Empirical Analysis of Chinese Stock Market Behavior:
Evidence from Dynamic Correlations, Herding Behavior, and Speed of Adjustment

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To

Huiqing, my supporting and caring husband,

Helena, our precious newborn daughter,

and my beloved parents.
Acknowledgments

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How can this one page include all my appreciation? Only one thing is clear: To the people who care about me, they are happy because I am finally here, and I am happy because I can write this page of this thesis.
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Abstract
Empirical Analysis of Chinese Stock Market Behavior:
Evidence from Dynamic Correlations, Herding Behavior, and Speed of Adjustment
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In its rapid transition to a modern economy, China is undergoing dynamic changes in all of its business sectors and industries, a situation that presents features unique to Chinese culture and China’s economy. This dissertation focuses on several issues related to the Chinese stock market, and these issues are separated into the following three essays.

Essay One: Dynamic Correlation Analysis of Chinese Stock

This paper examines A-share and B-share market segmentation conditions by employing a dynamic multivariate GARCH model to analyze daily stock-return data for the period 1996 through 2003. Statistics show that stock returns in both A and B shares are positively correlated with the daily change in trading volume or abnormal volume. The evidence reveals that the correlation coefficients between A-share and B-share stock returns are time-varying. Analyzing the dynamic path of the correlation coefficients suggests that the recent increase in correlation coefficients is significantly related to a more liberal policy. There is a substantial spillover effect from the Asian crisis into Chinese stock-return dynamic correlations. The evidence suggests that the time-varying correlation is associated with time-varying risk measured by a daily high-low price differential.

Essay Two: Is There Herding Behavior in Chinese Stock Markets? An Examination of Chinese A and B Shares

This essay examines whether herding behavior exists in Chinese A- and B-share markets. By applying the methodology proposed by Chang, Cheng, and Khorana (2000) to
examine Chinese stock data, we provide evidence that shows there is herding behavior in both the Shanghai and Shenzhen A-share markets. However, no supportive evidence for herding behavior is found in either B market. Herding behavior in Chinese markets demonstrates similar patterns of asymmetric effects as the market goes up vs. as it goes down, trading volume becomes excessively high vs. excessively low, and volatility becomes excessively high vs. excessively low. There is no concrete evidence in favor of herding behavior across A and B markets, nor across Shanghai and Shenzhen markets. Volatility seems to have more explanatory power than volume in explaining herding behavior.

**Essay Three: Empirical Analysis of the Speed of Adjustment to Information:** Evidence from Chinese Stock Markets

This essay studies investors’ behavior characterized by different degrees of sophistication involved in Chinese stock markets. By employing a VAR model to examine different speeds of adjustment in response to common information between Chinese A- and B-share markets, we find evidence that domestic investors who mainly invest in A shares adjust to information faster than foreign investors, who can trade only in B shares. By further looking at characteristics of individual firms and market structure, we find evidence that stocks with higher information flows and/or with more prominent status adjust to information faster. The implementation in February 2001 of a more liberal policy of allowing domestic investors to purchase B shares has reduced the difference of speed adjustment between A and B shares. Evidence also indicates that the A-share market has unobserved components that significantly enhance the speed of price adjustment.
Chapter 1. Introduction and Overview

1.1. Introduction

With China’s rapid transition to a modern economy, all of its business sectors and industries are undergoing dynamic changes. A substantial amount of working capital is required by business firms, and economic development in China demands rapid advancement of capital markets. In retrospect, the first stock in China, Shen BaoAn, was issued in 1983. By then China had no securities exchange, and stock trading activities were operated virtually underground (Chen and Sun, 2003). It was three years later, on September 26, 1986, that the JinAn Business Branch of CICB\(^1\) Shanghai Trust and Invest Company began to trade its stocks over the counter. Nevertheless, the local secondary market trading was still unofficial and unorganized (Gordon and Li, 1991). After several years’ effort and a learning period, the Shanghai Stock Exchange and Shenzhen Stock Exchange were formally established on December 19, 1990, and December 1, 1990, respectively.

Since their establishment in the early 1990s, developing Chinese stock markets have received a great deal of attention from both domestic and international practitioners and researchers. The main reason for this is that, before 1982, the Chinese economy was a central planning system in which no private business was allowed, and there was no market-oriented banking system. The Constitution Act in 1982 lifted the ban on private business activities (Shirai, 2002), allowing a large number of state-owned enterprises (SOEs) and banks to be privatized and incorporated.

\(^1\) CICB: China Industrial and Commercial Bank.
Focusing on profit maximization, commercial banks limited the low-cost funds that used to be provided to finance SOEs. Thus, the majority of SOEs in Chinese markets were forced to raise their own capital from stock markets. A primary strategy was to expand their business so they were able to produce positive earnings. Since the government held the majority of shares, strong government support seems to guarantee that share prices are not very likely to fall; investment risk from the viewpoint of common stockholders does not appear to be very profound. In addition, investment opportunity was rather thin, since very few instruments are available to the public. The limited supply and inelastic demand for stock made stock investment rather attractive. In many cases, the purchase of stocks had to be done through a lottery process. It has been observed that most investors in Chinese markets have very little knowledge of economic fundamentals. Most investors think that when someone owns stocks, the value of stocks will definitely go up in the future. The concept of risk is grossly underestimated or unknown. The decision to hold securities is mainly constrained by budget or the opportunity to obtain stocks. The trade and selection of portfolios are mainly based on information provided by friends or rumors heard on the streets. Thus, the Chinese market provides a unique environment for analyzing a large population of small-asset and non-fundamental investors and provides an interesting case for analyzing herding behavior.

Owing to the Chinese market’s dual characteristics of having an indigenous economy and modern corporations coexisting in the political economy regime, it is also of interest to investigate the stock market behavior of an economy in transition from a central planning system to a market-oriented system. From the standpoint of the economics literature, the Chinese investment environment provides a unique forum in which people
can study two-tier financial markets and the significance of market liberalization to economic growth. Since the Chinese stock market is a newcomer in the emerging markets, it is necessary to provide readers with some informational background and the institutional setting of the stock market, and these are the main focus in the following sections.

1.2 Stock Market Development from 1992 to 2003

The size of the Chinese stock market has grown rapidly since its establishment in the early 1990s. The total market capitalization (including A and B shares) increased from Yuan 104.8 billion at the end of 1992 to Yuan 4,245.8 billion at the end of 2003. The market capitalization as a percentage of GDP increased from 4.1% to 36.3%. The annual market capitalization information from 1992 to 2003 is listed in Table 1.1. The amount of Chinese stock market capitalization ranks second in Asia only after Japan, but in terms of the percentage of GDP, it is smaller than that of the U.S., Hong Kong, Singapore, Japan, and India, yet higher than Germany’s and that of other Asian countries (refer to Figure 1.1). The number of listed firms (including A and B shares) increased from 53 at the end of 1992 to 1287 at the end of 2003. The number of investors increased from 2.17 million in 1992 to 70.25 million in 2003. The annual information for the number of listed firms and number of investors is presented in Table 1.2.

< Insert Table 1.1 and 1.2 about here>

< Insert Figure 1.1 about here>
1.3 Institutional Facts about the Chinese Stock Industry

1.3.1 Stock market structure

The Chinese stock market consists of one regulator, two stock exchanges, one clearing company, and numerous securities exchange companies. The China Securities Regulatory Commission (CSRC) and the State Council Securities Committee (SCSC) were established in 1993. They consolidated in 1998, and the China Securities Regulatory Commission is now the regulator of the securities industry. The Shanghai Stock Exchange and the Shenzhen Stock Exchange were established in December 1990. By the end of 2003, there were 746 A shares and 54 B shares listed on the Shanghai Stock Exchange and 489 A shares and 57 B shares listed on the Shenzhen Stock Exchange. By the end of 2003, the Shanghai Stock Exchange had Yuan 2980.5 billion (70.2%) total market capitalization, while the Shenzhen Stock Exchange had Yuan 1265.3 billion (29.8%) total market capitalization. In March 2000, the China Securities Depositary and Clearing Company (CSDCC) was established as the central securities clearing company.

1.3.2 Share structure

To attract foreign investment, the government allows the coexistence of A and B shares for listed companies.² A shares are restricted to domestic investors and RMB-denominated; B shares were restricted to foreign investors before February 2001 (the restriction was lifted after February 2001). They are U.S.-dollar denominated on the

² Besides A, B shares issued by domestic stock exchanges, there are H shares, Red Chip, and N shares related to Chinese companies. H shares are Chinese companies listed in Hong Kong. Red Chips are Chinese companies incorporated in Hong Kong and listed in Hong Kong. N shares are Chinese companies listed on the New York Stock Exchange.
Shanghai Stock Exchange and Hong-Kong-dollar denominated on the Shenzhen Stock Exchange. In terms of the number of shares issued, capital raised, and market capitalization, the B-share market is much smaller than the A-share market. Until December 31, 2003, 87 companies were dual listed in A and B shares. These 87 paired A- and B-share companies have similar or even identical business and operating performance. They represent the same voting rights, trade simultaneously on the Shanghai or Shenzhen stock exchanges, and cannot cross-list on the above two exchanges (Bailey, 1994). It is widely reported in the literature that there is a large A- to B-share price premium. The related arguments will be presented in more detail in a later section.

With reference to state-owned enterprises (SOEs), 37% and 27% of the shares of the listed companies are held by the state (government) and legal persons (enterprises and institutions), respectively, and are non-tradable. Tradable public shares comprise only 35% of the market. This represents another distinctive feature of the share structure of the Chinese stock market.

1.3.3 Investors

Insurance funds and social security funds cannot participate in the stock market, and mutual funds are very limited. By 2000, according to CSRC, individual investors overwhelmingly dominated the A-share market, holding over 99.5% of the accounts, with less than 0.5% held by institutional investors. In the B-share market, institutional investors dominate.
1.3.4 Listing and de-listing 

The following conditions must be met to list a company on the exchanges:

(1) The company must obtain approval from the CSRC to issue public shares.

(2) The company’s total capital must not be less than RMB50 million.

(3) The company must have been operating for more than three years and must have recorded three consecutive years of profit.

(4) The number of shareholders holding more than RMB1,000 worth of the company’s shares must not be less than 1,000, and the public shares must be more than 25% of the company’s total shares. For those with more than RMB400 million worth of capital, the ratio is 15%.

