets: Chinese Evidence
Name of the Supervisor:	Professor Timo Rothovius
Degree:	Master of Science in Economics and Business Administration
Department:	Department of Accounting and Finance
Major Subject:	Accounting and Finance
Line:	Finance
Year of Entering the University:	2006
Year of Completing the Thesis:	2008

Pages: 75

ABSTRACT

This study analyzes the effect of information flows on Chinese A-share market. The purpose of the study is of three aspects. First, the study investigates whether trading volume and volatility of world market are correlated to the volatility of Chinese market. Second, the effects of information flows are compared between Shanghai with Shenzhen market, from bear period to bull period. Finally, the leverage effect, namely the asymmetric reflections to bad and good news, on Chinese market is also analyzed.

The main sample in this study is Shanghai, Shenzhen A-share market and the world market represented by MSCI World Index. The data pool is comprised of daily observations of Shanghai A-share Index (SHAI), Shenzhen A-share Index (SZAI) and MSCI World Index. The trading volume of SHAI and SZAI are also utilized in the study. The sample period spans from 1st, Jan. 2003 to 31st, Dec. 2007. GARCH (1,1) and EGARCH (1,1) model are employed in the empirical studies.

The empirical findings demonstrate the MDH theory holds in Chinese A-share market, which indicating the volatility is affected by old information and new information together. The old information has a bigger effect on the volatility during the bear period while the new information impacts more on volatility in the bull period. The effect of international information is more significant in Shenzhen market, but is larger in Shanghai market in the bear period. Leverage effect is also found in Chinese market. This study contributes to existed literature by the consideration of international factor.

KEYWORDS: Chinese A-share stock market, MDH Theory, Information Flows, Trading volume, Volatility

1. INTRODUCTION

The estimation and forecast of volatility stays to be the focus of modern financial studies. As one of the most important characteristics in financial market, volatility directly relates to the risk and uncertainty in the financial market. The volatility is considered as one of the core variables in many financial analyses, such as portfolio theory, CAPM model, APT model and option pricing model. It is one of the most effective indicators that represent the market's quality and efficiency as well.

The volatility is a stochastic process. According to the theory of market microstructure, it is mainly caused by the continuously arriving of new information and the absorption procession of the information into the market. Generally, the financial market always fluctuates as soon as information comes out, bad or good news for instance. The fluctuation will continue for a period of time. Since the information is considered to occur stochastically, the volatility is also thought to be a random process. In a large number of studies, the stock index is found to possess the time varying variance, namely in some periods, the volatility is large while in some other periods, it is relatively small.

Engle (1982) suggested the autoregressive conditional heteroskedasticity model (ARCH) in depicting the time varying characteristic in stock market. Bollerslev (1986) developed the model further into generalize ARCH model (GARCH). In several studies, the GARCH model is found to explain volatility in different countries and periods.

However, the cause of volatility can be hardly explained completely by the GARCH model along. One basic assumption of GARCH model is that the volatility is estimated conditionally by the previous shocks. To some extent GARCH model can explain the time varying characteristic in volatility. However it can hardly throw light upon which kind of exogenous factors, more than historical data, also helps explain the cause of volatility. In terms of the theory about market microstructure, the ARCH effect in the GARCH model is considered as the generator of volatility. It can be explained as the information arrived and absorbed in the past time. Besides the historic information, the present information also deserves to be investigated in the study of volatility.

To study the effect of current information, one should first search for a proxy so that the abstract concept of information flow can be represented in a much more concrete way. In fact, the announcement of information always followed by dramatically increase of trading volume. As soon as good or bad news comes out, investors will trade actively,

causing the trading volume to increase rapidly and the price to fluctuate a lot. In contrast, when the market goes without news of importance, it will perform in a stable phase. The trading behavior will be inactive and the price will just get small volatility. Given the casual relationship between information and trading volume, many researchers consider volume as a proxy of information in their studies. Clark (1973) proposed the mixture distribution hypothesis (MDH) to illuminate the relationship between the volatility and trading volume in the stock market. The MDH theory founded the theory base for applying volume as the proxy of information flow.

A large amount of empirical research results based on studies on various countries' stock market verified the theory of MDH. After employing trading volume into the GARCH model, many researchers (Lamoureux and Lastrapes 1990, Brailsford 1996, Phylaktis and Kavussanos 1996, Omran and Mckenzie 2000, Marsh and Wagner 2000) found that the coefficient of trading volume was really significant and the coefficient of ARCH and GRACH factors became not significant at all. They concludes that trading volume as a proxy of information flows can absorb most ARCH effect and drive the volatility in the market.

However, there are also some other researches, based on evidence from different countries in different periods, claiming that the addition of volume can only perform as a complementation for the ARCH effect rather than totally eliminate the ARCH effect. The ARCH will still be significant in explaining the volatility (Lamoureux and Lastrapes 1994, Sharma 1996, Locke and Sayers 1993).

Miyakosh made further analysis and suggested that trading volume as the proxy of information flows could be determined by two parts, one of which is related to the old information while the other is related to present or future potential information. Thus the trading volume can explain both the volatility persistence, which is used to be depicted by ARCH effect, and the new information flows' effect on the market. When volume is added into the conditional variance model, the old information part would be absorbed by the ARCH process. Therefore, in the ARCH model with volume, the trading volume represents the present information arriving in the market. The ARCH effect reflects the old information's influence on the market.

With the addition of trading volume into the GARCH model, one can test the effect of information flows on the volatility. This will throw light on the behavior of investors by analyzing which kind of information (old or new) could depict the volatility better. Such

kind of researches will be of importance in understanding and comprehending the cause and regularity of volatility. They will be especially important for markets where investors are considered to be really sensitive to information, such as Chinese stock market (Chen 2002; Hu 1999).

Over the last decade, Chinese stock exchanges (CSEs), consisted of Shanghai Security Exchange (SHSE) and Shenzhen Security Exchange (SZSE), have experienced rapid expansion and development. SHSE was opened in December, 1990 followed by SZSE in July 1991. At the beginning of their establishment, there were only 10 listed companies with share trading being restricted to domestic investors only. By the end of 2007, there were 1534 listed companies (860 and 674 on the SHSE and SZSE respectively), with total market capitalization of US\$ 4166.87 billion (RMB 30209.97 billion) and total investors accounts over 124 million (SHSE, www.sse.com.cn and SZSE, www.szse.cn). The market capitalization of China's stock market exceeds that of Hong Kong, and is ranked the second largest in Asia after Japan since 2001. At the end of 2006, the SHSE was ranked 19th in the world, surpassing the Taiwanese and Singapore exchanges in Asia.

SHSE and SZSE together comprise the Chinese Security Market. Companies may choose either exchange to be listed but not both. Both SHSE and SZSE are controlled by the central government and have very similar listing rules and regulations. There are some slight differences between the two exchanges, such as Shanghai Exchange gets higher trading fees, Shenzhen exchange has both close call auction and open call auction while Shanghai exchange only has open call auction. The main differences between the two markets come from the local character of the two exchanges.

SHSE is located in the east coast city of Shanghai, the largest city and the financial centre of China. To reinforce Shanghai's position as a financial centre and also due to other political reasons, the central government invested more in development of the SHSE than SZSE. For instance, from 2001 to 2003, all IPOs (initial public offering) are required to be listed on the SHSE. Thus, SHSE has more listed companies than Shenzhen Exchange, most of which are large and state-owned enterprises (SOE), making up the bulk of the trading volume.

SZSE is situated in the southern city of Shenzhen neighboring Hong Kong, the first and most important special economic zone in China, where the economic reform was carried out initially in 1978. SZSE consists of mainly small, manufacturing and export oriented

companies doing business with Hong Kong, many of which joint ventures. This export-oriented nature of the Shenzhen market and its local position nearby Hong Kong may contribute it to be more sensitive to global information. Moreover, the SZSE develops a second board market for small and newly established enterprises. In the long run, Shenzhen market is much more possible to serve mainly for small enterprises.

Two types of shares are traded on both SHSE and SZSE. One is A shares which are ordinary shares issued by mainland Chinese companies, subscribed and traded in RMB (also called Chinese Yuan, denoted as CNY) and designed for domestic investors. At the end of 2003, qualified foreign institution investors (QFII) are approved to invest in the A-share markets. The other is B shares which are issued by mainland Chinese companies, denominated in RMB but traded in foreign currencies (HKD in SZSE and USD in SHSE). Initially, B shares are restricted to foreign investors. Since February 2001, the B-share markets have been opened to domestic investors.

Given the restriction on foreign investment and controls on the market imposed by Chinese government, Chinese A-share stock market was almost closed to the world since it's born. However, China's entry into the WTO on 11th Nov., 2001, is a significant milestone in the opening of the A-share market to other global markets (Cheong and Yee, 2003). In keeping its commitment to the WTO, China changed the term structure of its interest rates by extending the maturity and RMB's exchange rate is no longer fixed to the dollar but is put on an adjusting pegged regime (Los and Yu 2008). Chinese domestic enterprises are affected deeper by foreign enterprises through the international competition and trading, which drove the stock market more susceptible to the global economy atmosphere. The GATS (General Agreement on Trade in Services) has posed great challenges to China's securities regulatory systems, namely, its accounting system and transparency of law and regulations.

In the end of 2002, the Chinese government implemented the Qualified Foreign Institutional Investors (QFII) policy introducing foreign investment into the A share market and Chinese bond market. Despite the strict criteria outlined in the QFII policy, since 2003 the number and investment quota of QFIIs keeps increasing. The total investment quota has already excess 30 billion USD by the end of 2007 and QFII following social security funds, becomes the second largest investing part in A-share market. Therefore, Chinese A-share market made obvious progress towards opening to the world and becoming more internationalized.

Thus, it is essential to take global economic factors into account when estimate the volatility of Chinese market. In this paper, the volatility of international stock market will be added into the GARCH model as an exogenous in the conditional variance equation. Granted the assumption that the trading volume as a proxy of information flows can be divided by two parts, namely old information and new information, the new information part is further divided into two parts, the domestic information and the international information. The international effect is expected to be absorbed by the factor of international market volatility while the remained domestic effect will be mainly represented by the trading volume. In this way, the effects of old information, domestic information and international information will be estimated clearly and separately. The generation process of volatility in Chinese A-share market would be analyzed more thoroughly.

1.1. Purpose of the study

Chinese stock market is still an emerging market. However, by entering into WTO and implementing the QFII policy, it starts to open to the world and gets more tightly related to the international financial atmosphere. Provided China's the rapid economy development during the last two decades, Chinese market is attracting more and more attention from all over the world. Thus, Chinese stock market will provide more opportunities for research and investment.

This paper mainly intends to discover the sources of volatility by studying the information flows' influence on the volatility of Chinese A-share market. Taking international factors into account, the effect of three kinds of information: the old information, the domestic information and the international information will be compared and analyzed in detail. The study is supposed to assist investors and researchers treat different kinds of information with different weight when they estimate the risk of Chinese A-share market.

The study also tests the correlation and cointegrated relationship between Chinese A-share market and the world stock market (employing MSCI World as a proxy). Chinese market has closed to the outside world for such a long time and even now it is still not totally opened, the purpose for the cointegration test is to provide reasonable data scale in the international information's effect analysis. It will find out the critical time since when Chinese market starts to be affected by the world market with acceptable significance. Moreover according to the CAPM theory, investors can diversify risk by

making portfolio of two market indexes if their correlation is less than 1. Therefore, the results of cointegration test will also provide the foreign and domestic investors with the information about the risk diversify function of Chinese A-share stock market.

Given the fact that Chinese stock market has performed as a bull market since 20th July, 2005, and as a bear market in a long period before, this paper will carry out the study base on the couple kinds of market conditions separately. More specific results are expected to be obtained through the period dividing. In addition, this paper also intends to study leverage effect by employing EGARCH model in order to distinguish the asymmetry between effects of bad news and good news on the volatility.

1.2. Research hypothesis

In this paper, only A-share market is studied for the following reasons. Firstly, A-shares substantially dominate the market with respect to number of shares issued, market capitalization and trading activity. At the end of 2007, 1507 companies listed in A-share markets while only 109 companies listed in B-share markets, most of which also issue A-shares. The total market capitalization of A-share markets is over 30000 billion RMB while that of B-share markets is only 226 billion RMB. The trading volume of A-share market in 2007 is about 3500 billion shares contrast to 70 billion shares in B-share market (www.sse.com.cn and www.szse.cn). Second, the B-share failed to attracted foreign investment (Huang, Yang and Hu 2000) especially after the implement of QFII policy in A-share market.

Given the opening up of Chinese stock market, we tends to take international information factor into account when estimate the volatility. However, since it still has a quite long history almost totally closed to the world, we should first exam from when the Chinese market started to be obviously influenced by the world market. The cointegration test between Chinese A- share market and the World market is employed and the first hypothesis comes out:

H1: Both Shanghai and Shenzhen A-share stock indexes are cointegrated with the world stock market, in each year from 1997 to 2007.

After deciding the exact period for the study, we should test if GARCH model fits the characteristics of returns in Chinese-A share market well. Then we can decide whether we can estimate the return series by GARCH model or not. Thus, we arrive at the second hypothesis:

H2: The return series in both Shanghai and Shenzhen A share market can be well depicted by GARCH model.

Next, the trading volume as the proxy of information flows would be added into the conditional variance equation. The old information's effect conveyed in trading volume would be absorbed by the ARCH effect. The trading volume now represents the new information arriving in the market, causing the volatility together with the ARCH effect. Then the hypothesis should be as follows:

H3: The trading volume, as the proxy of new information can help explain the volatility of Shanghai and Shenzhen A share market.

H4: The effect of old information, represented by ARCH effect, decreases and gets less significant after the addition of trading volume.

Then, international information is taken into account. The international factor is expected to have some explanation power on the volatility. Therefore we have the other hypothesis:

H5: The effect of international information is one of the sources of risk in Shanghai and Shenzhen market.

Then, we test the EARCH effect in the return series and tend to distinguish effects of good news and bad news with the following hypothesis:

H6: Bad news generally causes bigger volatility than good news in Shanghai and Shenzhen market.

Through comparing the results from bull period with that from bear period, the effect of information is not expected to be the same. Our final hypothesis is:

H7: Old information increases larger volatility during the bear period while new information affects more during the bull period.

1.3. Previous studies

1.3.1 Review of the international research

There is a large amount of researches focus on the volatility in financial market. Given the fact that many stock indexes have the characteristic of time-varying variance, ARCH and GARCH model is widely used to depict the volatility of stock markets. The ARCH model (autoregressive conditional heteroskedasticity) was first proposed by Engle (1982) to deal with the time-varying characteristic and later, Bollerslev (1986) improved the ARCH model into GARCH model (generalized ARCH) to estimate the volatility. Some other scholars further improved the model putting modification and addition upon original ARCH model, for instance GARCH-M (Marsh and Wagner 2000) and E-GARCH (Pan 2003). Numerous empirical results show that the GARCH model and its extension models are fit for many financial return time series well.