(5) The company must have no record of illegal activity, and its financial and accounting documents must not have contained any false records in the past three years.

(6) Other conditions may be stipulated by the State Council.

A company is to be de-listed from the exchange under the following conditions:

(1) The company’s total capital and shareholder structure has changed so that it no longer meets the statutory conditions for listing.

(2) The company has failed to release its financial performance record as required, or its financial and accounting documents contain false information.

(3) The company has been found to conduct illegal activities.

(4) The company has been losing money for three consecutive years.

Section 1.3.4 Listing and De-listing: the whole section is quoted from “Standard Chartered Bank, 2001, Emerging and Transforming the Securities Industry in China - Markets, Institutions and Legal System. Business Intelligence – China, No. 7”
1.3.5 Trading mechanism

(1) Since December 16, 1996, an increase ceiling and decrease floor of 10% applies to every stock during one-day trading. This practice says that the maximum stock price during a trading day is 110% of the previous closing price; the minimum stock price is 90% of the previous closing price.

(2) An A share applies a T+1 settlement policy, while a B share applies a T+3 settlement policy.

(3) For every trade of A-share stock, the minimum investment is 100 shares. The actual number of shares purchased/sold for every trading is the integer times 100 shares. When the investment is less than Yuan 30 million, the maximum number of shares traded is less than 100,000 shares. When the investment is more than Yuan 30 million and less than Yuan 100 million, the maximum number of shares traded is less than 200,000 shares. For every trade of B-share stock, the minimum investment is 1000 shares. The actual number of shares purchased/sold for every trading is the integer times 1000 shares. There is no maximum investment limit for B-share stock.

(4) For A shares, the commission is smaller than or equal to 0.3% of the stock value, and the minimum is Yuan 5. The stamp tax is 0.2% of the stock value. There is a stock transfer fee, which is equal to 0.1% of the stock value. For B shares, the commission is smaller than or equal to 0.3% of the stock value, and the minimum is 1 U.S. dollar. The stamp tax is 0.2% of the stock value. There is a settlement fee, which is equal to 0.05% of the stock value. For both A and B shares, there is no income tax, such as a capital gains tax.
1.4 Literature Review

Although a large number of research papers have been devoted to the study and evaluation of the development of the Chinese stock market, the research papers can be categorized into the following two general areas:

In the first area of study, research focuses on the general stock market behavior and momentum. Within this area, there are three groups of studies:

The first group includes studies about the Chinese stock market mechanism and tests the random walk hypothesis of the Chinese stock market. Su and Fleisher (1999) study the dynamic behavior of risk and returns in the Chinese stock market. They reject the random walk hypothesis using a variance ratio test. Long, Payne, and Feng (1999) examine the price-volume relation relative to the U.S. equity market. They use variance ratios and run tests for market efficiency and find support for the hypothesis that both class A and class B share markets follow a random walk. Their test suggests that volume may be more important to information transmission in China than in the U.S. markets.

The second group attempts to explain the price premium puzzle between segmented A and B shares. A shares are restricted shares sold only to Chinese investors and are denominated in local currency RMB Yuan. B shares are unrestricted shares denominated in U.S. dollars and were sold only to foreign investors before February 11, 2001, and have been sold to both foreign and domestic investors after that date. A and B shares trade simultaneously on the Shanghai and Shenzhen stock markets, and neither market allows cross-listing. The puzzle lies in the fact that unlike most emerging markets\(^4\) where unrestricted shares are trading at a premium price compared to restricted shares, Chinese

\(^4\) Refer to Hietala (1989) on Finland; Lam et al. (1990) on Singapore; Bailey and Jagtiani (1994) on Thailand; Stulz and Wasserfallen (1995) on Switzerland; and Domowitz et al. (1997) on Mexico.
B shares are trading at a much lower price compared to A shares (see Figure 1.2 and 1.3). Bailey (1994) initiates the research by analyzing eight Chinese stocks from March 1992 to March 1993 and finds a substantial discount in B-share prices relative to the A-share prices. A follow up study by Su (1998) investigates 47 stocks from 1993 through 1996 and discovers that the average daily discount of B shares relative to A shares is about 62.2 percent. By examining a sample consisting of 68 firms issuing both A-share and B-share stocks, Chen, Lee, and Rui (2001) also find that the average B-share discount on the SHSE is about 66.2% and that on the SZSE is about 52.4% from 1992 to 1997. The existence of persistent price differentials between A and B shares leads to various testable hypotheses.

<Insert Figure 1.2 and 1.3 about here>

First: Differential risk hypothesis. Su (1998) presents evidence that the cross-sectional spread between A- and B-share returns is correlated with the difference in risk factors.

Second: Differential liquidity hypothesis. Chen, Lee, and Rui (2001) report that the price difference is primarily due to illiquid B-share markets. Their findings also suggest that B-share prices are more related to market fundamentals, while A-shares prices are more likely to be influenced by non-fundamental factors.

Third: Asymmetric information hypothesis. Chakravarty, Sarkar, and Wu (1998) use a media coverage variable to reflect foreign investors’ language and other barriers and conclude that foreign investors require a discount to hold B shares.

Fourth: Differential demand hypothesis. Sun and Tong (2000) argue that since there are only limited investment alternatives for domestic investors, and the return on other
alternatives are too low to be attractive, the demand for A shares is very high compared to B shares, which are one of the many investment substitutes for foreign investors. So there is a huge A- to B-share price premium.

All of the above-mentioned studies were carried out before February 2001, when the Chinese Securities Regulatory Commission (CRSC) allowed Chinese investors to own B shares. Karolyi and Li (2003) compare the change of the B-share discount relative to the A-share before and after February 11, 2001. They find that the B-share discount declined from 75% to 8%, and they do not support differential demand or liquidity hypotheses, but they do support differential risk and asymmetric information hypotheses.

The third group of research includes studies about return, volume, and volatility. Lee and Rui (2000) use daily return and volume data from 1990 to 1997 for the Shanghai A- and B-shares index and the Shenzhen A- and B-shares index to study the relationship between stock returns and volume. Using VAR and GARCH models, they find that trading volume does not Granger-cause stock returns on each of the markets and conclude that the U.S. and Hong Kong markets have predictive power over Chinese markets, but not in the opposite direction. Chen, Firth, and Rui (2001) study the relation among returns, volume, and volatility of stock indexes. The data come from nine national markets and cover the period from 1973 to 2000. They find a positive correlation between trading volume and the absolute value of the stock price change. They use Granger causality tests, which demonstrate that for some countries, returns cause volume and volume causes returns.

The second area of research focuses on the behavior of listed firms. Within this group, there are mainly three groups of studies.
The first is mainly about shareholding structure and corporate performance. Qi, Wu and Zhang (2000) state that there are, at most, five different classes of shares for a Chinese firm: State-owned shares, legal-person (LP) shares, tradable A shares, employee shares, and shares available only to foreign investors. They find that firm performance is positively related to shares held by legal persons, but negatively related to shares held by the state. Tian (2001) studies the ownership and control of 826 listed corporations. The author finds a “U” shape relationship between government ownership and corporate value, meaning that corporate value is lower with a larger stake of government ownership when the government is a small shareholder, but it increases with increased state shareholding when the government is a large shareholder.

The second group of research focuses on privatization. Sun and Tong (2003) find that for 634 listed SOEs, share-issuing privatization (SIP) in the period from 1994 to 1998 improves firms’ earnings and real sales but not profit returns or leverage. Like Qi, Wu and Zhang (2000), they also find that after SIP, state ownership negatively affects firm performance, while LP ownership positively affects firm performance, suggesting legal persons behave differently from government.

The third group of research includes studies about the mechanism of the stock market that governs and disciplines individual firms. Lin (2001) summarizes that “governance practices of corporatized Chinese firms are seriously defective, characterized by excessive power of CEOs, insider control and collusion, lack of safeguards for minority shareholders and weak transparency. These shortcomings are attributable to factors such as cultural and political traditions, uncompetitiveness of markets, poor legal enforcement,
weak debt and equity markets, but above all to continued state dominance in ownership and control of the corporate sector and listed companies.”

1.5 Motivation and Organization

Recognizing the dominance of inexperienced, unsophisticated, and small-asset investors, Chinese firms offer two classes of shares: Class A, which could be held only by domestic residents, and class B, which could be traded only by foreigners with foreign exchanges. In general, the prices of A shares are substantially higher than those of B shares, producing a premium on holding A shares. Part of the reason may be attributable to different demand elasticity faced by the two classes of investors.

This dissertation will investigate several issues of Chinese stocks, including the time-series dynamic relationship between A and B shares, the herding behavior of Chinese markets, and the relative speed of adjustment of A and B shares. Those issues are separated into three essays. The three essays in this dissertation mainly belong to the first area of research mentioned above. The segmentation of A- and B-share markets has been regarded as a stylized fact, and most previous studies use data prior to February 11, 2001, when B shares were available only to domestic A-share investors. Since February 2001, the B-share market has been conditionally available\(^5\) to domestic investors. With a more liberal investment environment, it becomes more meaningful to reinvestigate the dynamic relationship between A- and B-share markets by incorporating the impact of policy changes and other exogenous shocks. The first essay is thus devoted to analyzing the dynamic correlation between A- and B-share returns by using the methodology

\(^5\) Chinese currency RMB is not freely tradable, but foreign currencies are freely tradable among themselves. So only investors who have access to foreign currency can invest in B shares freely.
developed by Engle (2002). The second essay examines whether the herding behavior phenomenon exists in Chinese A- and B-share markets, and factors that may explain herding behavior. The third essay examines the speed of adjustments by examining individual firms associated with A- and B-share markets. This dissertation is organized as follows: Chapter 2 contains the first essay: Dynamic Correlation Analysis of Chinese Stock. Chapter 3 covers the second essay: Is There Herding Behavior in China? An Examination of Chinese A- and B-Share Markets. Chapter 4 is the third essay: Empirical Analysis of the Speed of Adjustment to Information: Evidence from Chinese Stock Market. Chapter 5 provides a summary.
Chapter 2. Dynamic Correlation Analysis of Chinese Stock

Chapter 2 Abstract
This paper examines A-share and B-share market segmentation conditions by employing a dynamic multivariate GARCH model to analyze daily stock return data for the period 1996 through 2003. Statistics show that stock returns in both A and B shares are positively correlated with the daily change in trading volume or abnormal volume. The evidence reveals that the correlation coefficients between A-share and B-share stock returns are time-varying. Analyzing the dynamic path of the correlation coefficients suggests that the recent increase in correlation coefficients is significantly related to a more liberal policy. There is a substantial spillover effect from the Asian crisis into Chinese stock return dynamic correlations. The evidence suggests that the time-varying correlation is associated with time-varying risk measured by a daily high-low price differential.

2.1 Introduction
The increasing and persistent expansion in the Chinese economy, accompanied by rapid growth in the Chinese stock market over the last decade, has generated considerable interest in studying the Chinese stock market. Investor interest in Chinese corporations stems from anticipation of investment opportunities – earning a potentially higher return and at the same time achieving international portfolio diversification.

Owing to the fact that China’s markets are characterized by a dual phenomenon – a traditional indigenous economy coexisting with modern efficient corporate organizations (Boeke, 1953; Higgins, 1968; Meier, 1970) – prices and corresponding adjustment processes are in fact far from achieving perfect and efficient markets. Some researchers argue that Chinese stock prices are unable to be analyzed using economic fundamentals. Rather, determinants seem mainly to be driven by non-fundamental components (Chen, Lee, and Rui, 2001; Mei, Scheinkman, and Xiong, 2004). Despite market functions being distorted by institutional regulations, domestic rigidity, and market segmentation, Chinese enterprises have successfully raised capital by selling stock to domestic and
foreign investors, although the markets have been characterized by excessive volatility. From an academic point of view, the Chinese market provides an interesting forum for researchers who intend to investigate and compare Chinese market behavior and institutional characteristics with those prevailing in advanced markets. Empirical regularities derived from investigating Chinese markets should provide new insight, not only in enabling investors to form a sound investment strategy but also in helping policymakers to formulate better policies for regulating and monitoring their financial markets.

Given the built-in dual-market characteristics, Chinese regulators have divided stock issues into two classes of shares since the establishment of the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) in December 1990. A shares can be purchased and traded by domestic (Chinese) investors only and are denominated in their local currency, the RenMinBi (RMB). B shares were sold only to foreign investors before February 2001 and have been sold to both foreign and domestic investors since that date. A shares and B shares are traded simultaneously on the Shanghai and the Shenzhen stock markets, and neither market allows cross-listing.

In response to the two-tier market structure, studies of Chinese stock markets have focused on cross-market causal relationships and persistent price differentials between A shares and B shares (Chui and Kwok, 1998). By employing a vector autoregressive model to perform the Granger causality test, Lee and Rui (2000) report that there is a feedback relationship in returns between Shanghai B and Shenzhen B stocks. Trading volume helps predict the volatility of returns, but not Granger-caused stock returns on either the Shanghai or the Shenzhen stocks. By emphasizing individual firm data, Chen,
Lee, and Rui, (2001) also find evidence of bilateral feedback between A-share and B-share returns, although more cases occurred in a causal direction from A shares to B shares.

Researchers studying Chinese stock prices also find significant price differentials between A shares and B shares. The plots of the price series for A and B shares over time are presented in Figures 2.1.1 and 2.1.2.

Bailey (1994) began this research by analyzing eight Chinese-share stocks from March 1992 to March 1993, finding a substantial discount in B-share prices relative to A-share prices. A follow-up study by Su (1998) investigates 47 stocks from 1993 through 1996 and discovers that the average daily discount of B shares relative to A shares is about 62.2%. By examining a sample consisting of 68 firms issuing both A-share and B-share stocks, Chen, Lee, and Rui (2001) find that the average B-share discount on the SHSE was about 66.2% from 1992 to 1997 and that on the SZSE was about 52.4%.

The existence of persistent price differentials between A shares and B shares leads to various testable hypotheses. Su (1998) presents evidence that the cross-sectional spread between the A- and B-share returns is correlated with a difference in risk factors. Chen, Lee, and Rui (2001) report that the price difference is due primarily to illiquid B-share markets, since the shareholders of B stocks require a lower price to compensate for a higher transaction cost. Their findings also suggest that B-share prices are related more to market fundamentals, while A-share prices are more likely to be influenced by non-fundamental factors.
In summary, recent studies demonstrate two empirical conclusions. First, A-share and B-share prices and, in turn, expected returns, are somehow correlated with each other because of their common sharing of at least part of the economic fundamentals derived from the same company. Second, price differentials between A and B shares are related to risk or liquidity factors due to market segmentation. However, the methodology employed in this literature uses a standard vector autoregressive process. In these models, correlation is assumed to be constant, and the risk factor is generated from a simple GARCH (1,1) specification (Bollerslev, 1986; Bollerslev et al., 1992). These models fail to take into account the dynamic elements that capture the evolution of the two segmented-market forces (Ma, 1996).

As policy and regulations change over time, investors in the two classes of shares react endogenously to new regulatory requirements and market conditions. Given the heterogeneity of investor sophistication (Albuquerque, Bauer, and Schneider, 2004), innovations and developments in market reactions will be transmitted instantaneously to the parameters of conditional variance-covariance in different degrees, as reflected in the time-varying correlation coefficients. Thus, analyzing time-varying stock-return correlations provides a simple and unique method for studying dynamic segmentation status caused by heterogeneous investor reaction to external shocks over time.

The remainder of this essay proceeds as follows. Section 2.2 describes the data and summary statistics of Chinese stock returns. Section 2.3 presents a multivariate GARCH model characterized by a dynamic conditional correlation (DCC). Section 2.4 tests Chinese stock return series by employing a DCC model. Section 2.5 analyzes the sources of the time-varying correlation coefficients. Section 2.6 presents conclusions.
2.2 Data and Descriptive Statistics

2.2.1 The data

The data employed in this study consist of daily stock indices and trading volumes (number of shares turned over during the same business day) for the Shanghai composite A-share index (SHA), Shanghai composite B-share index (SHB), Shenzhen composite A-share index (SZA), and Shenzhen composite B-share index (SZB). The sample spans the period from 1996:01:01 through 2003:06:30. SHB shares are denominated in U.S. dollars, and SZB shares are denominated in Hong Kong dollars. The data are taken from Shen Yin Wan Guo Securities Co. Ltd. in China. To reiterate, the rationale for issuing two classes of stocks in Chinese markets is to offer different channels for attracting foreign capital that will support rapid economic growth while at the same time protecting a relatively thin domestic market.

2.2.2 Summary statistics

Table 1 contains statistics of stock returns for Chinese A-share and B-share indices in Shanghai and Shenzhen as well as the Hong Kong Hang Seng stock index and the U.S. S&P 500 index. The inclusion of Hong Kong and U.S. stock returns provides reference for comparison, especially for B shares.

< Insert Table 2.1 about here >

Daily stock returns are calculated as the first difference of the natural log of the stock indices times 100. All stock returns in Panel A show that Chinese markets are higher than they are in U.S. and Hong Kong markets, with higher returns matched by higher variances. However, A shares have higher returns and lower variances compared with B shares. The skewness parameters display mixed signs. B shares have significant positive
signs, while A shares register negative ones. This statistic is consistent with the finding by Chen, Hong, and Stein, (2001) that negative skewness is most pronounced in stocks that have experienced an increase in trading volume relative to trend. Coefficients of kurtosis are higher for Chinese A shares than those of B shares or U.S. stocks, indicating that extreme return volatility is inherent in Chinese markets. In the last column, Ljung-Box Q statistics (LB) are highly significant, indicating that stock returns in Chinese markets display stronger serial correlations than do those in U.S. market. A general message derived from these statistics is that Chinese stocks have higher returns but are exposed to higher risks. As shown by the time-series plots in Figure 2.2, the return series, in general, shows a stationary process, and the volatility evolution appears to demonstrate a clustering phenomenon, indicating that some type of GARCH model is appropriate.

< Insert Figure 2.2 about here >

Since correlation coefficient between A shares and B shares provides a useful measure of the long-run relationship between the two types of shares, Table 2.2 presents a simple pair-wise correlation matrix between the stock returns. The calculation is based on the constant coefficient given by:

$$\rho_{AB} = \frac{\sum_{t=1}^{T} (R_{A,t} - \bar{R}_A)(R_{B,t} - \bar{R}_B)}{\sqrt{\sum_{t=1}^{T} (R_A - \bar{R})^2 \sum_{t=1}^{T} (R_B - \bar{R})^2}}.$$

< Insert Table 2.2 about here >

Since the correlation coefficient demonstrates a symmetrical nature, $\rho_{AB} = \rho_{BA}$, only the lower triangle portions are reported. These statistics offer two interesting observations. First, correlations within each class of stock returns are relatively higher than those of the cross-stock returns. That is, the correlation coefficient between SHA and SZA (SHB and SZB) is higher than the correlation coefficient between SHA and SHB (SZA and SZB).
Second, using March 1, 2001, as a demarcation point to account for the impact of the policy change allowing domestic residents to purchase B shares, the correlation coefficients in two sub-sample periods change substantially. In particular, the correlation coefficients increased in both cross-class and own-class stock returns. This outcome is encouraging, since it indicates the effectiveness of adopting the new policy. The main drawback of this constant correlation approach, however, is that it offers only two parameters associated with two sub-periods that distinguish the effect of policy on and policy off. In fact, dynamic relations in stock markets are often subject to continual changes, and these changes may not be directly observable based on fundamental factors. To trace the full spectrum of such a dynamic trajectory, we need a conditional correlation coefficient that more accurately reflects market reality.

2.3 The Dynamic Correlation Coefficient Model

Recognizing the fact that the constant correlation coefficient fails to reflect dynamic market conditions in response to innovation, in this section we present a multivariate GARCH model to estimate dynamic conditional correlations (DCC) for A shares and B shares. The DCC model was proposed originally by Engle (2002). Chiang, Jeon, and Li (2005) then apply the model to investigate Asian stock market contagion. The strength of the DCC model over competing techniques is its capacity to resolve the heteroskedasticity problem, since the estimation of correlation coefficients is based on standardized residuals. Thus, the correlation coefficient derived from a DCC model will alleviate the effect of a parametric impact resulting from volatile variances. Additionally, explanatory variables such as $\Delta V$ (change of volume) can be added to the mean equation to account for a trading volume effect (Gallant, Rossi, and Tauchen, 1992; Campbell, Grossman, and Wang, 1993;
Moreover, the multivariate GARCH model can be used to examine the cross relations for multiple asset returns without adding too many parameters. The resulting estimates of time-varying correlation coefficients provide us with dynamic trajectories of correlation behavior for the two classes of A- and B-share index returns in a multivariate setting. This information enables us to analyze correlation behavior while presenting multiple regime shifts in response to shocks, risk, or policy changes.