However, the GARCH model can only explain the past volatility's effect on stock market fluctuation and ignore the exogenous that also impact on the market. Clark (1973) firstly proposed mixture distribution hypothesis (MDH) to explain the relationship between stock market volatility and trading volume. He considered that the volatility and trading volume are both determined by information flows arriving in the market, which is an intangible underlying factor. Since the information flows are unpredictable and abstract, one can use the trading volume as its proxy. The theory of market microstructure indicated that the volatility is mainly caused by the continuously arriving of information flows and the absorption of the information flows into the market. Thus one can expect that the effect and significance of ARCH factor will decrease after the addition of trading volume as a proxy of new information flows.

The MDH theory was supported by a great deal of empirical tests based on evidence from different countries. Lamoureux and Lastrapes (1990) studied on a sample of 20 common stocks in American market and found that ARCH effects vanished when volume is added as an explanatory variable in the conditional variance equation. They concluded that daily trading volume, used as a proxy for information arriving at the market, is tested to have significant explanatory power on the variance of daily returns.

Brailsford (1996) employed trading volume as a proxy for news and found a reduction in the significance and magnitude of volatility persistence (ARCH effect), based on empirical study on Australian stock market. Phylaktis and Kavussanos (1996) did similar research on the Athens Stock Exchange. They also found that trading volume or trading value as proxies for information flows are significant in explaining the variance of daily returns and reducing GARCH effects substantially.

Omran and Mckenzie (2000) extended the studies of Lamoureux and Lastrapes (1990) into the UK stock market, using data on 50 UK companies. They find the autocorrelations of the squared residuals still contains a highly significant GARCH effect when trading volume is used in the conditional variance. Their studies get different results from above mentioned findings that GARCH model become insignificant after the addition of trading volume.

Marsh and Wagner (2000) proposed to utilize unexpected trading volume as a new proxy for information flow and studied return-volume dependence relationship in the US and six international equity markets. They found that unexpected volume is superior in explaining conditional variance.

Besides researches on stock market, the analysis about momentum in return was also extended to other financial markets. Similar results are found. Locke and Sayers (1993) studies on the variance structure of minute-minute S&P 500 index Future return series. The contract volume is found to explain a significant amount of returns variance, however, some evidence of remaining variance persistence was still found. They suggested that utilization of a pure ARCH-type model for high frequency returns data implies a mis-specification.

In 1994, Lamoureux and Lastrapes again examined the ability of volume data to shed light on the source of persistence in stock-return volatility. However, their results contrasted to those in their 1990 study. They suggested that considering serial dependence in trading volume does not eliminate GARCH persistence in variance. Two years later, Sharma, Mougoue and Kanath (1996) tested the GARCH effect in NYSE with volume data for four years. Their finding is quite astonishing showing that even by the addition of trading volume, the ARCH effect is still significant. They claimed that the inclusion of volume as a proxy of information in the conditional variance model helps in explaining the GARCH effects in stock return. However, the GARCH effects do not completely vanish as a result of this inclusion.

Japanese researcher Miyakosh Tatsuyoshi studied further based on the price index of Tokyo Stock Exchange (TOPIX) applying the idea proposed by Lamoureux and Lastrapes(1990). He divided the sample period into two parts, one of which is from 1990 to 1997 (TOPIX9097) while the other is from 1998 to 2000 (TOPIX9820). The results found that for the former sample period, the coefficient of trading volume is not so significant while for the latter one, the coefficient of trading volume got really significant and the ARCH effect dampened obviously. According to the test of the whole period from 1990 to 2000, both trading volume and ARCH effect are significant in the conditional variance equation.

To explain the phenomenon, Miyakosh Tatsuyoshi estimated the trading volume by AR process and suggested that the current trading volume is consisted of predictable part (AR part) and unpredictable part (the estimated error). The predictable part can be explained as old information which will be absorbed by the ARCH effect. The unpredictable part, named “news” by Miyakosh Tatsuyoshi, is left to represent the new information arriving in the market. In addition, there were not so many big “news” in the Japanese market during the early 1990s. This fact fitted the insignificance of trading volume in the test result well. However, during the later 1990s, the occurrence of big financial or economics accident got more frequently, thus the volatility was mainly affected by the “news”, which is represented by the trading volume.

1.3.2 Review of the Chinese research

In 1994, Yu found that the ARCH effect existed in Shanghai stock market. Ding (1999), Tang (2001), Li (2002) employed different derivatives of ARCH model and all verified the characteristics of volatility clustering and persistence in the return series of Chinese Stock Market.

As to Chinese domestic scholars, the relationship between trading volume and stock price keeps attracting their attention as well. Zhang & Yan (1998), Chen & Song (2000) tested the relationship between absolute changes in stock price and the trading volume. Wang & Wu (2002) tested the relationship between changes in stock price and the trading volume. Zhao & Wang (2003) and Xu (2000) studied the relationship between price variance and the trading volume. Wu (2001, 2002) started to enclose the trading

volume into stock price estimation series to find out how the trading volume drove the change in price.

Many Chinese researchers studied on the effect of information flows on the stock price variance and tested the effectiveness of MDH theory on Chinese stock market. Wang and Wu (2001) studied the correlation between Chinese A-share market and B-share market. They estimated the two markets separately by GARCH (1, 1) with trading volume included. They found the results of the two markets are quite different. For the A-share market, the coefficient of trading volume was significant and ARCH effect damped after trading volume is added. However, for the B-share market, the ARCH effect kept significant after the inclusion of trading volume. Li (2002) also found that in the GARCH (1, 1) model, adding trading volume as the proxy of new information flows will decrease the significance and persistence of ARCH effect. Their results supported the effectiveness of MDH theory in Chinese stock market.

Wang (2002) employed GARCH-M model to estimate Shenzhen and Shanghai stock market. He found that for conditional variance of Chinese stock markets, after adding the trading volume, the extent to which ARCH effect decreased was quite smaller than that for foreign developed countries. Pan & Wu (2003) divided the sample period according to different market condition, bull market, soft market and bear market. They studied how the information flows, represented by trading volume, effect on volatility in each kind of market condition. They found that both the ARCH effect and trading volume are significant in Chinese stock market, however, during the bear period, the volatility depended more on the new information than historical information.

1.4. Structure of the thesis

This thesis is supposed to be organized as follows. The first three chapters mainly provide theoretical introduction and the later three chapters is expected to deal with empirical investigation. The opening chapter is an introduction to the study which rendered the purpose, the hypothesis, and the overview of earlier studies. The second chapter explains the market microstructure theory, together with the mixture distribution hypotheses theory introduced in Chapter 3, is the theory basic of this study.

Chapter four is the beginning of the empirical part which introduced the data studied in this paper and the methodology application as well. The empirical researching results

are presented and discussed in chapter five. Chapter six provides the conclusions of the study and summarizes the whole thesis.

2. MARKET MICROSTRUCTURE THEORY

Market microstructure theory is an important emerging branch of finance theory born at the end of 1960th, founded by *the cost of transacting* (Demsetz 1968). Due to the increasing global transaction in financial markets, the rapid development of electronic network communication technology and the nonstop renovation of financial derivatives during the last two decades, scholars get more and more interest in researching on market microstructure. The global market crash in 1987 and the Asian financial crisis in 1997 undoubtedly further impulse people make deeper investigation in the market microstructure. The Market microstructure theory is the study of the process and outcomes of exchanging assets under explicit trading rules. The microstructure literature analyzes how specific trading mechanisms affect the price formation process (O' Hara1995:1). The market microstructure theory provides an alternative to frictionless Walrasian models of trading behavior.

2.1 Prices behaviors and information

Traditionally, economics consider short term price is the equilibrium of demand and supply in the market. In the long run, it is the real value that determinates the price. In the perfect market, assuming the exists of perfect competition, symmetric information and free entry, Walrasian equilibrium price reflects the demand curve of all latent investors and claims that the trading mechanism does not effect on the equilibrium price. According to the traditional Walrasian equilibrium, the security market is studied as a whole and the effect of individual market participants is overlooked in the generation process of price.

However, actually, the security markets are imperfectly competitive which ask for transacting cost, such as order process cost, trading cost, market maker's inventory cost and do have asymmetry information. Moreover, in terms of the real value of assets, according to the traditional asset pricing model, the long term equilibrium value does not only exist but also be unique. Nevertheless, in the real economy circumstance, even the specialists in economy who share the same information cannot get consensus in the estimation of the real value of assets, let alone the mass investors.

Because of the above friction in the market, traders will chose trading strategy according to the maximal utility principle under the rules of the financial market, namely the trading mechanisms. Market microstructure research exploits the structure

provided by specific trading mechanisms to model how price-setting rules evolve in markets. This provides the ability to characterize not only how different trading protocols affect price formation, but also why prices exhibit particular time series properties process (O' Hara1995: 1-2). The core proposition of market microstructure is that various frictions exist in the market, thus the price is not necessary equal to the expected value of asset under complete information circumstance, which can represent the essence of markets well.

Nowadays, the main research problems are more and more related to the effect of information on the price behavior and the market mechanism (Dai 1999). In this paper, we will also merely focus on the information's influence on price behaviors. Different from traditional economy theory which treated price as a whole macro phenomenon, the market microstructure theory explains the price behavior as the outcome of individuals' optimal chooses under certain market mechanism. Thus, prices are determined by individuals' behavior and the market mechanism. Moreover, the changing of the price can be forecasted given the strategy of individual market participants. Two different methods in market microstructure theory are employed for asset pricing: one is the inventory model, while the other is the information model, which will be introduced as the theory basic in this paper.

The information model was initially proposed by Bagehot (1971), concluding that the ask-bid spread is caused by the information asymmetry in the financial market. In this model, the market maker receives all orders, clears trades and provides unequal bid price and ask price at the beginning of the time. Two types of traders are acting in the market: one is informed traders with special information about the true value of the asset; the other is uninformed traders without private inner information. The informed traders make profit by the information advantage through the trade while the uninformed traders, which are also called liquidity traders, trade for the liquidity demand.

The market maker will always get loss in the trade with informed traders who know better about the true value of the asset. Informed traders will buy when the asset is underpriced and sell when it is overpriced. Thus, to avoid bankrupt, the market maker has to offset the loss by the gains from trading with uninformed traders, which arises from the bid-ask spread. Copeland and Galai (1983) provided quantitative framework to prove that information alone is sufficient to induce market spreads.

Glosten and Milgrom (1985) and Easley and O' Hara (1987) further developed the concept of trades as signals of information. They reasoned that as soon as certain kind of information is achieved by informed traders, they will render an order to the market maker to gain profit from the information advantage. With asymmetric information, the nature of the order flow is not exogenous to the dealer's problem, and consequently the trade itself conveys information (O' Hara 1995:57). During the price setting process, the market maker learns from the order flow and in turn, the learning process affects the movement of prices over time.

According to game theory, Glosten and Milgrom (1985) proposed the sequential trade models to explain the information's effect on the price behavior. The basic idea is that the learning process of the market maker is analyzed explicitly by the Bayesian Learning Models. At the beginning, the market maker holds initial beliefs about the possibilities of the occurrence of information, the kinds of the information and facing an informed trader. He renders the prices by his beliefs to balance the probable loss and gain. Then the order flows are available to the market maker. Because of the information asymmetry, the market maker has to extract the information conveyed by the order flows. For instance, as to a sell order, it is possible to be given by a liquidity trader and is also possible to be rendered by an informed trader who considers that the asset is overpriced. After a infinite short period, the market maker would revise his beliefs about above possibilities according to the outcomes of the trade and adjust the bid and ask prices for the next time point. Thus, a large number of buy orders will cause the market maker to revise his expectation of the asset's value upward and his ask price move accordingly. The sell orders will cause the opposite revision. Finally, the continuous Bayesian learning process explains the dynamic price behavior, which is basically effected by the information asymmetry in the market.

To sum up, according to the information model, the fact of information asymmetry not only determines the ask-bid spread but also indirectly effects on the behavior of price. The informed traders make trading decision according to the new information while the market maker continuously revised bid and ask price based on the outcome of the trade. By this process the new information is absorbed and the price serious is generated. The price behavior reflects the trading history as well as the new information's arrival and absorption process into the market.

2.2 Information and trading volume

The relationship between information and trading volume is one of the studying directions in market microstructure theory. Just because of the actual frictions mentioned above, when the information is quite hugely flowing into the market, the traders will not execute their orders immediately until find the frictionless equilibrium price. As a result, market microstructure theory tends to establish unequilibrium models rather than Walrasian equilibrium to depict the market behavior.

Easley- O' Hara (1987) proposed another sequential trade model to exam the trade quantities in the market. This model differed from previous ones by allowing traders to transact in different sizes and adding the uncertainty of the existence of new information. Easley- O' Hara demonstrated that in this model, two types of equilibrium are possible. One is called separated equilibrium, where the informed traders could all choose to trade only the large quantity and hence be distinguished from the small uninformed traders. The other one is called pooled equilibrium, where the informed traders could choose to submit both large and small orders and thus be pooled with the uninformed traders. Which kind of equilibrium prevails in the market depends on the market parameters, such as the size of the trade, the fraction of the informed traders in the market. The result indicates that in many active markets huge blocks often be transacted, suggesting that in such markets a separating equilibrium might be expected to exist and the arrival of new information would cause increase in trading volume.

Copeland (1976) analyzed the change in demand and trading behavior based on the study of indentified traders receiving the same information sequentially. Copeland testified that when all the traders hold the same understanding about the information, the trading volume will be a logarithmically increasing function with respect to the number of traders and the amount of the information flows. In general markets, where the understanding of information is different among traders and the short selling is limited, Copeland proved that the trading volume would reach to the pick when the traders share the largest degree of agreement towards the information.

To examine the role of information by analyzing the trading volume, two approaches are generally utilized. One way can be exemplified by Wang (1994) which represented that the volume emerges when traders transact due to different information signals. Kim and Verrecchia (1991) found that public information stimulates trading. The explanation is provided by Wang's model, reasoning that public information affected different

investors (informed and uninformed) in different ways. The greater the asymmetry between traders' information is, the greater the trading volume gets when new information flows in. In this model, volume emerges as the result of traders' optimal demands according to their information set. When new information arrives at the market, trading behavior happens because of the information asymmetry among traders.

The other method focuses on the information inherent in the volume statistic and what traders can learn from observing volume (O'Hara (1995): 161.) Blume, Easley and O'Hara (BEO 1994) analyzed the learning process of price and volume data, demonstrating how the volume statistic itself affects the adjustment of prices to information (O'Hara 1995:166-168). In their model, each trader receives an informative signal every period, however, the level and the quality of signals are unknown to the market. BEO presented the formula of volume statistic. Through the formula, they demonstrated that given the price, volume conveys information about signal quality which can be learned by traders. Therefore, volume provides traders with the ability to sort out the effects of the quality of information from the direction of information effects impounded in price. If the quality is quite high, all the informed traders' strategies based on new information are highly correlated and they do not trade with each other. The only trade that occurs is between traders in the two groups. Thus, the model suggests that low volume may be as indicative of new information as high volume is.

Moreover, the BEO model also indicated that the occurrence of the new information can be inferred by the trading volume. Once the new information is received by informed traders, they will trade for profits actively. However, for uninformed traders, they will only trade for fluidity and is much more apt to cancel the trading because of an unpleasant price. The number of no-trade outcomes may be reasonable related to the number of uniformed trade. Thus, the greater the volume, the less frequent no-trade outcomes are, and the more likely it is that new information exists (O'Hara 1995:176).