A bivariate VAR(1) return equation with an exogenous variable model can be expressed as:

\[
R_{i,t} = \delta + \gamma R_{i,t-1} + \phi Z_{i,t} + \varepsilon_{i,t}, \quad i = A, B
\]  

(2.1)

where \( R_{i,t} = [ R_{A,t} \ R_{B,t} ] \), \( \gamma \) and \( \phi \) are 2x2 constant coefficient matrices with off-diagonals being zero, \( \varepsilon_{i,t} | I_{t-1} = [ \varepsilon_{A,t} \ \varepsilon_{B,t} ] \sim N(0, H_t) \). Equation (2.1) follows the conventional approach that an AR(1) term is included to account for autocorrelation arising from price limitations, slow price adjustments, or other types of market frictions (see Amihud and Mendelson, 1987; Fama and French, 1988; Sentana and Wadhwani, 1992; Damodaran, 1993; Harvey, 1995; Scholes and Williams, 1977; Koutmos, 1998, 1999; Lo and MacKinlay, 1990). We also add \( Z_{i,t} \) to serve as an exogenous variable, where \( Z_{i,t} \) can be the change in trading volume in our context (Karpoff, 1987a, 1987b; Lamoureux and Lastrapes, 1990; Wang, 1994; Omran and McKenzie, 2000; Suominen, 2001; Solibakke, 2001; Lee and Rui, 2002).

The multivariate conditional variance is given by:

\[
H_t = D_t V_t D_t
\]  

(2.2)
where $D_t = \text{diag}(\sqrt{h_{i,t}})_{(2,2)}$ and $V_t = \begin{bmatrix} 1 & \rho_{AB,t} \\ \rho_{BA,t} & 1 \end{bmatrix}_{(2,2)}$. Here, $V_t = D_t^{-1}H_tD_t^{-1}$, which is a conditional-correlation matrix of the residuals or standardized residuals, and $h_{i,t}$ (where $i = A,B$) is the conditional variances for two (A-and B-share) stock index returns. Expanding the variance-covariance matrices into individual equations yields the conditional variances as:

$$h_{AA,t} = c_A + a_A h_{AA,t-1} + b_A e_{A,t-1}^2,$$

$$h_{BB,t} = c_B + a_B h_{BB,t-1} + b_B e_{B,t-1}^2.$$  

Assuming that the conditional covariance, $q_{AB,t}$, between the standardized residuals, $\eta_{A,t}$ and $\eta_{B,t}$, follows a GARCH(1,1) process (Bollerslev et al. 1992), we write:

$$q_{AB,t} = \bar{\rho}_{AB}(1-\alpha-\beta) + \alpha q_{AB,t-1} + \beta \eta_{A,t-1}\eta_{B,t-1},$$

with $\eta_{A,t} = e_{A,t} / \sqrt{h_{AA,t}}$, $\eta_{B,t} = e_{B,t} / \sqrt{h_{BB,t}}$, and $\bar{\rho}_{AB}$ as the unconditional correlation between $e_{A,t}$ and $e_{B,t}$. The average of $q_{AB,t}$ is $\bar{\rho}_{AB}$, and the average variance is unity.

The correlation estimator is given by:

$$\rho_{AB,t} = q_{AB,t} / \sqrt{q_{AA,t}q_{BB,t}}.$$  

(2.6)

The mean reversion requires that $\alpha + \beta < 1$. However, when $\alpha + \beta = 1$, the process followed by the $q_{AB,t}$ in Equation (2.5) will be integrated. That is,

$$q_{AB,t} = \alpha q_{AB,t-1} + \beta \eta_{A,t-1}\eta_{B,t-1},$$

(2.7)

---

6 There are a number of ways to formulate this equation, ranging from an exponential smoothing method to an ARIMA process. Since the simulation in Engle (2002) shows that the mean-reverting specification performs best among alternative methods, this study employs Equation (2.5) in our analysis.
where $q_{AB}$ in Equation (2.7) is a weighted average of its own lag and the lagged product of two standardized residuals.

As suggested by Engle (2002), the DCC model can be estimated by using a two-stage approach to maximizing the log-likelihood function as:

$$L = -\frac{1}{2} \sum_{t=1}^{T} \left( n \log(2\pi) + \log |H_t| + \varepsilon_t H_t^{-1} \varepsilon_t \right)$$

$$= -\frac{1}{2} \sum_{t=1}^{T} \left( n \log(2\pi) + \log |D_t V_t D_t| + \varepsilon_t D_t^{-1} V_t^{-1} D_t^{-1} \varepsilon_t \right)$$

$$= \left[ -\frac{1}{2} \sum_{t=1}^{T} (n \log(2\pi) + \log |D_t|^2 + \varepsilon_t D_t^{-2} \varepsilon_t) \right] + \left[ -\frac{1}{2} \sum_{t=1}^{T} (\log |V_t| + \eta_t V_t^{-1} \eta_t - \eta_t \eta_t) \right] \quad (2.8)$$

The first part of the likelihood function in Equation (8) is volatility, which is the sum of individual GARCH likelihoods. The log-likelihood function can be maximized in the first stage over the parameters in $D_t$. Given the estimated parameters in stage one, the correlation component of the likelihood function in the second stage (the second part of Equation (8)) can be maximized to estimate correlation coefficients.

### 2.4 Empirical Estimations

The DCC models are estimated with three different specifications of mean-return equations. Model 1 assumes a simple AR(1) form by restricting the coefficient of $Z_{i,t}$ ($i = A,B$) to zero (Koutmos, 1998; 1999). Since the literature shows that trading volume has significant informational content, we set $Z_{i,t} = \Delta V_{i,t}$ in Model 2 and $Z_{i,t} = DMV_{i,t}$ in
Model 3 for $i = A, B$, where $DMV_{t,i}$, is used to measure the deviations of the natural log of trading volume from the natural log of a 60-day moving-average trading volume.$^7$

Estimates of the mean equations and variance equation are presented in Table 2.3. All the coefficients of the AR(1) term in the mean equation display positive signs and are statically significant. These results are consistent with the general finding of positive autocorrelation reported by Harvey (1995). However, the magnitude of the coefficients on B shares is higher than that of A shares. Our finding here is different from that reported by Lee and Rui (2000), where the estimated coefficients of AR(1) on B shares are negative and insignificant. This could be the result either of applying more updated data or simply just employing a more efficient DCC model.

With respect to volume variables, the estimated coefficients are positive and highly significant. This result is consistent with a number of hypotheses in the literature. For instance, a change in volume may provide information about an expected change of future returns (Wang, 1994). It may also reflect changes in market volatility. Thus, changes in stock prices are associated with changes in volume. Lamoureux and Lastrapes (1990) present evidence to justify this argument. Further, by defining normal trading volume as the state in which no unanticipated information enters the market, Karpoff (1987a, 1987b) contends that “abnormal” trading volume should be the state in which unanticipated information enters the market. The significance of $DMV_{t,i}$ in our Model 3 is in agreement with Karoff’s hypothesis. It should be noted that coefficients of the

---

$^7$ The inclusion of volume in the return equation has been justified by Karpoff, 1987b; Lamoureux and Lastrapes, 1990; Wang, 1994; Suominen, 2001; Solibakke, 2001; Chen, Hong, and Stein, 2001; Lee and Rui., 2002.
volume variables are much higher in A shares than in B shares, indicating that stock price changes in A shares are more sensitive in response to volume variables than changes in B shares.

With respect to the variance equation, we find that the coefficients of the lagged variance and shock-squared terms are highly significant, which is consistent with time-varying volatility and justifies a clustering phenomenon in the evolution of volatility. Note that the sum of the estimated coefficients (see last column) in the variance equation, \((a + b)\) is close to unity for all cases, implying that volatility displays a highly persistent behavior.\(^8\)

### 2.5 Analysis of Dynamic Correlation

#### 2.5.1 Effects of policy change

An important implementation of DCC models in the previous section is that it allows us to generate a time-series path of dynamic correlation coefficients. The time-series plots of these correlation coefficients based on the three models are depicted in Figures 2.4.1 to 2.4.3.\(^9\) These figures appear to display more sensitive movements over time as compared with that of the two-year rolling correlation coefficient in Figure 2.3. By examining the mean and variance of these correlation coefficients, the statistics in Table 2.4 suggest two interesting points. First, within each stock exchange location, the time-varying correlations, \(\rho_{AB,t}\), in general are higher than the values based on constant

---

\(^8\) As may be seen from the footnote in Table 3, the sum of \(\alpha\) and \(\beta\) is close to 1. This implies that our data are more consistent with the specification of Equation (2.7).

\(^9\) Cholesky decomposition can also be used to derive the time-varying correlation coefficient (see Tsay, 2002, pp. 358-383).
correlation coefficients in the same exchange location. Second, the correlation coefficients are higher in the Shanghai exchange than in the Shenzhen exchange.

< Insert Figure 2.3 about here >

< Insert Figures 2.4.1-2.4.3 here >

The question that remains to be answered is what the factors are that cause correlation coefficients to be time-varying. By carefully analyzing the dynamic time paths in Figures 2.4.1-2.4.3, we identify two distinctive features. First, there is high volatility during the period July 2, 1997, to December 31, 1998. In fact, for some periods of time, the $\rho_{AB,t}$ even displays negative values due to the Asian crisis. Second, after February 2001, the correlations have been consistently moving higher over time. This pattern may be attributable to the more liberal governmental policy allowing domestic citizens to purchase B shares.

In light of these observations, we set up a regression model to capture the dynamic feature of the correlation changes as:

$$\rho_{AB,t} = c + f_1 \rho_{AB,t-1} + \sum_{s=1}^{3} g_s DM_{s,t} + e_t, \quad (2.9)$$

where $\rho_{AB,t}$ is the pair-wise correlation coefficient between the stock returns of A and B shares for Shanghai A and Shanghai B returns or Shenzhen A and Shenzhen B returns derived from the GARCH-DCC models (Model 1, Model 2, and Model 3); $c, f_1$ and $g_s$ are constant coefficients. The lagged AR term is included to capture the stochastic trend.\(^{10}\) $DM_{s,t}$ ($s = 1, 2$ and $3$) are dummy variables: $DM_1$ is for the first phase of the Asian crisis (7/2/1997–11/17/1997); $DM_2$ is for the second phase of the Asian crisis (11/18/1997–

\(^{10}\) A longer lag will be added if a time-series pattern is present.
12/31/1998); and $DM_3$ is an indicator of the post-policy-change period when domestic investors were allowed to purchase B shares (3/1/2001–6/30/2003). The $DM_{s,t}$ takes the value of unity to indicate an effect; otherwise, the values are zero.

Since our pre-tests from the ARCH-LM statistics (not reported) find significant heteroskedasticity in all $\rho_{AB,t}$ series, the series is also modeled in a GARCH(1,1) fashion (Bollerslev et al., 1992). In addition, the dummy variables are added to a GARCH(1,1) specification to examine the effects of the Asian crisis and policy change on the variance. This leads to:

$$\sigma_{\rho,t}^2 = c + a_1 \sigma_{\rho,t-1}^2 + b_1 e_{t-1}^2 + \sum_{t=1}^{3} \epsilon_{s,t}DM_{s,t}.$$  

(2.10)

The estimated coefficients for Equation (2.9) and Equation (2.10) are reported in Table 2.5. The coefficient of AR(1) is highly significant, confirming the existence of a stochastic trend. With respect to the evidence of dummy variables, the $DM_1$ coefficient in Panel A is insignificant, indicating that the outbreak of the Asian crisis had only a minor influence on the correlation in the first phase. However, when the Asian crisis moved to the second phase, the correlation became more negatively significant, especially in the Shanghai exchange. This might have resulted from the fact that in the later stages of the Asian crisis, many foreign investors withdrew their assets from Asian markets owing to a contagious effect (King and Wadhwani, 1990; Chiang et al. 2005), including the part of their investments associated with B shares.

The dummy variable used to test the impact of the Chinese government’s policy change shows a positive sign. However, the evidence shows that only the Shanghai exchange is statistically significant. This suggests that the correlation coefficients for the
post-policy-change period are significantly higher than those in the pre-policy-change period.

The statistics in Panel B provide estimates of the conditional variance equation for the $\rho_{AB,t}$ series. As do most financial time-series, the parameters on the GARCH(1,1) specification are all statistically significant. The coefficients that reflect the Asian crisis in general are positive, indicating that stock market volatility in Asian markets has a spillover effect on the dynamic volatility of correlations in Chinese A shares and B shares. More interestingly, the result from the coefficients on $DM_j$ in the variance equations are all negative and highly significant, indicating that the volatility of the time-varying correlation coefficients has declined since the Chinese government adopted a more relaxed policy on purchasing B shares. These testing results conclude that the Asian crisis did have some spillover effect on the correlation coefficient in the sense that it reduced the correlation coefficient and at the same time aggravated volatility. On the other hand, removal of the more restrictive policy tended to enhance market correlation and reduce volatility of the correlation coefficient, leading to a higher degree of market integration between A- and B-share markets.

2.5.2 Time-varying risk

An alternative argument we employ to interpret the dynamic correlation coefficient is the time-varying risk hypothesis. Since by its construction, the correlation coefficient is highly sensitive to the volatilities associated with A-share or B-share stock returns during a particular day, shocks reflecting either good or bad news are transmitted
instantaneously into prevailing prices. The high-low price differential during the day thus can be used as a proxy for the risk factor. Our specification is given by:

$$\rho_{AB,t} = \nu_0 + \nu_1(p_{A,t}^{HL}) + \nu_2(p_{B,t}^{HL}) + u_t,$$

where $\rho_{AB,t}$ is the correlation coefficient series between A-share stock return and B-share stock returns. Additionally, $p_{A,t}^{HL} = (\ln P_{A,t}^H - \ln P_{A,t}^L)$ and $p_{B,t}^{HL} = (\ln P_{B,t}^H - \ln P_{B,t}^L)$, respectively, represent the difference between the highest price ($\ln P_{A,t}^H$ or $\ln P_{B,t}^H$) and lowest price ($\ln P_{A,t}^L$ or $\ln P_{B,t}^L$) and are expressed in natural logarithms during a particular trading day for A- and B-share indices. Both $\nu_1$ and $\nu_2$ are constant parameters, with $\nu_1 < 0$ and $\nu_2 < 0$, since a greater price differential reflects a higher risk and thus leads to a lower correlation.\(^{11}\)

Table 2.6 reports the estimation results for Shanghai A- and B-share and Shenzhen A- and B-share markets.

< Insert Table 2.6 about here >

The evidence indicates that the null hypothesis that the time-varying correlation is independent of daily high-low price differential is decisively rejected; the exception is the SHA market. Our results are thus consistent with the time-varying risk hypothesis. As shown by Chen, Lee, and Rui (2001), B-share price movements are more closely related to market fundamentals than are A-share prices, implying that time-varying correlations may be correlated with variations of fundamental factors. A formal examination of this hypothesis will be left for future research.

\(^{11}\) Pagan and Schwert (1990) provide a number of specifications of conditional volatility and risk.
2.6 Conclusions

This essay examines both A-share and B-share market segmentation conditions by employing a dynamic multivariate GARCH model to analyze daily stock-return data during the period 1996 to 2003. Statistics show returns for both A shares and B shares are significantly and positively correlated with the change in trading volume or abnormal volume. This evidence is in agreement with most findings presented for advanced markets (Chen, Hong, and Stein, 2001).

The results of this study reveal several empirical regularities pertinent to illustrating the dynamic segmentation between A-share and B-share markets. First, correlation coefficients between A- and B-share stock returns are time-varying. Analysis of the dynamic path of correlation coefficients suggests that a recent increase in correlation is associated with a relaxation of government restrictions on the purchase of B shares by domestic residents, indicating that the degree of segmentation has been moderate and that the two classes of markets have tended to gradually merge. Second, the variance of time-varying correlation coefficients has been reduced during the post-policy-change period, meaning that the market integration process has been stabilized. Third, the dynamic relationship between A shares and B shares is not independent of external shocks such as the Asian crisis. Moreover, these shocks affect both the level and the conditional variance of the correlation coefficient. Fourth, the time-varying correlation coefficient is negatively correlated with the ongoing daily high-low price differential. This finding is consistent with the time-varying risk hypothesis. In sum, our study of time-varying stock return correlations provides a simple and unique method to use in examining dynamic segmentation due to heterogeneous investor reactions to external shocks over time.
Chapter 3. Is There Herding Behavior in Chinese Stock Markets?  
An Examination of Chinese A and B Shares

Chapter 3 Abstract

In this essay, we examine whether herding behavior exists in Chinese A- and B-share markets. By applying the methodology proposed by Chang, Cheng, and Khorana (2000) to Chinese stock data, we find that there is herding behavior in both the Shanghai and Shenzhen A-share markets. However, there is no supportive evidence for herding behavior in both B markets. Herding behavior in Chinese markets demonstrate similar patterns of asymmetric effects as market goes up vs. as it goes down, trading volume becomes excessively high vs. excessively low, and volatility becomes excessively high vs. excessively low. There is no concrete evidence in favor of herding behavior across A and B markets, nor across Shanghai and Shenzhen markets. Volatility is found to have more explanatory power than volume in explaining herding behavior.

3.1 Introduction

In recent years, herding has been commonly recognized as a behavior describing individual investors’ reaction to public news, especially when facing big price changes or excessive market volatility. The research in the finance literature can be divided into the following categories. The first approach may be termed the rational approach advocated by Bikhchandani, Hirshleifer and Welch (1992) and Scharfstein and Stein (1990). The approach views herding as an informational cascade that occurs when an individual believes it is optimal to follow the behavior of previous individuals and disregard his own information. The optimal decision made by investors is to “mimic the investment decisions of other managers” and simply ignore their own private information. This approach appears to be cost saving and without time delay in making decisions. The second approach proposed by Devenow and Welch (1996) may be called the irrational approach, which views herding as a blind behavior in which investors irrationally follow other investors for psychological reasons.
In response to the above theoretical arguments, empirical studies have mainly focused on detecting the existence of herding behavior for mutual funds managers (Lakonishok, Shleifer, and Vishny, 1992; Daniel, Grinblatt, Titman, and Wermers, 1997; Wermers, 1999; Wermers, 2000) or financial analysts (Trueman, 1994; Graham, 1999; Hong, Kubik, and Solomon, 2000; Gleason and Lee, 2003; Clement and Tse, 2005). Very few attempts have been devoted to examining market conditions or economic parameters with which herding behavior is associated. In this study, we argue that market conditions of return volatility and trading volume are crucial to describing the relation between herding and market conditions.

The prerequisite to carrying out such a study is to detect whether herding behavior prevails in a market. Based on the research of Christie and Huang (1995), Chang, Cheng, and Khorana (2000) (henceforth referred as CCK) provide a simple technique to test the existence of general investor herding behavior in financial markets. In CCK’s model, herding behavior is defined as “the tendency of investors to mimic the actions of others.” By applying data from markets in the U.S., Hong Kong, Japan, South Korea, and Taiwan, they find no evidence of herding in developed markets such as the U.S. and Hong Kong. However, they find evidence of herding in two emerging markets: South Korea and Taiwan. Although CCK does not provide explanations of what may have caused the behavior difference in different markets or what kind of market behavior herding behavior is associated with, their interesting findings have motivated us to investigate the two-tier (A- and B-share) Chinese stock markets for the reasons given below.