In conclusion, new information may cause increase of trading volume; however, low volume may be also as indicator of information. To what degree the volume changes when new information arrives, depends on the market parameters, the comprehension of informed traders about the signal and the amount of information asymmetry in the market. In certain terms, new information determines the trading volume. Traders in the market can infer the underlying information conveyed in the volume and then adjust their trading strategy.

2.3 Trading volume and price changes

Trading volume is generally considered as a factor of price adjustment. Empirically, a strong link between volume and the absolute value of price movements is discovered. Empirical researchers have also established some asymmetric patterns to volume and the direction of price changes, although the generality of these results is subject to debate (O'Hara 1995:160-168). As early as Karpoff (1987), researches were already brought out to investigate the relationship between trading volume and price changes. However, there are not sufficient explanations about the empirical phenomenon. Kim and Verrecchia (1991) found that prices do not instantly adjust to publicly available information and volume appears to increase around the announcement of public information. Their analysis indicated that the change in volume is proportional to the precision of the public information signal and is decreasing in the amount of preannouncement public and private information.

In this study, we mainly tends to introduce the analysis of the relationship between volume and price changes presented in the two models mentioned in Section 2.2, namely the models proposed by Wang (1994) and Blume, Easley and O' Hara (1994). In Wang's model, the trading always happened with the price changing, because the traders are risk averse. The uninformed traders will apt to stop trading if the information-based trading is too high, in order to avoid losing from trading with informed traders. Only the price movement can compensate the riskiness in information asymmetry trading and induce the uninformed traders to participate in the trading. In this view, the positive correlation between trading volume and absolute price changes can be well interpreted. Wang also suggested that the more asymmetric information in the market, the more strong correlation will be between trading volume and the absolute price changing.

On the other method, Blume, Easley and O' Hara (1994) focused on the learning effect of traders and demonstrate that how the volume statistic itself affects the adjustment of prices to information (O'Hara 1995). Quite similar to Kim and Verrecchia (1991)'s result, they proved that the quality of information can be inferred from the trading volume. Provided the quality, the trading volume is a convex function with respect to the price, indicating that the volume has obviously positive correlation with the absolute price changing. BEO's theoretical demonstration was proved by empirical links between price and volume in most stock markets.

BEO further investigated the quality of information's effect on the positive correlation between trading volume and price changing. First they found that the higher the quality is, the more significant the correlation will be. However, the positive character of the correlation will not change generally. Secondly, the as the new information's diffusion among the traders, the convex relationship between trading volume and price tends to get flat, suggesting that the slope of trading volume to the price changing may decrease for the information diffusion but will still exist.

Another point worth mentioning is the research result of Diamond and Verrecchia (1987), which took into account the effect of short selling limitation to the trading volume. The basic assumption of D-V model is that if the trade is banned under some conditions, then the thin trade in the market will indicate the occurrence of certain conditions. The short selling limitation or banning may affect the behavior of traders and thus effect the adjustment of price to the new information.

In a market where short selling is totally banned, even if the informed traders detect the negative information, they cannot make profit by selling the stocks they don't possess. Thus, the occurrence of negative information may not be able to cause the increasing trading volume. The market maker cannot tell this situation from that new information does not exist. The price's adjustment to the new information, especially to the bad information may be slowed down by the confusion of the market maker caused by the short sell banning.

On the other hand, the result indicated that when the short selling is limited, namely the earning from short selling cannot be received immediately after the trade, the adjustment of price to the new information will be accelerated. The interpretation is that if the bad news exists, informed traders will chose short selling for information advantage while the uninformed may not do so because the limitation unsatisfied their liquidity requirement. Thus the thin trading period indicates the nonexistence of information and the increase of volume may enhance the probability of occurrence of new information.

To conclude, the strong link of trading volume and price changes has been identified in many empirical researches. One interpretation about this phenomenon is that uninformed traders need excess return to compensate the risk of information asymmetry trading. Thus the price change may stimulate uninformed traders to participate in the trading and hence increase the trading volume. Another interpretation is that market

makers will adjust the price by inferring the information conveyed in the trading volume. A low volume may indicate the higher portion of no-trading strategy belonged to uninformed traders and thus lower the probability of new information's occurrence. Moreover, in a short selling forbidden market, the price adjustment to the information especially to the bad information will be slow while in a short selling limited market, the adjustment will be accelerated.

3. MIXTURE DISTRIBUTION HYPOTHESIS

Clark (1973) proposed mixture distribution hypothesis (MDH) theory to depict the non-normal distribution phenomenon of financial data. In traditional financial theory the distribution of returns in financial market was simplified into normal distribution model. For instance, Markowitz's portfolio theory and William Sharpe's CAPM theory assume the utility function to follow the model with of mean and variance. The returns are also assumed to follow the normal distribution. However, empirically, the return series cannot fit the normal distribution well and generally display the fat tail characteristic. Generally, the distribution of daily price changes is kurtosis, the distribution of the daily volume of trader is positively skewed, and the squared daily price changes are positively correlated with trading volume, all of which can be interpreted by the MDH theory.

During the development of MDH theory in the past three decades, the core intensions of MDH theory keep unchanged which are presented as follows:

- (1) The information affects on the price and trading volume, and then finally induces the daily price and volume to follow series of distribution rather than a unique normal distribution.
- (2) The distribution series may be identified, with different parameters, while may also be different.

According to above intensions, MDH theory emphasizes the determinative effect of information on the price and trading volume. Therefore, the quality and quantity of information can be inferred by the analysis on the trading volume and the price.

3.1 The assumptions of MDH theory

The assumptions of MDH theory were first proposed by Clark (1973) while were later developed by Epps (1976), Tauchen (1983) and Harris (1986). Their studies constructed the foundation of empirical researches on early MDH theory. Supposing that the events, which generate information affects the stock price, occur sequentially the traders will adjust their portfolio and thus infuse the information into the stock price. Two assumptions should be introduced before the deduction of MDH theory (Harris 1986):

- (1) The post-event price changes and volumes of trade are jointly independently and identically distributed with finite variance.
- (2) The number of events occurring each day varies.

Suppose in day t , the number of events is n_t , then the price changes and the trading volume in day t is the cumulating of outcomes of n_t events. According to assumption (1) and the central limit theory, if the number n_t is big enough, the joint distribution of the price changes and the trading volume follows the dual variable normal distribution conditioned on n_t .

In the models in Tauchen (1983), Harris (1986) and Harris (1987), all the traders are assumed to be rational and make their expectation based on the price. If the unexpected information is symmetric, the traders' prior trades will also follow the symmetric distribution with zero mean and orthogonal to the price changes. The symmetry will induce the conditional covariance of daily price changes ΔP_t and daily trading volume V_t to be zero, which can be represented as the following formula:

$$\Delta P_t \sim N(an_t, bn_t | n_t) \quad (1)$$

$$V_t \sim N(cn_t, dn_t | n_t) \quad (2)$$

$$\text{cov}(\Delta P_t, V_t | n_t) = 0 \quad (3)$$

Where a, b, c, d are non-negative parameters and n_t is a random or pre-deterministic or seasonal variable.

Due to the amount of daily information is uncertain, the unconditional joint distribution of price changes and trading volume will be a mixture distribution. Each of their density function equals to expectation of their conditional distribution with respect to n_t . Since

the expectation can be interpreted as weighted average, the unconditional distribution of ΔP and V_t can be interpreted as the weighted average of a series of conditional distributions. According to the assumptions above, Harris demonstrated that the financial data have the kurtosis phenomenon and ΔP and V_t are positive correlated.

The earlier MDH theory subjected to the disadvantage that it is quite possible to get a negative volume and the effects of information on price and volume are the same. The later researches on MDH theory made some modifications to deal with these weaknesses.

Glosten(1985) and Anderson(1996) got some meaningful conclusions by combining the market microstructure theory with the MDH theory. In Glosten's sequential trading model, only one asset is assumed to be traded in the market with a random clearing value in the future. There are three risk neutral traders in the market: the market maker, the uninformed trader and the informed trader who can receive private information about the real value of the asset and gain profit through the informed trading. The trading process gradually reveals the private information of the informed traders. Finally all the traders in the market will reach at a consensus about the asset's value before the next new information arrives. Thus, the asset price changing process can be divided into two phases, one of which is the price discovering phase, namely the dynamic adjustment process caused by gradual learning, while the other one is the temporary equilibrium phase. Anderson presented the assumptions of MDH theory as follows:

$$\hat{V}_t | K_t \sim c * Poisson(m_0 + m_1 K_t) \quad (4)$$

$$R_t | K_t \sim N(0, K_t) \quad (5)$$

Where \hat{V}_t is the trading volume with time tendency subtracted; K_t is the relative strength of information occurring in day t; m_0 and m_1 are constants and m_0 represents the trades of liquidity traders.

Bollerslev (1999) admitted that the number of information arriving affect the price and trading according to MDH theory, however, it may be incorrect in short term. The

reason is that the reflections of price and volume to the information may be not identical, in another word, different models impulse the volume and price. They testified the MDH theory by long term memory process of trading volume and price.

In Fleming's findings, information should be assumed as a highly persistent memory process in order to explain the daily return's volatility in Anderson's model. Fleming's model assumed that the information arrived separately and the persistent memory can be realized by variable parameters. The conditional joint distribution of price changes and trading volume follows:

$$\begin{pmatrix} \Delta P_t \\ V_t \end{pmatrix} \Big| I_t, J_t \sim N \left(\begin{pmatrix} 0 \\ \lambda \sigma_v I_t J_t \end{pmatrix}, \begin{pmatrix} \sigma_p^2 + \frac{\sigma_v^2}{J_t} & 0 \\ 0 & k \lambda^2 \sigma_v^2 I_t J_t \end{pmatrix} \right) \quad (6)$$

Where I_t is the number of information arriving everyday, J_t is the number of active traders (not consider the liquidity trades). Fleming assumed that I_t is independent:

$$\begin{aligned} \Delta P_t &= \mu_{pt} + \sigma_{pt} \sqrt{I_t} Z_t \\ V_t &= \lambda \sigma_v I_t J_t \end{aligned} \quad (7)$$

Where μ_{pt} , σ_{pt} and σ_v are random variables, which may also have memory.

The researches of MDH theory are important for other related researches. For instance, Lamoureux (1990) employed trading volume into GARCH (1, 1) model:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \alpha_3 V_t \quad (8)$$

Among the sample of 20 common stocks, Lamoureux found that ARCH effect decreased or even disappeared in some samples. They interprets that the returns of financial assets obey the MDH theory and the arrival rate of information is the very variable in the mixture distribution. The arrivals of information in each day induce the

volatility of return. ARCH model can depict the relation of information and volatility. Actually, in equation (4) and (5), assume the information follows this equation:

$$K_t^{1/2} = \omega + \beta K_{t-1}^{1/2} + \alpha K_{t-1}^{1/2} \mu_t \quad (9)$$

Where $\alpha, \beta, \omega > 0$; μ_t follows independent identity distribution and $E(\mu_t) = 0$, $\text{Var}(\mu_t) = \sigma_\mu^2$. Otherwise, it can also be represented as:

$$\ln K_t = \omega + \ln K_{t-1} + \sigma_\mu \mu_t \quad \sigma_\mu > 0 \quad (10)$$

With the model of information, results can be obtained similar to that of GARCH or EGRACH model.

In the time varying researches, MDH theory strongly indicates that the changes of return are driven by the information arriving at the time point rather than calendar time. The researches about time deformation are also based on MDH theory.

3.2 The model of MDH theory

In traditional MDH models, the trading volume is probable to be negative. Anderson improved the model based on market microstructure theory. In this paper, a normal mixture distribution model with liquidity traders provided by Wang (2003), based on both traditional idea and Anderson's model is introduced.

According to market microstructure theory, two types of traders are assumed to trade in the market: the informed traders and the liquidity traders. The liquidity traders trade only for exogenous reasons, such as the consumption demand, the adjustment of portfolios and are insensitive to market information. The informed traders adjust their investment according to the new information in order to maximize the utility.

Assuming in day t , the i th information is I_t , and a number of n_t information arrives.

Every information set is independent, every signal from the information affect the supply and demand in the financial market, thus induce the price to move down and up

until the new equilibrium price arrives. Therefore, the price process every day is consisted of the market discovering phase and the temporary equilibrium phase. Assume the reflection of price changes to information is linear,

$$\Delta P_{i,t} = a + bI_{i,t} \quad (11)$$

And the reflection of trading volume to information is also linear,

$$V_{i,t} = c + d|I_{i,t}| \quad (12)$$

Equation (11) and (12) will be deduced into the traditional MDH theory. However, taking into account the liquidity traders in the market and assuming the number of liquidity traders is constant every day, the trading volume should include a factor of $\frac{e}{n_t}$,

where e represents the trading volume of liquidity traders. Thus equation (12) would be improved into:

$$V_{i,t} = c + d|I_{i,t}| + \frac{e}{n_t} \quad (13)$$

The trading volume and price changes every day would be represented as:

$$\Delta P_t = \sum_{i=0}^{n_t} \Delta P_{i,t} = \sum_{i=0}^{n_t} (a + bI_{i,t}) \quad (14)$$

$$V_t = \sum_{i=0}^{n_t} V = \sum_{i=1}^{n_t} \left| c + d|I_{i,t}| + \frac{e}{n_t} \right| = e + \sum_{i=1}^{n_t} |c + d|I_{i,t}| \quad (15)$$

Suppose that the every information set follows the independent identity normal distribution $I_{i,t} \sim i.i.d(0, \sigma^2)$. When the amount of information is huge enough, according to the central limit theory, we have:

$$\Delta P_t | n_t \sim N(an_t, b^2 \sigma^2 n_t) \quad (16)$$

$$V_t | n_t \sim N \left(e + \left| c + d \sqrt{\frac{2}{\pi}} \sigma \right| n_t, \left| 1 - \frac{6}{\pi} \right| d^2 \sigma^2 n_t \right) \quad (17)$$

Set $\alpha = \mu_p, b^2 \sigma^2 = \sigma_p, e = c, c + d \sqrt{\frac{2}{\pi}} \sigma = \mu_v, \left| 1 - \frac{6}{\pi} \right| d^2 \sigma^2 = \sigma_v$, the model will be simplified as:

$$\Delta P_t \sim N(\mu_p I, \sigma_p^2 I | I) \quad (18)$$

$$V_t \sim N(c + \mu_v I, \sigma_v^2 I | I) \quad (19)$$

Equation (18) divides the trading volume into two parts: one part is c , generated by exogenous factors, such as consumption demands, portfolio adjustments, while the other part is μ_v , caused by the arrival of information.

To sum up, Clark (1973) proposed the MDH theory as the theory base for the study of relationship between information flows and price volatility. MDH theory suggests that the price changes and the trading volume are determined by the unobservable underlying information flows. To be specific, the price change every day is the commutation of every change during the day while the number of changes is determined by the number of informational events n_t . According to MDH theory, the dynamic characteristic of price changes depends on the time series behavior of information flows. If n_t is large enough, the central limit theory considers the price changes approach to the normal distribution and the variance is a proportion of n_t . Thus, the conditional variance of daily price change could be considered as an increasing function with respect to the number of new information flows into the market. Since the new information is unobservable, the trading volume can be considered as a proxy of information flows. In another word, since the both trading volume and price changes follow the distributions with variable of n_t , the trading volume and price changes are all determined by information flows.