Chinese stock markets have a short history: a little over 10 years. Stock issues are divided into two classes of shares since the establishment of Shanghai Stock Exchange
(SHSE) and Shenzhen Stock Exchange (SZSE) in December 1990. A shares can be purchased and traded by domestic (Chinese) investors only and are denominated in the local currency, Renminbi (RMB). B shares were sold to foreign investors only before February 2001 and have been sold to both foreign and domestic investors since then. A shares and B shares are traded simultaneously on the Shanghai and Shenzhen stock markets, and neither market allows cross-listing. Although A- and B-share stocks coexist in Chinese stock markets, the components of investors are quite different. That is, A-share markets are dominated by individual domestic investors. The A-share markets can be viewed as an emerging market similar to those of South Korea and Taiwan. The B-share markets, which are dominated by foreign institutional investors, can be viewed as advanced markets.\(^\text{12}\) The investment decisions of A-share investors are likely to be more influenced by other investors owing to their lack of experience, education, or basic knowledge of investments. Since A and B shares have different components of investors for a major part of the Chinese stock market’s history (from its establishment to February 2001), it is anticipated that investors participating in these two classes of shares display different behavior. Analyzing the data in these two-tier markets allows us to examine not only their herding behavior but also the asymmetric effects due to changes in market return changes or different states of market volatility. Specifically, we test whether there is herding behavior in Shanghai and Shenzhen A-share markets and Shanghai and Shenzhen B-share markets by using a modified methodology of CCK.

The remainder of this paper is organized as follows. Section 3.2 describes data. Section 3.3 presents the methodology proposed by CCK’s model. Section 3.4 examines

the asymmetric effects of the herding behavior. Section 3.5 presents the evidence of herding in relation to volatility and trading volume. Section 3.6 contains the conclusion.

3.2 Data

We collect all individual stock information listed on the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) from 1995 to 2003. The Wednesday weekly data range from January 1, 1995, to December 31, 2003. Among stocks listed on the Shanghai and Shenzhen stock exchanges, there are 746 Shanghai A-share firms (SHA), 54 Shanghai B-share firms (SHB), 489 Shenzhen A-share firms (SZA), and 57 Shenzhen B-share firms (SZB). There are 44 firms that dual list A and B shares on SHSE and 43 firms that dual list A and B shares on SZSE. We also collect a Shanghai Composite Index for the Shanghai market and a Shenzhen Composite Index for the Shenzhen market. The above data are provided by Shenyin Wangguo Securities Co Ltd. in China.

3.3 Methodology

3.3.1 The model

The model used in this paper is a modified version of CCK’s model. CCK argue that “market participants suppress their own predictions about asset prices during periods of large market movement,” especially “in the presence of severe (moderate) herding.” They expect that return dispersions will “decrease (or increase at a decreasing rate) with an increase in the market return.”

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In the CCK model, the cross-sectional absolute deviation (CSAD) is employed to represent return dispersion. The following procedure describes how CSAD is derived in this study. The methodology is a modified version of CCK’s procedure.

To start, let us consider Black’s (1972) conditional version of CAPM:

$$E_t(R_t) = \gamma_{0,t} + \beta_{i,t} E_t(R_m - \gamma_0)$$

(3.1)

where $E_t(\cdot)$ is an expectation operator conditioned on time $t$, $\gamma_{0,t}$ is the return on zero-beta portfolio at time $t$, $\beta_{i,t}$ is the time-invariant systematic risk measure of the stock, $i = 1, \ldots, N$ and $t = 1, \ldots, T$. $R_i$ is the individual stock return, and $R_m$ is the market return.

Using $\beta_{m,t}$ to represent the systemic risk of an equity-weighted market portfolio, we define:

$$\beta_{m,t} = \frac{1}{N} \sum_{i=1}^{N} \beta_{i,t}$$

(3.2)

The absolute value of the deviation ($AVD$) of stock $i$’s expected excess return in period $t$ from the $t^{th}$ period market portfolio expected excess return can be expressed as

$$AVD_{i,t} = |\beta_{i,t} - \beta_{m,t}| E_t(R_m - \gamma_0)$$

(3.3)

The expected cross-sectional absolute deviation of stock returns ($ECSAD$) in period $t$ is defined as follows:

$$ECSAD_t = \frac{1}{N} \sum_{i=1}^{N} AVD_{i,t} = \frac{1}{N} \sum_{i=1}^{N} |\beta_{i,t} - \beta_{m,t}| E_t(R_m - \gamma_0)$$

(3.4)

Since rational expectations imply that the actual value is the sum of expected value plus error term, $ECSAD_t$ can be measured by:

---

\[
CSAD_t = \sum_{i=1}^{N} \frac{1}{N} \left| \beta_{i,t} - \beta_{m,t} \right| \left[ E_i (R_m - \gamma_0) + \varepsilon_i \right] \tag{3.5}
\]

Having generated the \( CSAD_t \) value by employing (3.5), herding behavior can be tested by examining the coefficient of \( (R_{m,t})^2 \) in the following specification:

\[
CSAD_t = \alpha + \gamma_1 R_{m,t} + \gamma_2 (R_{m,t})^2 + \varepsilon_i \tag{3.6}
\]

In equation (3.6), restricting \( \gamma_2 \) to be negative implies herding behavior. This means that when there is a big market movement, such as market return goes up (down), if herding behavior exists among investors who tend to herd around market return, the return dispersion measured as \( CSAD_t \) will decrease. Therefore, a negative significant \( \gamma_2 \) is an indicator of herding behavior.

One drawback of CCK’s measure is that \( i \beta \) is time-invariant, assuming a linear and stable relationship between risk factors and return. However, literature shows that the assumption of beta stability is widely rejected (Fama and French, 1992; Jagannathan and Wang, 1996 etc.). Since herding is more observable during time of large market movements, it is important to employ a model characterized with time varying beta to capture the dynamics involving extreme market movements. To construct a time-varying \( CSAD_t \), this study uses a 26-week\(^{14}\) rolling regression to obtain \( \beta_i \) series. Specifically, the coefficients of the market return (and square term) are estimated using 26 weeks as a given window width; the sample rolls one week ahead at a time by adding

\(^{14}\) Choosing 26 weeks or half-year observations would allow adequate variations to generate beta, while avoiding the problems of having to smooth beta if too many observations are applied in the rolling regression.
the most recent one week of data and deleting the most distant week (Chiang, 1988). By incorporating the latest market return, the coefficients will reflect the changes of the most recent market information.

### 3.3.2 Estimation

Table 3.1 reports the summary statistics of market return from July 12, 1994, to December 31, 2003. The $CSAD_t$ series is generated following equation (3.5). Because using a zero-beta portfolio mentioned in equation (3.1) is not practical in this research, we collect a risk-free asset proxy $\gamma_0$ for the four markets. Specifically, we use the U.S. Treasury bill rate as the risk-free rate for the Shanghai B market, since stocks listed on the Shanghai B market are denominated in U.S. dollars; we use the Hong Kong Treasury bill rate as the risk-free rate for the Shenzhen B market, since stocks listed on the Shenzhen B market are denominated in Hong Kong dollars. For Shanghai A and Shenzhen A markets, the Chinese demand deposit rate is used, since it is the only openly available risk-free rate in these markets. All three rates are obtained from the IFS database.

<Insert Table 3.1 about here>

Table 3.2 reports the estimation results of equation (3.6). Equation (3.6) applies to $j$ market, where $j = \text{SZA, SZB, SHA, and SHB}$. Since a negative $\gamma_2$ implies herding

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15 A zero-beta portfolio is a portfolio designed to represent the risk-free asset, which has a beta of zero. We do not find empirical research describing how to generate such a portfolio from empirical market data, including the research of Chang, Cheng, and Khorana (2000). Instead, most researchers use a risk-free asset proxy. Besides, since this study uses a rolling regression methodology to generate time-varying beta, the components of zero-beta portfolio will be constantly changing, which poses a problem for studying the market portfolio, which has relative constant components. For the above reasons, this study uses proxies for risk-free assets.
behavior, we pay special attention to the $\gamma_2$ coefficients. In Table 3.2, we find that the sign on $\gamma_2$ is negative for both the Shanghai A- and the Shenzhen A-share markets, and the coefficients are statistically significant. When checking the signs for both B-share markets, we find that both of them turn out to be positive. The results suggest that herding behavior exists in both the Shanghai A- and the Shenzhen A-markets, but the testing results do not suggest herding behavior exists in either of the B markets. Since the A markets are dominated completely by Chinese investors, while the B markets are mainly composed of institutional investors from developed countries, the results reported here are consistent with those of CCK, who document significant herding on the emerging markets and find no evidence of herding on the developed markets\footnote{We further test the impact of the Asian Crisis on herding behavior using the following model: $CSAD_t = \alpha + \gamma_1 R_{m,t} + \gamma_2 (R_{m,t})^2 + \gamma_3 (R_{m,t})^2 \cdot DM + \epsilon_t$, where $DM$ is the dummy variable for Asian Crisis from July 2, 1997 to November 17, 1997. The estimation results on all Shanghai and Shenzhen A and B markets indicate insignificance of the coefficients of dummy variable, indicating Asian Crisis does not have significant contribution to the herding behavior on Chinese A-and B-share stock markets.}.

<Insert Table 3.2 about here>

\section*{3.4 Asymmetric Effect}

In its transition from a state-controlled, planned economy to a market-oriented economy, the Chinese stock market shows strong and continuous government intervention (Hu, 1999). Because the Chinese stock market in its early stages showed easy and high profits from stock investments and because investors had strong habitual belief in the role played by government in supporting the stock market, Chinese investors showed over-confidence (Mei, Scheinkman, and Xiong, 2004) in making investment...
decisions. To place this phenomenon in the context of herding behavior, investors in A-share markets are likely to have different reactions with respect to different market conditions. It is of interest to investigate the asymmetric effect of stock returns that go up against returns that move down.

The literature often reports that stock returns, trading volume, and return volatility display a close relationship. For instance, Gallant, Rossi, and Tauchen (1992) document that large price movements are associated with high volume. Lamoureux and Lastrapes (1990) find that trading volume has significant explanatory power in terms of the daily return variance, which is the measure of volatility in our study. Lee and Rui (2002) find a positive feedback relationship between trading volumes and return volatility in several national markets. For this reason, in the following sections, we shall examine the asymmetric herding behavior in terms of market return, trading volume, and return volatility.

### 3.4.1 Asymmetric effects of market return

To examine whether herding behavior has an asymmetric effect in the up versus the down market, we set up a nonlinear model by examining $R_{m,t} > 0$ vs. $R_{m,t} < 0$. This leads to the following empirical specifications:

$$CSAD_{iUP}^{UP} = \alpha + \gamma_1^{UP} R_{m,t}^{UP} + \gamma_2^{UP} (R_{m,t}^{UP})^2 + \varepsilon_t, \text{ if } R_{m,t} > 0 \quad (3.7A)$$

$$CSAD_{iDOWN}^{DOWN} = \alpha + \gamma_1^{DOWN} R_{m,t}^{DOWN} + \gamma_2^{DOWN} (R_{m,t}^{DOWN})^2 + \varepsilon_t, \text{ if } R_{m,t} < 0 \quad (3.7B)$$
where $R_{m,t}^{UP} (R_{m,t}^{DOWN})$ is the equally weighted realized return of all available securities on day $t$ when the market is up (down) and $(R_{m,t}^{UP})^2 ((R_{m,t}^{DOWN})^2)$ is the squared value of this term. $CSAD_t^{UP} (CSAD_t^{DOWN})$ is the CSAD at time $t$ corresponding to $R_{m,t}^{UP} (R_{m,t}^{DOWN})$.

The estimates in Panels A and B of Table 3.3 are the results of equation (3.7A) and (3.8B), respectively. Panel A reports the regression results when the market goes up. The evidence shows that the estimated $\gamma_2$ for both A markets is negative and statistically significant at the conventional level. We also find the estimated coefficients of $\gamma_2$ for B-share markets are negative but the significance level is relatively low.

Panel B reports the regression results when the market goes down. We see that the $\gamma_2$ coefficients are positively significant for all four markets. The estimation results indicate that when the market goes up, herding behavior exists on the A markets, but when the market goes down, no herding behavior exists on the A markets. The asymmetric effects in A-share market returns reflect the view that Chinese investors are very optimistic about the market potential and confident of the supportive role played by government authorities. When the market goes up, investors herd around the market, believing the government is continually supporting the market. When the market goes down, investors do not herd around the market, believing the government will save the market.

<Insert Table 3.3 about here>

3.4.2 Asymmetric effects of trading volume
In this section, we shall examine whether herding behavior has an asymmetric effect in response to excessively high versus excessively low trading volume in the markets. Trading volume $V_t$ is regarded as excessively high ($V$-HIGH) if it exceeds the mean trading volume plus one standard deviation of trading volume in the past 26 weeks. That is, $(V_t > (V_{\text{Mean}} + V_{1.s.d.})$. Trading volume $V_t$ is regarded as excessively low ($V$-LOW) if it is lower than the mean trading volume minus one standard deviation of trading volume in the past 26 weeks. That is, $V_t < (V_{\text{Mean}} - V_{1.s.d.})$. The asymmetric effects are tested using the following empirical specifications:

\[
CSAD_{t}^{V-HIGH} = \alpha + \gamma_1^{V-HIGH} R_{m,t}^{V-HIGH} + \gamma_2^{V-HIGH} (R_{m,t}^{V-HIGH})^2 + \epsilon_t, \text{ if } V_t > (V_{\text{Mean}} + V_{1.s.d.}) \tag{3.8A}
\]

\[
CSAD_{t}^{V-LOW} = \alpha + \gamma_1^{V-LOW} R_{m,t}^{V-LOW} + \gamma_2^{V-LOW} (R_{m,t}^{V-LOW})^2 + \epsilon_t, \text{ if } V_t < (V_{\text{Mean}} - V_{1.s.d.}) \tag{3.8B}
\]

where $CSAD_{t}^{V-HIGH}$ ($CSAD_{t}^{V-LOW}$) is the CSAD at time $t$ corresponding to $V$-HIGH ($V$-LOW); $R_{m,t}^{V-HIGH}$ ($R_{m,t}^{V-LOW}$) is the market return at time $t$ corresponding to $V$-HIGH ($V$-LOW).

Panels A and B in Table 3.4 report the estimation results of equation (3.8A) and (3.8B), respectively. In Panel A, the evidence shows that estimated values of $\gamma_2$ for both the Shanghai and Shenzhen A markets are negatively and statistically significant. No comparable evidence is shown in the B market, where the estimated values of $\gamma_2$ are positive. Panel B reports the regression results for the excessively low trading volume. We find that the coefficients of $\gamma_2$ in Panel B are insignificant. The estimation results thus conclude that when trading volume is high, herding behavior exists on the A markets;
however, when trading volume is low, herding behavior does not exist on the A markets. Herding behavior does not exist on either of the B markets, no matter whether the trading volume is high or low. From sections 3.4.1 and 3.4.2, we find herding behavior demonstrates a very similar asymmetric pattern between market return and trading volume. This finding is consistent with the literature mentioned earlier that shows that return and trading volume have a close relationship.

< Insert table 3.4 about here>

3.4.3 Asymmetric effects of return volatility

To continue our investigation, in this section we examine whether herding behavior has an asymmetric effect on excessively high volatility versus excessively low volatility. Return volatility, $\hat{\sigma}^{2}_{t}$, is generated based on the rolling sample of 26 weeks as a fixed window ending at week $t$. Return volatility is defined as excessively high ($\hat{\sigma}^{2.\text{HIGH}}_{t}$) if it exceeds the mean volatility plus one standard deviation of volatility in the past 26 weeks. That is, $\hat{\sigma}^{2.\text{HIGH}}_{t} = (\hat{\sigma}^2_{t} > (\hat{\sigma}^{2.\text{Mean}}_{t} + \hat{\sigma}^{2.\text{s.d.}}_{t}))$. Return volatility $\hat{\sigma}^{2.\text{LOW}}_{t,m}$ is regarded as excessively low ($\hat{\sigma}^{2.\text{LOW}}_{t,m}$) if it is lower than the mean volatility minus one standard deviation of volatility in the past 26 weeks, that is, $\hat{\sigma}^{2.\text{LOW}}_{t,m} = (\hat{\sigma}^2_{t} < (\hat{\sigma}^{2.\text{Mean}}_{t} - \hat{\sigma}^{2.\text{s.d.}}_{t}))$.

The asymmetric effects are tested using the following empirical specifications.

$$CSAD_t^{\text{HIGH}} = \alpha + \gamma_1 \hat{\sigma}^{2.\text{HIGH}}_{t,m} + \gamma_2 \left( \hat{\sigma}^{2.\text{HIGH}}_{t,m} \right)^2 + \varepsilon_t$$

if $\hat{\sigma}^2_{t} > (\hat{\sigma}^{2.\text{Mean}}_{t} + \hat{\sigma}^{2.\text{s.d.}}_{t})$ \hspace{1cm} (3.9A)

$$CSAD_t^{\text{LOW}} = \alpha + \gamma_1 \hat{\sigma}^{2.\text{LOW}}_{t,m} + \gamma_2 \left( \hat{\sigma}^{2.\text{LOW}}_{t,m} \right)^2 + \varepsilon_t$$
\[
\text{if } \hat{\sigma}_t^2 < (\hat{\sigma}_{\text{mean}}^2 - \sigma_{1.s.d.}^2) \quad (3.9B)
\]

where \( CSAD_{t,\text{HIGH}} \) (\( CSAD_{t,\text{LOW}} \)) is the \( CSAD \) at time \( t \) corresponding to \( \hat{\sigma}_{t,\text{HIGH}}^2 \) (\( \hat{\sigma}_{t,\text{LOW}}^2 \)).

Table 3.5 reports the estimation results of equation (3.9A) and (3.9B), respectively. Panel A reports the regression results for excessively high volatility. The results indicate that the estimated values of \( \gamma_2 \) for the Shanghai and Shenzhen A markets are negative and statistically significant, while the estimated values of \( \gamma_2 \) for both of the B markets are positive. Turning to the statistics in Panel B, none of the coefficients is negative, implying that the herding phenomenon does not exist when volatility is excessively low.

In summary, the estimated results conclude that when volatility is excessively high, herding behavior is displayed in both of the A markets; however, when volatility is excessively low, there is no herding in either of the A markets. The evidence consistently shows that herding behavior does not occur in either of the B markets, regardless of whether volatility is high or low. The finding in this section is similar to those in the previous two sections. We conclude that herding behavior demonstrates a similar asymmetric pattern in terms of market return, trading volume, and volatility.

<Insert table 3.5 about here>

### 3.4.4 Herding behavior across A and B markets

Since Chen, Lee, and Rui (2001) find bilateral feedbacks between A-share and B-share returns, it is of interest to exam whether A-share investors make their investment decisions based on B-share investors’ decisions and vice versa. If the evidence appears
to conform to this argument, we say that A shares herd around B shares or vice versa, or both. To test this hypothesis, an incremental variable of cross-market return squared is included in each of the test equations as follows:

\[
CSAD_{SZA,t} = \alpha + \gamma_1 (R_{SZA,t})^2 + \gamma_2 (R_{SZA,B})^2 + \gamma_3 (R_{SZA,A})^2 + \epsilon_t, \quad (3.10A)
\]

\[
CSAD_{SZB,t} = \alpha + \gamma_1 (R_{SZB,t})^2 + \gamma_2 (R_{SZB,B})^2 + \gamma_3 (R_{SZB,A})^2 + \epsilon_t, \quad (3.10B)
\]

\[
CSAD_{SHA,t} = \alpha + \gamma_1 (R_{SHA,t})^2 + \gamma_2 (R_{SHA,B})^2 + \gamma_3 (R_{SHA,A})^2 + \epsilon_t, \quad (3.10C)
\]

\[
CSAD_{SHB,t} = \alpha + \gamma_1 (R_{SHB,t})^2 + \gamma_2 (R_{SHB,B})^2 + \gamma_3 (R_{SHB,A})^2 + \epsilon_t, \quad (3.10D)
\]

Equation (3.10A) tests whether the Shenzhen A market herds around the Shenzhen B market. The same argument applies to the other three equations. If A markets herd around B markets, or B markets herd around A markets, not only do we expect \(\gamma_2\) to bear a negative sign, but we also expect \(\gamma_3\) to be negative and statistically significant. Table 3.6 reports the estimation results for equations (3.10A) to (3.10D). In both A markets, \(\gamma_2\) is negatively significant, but \(\gamma_3\) is positively significant. In both B markets, both \(\gamma_2\) and \(\gamma_3\) are positively significant, indicating that there is no herding behavior across A and B markets. The results indicate that there is no evidence to support the view that A- and B-share investors base investment decisions on each other’s decisions.