4. DATA AND METHODOLOGY

Shanghai A-share index (SHAI), Shenzhen A-share index (SZAI) and the trading volume of the two indices are the main data sets employed in the empirical study. The reason for choosing these two indexes is that they enclose all the A-share stocks listed in Shanghai and Shenzhen market and represent the Chinese A-share stock market well. The first part in this section provides a detailed description on the data employed in this paper while the later parts explain the model in the empirical test.

4.1 Data

4.1.1 Data descriptions

During the early 1990s, when Chinese stock market was newly established, the market fluctuated dramatically due to faulty regulations and immature investment behavior. Take Shanghai market index for instance. It started at 100 at the end of 1990 and only after one and a half years, it astonishingly rose to 1429. In the next five month, it tumbled below 400, the decrease rate reached at 75% by the end of 1992. However, only three month later, it increased to 1536 and stayed at this peak for four days, then began to fall down. The new decrease phase lasted 17 month until the index got 333 point on 19th, July, 1994. Just after one month, the index jumped to 1053, with the increasing rate over 200%. Then the index started to descend, to 512 point in the January of 2006 and increased to the year 1997. Chinese scholars generally consider that not until 1997, did Chinese stock market start to perform in a mature and stable way (Zhang 2002; Zhao and Wang 2003). The tempestuous fluctuation before 1997 may affect the statistic accuracy. Thus, we set the original pool in this paper to be Shanghai and Shenzhen A-share stock index from 1st Jan., 1997 to 31st, Dec., 2007.

The daily observations of the closing values of SHAI and SZAI are downloaded from <http://finance.sina.com.cn>. SHAI, reflecting the price changes of Shanghai A-share stocks was launched on 21st, Feb. 1992. The base period of SHAI is 19th, Dec. 1990 and the base value is 100. The method of weighted computation according to the market value of sample stocks is utilized in calculating the SHAI. SZAI is also calculated base on the weight of market value. The base period of SZAI is 3rd, Apr. 1991 and the base value is 100. SZAI is launched on 4th, Oct., 1992.

Both of the two indices are expressed in RMB, the Chinese currency. Since the establishment at the beginning of 1990^s, Chinese stock markets experienced rapid development. Figure 1 shows the history of the two indices from 1st Jan, 1997 to 28th, Dec. 2007. Figure 1 clearly represents that both Shanghai and Shenzhen market started to perform as a bull market around 2005. According to relevant studies, we consider the market as a bull market after 20th July, 2005 while as a bear market from 2002 to 20th July, 2005 ([http://www.chinaamc.com/.](http://www.chinaamc.com/))

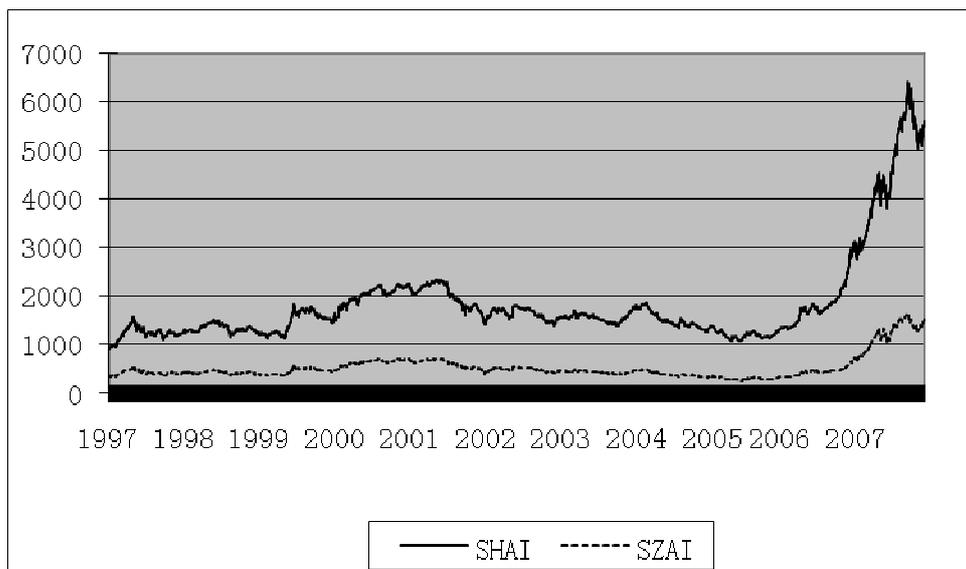


Figure 1 Shanghai and Shenzhen A-share Index from 1997 to 2007

MSCI World (Morgan Stanley Capital International World equity market index), as a benchmark index representing the world market portfolio, are considered in the international cointegration test. MSCI World, expressed by US dollar, includes a selection of stocks from all the developed markets in the world as defined by MSCI. This index includes securities from 23 countries¹, and has been calculated since December 31, 1969. The daily observations of MSCI World are downloaded from the Thomson Datastream database at University of Vaasa.

¹ List of countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States

4.1.2 The Sample period

In order to analyze the effects of international information on Chinese stock market, we should first test the influence of world stock market on Chinese stock market. Chen and Han (2003) suggested that Chinese stock market did not share the same long term trend with the world market, namely reject the cointegration hypothesis. However, with the entry into WTO at the end of 2001 and the implement of QFII policy at the end of 2002, China expedited the open of domestic stock markets. Thus, we test the cointegration and correlation between Chinese A-share Index (SHAI and SZAI) and the MSCI World Index in each year from 1997 to 2007. Table 2 shows t-statistic result and probability in unit root test of SHAI, SZAI and MSCI.

Table 1 ADF value in unit root tests of SHAI, SZAI and MSCI from 1997 to 2007

Null Hypothesis: The index has a unit root

	SHAI	SZAI	MSCI
1997	-2,3779 (0,1491)	-2,2009 (0,2066)	-1,6200 (0,4708)
1998	-1,4514 (0,5567)	-1,3341 (0,6140)	-1,9636 (0,3029)
1999	-1,3913 (0,5864)	-1,4211 (0,5717)	-0,3329 (0,9166)
2000	-2,5796* (0,0986)	-2,9457** (0,0418)	-1,4559 (0,5544)
2001	-0,4814 (0,8912)	-0,4809 (0,8913)	-2,0308 (0,2736)
2002	-1,2240 (0,6644)	-1,0959 (0,7178)	-1,3429 (0,6097)
2003	-2,4735 (0,1233)	-1,2139 (0,6689)	0,4377 (0,9842)
2004	-0,5105 (0,8855)	-0,3683 (0,9110)	0,0833 (0,9639)
2005	-1,8601 (0,3509)	-1,7130 (0,4234)	-0,6023 (0,8664)
2006	3,5701 (1,0000)	0,5770 (0,9618)	0,6226 (0,8618)
2007	-1,1578 (0,6929)	-1,7750 (0,3924)	-2,1573 (0,2227)

In parenthesis is the probability.

* denotes the significance of T-test value at the 10% level

** denotes the significance of T-test value at the 5% level

From Table 1 we can see that the null hypothesis cannot be rejected in all the three indexes from 1997 to 2007 except in the year 2000. In 2000, the unit root hypothesis should be rejected for SHAI with the significance level of 10% and for SZAI with the significance level of 5%. Then we can test the cointegration between SHAI, SZAI and the MSCI World from 1997 to 2007 except 2000, namely Hypothesis 1 introduced in Section 1.2. The result is represented in Table 2.

Table 2 Probability of Trace Statistic in Johansen Conintegration Test.

	1997	1998	1999	2001	2002	2003	2004	2005	2006	2007
SHAI	0,053*	0,803	0,994	0,668	0,886	0,494	0,971	0,414	0,029**	0,312
SZAI	0,063*	0,567	0,991	0,654	0,876	0,310	0,977	0,324	0,638	0,155

Null Hypothesis: The Index is not conintegrated with the MSCI World

*denotes rejection of the hypothesis at the 10% level

**denotes rejection of the hypothesis at the 5% level

As seen in Table 2, both Shanghai and Shenzhen A-share Index were cointegrated with the MSCI World Index at the significance of 10% level in 1997. The Asian Financial Crisis in 1997 affected the world market seriously, especially for the Asian markets. Chinese financial markets fluctuated together with many developed Asian markets, as Hong Kong, Singapore, and got a significant cointegration with the world market. After 1997, the hypothesis of none cointegration cannot be rejected at a significant level however, the probability fell dramatically during 2003, from 0,89 to 0,49 for SHAI and from 0,88 to 0,31 for SZAI. Since 2003, the probability fluctuated at a lower level and approximately keeps decreasing except for 2004. To 2006, SHAI can be considered cointegrated with MSCI World with the significance under the 5% level while in 2007, SZAI got the lowest statistic probability of 0,16 ever since 1998.

These indicate that although the cointegration does not generally exist between Chinese A-Share market Indexes and the World Index, the connection and interaction of Chinese A-Share market to the world market keeps strengthening since 2003. The correlation of SHAI, SZAI with the MSCI from 1997 to 2007 is shown in Figure 2. The correlation fluctuated a lot before 2003. However, it displays an ascending trend from 2003, suggesting the Chinese A-share market became more and more sensitive to the world market since 2003. Approximately, the correlation of SHAI and MSCI World increased from -0,4 in 2003 to 0,7 in 2007 while that of SZAI and MSCI World increased from -0,8 in 2003 to 0,7 in 2007.

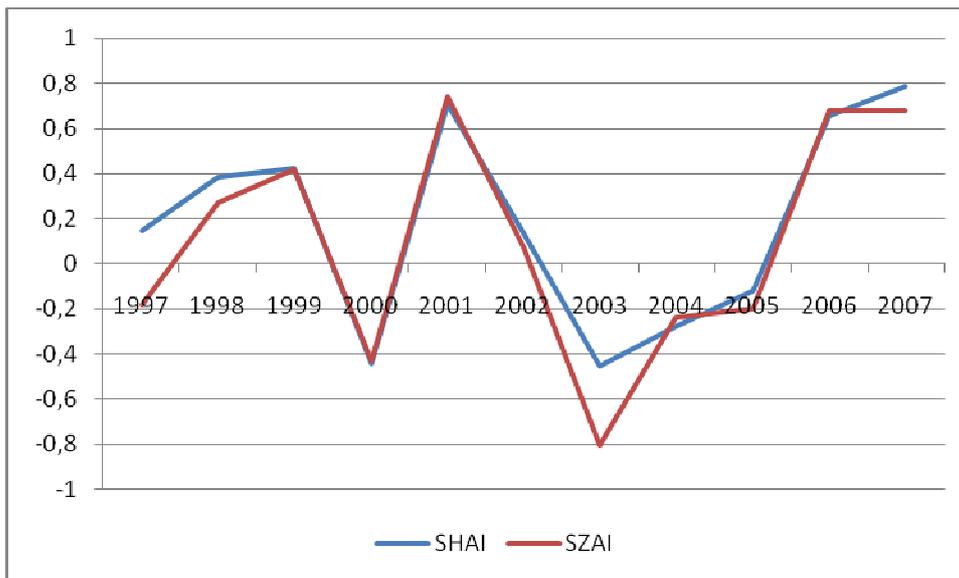


Figure 2 Correlation between MSCI World and SHAI, SZAI

One of the main causes is that at the end of 2002, the Chinese Government implemented the QFII policy, approving qualified foreign investment institutions to invest in the A-share market. Another reason is that at the end of 2001, China entered in to the WTO. Chinese enterprises are affected more and more by the global economy through the international competition and trading. Due to these factors, Chinese A-share market started to be more open and interactive to the world financial market. Thus, to test the effects of international information on Chinese A-share market, we set the sample period spanning from 1st Jan. 2003 to 31st Dec. 2007(1204 observations.) The period from 1st Jan., 2003 to 20th July, 2005 (609 observations) is considered as bear period while that from 21st July, 2005 to 31st Dec. 2007 (595 observations) is considered as bull period.

4.1.3 Descriptive Statistics of Returns

Daily returns are computed logarithmically from the closing values of indexes. The trending lines of the returns series are provided in Appendix 1. The descriptive statistics of returns from SHAI, SZAI as well as the MSCI World with the sample period spans from 2003 to 2007 is shown in Table 3.

Table 3 Descriptive statistics of returns (%) from 2003 to 2007

PANEL 1			
THE WHOLE PERIOD (1.1.2003–31.12.2007)			
	RETURN_MSCI	RETURN_SHAI	RETURN_SZAI
Mean	0,049	0,117	0,130
Median	0,087	0,109	0,158
Maximum	2,983	6,596	7,268
Minimum	– 2,719	– 9,533	– 9,377
Std. Dev.	0,690	1,475	1,561
Skewness	– 0,229	– 0,251	– 0,368
Kurtosis	4,252	6,564	6,008
Jarque-Bera	89,179	649,857	481,167
Probability	0,000	0,000	0,000
Observations	1204	1204	1204

PANEL 2			
THE BEAR PERIOD (1.1.2003–20.7.2005)			
	RETURN_MSCI	RETURN_SHAI	RETURN_SZAI
Mean	0,057	– 0,036	– 0,059
Median	0,077	– 0,073	– 0,060
Maximum	2,983	6,596	7,268
Minimum	– 2,719	– 3,968	– 5,109
Std. Dev.	0,690	1,242	1,295
Skewness	– 0,055	0,810	0,554
Kurtosis	4,629	5,383	5,263
Jarque-Bera	67,607	210,728	161,062
Probability	0,000	0,000	0,000
Observations	609	609	609

PANEL 3		THE BULL PERIOD (20.7.2005–31.12.2007)		
	RETURN_MSCI	RETURN_SHAI	RETURN_SZAI	
Mean	0,040	0,274	0,323	
Median	0,101	0,367	0,502	
Maximum	2,071	5,477	6,171	
Minimum	-2,515	-9,533	-9,377	
Std. Dev.	0,690	1,667	1,772	
Skewness	-0,406	-0,821	-0,883	
Kurtosis	3,852	6,813	6,154	
Jarque-Bera	34,393	427,352	324,015	
Probability	0,000	0,000	0,000	
Observations	595	595	595	

During the whole sample period, Panel 1 shows that the mean daily returns of both SHAI and SZAI, at 0.12% and 0.13% respectively, are much higher than that of 0.05% for MSCI World Index. In the bull period the mean returns of Chinese A-share markets exceed that of the world market even more, which is represented by Panel 2. In the bear period, the mean return of Chinese A-share market is negative, as shown in Panel 3, lower than that of the world market. However, the three panels in Table 3 represent that the standard deviation of daily returns in Chinese market is always higher than that in the world market, no matter what kind of market condition is prevailing (Bull, bear or the whole sample period.) Thus, consistent with previous studies, Chinese stock market as an emerging market exhibits the characteristic of high return as well as high risk. In addition, the standard deviation of returns in the bull period is larger than that in the bear period in both markets. The reason maybe that during the investment behavior is inactive in the bear period, thus the market goes more smoothly without so many fluctuations. In contrast, investors get more enthusiastic in trading during the bull market, resulting in higher volatility.

In the whole sample period and the bull period, shown in Panel 1 and Panel 3, negative skewness exists in the returns of all the three indexes. This suggests that extreme negative returns are much more likely to occur in these indexes than in those follow normal distribution. In the bear period as shown in Panel 2, the SHAI and SZAI have positive skewness, indicating extreme positive returns in Chinese A-share market are much more likely to occur in bear market condition. Kurtosis in each return series during all of the three periods is larger than 3, suggesting the distributions of all the

return series have fatter tails than normal distribution. The Jarque- Bera statistic results reject the normal distribution hypothesis for all of the three returns series.

Employ MA (1) model to regress the return series of MSCI, SHAI and SZAI from 2003 to 2007. Based on the OLS analysis, the residuals squared is found to be autocorrelated under the significance level of 1%, which is shown in Table 4.

Table 4 Autocorrelation of residuals squared for the MA (1) and OLS model from 2003 to 2007

	Residuals squared_MSCI Autocorrelation (Prob.)	Residuals squared_SHAI Autocorrelation (Prob.)	Residuals squared_SZAI Autocorrelation (Prob.)
1	0.126	0.133	0.214
2	0.198 (0.000)***	0.076 (0.000)***	0.085 (0.000)***
3	0.174 (0.000)***	0.032 (0.000)***	0.052 (0.000)***
4	0.153 (0.000)***	0.080 (0.000)***	0.101 (0.000)***
5	0.236 (0.000)***	0.051 (0.000)***	0.060 (0.000)***
6	0.163 (0.000)***	0.050 (0.000)***	0.061 (0.000)***
7	0.218 (0.000)***	0.024 (0.000)***	0.045 (0.000)***
8	0.109 (0.000)***	0.049 (0.000)***	0.077 (0.000)***
9	0.106 (0.000)***	0.012 (0.000)***	0.040 (0.000)***
10	0.237 (0.000)***	0.091 (0.000)***	0.075 (0.000)***

***denote the autocorrelation is significant under the level of 1%

Above results indicate that, the returns of MSCI, SHAI and SZAI display the characteristics of fat tail, kurtosis, and heteroskedasticity, which can be well fitted by GARCH model as most financial return series. By analyzing the return series with MA (1) and GRACH (1, 1) model, we can get the autocorrelation of residuals squared represented in Table 5, which decreases and is no longer significant. Therefore Hypothesis 2 introduced in Section 1.2 is verified and we will utilize the GARCH model in this paper to simulate the return series.

Table 5 Autocorrelation of residuals squared for the GARCH (1, 1) model from 2003 to 2007

	Residuals squared_MSCI Autocorrelation (Prob.)	Residuals squared_SHAI Autocorrelation (Prob.)	Residuals squared_SZAI Autocorrelation (Prob.)
1	-0.044	-0.011	-0.011
2	-0.003 (0.127)	0.003 (0.700)	0.003 (0.680)
3	0.042 (0.108)	-0.040 (0.352)	-0.040 (0.398)
4	0.051 (0.055)	0.017 (0.484)	0.017 (0.555)
5	0.016 (0.095)	0.009 (0.637)	0.009 (0.710)
6	-0.012 (0.153)	-0.023 (0.673)	-0.023 (0.772)
7	-0.009 (0.227)	-0.022 (0.710)	-0.022 (0.603)
8	-0.024 (0.264)	0.003 (0.807)	0.003 (0.714)
9	-0.027 (0.285)	-0.027 (0.793)	-0.027 (0.687)
10	0.099 (0.100)	0.025 (0.797)	0.025 (0.757)

4.1.4 Trading Volumes

In this paper, the trading volume of Shanghai and Shenzhen A-share markets will be added into the conditional variance equation, as a proxy of information flows. Actually in recent years, Chinese financial market developed rapidly. For instance, at the beginning of 2003, there are 682 companies listed in Shanghai A-share market and 473 companies listed in Shenzhen A-share market. To the end of 2007, these numbers increased to 846 and 671 respectively in the two markets. The increase rate is 24% for Shanghai A-share market and 41% for Shenzhen markets. Given the continuously new stocks issuing and the rapid expand of the market, the endogenous increase of trading volume will affect the accurate of empirical test. Thus, we should eliminate the long term trend from the trading volume series. We first logarithmize the trading volume series measured by shares which is shown in Figure 3, finding that the logarithmic series is unstable and displays ascending trend.

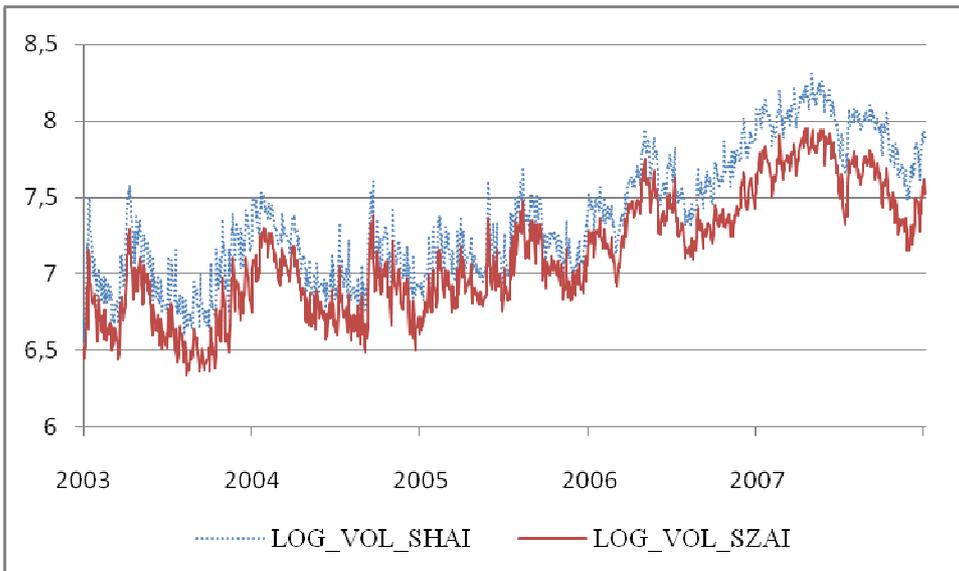


Figure 3 Logarithmic value of trading volumes for SHAI and SZAI

Gallant (1992) considered that both linear trend and nonlinear trend exist in the trading volume series. We employed AR (1) model to simulate the logarithmic trading volume series and generate the linear and nonlinear trends. The estimations of coefficients in the model are shown in Appendix 2. The results show that the linear trend is insignificant but the non linear trend is significant. Then we just delete the nonlinear trends in trading volume series of SHAI and SZAI. The residual of the following regressing equation (20) is considered as the adjusted trading volumes, which is shown in Figure 4.

$$\log(V_t) = \mu + \beta_1 \log(V_{t-1}) + \beta_2 t^2 + \varepsilon_t \quad (20)$$

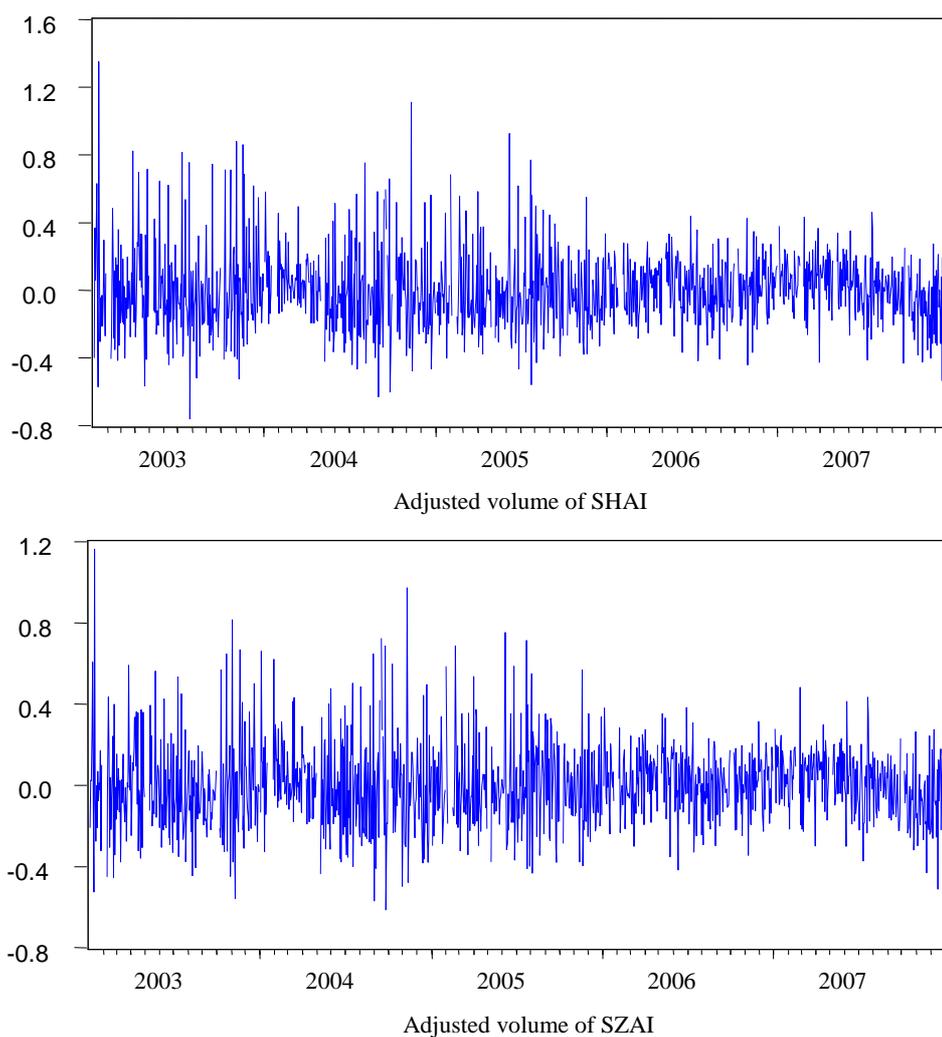


Figure 4 Adjusted trading volume of SHAI and SZAI

Through the ADF unit root test, the hypothesis of unit root is significantly rejected in the adjusted trading volume series for both SHAI and SZAI, indicating that the adjusted trading volume series is stable. The results of ADF test are represented in Appendix 3. In this paper, the adjusted trading volume series is utilized as the data of trading volume.

4.2 Methodology

Many researchers agree on that GARCH (1, 1) and EARCH (1, 1) model can reflect the conditional variance of financial series (Pan, Wu 2003; Wang 2002; Zhao&Wang 2003, Lamoureux and Lastrapers 1990, 1993; Hamilton 1994 etc.). For this reason, we also

employ GARCH (1, 1) and EARCH (1, 1) to simulate conditional variance of return series in this paper. The coefficients of ARCH and GARCH factors are denoted as ARCH effect, representing the effect of old information.

4.2.1 Return series

The daily returns in this paper are calculated in the method of continuous compounded return rate, namely the return on day t , r_t is obtained by

$$r_t = \ln(I_t / I_{t-1}) \times 100 \quad (21)$$

Where I_t is the close value of the Index on day t .

To get the conditional expected return on day t , we should first examine the autocorrelation of return series, which is shown in Table 6.

Table 6 Autocorrelation of returns of MSCI, SHAI and SZAI from 2003 to 2007

	RETURN_MSCI Autocorrelation (Prob.)	RETURN_SHAI Autocorrelation (Prob.)	RETURN_SZAI Autocorrelation (Prob.)
1	0.106(0.000)***	-0.095(0.001)***	-0.061(0.033)**
2	0.016(0.001)***	-0.029(0.003)***	-0.017(0.086)*
3	0.012(0.003)***	0.043(0.003)***	0.065(0.019)**
4	-0.022(0.006)***	0.041(0.003)***	0.042(0.016)**
5	-0.053(0.003)***	0.015(0.006)***	0.007(0.032)**
6	-0.049(0.002)***	-0.052(0.003)***	-0.002(0.058)*
7	-0.089(0.000)***	0.030(0.004)***	0.040(0.048)**
8	0.007(0.000)***	0.014(0.007)***	-0.007(0.076)*
9	-0.029(0.000)***	0.015(0.012)**	-0.004(0.114)
10	0.007(0.000)***	0.019(0.017)**	0.066(0.033)***
11	-0.011(0.001)***	0.089(0.001)***	0.060(0.013)**
12	0.003(0.001)***	0.009(0.002)***	-0.014(0.019)**
13	0.005(0.003)***	0.041(0.001)***	0.013(0.028)**
14	0.039(0.002)***	0.046(0.001)***	0.065(0.009)***
15	-0.044(0.002)***	0.053(0.001)***	0.025(0.011)**

In parenthesis is the probability.

* denotes the significance of Q Statistic test value at the 10% level

** denotes the significance of Q Statistic test value at the 5% level

*** denotes the significance of Q Statistic test value at the 1% level

Table 6 shows that the autocorrelation of return series for MSCI, SHAI and SHZI are all very significant even till after 15 orders. Many of the values are larger than 0.05. Thus we choose MA (1) model, which may fit this characteristic well, to calculate the conditional expect return. The daily return can be expressed by equation (22).

$$r_t = \mu_{t-1} + \varepsilon_t; \quad \varepsilon_t \sim IN(0, h_t) \quad (22)$$

Where μ_{t-1} is the conditional expectation of r_t , obtained by MA(1) model; ε_t is the unexpected price change on day t, equaling to the sum of all the price changes occurred in the day, which can be represented as follows:

$$\varepsilon_t = \sum_{i=1}^{n_t} \Delta p_{it} \quad (23)$$

Where Δp_{it} is the i th price change on day t; n_t represents the random number of information flows arrive at the market at day t. According to the MDH theory, we can assume Δp_{it} follows independent identified distribution, with the mean of zero and the variance of σ^2 . Additionally, if n_t gets big enough, we will have $\varepsilon_t | n_t \sim IN(0, \sigma^2 n_t)$.

4.2.2 GARCH Model

GARCH model can be employed to depict the accumulation process of daily price changes driven by n_t . The MDH theory considers the numbers of daily information flows are autocorrelated, which can be represented by the following autoregression equation:

$$n_t = \xi_0 + \sum_{i=1}^k \xi_i n_{t-i} + u_t \quad (24)$$

Where the impact of information flows will persist and u_t is the white noise. Setting the variance as:

$$\Omega_t = E(\varepsilon_t^2 | m_t) = \sigma^2 n_t \quad (25)$$

Substitute equation (24) in to equation (25), we can get an equation similar to GARCH model:

$$\Omega_t = \sigma^2 \xi_0 + \sum_{i=1}^k \xi_i \Omega_{t-i} + \sigma^2 u_t \quad (26)$$

Since n_t cannot be observed, we utilize the daily trading volume as its proxy. The equation (26) presented the persistence of volatility which can be depicted by GARCH model.

The GARCH (1,1) model in this paper is represented as follows:

$$r_t = \mu_{t-1} + \varepsilon_t; \quad \varepsilon_t \sim IN(0, h_t) \quad (27)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (28)$$

Where $\alpha_0 > 0$, $\alpha_1 + \beta_1$, denoted as ARCH effect reflects the persistence of volatility, namely the extent to which the historic volatility is inherited at the current time point. The ARCH effect reflects the effect of old information on the volatility. The nearer it approaches to 1, the bigger the volatility persistence is in the return series. Thus, if the variance is stable, $\alpha_1 + \beta_1$ should be less than one. Equation (28) is the linear function of conditional variance which can simulate the heteroskedasticity and clustering of the volatility. The clustering characteristic implies that the volatility does not only change according to the time, but will also continuously get relatively high or low in certain periods.

According to MDH theory, the trading volume as a proxy of information flows has significant effect on the volatility. Therefore the trading volume can be added as an

exogenous variable into the conditional variance equation of GARCH model (Lamoureux and Lastrapes, 1990). Then the equation (28) can be represented as:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma V_t \quad (29)$$

Where V_t is the adjusted trading volume at day t defined in section 4.1.4. MDH theory considers that if the trading volume series are autocorrelated, when γ is positive and significant, the ARCH effect will decrease or even disappear in equation (29)

To exam the international influence, we first simulate the returns of MSCI World with MA (1) and GARCH (1, 1) model, and then obtain the residual series. Consider the squared residual as the fluctuation of the world market, conveying the effect of international information. Therefore, we can add ε_{t-1}^W , as a proxy of international information available at day t, into the conditional variance equation and arrive at the following model:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma V_t + \eta \varepsilon_{t-1}^{W^2} \quad (30)$$

Where ε_t^W is the residual in the MA (1), GARCH (1, 1) regression equation of the world market return at day t.

The factor of $\varepsilon_t^{W^2}$ is expected to absorb the effect of international information flows conveyed in the trading volume. Therefore, after the addition of $\varepsilon_t^{W^2}$, γ will decrease and uniquely reflect the effect of domestic information flows. Moreover, the ARCH effect, representing the effect of old information will get further less or even insignificant.

4.2.3 EGARCH Model

GARCH model implies such assumption: The positive shock and negative shock in the same strength will cause the same volatility, namely the conditional variance has symmetry reflects to the positive and negative shocks. However, Black (1976) noticed that good news (represented by the phenomenon that the real return is bigger than the expected return) and bad news (represented by the phenomenon that the real return is smaller than the expected return), which is denoted as the leverage effect.

Christie (1982) provided an explanation to the leverage effect. The shock caused by negative information does not only increase the fluctuation risk but also reduce the rate earned on shareholder's equity with respect to debt. This will increase the financial leverage rate and thus increase the risk of holding the stock. For this reason, bad news may cause bigger volatility to the price. On the other hand, good news will decrease the financial leverage rate when cause fluctuation risk at the same time. Obviously, GARCH model is not capable to depict this asymmetry. Nelson (1991) proposed the Exponential GARCH (EGARCH) model to simulate the asymmetry. His research testified the existence of leverage effect.

In this paper, the sample period is divided into two periods, the bear period and the bull period. In different market conditions, the stock market is supposed to display different reflections to the bad news and good news. Moreover, the leverage effects caused by domestic news and international news are also expected to be distinct. Therefore, we exam the volatility with EGARCH model and change equation (28), (29) and (30) into

$$\log h_t = \alpha_0 + (\phi | \varepsilon_{t-1} / h_{t-1}^{1/2} | + \phi^* \varepsilon_{t-1} / h_{t-1}^{1/2}) + \beta \log h_{t-1} \quad (31)$$

$$\log h_t = \alpha_0 + (\phi | \varepsilon_{t-1} / h_{t-1}^{1/2} | + \phi^* \varepsilon_{t-1} / h_{t-1}^{1/2}) + \beta \log h_{t-1} + \gamma \mathcal{V}_t \quad (32)$$

$$\log h_t = \alpha_0 + (\phi^d | \varepsilon_{t-1} / h_{t-1}^{1/2} | + \phi^d * \varepsilon_{t-1} / h_{t-1}^{1/2}) + (\phi^i | \varepsilon_{t-1}^W / h_{t-1}^{W1/2} | + \phi^i * \varepsilon_{t-1}^W / h_{t-1}^{W1/2}) + \beta \log h_{t-1} + \gamma \mathcal{V}_t \quad (33)$$

Where β measures the persistence of volatility; $h_t^{W1/2}$ is the GARCH variance of Equation (28) with the returns of MSCI World; ϕ^d and ϕ^i measure domestic and international leverage effect respectively. If they are negative and $-1 < \phi^d, \phi^i < 0$, then the negative news will cause bigger volatility than the same strength's positive news. Contrarily, if ϕ^d and ϕ^i are positive, for negative and positive news in the same strength, the positive news will cause bigger volatility. If ϕ^d and ϕ^i equal to zero, the volatility reflects to the negative and positive news symmetrically. To sum up, the equations (27)-(32) consist of the model in the empirical study of this paper. The results will be presented and discussed in the next chapter.

5. EMPIRICAL RESULTS AND DISCUSSIONS

This paper analyzes the effect of the information flows on the volatility of Chinese A-share market. The GARCH and EGARCH model expressed by Equation (27)-(32) is utilized in the empirical studies. In the mathematics models, the old information is represented by the ARCH part while the factor of trading volume is consider as a proxy of new information flows. Then the squared residual of the world index is added into the conditional variance equation to examine the effect of international information flows. The effect of international information conveyed in the trading volume factor will be absorbed and the trading volume will only represent the new domestic information flows. All the empirical studies are carried out based on the sample period spans from 2003 to 2007 and the sub-periods of bear period and bull period as well. The statistic bearware utilized in the empirical test is EVIEWS 6.0. Many graphs and tables are obtained by the Microbear Excel Spreadsheet program.

This chapter presents and discusses the empirical results of this paper. The analysis follows the Hypotheses 3 to Hypotheses 7 which was introduced in Section 1.2. The first part of this chapter focuses on the GARCH model, analyzing the effects of old information, domestic information flows, and international information flows on the volatility of Chinese A-share market. The later part focuses on the EARCH model, investigating the leverage effect in Chinese A-share market. The discussions about the empirical results are also provided.

5.1 Results of GARCH model

The MA (1), GRACH (1, 1) model introduced as Equation (27) and (28) is utilized to simulate return series of SHAI and SZAI. The results of MA (1) model is provided as Appendix 4 while the results of GARCH model is represented in Table 7.

Table 7 The GARCH results of Equation (27) and (28)

	Return of SHAI			Return of SZAI		
	α_1	β_1	$\alpha_1 + \beta_1$	α_1	β_1	$\alpha_1 + \beta_1$
The whole period	0,062 (0,000)	0,927 (0,000)	0,989	0,058 (0,000)	0,934 (0,000)	0,992
The bear period	0,052 (0,004)	0,891 (0,000)	0,942	0,062 (0,002)	0,914 (0,000)	0,975
The bull period	0,065 (0,000)	0,932 (0,000)	0,997	0,055 (0,000)	0,937 (0,000)	0,992

In parenthesis is the z-test probability.

Table 7 represents the results of GARCH (1, 1) model without trading volume. For all the periods in both the Shanghai and Shenzhen A-share market, the ARCH effect is very significant and the value of $\alpha_1 + \beta_1$ approaches to 1. This suggests that strong volatility persistence and clustering exist in Chinese A-share stock market. Additionally, the sum of GARCH and ARCH estimated coefficients gets smaller in the bear period than in bull periods. The reason may be that during the bear period, it is hard for investors to forecast the further performance of the market and make investment decision. The trading behavior in the market gets inactive in the bear period, thus the market does not fluctuate a lot and the volatility persistence becomes smaller than that in the bull market.

By adding adjusted trading volume as a proxy of information flows into the GARCH equation, we examined Equation (29) and represented the results in Table 8.

Table 8 The GARCH results of Equation (29) for returns of SHAI and SZAI

Panel 1	Returns of SHAI			
	α_1	β_1	$\alpha_1 + \beta_1$	γ
The whole period	0,174 (0,000)	0,534 (0,000)	0,708	3,002 (0,000)
The bear period	-0,020* (0,366)	0,518 (0,000)	0,498	2,299 (0,000)
The bull period	0,091 (0,000)	0,132 (0,020)	0,223	4,955 (0,000)

Panel 2	Returns of SZAI			
	α_1	β_1	$\alpha_1 + \beta_1$	γ
The whole period	0,146 (0,000)	0,575 (0,000)	0,721	3,016 (0,000)
The bear period	0,016* (0,554)	0,538 (0,000)	0,553	2,585 (0,000)
The bull period	0,215 (0,000)	0,281 (0,000)	0,496	5,747 (0,000)

In parenthesis is the z-test probability.

* denotes the estimation is insignificant out of the 10% level

Table 8 shows the results of GARCH (1, 1) model with the trading volume. The coefficient of trading volume is estimated to be significant under the 1% level in all of the periods for both markets. These empirical results verified Hypothesis 3 that the trading volume can help explain the generation process of volatility in Chinese A-share stock market. The volatility and the trading volume are correlated positively.

In both of the two markets, the coefficient of the trading volume gets bigger in the bull period than in the bear period, suggesting Chinese A-share market is more sensitive to the new information flows in bull period. One explanation is that during the bull period, investors are enthusiasm and active. Any new information will be paid attention to for making investment decision. Thus, the new information flows may cause larger volatility in the bull period. However, in the bear period, invest decisions are made more cautiously and the investment behavior is tepid. Investors do not focus so much on new information.

Comparing Table 8 with Table 7, we can testify Hypothesis 4 introduced in Section 1.2. Through the addition of the trading volume into the GARCH model, the ARCH effect decreased dramatically in all periods and the estimated coefficient for ARCH factor gets insignificant in the bear period for both Shanghai and Shenzhen market. Thus, we conclude that the trading volume is one of the sources of the market risk. However, in spite of the decrease, the ARCH effect is still very significant in all the three periods for the two markets. This indicates that the old information and the new information flows together explain the volatility of Chinese A-share stock market.

In order to examine the effect of international information, we introduced the squared residual of MSCI World's return series simulated by Equation (27) and (28). Adding the squared residual into the Equation (29) as a proxy of international information, we arrive at Equation (30), the empirical results of which are shown in Table 9.

Table 9 The GARCH results of Equation (30) for returns of SHAI and SZAI

Panel 1		Return of SHAI				
	α_1	β_1	$\alpha_1 + \beta_1$	γ	η	
The whole period	0,071 (0,015)	0,450 (0,001)	0,521	2,041 (0,000)	-0,228 (0,000)	
The bear period	-0,012* (0,653)	0,326 (0,089)	0,314	1,176 (0,000)	-0,115 (0,000)	
The bull period	0,204 (0,000)	0,304 (0,001)	0,508	4,827 (0,000)	-0,020* (0,793)	
Panel 2		Return of SZAI				
	α_1	β_1	$\alpha_1 + \beta_1$	γ	η	
The whole period	0,131 (0,000)	0,605 (0,000)	0,736	2,981 (0,000)	0,060 (0,092)	
The bear period	0,009* (0,664)	0,596 (0,000)	0,605	2,497 (0,000)	-0,045 (0,080)	
The bull period	0,196 (0,000)	0,235 (0,006)	0,432	5,584 (0,000)	0,312 (0,030)	

In parenthesis is the z-test probability.

* denotes the estimation is insignificant out of the 10% level

Table 9 represents the results of GARCH model with further addition of international information. The squared residual for the return series of MSCI World is utilized as a proxy of international information. In the whole sample period, the coefficient of international factor is estimated to be negative and significant under the 1% level for the Shanghai market. It is estimated to be significant and positive under the 10% level for the Shenzhen market. This verified Hypothesis 5 introduced in Section 1.2 that the international information flows help in explaining the volatility of Chinese A-share markets.

Moreover, the coefficient of volume factor decreases by the addition of international factor in both of the two markets. The reason is that the effect of international information conveyed in the trading volume is absorbed by the new added international factor. Then the volume will only represent the domestic information. Since the ARCH effect is still significant in spite of decrease, we conclude that the risk of Chinese A-share market is caused by the old information, the new domestic information and the international information together.

Comparing the empirical results obtained from Shanghai markets with those from Shenzhen markets, we can get some interesting findings. For instance, the coefficient of international factor is estimated to be bigger and more significant in returns of SHAI than that in returns of SZAI. This suggests the Shanghai market is more sensitive to international information than Shenzhen market. More companies with big market size and keeping well performance for years are listed in Shanghai Exchange. Such kind of companies is more likely to get preferred by foreign investment institutions, generating a bigger correlation with the world market. The bulk foreign investment in Shanghai market may bring bigger effect of international information on volatility.

This can also explain the fact that in the bull period, the international factor is tested to be insignificant in Shanghai market. Some investigations from China Security Journal show that many foreign investment institutions shorted the shares in a large amount from the end of 2006 to take the profit and avoid risk in the bull market. After the withdrawing of the foreign investments, Shanghai A-share market gets less affected by the international information flows during the bull period. However, most companies listed in Shenzhen Exchange are new born export-oriented small enterprises doing business with Hong Kong. Shenzhen market is affected largely by Hong Kong market, which correlated with the US market tightly. This can help explain that the effect of international information is tested to be significant during all the periods.

In addition, the volatility is estimated to correlate with the world fluctuation negatively in Shanghai market while slightly positively (less than 0.4) in Shenzhen market. This implies that Chinese stock market has not got integrated with the world market and thus invests in Chinese A-share market will diversify the risk from investment in the World market.

To sum up, the effects of old information, domestic new information and international information on Chinese A-share markets in different periods are presented and compared in the following Table.

Table 10 Effects of information flows on the volatility, compared with the whole sample period from 2003 to 2007.

Panel 1		Shanghai A-share Market		
	Old information	New Domestic Information	International information	
The bull period	Low	High	Insignificant	
The bear period	Middle	Low	Middle	

Panel 2		Shenzhen A-share Market		
	Old information	New Domestic information	International information	
The bull period	Low	High	High	
The bear period	Middle	Low	Low	

Table 10 shows that in both Shanghai and Shenzhen market, the effect of old information is lower in the bull period than that in the bear period. Just as mentioned above, investors may pay more attention to new information in the bull market, thus the old information effects volatility less.

The new domestic information has high level effect in the bull period and low level effect in the bear period on the volatility of both Shanghai and Shenzhen market. This implies that investors should pay more attention on new domestic information when estimating the risk in Chinese A-share market.

As to the international information, it affects differently on Shanghai and Shenzhen market. For Shanghai market, it is tested to be only significant in the bear period and the effect is of middle level. In the Shenzhen market although its effect keeps significant in different periods, it does not affect as much as in Shanghai market during the bear period. However during the bull period, the international news holds a high level effect on Shenzhen market. Therefore, in the bull period, if one wants to estimate the risk of Shenzhen market, he should never neglect the role of international information. Additionally, one should also take international information into account when he analyzes the risk on Shanghai market during the bear period.

5.2 Results of EGARCH model

In order to test the leverage effect on Chinese A-share market, we employed EGARCH model to analyze the returns series of SHAI and SZAI. To begin with, we model the return series by Equation (31) and get the results represented by Table 10. The coefficient φ indicates the leverage effect while the coefficient β denotes the volatility persistence in the returns series.

Table 11 The EGARCH results of Equation (31) for returns of SHAI and SZAI

	Return of SHAI		Return of SZAI	
	φ	β	φ	β
The whole period	0.007* (0.508)	0.983 (0.000)	0.002* (0.816)	0.987 (0.000)
The bear period	0.019* (0.645)	-0.677 (0.001)	-0.046* (0.218)	-0.700 (0.000)
The bull period	0.053 (0.000)	0.994 (0.000)	0.049 (0.000)	0.995 (0.000)

In parenthesis is the z-test probability.

* denotes the estimation is insignificant out of the 10% level

As shown in Table 11, the persistence coefficient β keeps significant under the 1% level in all the periods in the two markets. It approaches to 1 for both Shanghai and Shenzhen market in the whole and bull period. However, in the bear period, it is estimated to be negative, about -0.7. This is consistent with the GARCH results shown in Table 7, suggesting that the volatility persistence gets less in the bear period than that in the soft period.

The coefficient φ measures the leverage effect. It is estimated to only significant in the bull period for both of the Shanghai and Shenzhen market. In fact during the bear period, the Chinese government always interferes in the market and implements policies in order to stimulate investment or to flat the price fluctuations. The policy effect may set off the leverage effect in bear period.

However, in the bull period, the leverage effect is test to be around 0.05 with significance under the 1% level. This suggests that in the bull period, the good news

causes bigger volatility than bad news does. The reason may be that there are many speculations in the market, especially during the bull period. Wang and Firth (2004) indicated that Chinese stock market participants are dominated by retail or private investors who have limited knowledge of financial matters and investment decisions are often based on rumor. Inexperienced individual investors dominate the A-share market and speculation rather than liquidity drives trading. Moreover, the Chinese market has a very high share turnover rates relative to a broad cross-section of other developed markets such as markets of the USA, London, Frankfurt and Australia. The high share turnover rate has been attributed to a preponderance of small naïve investors, who would tent to engage in speculative trading and herding behavior (Shenoy and Zhang, 2007). Investors are more likely to get overconfident with the market during the bull period. They pay more attention to good news than bad news, in order to grasp the next opportunity of price increase. Thus, to some extent, the speculations and irrational investment may explain why in bull period, good news bring with bigger volatility than bad news.

Secondly we add the adjusted trading volume into Equation (31), in order to test the leverage effect with new information flows considered. γ measures the effect of new information flows. Equation (32) is utilized and the results are presented in Table 12.

Table 12 The EGARCH results of Equation (32) for returns of SHAI and SZAI

	Return of SHAI			Return of SZAI		
	φ	β	γ	φ	β	γ
The whole period	-0.173 (0.000)	0.873 (0.000)	1.782 (0.000)	-0.142 (0.000)	0.917 (0.000)	1.635 (0.000)
The bear period	-0.224 (0.000)	0.584 (0.000)	2.684 (0.000)	-0.332 (0.000)	0.625 (0.000)	2.811 (0.000)
The bull period	-0.510 (0.000)	0.362 (0.000)	3.603 (0.000)	-0.215 (0.000)	0.955 (0.000)	2.229 (0.000)

In parenthesis is the z-test probability.

In the EGARCH model with trading volume the coefficients of volume are estimated significantly positive, in all the periods for both of the two markets. This is consistent with the results of the GARCH model in that the trading volume explains the volatility in Chinese-A share market. In Shanghai market, the correlation between trading volume

and the volatility is tested bigger in the bull period than in the bear period, also consistent with the results of GARCH model. This verifies Hypothesis 7 and indicates that the volatility of Shanghai A-share stock market is more sensitive to the new information flows in bull period than in bear period. However, in Shenzhen market, effect of new information is estimated slightly stronger in the bear period than in the bull period, which is different from the results obtained by the GARCH model.

Moreover, with the addition of trading volume the leverage effect is estimated significantly negative in all the periods for the two markets. This verified Hypothesis 6 introduced in Section 1.2 that bad news will cause larger volatility than good news in Chinese A-share market. For Shanghai market, the leverage effect is bigger in bull period than in bear period while for Shenzhen market, it gets bigger in bear period.

In addition, although in the whole sample period the ARCH effect decreased by the addition of trading volume, it still keeps significant under the 1% level, indicating the old information still has explanation power on the volatility. In Shanghai market, the ARCH effect falls dramatically from 0,99 to 0,36 after the addition of trading volume. Considering the fact that the coefficient of volume is estimated bigger in bull period, we can conclude that the volatility depends more on new information than on old information in the bull period. One explanation is that in the increasing phase, investors are enthusiasm with the investment. They quest for new information actively and wish to make advantage of it to get profit. Thus, the new information is paid more attention to than old information and correlated to the volatility more tightly.

Finally, we take international information into account, adding the standardized residuals of MSCI World Index return series and its absolute value into Equation (32). Leverage effect of international news on Chinese A-share markets is represented by ϕ^i . Table 13 shows the results.

Table 13 The EGARCH results of Equation (33) for returns of SHAI and SZAI

Panel 1		Return of SHAI			
	ϕ^d	β	γ	ϕ^i	
The whole period	-0.192 (0.000)	0.827 (0.000)	1.990 (0.000)	-0.051 (0.065)	
The bear period	-0.218 (0.000)	0.565 (0.000)	2.787 (0.000)	-0.116 (0.040)	
The bull period	-0.482 (0.000)	0.569 (0.000)	3.324 (0.000)	-0.073* (0.113)	

Panel 2		Return of SZAI			
	ϕ^d	β	γ	ϕ^i	
The whole period	-0.147 (0.000)	0.889 (0.000)	1.482 (0.000)	-0.036* (0.205)	
The bear period	-0.322 (0.000)	0.618 (0.000)	2.850 (0.000)	-0.044* (0.383)	
The bull period	-0.226 (0.000)	0.955 (0.000)	2.242 (0.000)	-0.024* (0.416)	

In parenthesis is the z-test probability.

* denotes the estimation is insignificant out of the 10% level

From Table 13, we can see in Shenzhen market, the leverage effect of international news is not significant, although the GARCH model shows the market is significantly affected by international information. This indicates that Shenzhen market reflect to international good news and bad news symmetrically. One explanation about the leverage effect proposed by Christie (1982) is that the price decrease may increase the company's financial leverage rate and thus increase the risk of holding its stocks. According to this theory, since the international news has nothing to do with Chinese companies' financial leverage rate, the leverage effect is not significant in Shenzhen market can be explained.

However, Shanghai market gets international leverage effect with significance under the 10% level in the whole sample period and under the 5% level in the bear period. The international leverage effect in the bear period is larger. It suggests that there should be other factors causing the leverage effect besides the financial leverage increase. As mentioned above, more companies as preference of foreign investments are listed in

Shanghai Exchange. The large amount of foreign investment may get Shanghai market more affected by international information and display an international leverage effect.

During the whole sample period, the coefficients of trading volume and the ARCH effect decrease in both of the two markets by the addition of international information factor. This is consistent with the GARCH model, suggesting that the international information flows is one of the risk sources of Chinese A-share market. In spite of the decrease, the ARCH effect and the trading volume coefficients still keep significant. Therefore, the volatility of Chinese A-share market should be explained by the old information, the domestic information and the international information together.

6. CONCLUSIONS

In the last two decades, China has experienced rapid economy development. Chinese market is attracting more and more attention from all over the world. However, Chinese domestic stock market is still an emerging market, having a long way from totally open up and maturity. It is comprised of Shanghai A-Share market and Shenzhen A-share market, with the age of less than 17. In keeping its commitment to the World Trade Organization (WTO), the Chinese government is looking at expanding the stock market and opening them to foreign investments. At the end of 2002, the QFII policy was implemented, indicating that Chinese stock market started to open to the world and got more and more sensitive to the international financial atmosphere.

As most emerging markets, Chinese stock markets possess the characteristics of both high returns and high risk. Given the rapid development and capriciousness, a thorough comprehension of volatility not only would benefit Chinese investors but also the international investors. It may also have important implications in policy design and improvement of market efficiency.

This paper analyzes the effect of information flows on volatility, intending to discover the sources of risk in Chinese A-share market. The leverage effect of bad news on the volatility is also studied. GARCH (1, 1) and EGARCH (1, 1) model is utilized in the empirical test. Information flows are classified into three types: the old information is represented by ARCH effect; trading volume is employed as a proxy of new domestic information; the international information is denoted by the variance of returns in World market. Shanghai A-share Index (SHAI) and Shenzhen A-share Index (SZAI), together with MSCI World Index from 1st. Jan. 2003 to 31st, Dec. 2007 are utilized as the data pool. The study is further carried out in two sub-periods, the bear period (from 1st. Jan. 2003 to 20th, Jul. 2005) and the bull period (from 21st, Jul. 2005 to 31st, Dec. 2007.) It is supposed to assist investors and researchers treat different kinds of information with different weight when estimating the risk of Chinese A-share market. The main findings of this paper are concluded as follows:

Chinese A-share stock market has not cointegrated with the World market. However, it is becoming more and more sensitive to the world market. The correlations between SHAI, SZAI and MSCI World kept increasing since 2003 but are still far less than 1, suggesting that investing in Chinese stock market will diversify risk from the world market.

The returns series of Chinese A-share market display the characteristics of fat tail, kurtosis and heteroskedasticity, indicating the existence of volatility persistence and clustering. Compared with the world market, higher return as well as higher volatility exists in Chinese A-share market.

In the whole sample period, after the addition of trading volume and international variance into the conditional variance equation of return series, the ARCH effect decreases dramatically but still keeps significant. The trading volume and the international variance are both estimated to be significant. This suggests that the volatility of Chinese A-share market is determined by three factors together: the old information, the new domestic information and the international information. This result verified the MDH theory in Chinese stock market.

Moreover, the information flows affect volatility differently between Shanghai and Shenzhen market from bear period to bull period. In both Shanghai and Shenzhen market, the ARCH effect has a bigger correlation with the volatility in the bear period than in the bull period. During the bear period, the trading behavior is inactive and there are not so much new information arriving at the market, thus the market goes quite smoothly without large fluctuations. Traders are more likely to make the investment decision according to historical information. Therefore, the old information has a larger effect on the volatility of Chinese A-share market in the bear period.

Additionally, the trading volume as a proxy of new domestic information is positively correlated to the volatility and affects more in the bull period than in the bear period. Investors get enthusiastic in trading during the bull period, concerning more to the new information to pursue the information advantage. Thus in the bull period the market fluctuates more with the arrival of the new information. This implies that investors should pay more attention to the new domestic news during the price increasing phase when estimating the risk.

The international information is significantly tested to be a source of risk in Shenzhen market all through the sample period, but is only significant in the bear period for Shanghai market. Due to more companies preferred by foreign investments are listed in Shanghai market, the international information may be conveyed in the foreign investment and impact on Shanghai market more than on Shenzhen market. In the bear period, the variance of world market is negatively correlated to the volatility of both the

two markets. This is indicating that the more fluctuated the world market is, the less risky Shanghai A-share market would be.

In the bull period, the international information is only tested to affect the Shenzhen market. The variance of world market has a significantly positive correlation with the volatility in Shenzhen market. Companies listed in Shenzhen market are mostly export-oriented small companies doing business with Hong Kong. They will be more sensitive to the global information, especially in the bull market condition when trading is active. As a result, the risk of Shenzhen market goes in the same direction with that of the world market. Thus more attention should be paid to international news when estimating the risk of Shenzhen market during the bull period.

Significant leverage effect is found in Chinese A-share market. For Shanghai market, the leverage effect gets bigger during the bull period than during the bear period while it performs oppositely in Shenzhen market. This result indicates that bad news always causes larger volatility than good news, especially in the bull period for Shanghai market or in the bear period for the Shenzhen market. The international leverage effect is only found significant in the bear period of Shanghai market. Bad international news always causes larger volatility than good international news to Shanghai market. Shenzhen A-share market reflects to international information in a symmetrical way.

This paper contributes to existed literature in the following aspects: First, the study sample is chosen to be SHAI and SHZI, enclosing all A-share stocks listed in Shanghai and Shenzhen Exchange markets. It will serve as a good representation of the Chinese A-share market. Additionally, the empirical results obtained from the two markets are analyzed separately and compared with each other. This will provide a more comprehensive investigation about the information effect on Chinese A-share market.

Second, besides the GARCH model, the EGARCH model is also implied in order to distinguish the impacts of bad news from those of good news on the volatility. The relationship between information and volatility is explained in a more detailed way.

Third, the international information is taken into account. With the background of China's entry into WTO and the implement of QFII Policy, Chinese stock market is more and more affected by the world market. Thus, the international factor should not be neglect when considering the risk of Chinese Stock market. In this paper, the effect of international information is found to be one of the sauces of risk in Chinese market.

Finally, the paper studied on different market conditions. The whole sample period is divided into bull period and bear period. The study is carried out in each sub-period separately. This paper not only intends to examine the whether MDH theory holds on Chinese A-share market, but also tries to find out the relationship between information and volatility under different market conditions.

Moreover, the study is only based on A-share market while similar researches can also be carried out on other Chinese financial markets, as B-share market, H-share market, futures market and so on.

REFERENCES

- Andersen, T. (1996). Return volatility and trading volume: an information flow interpretation of stochastic volatility. *Journal of Finance* 51(1), 169-204.
- Bageot, W. (1971). The only game in town. *Financial Analysts Journal* 21, 12-14, 22.
- Black, F. (1976). The Pricing of Commodity Contracts. *Journal of Financial Economics* 3, 167-180.
- Blume, L. E., D. Easley, and M. O' Hara. (1994). Market Statistics and Technical Analysis: The role of Volume. *Journal of Finance* 49, 153-182.
- Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *J. Econometrics* 31, 307-327.
- Bollerslev, T. & D. Jubinski. (1999) Equity trading volume and volatility: latent information arrivals and common long-run dependencies. *Journal of Business and Economic Statistics* 17, 9-12
- Brailsford, T. J. (1996). The empirical Relationship Between Trading Volume, Returns and Volatility. *Accounting and finance* 35, 89-111.
- Chen, D.C. (2002). A study on stock market as a policy market. *Social Science Journal for Central South University of Technology* 8:4, 350-354.
- Chen, Y.L. & F.M.Song. (2000). Empirical research on price and volume relationship in China Stock Market. *Journal of Management Sciences in China* 3:2, 62-68.
- Christie, A.A. (1982). The Stochastic Behavior of Common Stock Variances: Value, Leverage, and Interest Rate Effects. *Journal of Financial Economics* 10, 407-432.
- Chen, S. D., G. Z. Han, and W. Jing. (2003). Co-integration analysis between international stock markets and Chinese Stock Market. *The Journal of Quantitative & Technical Economics* 5, 124-129.

- Clark, P.K. (1973). A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices. *Econometrica* 41(1),135-156.
- Copeland, T. (1976). A model of asset trading under the assumption of sequential information arrival. *The Journal of Finance* 31:4, 1149-1168
- Copeland, T. and D. Galai. (1983). Information effects and the Bid-Ask Spread, *Journal of Finance* 38, 1457-1469.
- Dai, G. Q. & X. L. Wu. (1999). Financial Market Microstructure Theory. *Shanghai University of Finance and Economic Pressing*.
- Demsetz, H. (1968). The cost of transacting. *Quarterly Journal of Economics* 82, 33-53.
- Diamond, D.W. and R. E. Verrecchia. (1987). Constraints on Short-selling and Asset Price Adjustments to Private Information, *Journal of Financial Economics* 18, 277-311.
- Ding, H. (1999). The ARCH Effect of Stock Price Volatility. *The Journal of Quantitative & Technical Economics* 16:9, 22-25.
- Easley, D., O'Hara, M. (1987). Price, trade size, and information in securities markets. *Journal of Financial Economics* 19, 69-90.
- Engle, R.F. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica* 50, 987-1007.
- Epps, T. W. & M. L. Epps. (1976). The stochastic dependence of security price changes and transaction volumes: implications for the mixture-of distributions hypothesis. *Econometrica* 44, 305-321.
- Gallant, A.R., P.E. Rossi, and G. Tauchen. (1992). Stock Prices and Volume. *Review of Financial Studies* 5, 199-242.
- Glosten, L.R., Milgrom, P. (1985). Bid, ask, and transaction prices in a specialist market with heterogeneously informed agents. *Journal of Financial Economics* 14, 71-100.

- Hamilton, J.D. (1994). *Time Series Analysis*. Princeton University Press. Princeton, New Jersey.
- Harris, L. (1987). Transaction data tests of the mixture of distributions hypothesis. *Journal of Financial and Quantitative Analysis* 22, 127-141.
- Harris, L. (1986). Cross-security tests of the mixture of distribution hypothesis. *Journal of Financial and Quantitative Analysis* 21, 39-46.
- Hu, J.Z. (1999). *The evolution of Chinese Stock Market and the regulatory changes*, 25-89. Economic Science Press.
- Huang, B., C.W. Yang, and J.W. Hu (2000). Causality and cointegration of stock markets among the United States, Japan, and the South China Growth Triangle. *International Review of Financial Analysis* 9:3, 281-297.
- Karpoff, J.M.(1987). The relation between price changes and trading volume: a survey. *Journal of Financial and Quantitative Analysis* 22, 109-126.
- Kim, O., and R.E. Verrecchia. (1991) Market Reactions to Anticipated Announcements. *Journal of Financial Economics* 30, 273-310.
- Lamoureux, C.G. and W.D. Lastrapes. (1990). Heteroskedasticity in Stock Return Data: Volume versus GARCH Effects. *Journal of Finance* 45, 221-229.
- Lamoureux, C.G. and W.D. Lastrapes. (1994). Endogenous Trading Volume and Momentum in Stock Return Volatility. *Journal of Business and Economic Statistics* 12, 253-260.
- Li, S.C. (2002). A study on leverage effect of Chinese Stock Market. *Securities Market Herald* 10, 10-14.
- Li, S.C., H.W. Zhang, & C. C. Zhao. (2002). Empirical study of the effect of information flows on volatility on Chinese Stock Market. *Journal of Hebei Univeristy of Economics and Trade* 23:4, 40-45.

- Locke, P.R. and C.L. Sayers. (1993). Intra-day Futures Prices Volatility: Information Effects and Variance Persistence. *Journal of Applied Econometrics* 8, 15-30.
- Los, C. A. & B. Yu (2008). Persistence characteristics of the Chinese stock markets. *International Review of Financial Analysis* 17, 64-82.
- Marsh, T.A. and N. Wagner. (2000). Return-volume Dependence and Extremes in International Equity Markets, May, Working paper RPF-293, Haas School of Business, UC Berkeley.
- Miyakoshi, T. (2002). ARCH versus Information-based Variances: Evidence from the Tokyo Stock Market. *Japan and the World Economy* 14, 215-231.
- Nelson, D.B. (1991). Conditional Heteroskedasticity in Asset Returns. *Econometrica* 55, 277-301.
- O'Hara, M. (1995). *Market microstructure theory*. Basil Blackwell, Cambridge, MA.
- Omran, M.F. and E. Mckenzie. (2000) Heteroskedasticity in Stock Returns Data: Volume versus GARCH Effects, *Applied Financial Economics* 10, 553-560.
- Pan, Y. & S.N.Wu. (2004). A study on Effect of Information Flows on Price Volatility in Shanghai Stock Market. *China Accounting and Finance Review* 6:2, 50-70.
- Phylaktis, K. and M. Kavussanos (1996), "Stock Price and the Flow of Information in the Athens Stock Exchange, *European Financial Management* 2(1), 113-126.
- Sharma, Mougoue, Kamath (1996). Heteroskedasticity in Stock Market Indicator Return Data: Volume versus GARCH Effects. *Applied Financial Economics* 6, 337-342.
- Shenoy, C. & Y.J. Zhang. (2007). *Order imbalance and stock returns: Evidence from China*. *The Quarterly Review of Economics and Finance* 47, 637-650.
- Tang, Q.M.& J. Chen. (2001). A study on the ARCH Effect on Chinese Stock Market. *The Journal of World Economy* 3, 29-36.

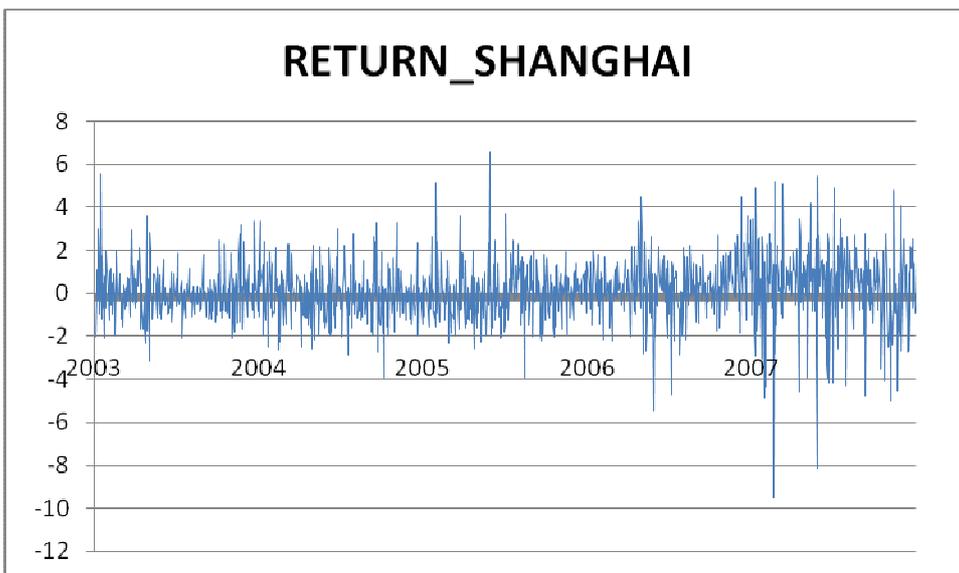
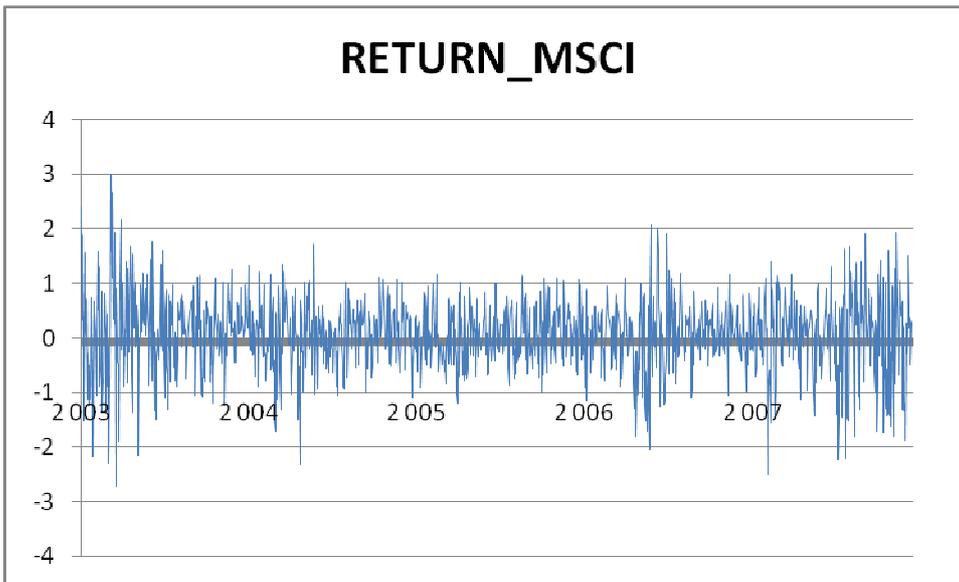
- Tauchen G, M. Pitts. (1983). The price variability-volume relationship of speculative markets. *Econometrica* 51: 485-505.
- Wang, C. F. (2002). *The second factor of price volatility: The trading volume*. Diagnosis and Treatment: Revealing the Chinese Stock Market, 75-94. Economic Science Press.
- Wang, C. F. (2002). *Policy market: the meanings and the estimation criteria*. Diagnosis and Treatment: Revealing the Chinese Stock Market, 116-119. Economic Science Press.
- Wang, C.W., C. F. Wu, & Z. Y. Zhu. (2003). Research on Mixture Distribution Hypothesis. *Journal of Shanghai Jiaotong University* 38, 335-339.
- Wang, C. Y. & C.F. Wu. (2001). A study on the correlation and autocorrelation between on A-shares and B-shares. *Systems Engineering Theory. Methodology. Applications* 10:4, 265-268.
- Wang, C.Y.& C.F.Wu. (2002). A study on the linear and nonlinear causality relationship between stock price and trading volume. *Journal of Management Sciences in China* 5:4, 7-12
- Wang, J. (1994). A model of competitive stock trading volume. *Journal of Political Economy* 102, 127-168
- Wang, S.S. & M. Firth. (2004). *Do bear and bulls swim across oceans? Market information transmission between greater China and the rest of the world*. *International Financial Markets, Institutions & Money* 14, 235-254.
- Wu, C.F. & W.F. Wu. (2001). Stock price series research basing on trading volume. *Systems Engineering Theory. Methodology. Applications* 10:1, 1-7
- Wu, C.F., C.Y. Wang & W.F. Wu. (2002). Trading volume and the dynamic analytic method based on volume-driving prices. *Journal of Management Sciences in China* 5:2, 1-12

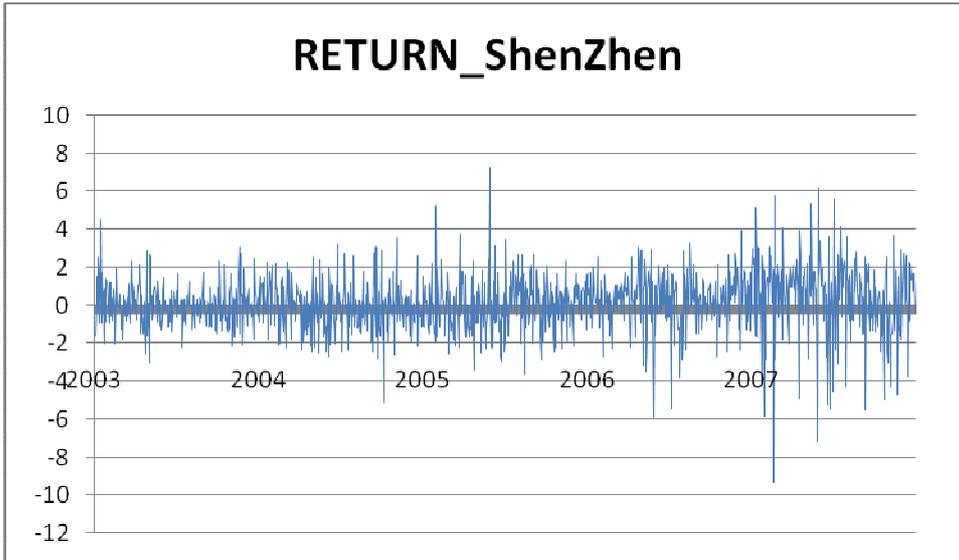
- Xu, C.K. (2000). The Microstructure of the Chinese Stock Market. *China Economic Review* 11, 79-97.
- Yu, Q. (1994). Market Efficiency, Seasonal Abnormality and Price volatility. *Economic Research Journal* 9, 43-50.
- Zhang, W. & J. N. Yan. (1998). An Empirical Study on the Causality Relationship between Trading Volume and Stock Price in Shanghai Stock Market. *Systems Engineering- Theory and Practice* 6, 111-114.
- Zhang, J. & Y.M. Wang. (2002). *The effect of price changes limit on Chinese Stock Market*. *Economic Science* 2002:4, 34-48.
- Zhao, L. Y. & Y. M. Wang. (2003). The correlations between trading volume, return and volatility: evidence from Shanghai and Shenzhen stock market. *Economic Science* 2, 57-67.

APPENDICES

Appendix 1 Return series of MSCI World, SHAI and SZAI from 2003 to 2007.

$$r_t = \ln(I_t / I_{t-1}) \times 100$$





Appendix 2 Trends test results for trading volume of SHAI and SZAI from 2003-2007.

$$\log(V_t) = \mu + \beta_1 \log(V_{t-1}) + \beta_2 t^2 + \beta_3 t + \varepsilon_t$$

	Trading volume of SHAI			Trading volume of SZAI		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
μ	1,780	8,366	0,000	1,417	7,573	0,000
β_1	0,889	67,368	0,000	0,908	74,783	0,000
β_2	-2,28E-06	-0,030	0,976	8,49E-05	1,237	0,216
β_3	2,07E-07	3,154	0,002	9,17E-08	1,638	0,102

$$\log(V_t) = \mu + \beta_1 \log(V_{t-1}) + \beta_2 t^2 + \varepsilon_t$$

	Trading volume of SHAI			Trading volume of SZAI		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
μ	2,556	10,781	0,000	1,400	7,500	0,000
β_1	0,868	56,976	0,000	0,910	75,902	0,000
β_2	3,66E-07	11,621	0,000	1,54E-07	6,197	0,000

Appendix 3 ADF values in unit root tests of adjusted trading volume, for SHAI and SZAI from 1997 to 2007

Null Hypothesis: The adjusted trading volume series has a unit root

	t-statistic	Critical Value of 1% Level	Prob.
SHAI	-40,159	-3,436	0,000
SZAI	-39,360	-3,436	0,000

Appendix 4 The estimation results for MA (1) model for returns series of SHAI and SZAI

The Whole Period						
	Returns of SHAI			Returns of SZAI		
	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.
C	0,068	2,070	0,038	0,064	1,865	0,062
MA(1)	-0,095	-3,234	0,001	-0,058	-1,993	0,046

The Bear Period						
	Returns of SHAI			Returns of SZAI		
	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.
C	-0,036	-0,802	0,423	-0,038	-0,833	0,405
MA(1)	-0,128	-2,727	0,006	-0,086	-1,860	0,063

The Bull Period						
	Returns of SHAI			Returns of SZAI		
	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.
C	0,208	3,719	0,000	0,236	3,714	0,000
MA(1)	-0,092	-2,436	0,015	-0,063	-1,664	0,096