<Insert Table 3.6 about here>

3.4.5 Herding behavior across the Shanghai and Shenzhen markets

Because the Shanghai and Shenzhen stock exchanges are two separate markets -- they are located in different cities, and they have different listed firms and management teams -- investment analysts often observe that one market follows the other. However, this
view has never been formally tested. In this section, we test whether herding can occur across Shanghai A and Shenzhen A markets.\(^\text{17}\) Since there is no herding behavior in each of the B markets, we omit testing across-market herding behavior for the two B markets. To address this issue, we add an incremental variable of across-market return squared in each of the equations as follows:

\[
CSAD_{SZA,t} = \alpha + \gamma_1 (R_{SZA,t}) + \gamma_2 (R_{SZA,t})^2 + \gamma_3 (R_{SHA,t})^2 + \epsilon_t, \quad (3.11A)
\]

\[
CSAD_{SHA,t} = \alpha + \gamma_1 (R_{SHA,t}) + \gamma_2 (R_{SHA,t})^2 + \gamma_3 (R_{SZA,t})^2 + \epsilon_t, \quad (3.11B)
\]

Equation (3.11A) tests whether the Shenzhen A market herds around the Shanghai A market, and equation (3.11B) tests the other way around. If either market herds around the other, both \(\gamma_2\) and \(\gamma_3\) should be negatively significant. Table 3.7 reports the estimation results. We find that both \(\gamma_3\) are positive, indicating there is no herding behavior across the Shanghai A and Shenzhen A markets.

<Insert Table 3.7 about here>

### 3.5 Herding, Volatility, and Trading Volume

Trading volume and volatility often reflect market sentiment and market trading activity. However, these two variables also have similar information content (Lamoureux and Lastrapes, 1990). In this section we further investigate Chinese stock returns by testing under what market conditions herding behavior is revealed. Earlier evidence suggests that the sign of \(\gamma_2\) implies the existence of herding; the magnitude of \(\gamma_2\) captures the degree of herding. Since only the A markets display herding behavior,

\(^{17}\) The correlation of two markets reveals the relation between two markets and the relation is bilateral. Herding behavior between two markets means that one market follows the other.
coefficients on the Shanghai and Shenzhen A markets are used as the herding index \((\text{Herdindex})\) to test if there is a relation between return volatility, trading volume, and herding. Return volatility \(\hat{\sigma}_t^2\) is the return variance over 26 weeks; \(V_t\) is the trading volume at time \(t\). \text{Herdindex} of the Shanghai A and Shenzhen A markets is the series of \(\gamma_2\) generated from the rolling equation (3.6) for the Shanghai A and Shenzhen A market, respectively. To simplify the exposition, we redefine the herding index by setting \(H = -\gamma_2\). We first report the simple correlation matrix among the \text{Herdindex}, volume, and volatility in Table 3.9. From Table 3.9, we find that in both A markets, the \text{Herdindex} is positively correlated with volatility.

Next, to further investigate whether the herding phenomenon can be explained by the level of market return volatility and trading volume, \(H_t\) (\text{Herdindex}) is regressed on volatility and trading volume as in the following equations.

\[
H_t = \phi_0 + \phi_1 \hat{\sigma}_t^2 + \phi_2 V_t + \varepsilon_t \tag{3.12}\]

Table 3.9 reports the estimation results of equation (3.12) for the Shanghai A and Shenzhen A markets. The results show that in both markets, the coefficient on volatility is positively significant, indicating that when market volatility is high, investors tend to herd around the market. The coefficient on volume is not significant on either market.

\[\text{Insert Table 3.9 about here}\]

\[\text{Since volatility and volume are correlated, the volume should be orthogonalized from volatility. This is done by regressing volume on volatility, and then plugging the resulted residual series into the estimated equation. The test results do not provide evidence of significant difference from equation 3.12.}\]
3.6 Conclusions

The focus of this essay is to examine the potential existence of herding behavior in Chinese A- and B-share markets. The testing results conclude that herding behavior exists on both the Shanghai and Shenzhen A markets, and there is no supportive evidence for the existence of herding behavior in both B markets. The difference in their investing behavior may be due to the different investor structure of the A and B markets as we illustrated in the introductory section of this study.

Testing asymmetric effects of herding behavior, the evidence shows that both Shanghai-A and Shenzhen-A markets demonstrate a similar asymmetric effect pattern in terms of extreme values of market returns, trading volumes, and return volatility. By further investigating the relative significance of volatility and trading volume in explaining herding, we find that volatility explains more than trading volume.
Chapter 4. Empirical Analysis of the Speed of Adjustment to Information: Evidence from the Chinese Stock Market

Chapter 4 Abstract

This essay studies investors’ behavior characterized by the different degrees of sophistication in the Chinese stock markets. By employing a VAR model to examine different speeds of adjustment in response to common information between Chinese A- and B-share markets, we find evidence that domestic investors who mainly invest in A shares adjust to information faster than foreign investors who can trade only in B shares. By further looking at the characteristics of individual firms and market structure, we find evidence that stocks with higher information flows and/or with more prominent status adjust to information faster. The liberalization of policy in February 2001 that allowed domestic investors to purchase B shares suggests that the difference in speed of adjustment between A and B shares has been reduced. Evidence also suggests that the A-share market has unobserved components that significantly enhance the speed of price adjustment.

4.1 Introduction

With a traditional indigenous economy coexisting with modern, efficient corporate organizations, the Chinese stock market established the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) in December 1990. Both of these exchanges issue two classes of shares. A shares can be purchased and traded by domestic (Chinese) investors only and are denominated in the local currency, RMB. B shares were sold to foreign investors only before February 11, 2001; after this date, B shares were sold to domestic Chinese investors who hold U.S. or Hong Kong dollars. B shares are denominated in U.S. dollars on the Shanghai Stock Exchange and HK dollars on the Shenzhen Stock Exchange.

Until December 31, 2003, both A and B shares were dual listed by 87 companies. The shareholders of these 87 paired A and B shares have the same voting rights and are

19 Foreign currency is not freely convertible in the Chinese market.
trading simultaneously on the Shanghai and the Shenzhen stock exchanges. However, cross-listings are prohibited on both exchanges (Bailey, 1994). Since investors of A and B shares have the same firm-level fundamentals and face equivalent systematic risk, market efficiency implies that the prices of A and B shares should reflect the similar intrinsic value and underlying price changes ought to follow the same speed of adjustment if investors have homogeneous characteristics.

However, as we investigate institutional backgrounds and investors’ characteristics, the assumption that investors in both A and B shares are homogeneous is far from reality. First, it is widely recognized that Chinese investors, who dominate the A-share market, in general lack knowledge of stock essentials, while B-share holders, who are mainly overseas investors, are considered to be a more educated group and appear to have more sophisticated analytical tools in processing market information and in assessing stock fundamentals. Second, a report from the Chinese Securities Regulatory Commission (CSRC) in 2004 indicated that the A-share market has been overwhelmingly dominated by individual investors, while the B-share market is mainly composed of foreign institutional investors. Hence, it is reasonable to classify B-share investors as more likely to be rational traders who focus on economic fundamentals, while A-share investors more or less act as noise traders. The latter intend to speculate and “stir-fry” stocks (Kang, Liu and Ni, 2003). Their trading decisions are based on their sentiments, and their investing strategies are prompted by news from informal resources.

In response to the two-tier market structure, studies of Chinese stock markets have focused on the issues of cross-market causal relationships and the interpretation of the

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20 A shares have individual investors holding over 99.5% of the accounts, while less than 0.5% are held by institutional investors.
persistent price differentials between A shares and B shares (Chui and Kwok, 1998; Lee and Rui, 2000; Chen, Lee, and Rui, 2001). Evidence from various studies indicates that there is a substantial price premium associated with A shares as compared to B shares. For instance, Su (1998) discovers that the average daily discount of B shares relative to that of A shares is about 62.2%. Similarly, Chen, Lee, and Rui, (2001) find that the average B-share discount on the SHSE was about 66.2% from 1992 to 1997 and that on the SZSE it was about 52.4%. Some recent research results suggest that the existence of persistent price differentials between A shares and B shares is due to differences in risk factors (Su, 1998) and different degrees of liquidity associated with the two markets (Chen, Lee, and Rui, 2001). Chen et al. (2001) also suggest that B-share prices are related more to market fundamentals, while A-share prices are more likely to be influenced by non-fundamental factors.

These empirical findings certainly provide a good foundation to understand the issues in Chinese stock market prices, especially in the causal relationship between A shares and B shares and the nature of price differentials between the two markets. However, the literature provides very little information about price dynamics, which may more directly reflect the nature of market efficiency and the reaction of market participants. In this study we shall examine the price dynamics and the speed of price adjustments of A and B shares in reacting to common information.

As noted by Damodaran (1993) and Theobald and Yallup (2004), the speed of price adjustment to new information provides either a direct measure of market efficiency or the degree of over- and underreaction in financial markets. Since it has been widely reported that the Chinese stock market is in the stage of weak-form market efficiency
(Ma and Barnes, 2001; Wang, Burton, and Power, 2004 etc.), it is appropriate to concentrate on examining the Chinese stock price changes, especially in the context of the relative speed of adjustment between A and B shares. More significantly, it is of interest to search out the factors that influence the speed of adjustment and the speed differentials between A- and B-share markets. A successful empirical result from this study will shed some light on the nature of market efficiency and provide some insight into Chinese stock market dynamics as well as investors’ behavior.

The reminder of the essay is organized as follows. Section 4.2 introduces the theory that entails the stock price dynamics and the speed of adjustment. Section 4.3 lays out a VAR model in which alternative hypotheses being used to examine the price adjustment are set up. Section 4.4 describes the data. Section 4.5 reports some estimated results of the VAR model. Section 4.6 describes the measure of speed proxy, the factors that influence the speed of adjustment for individual stocks, and the estimated results of speed in relation to its determinants. Section 4.7 contains concluding remarks.

4.2 Price Adjustment Process

Economic theory argues that price dynamics often follow a partial adjustment process (Cagan, 1956; Friedman, 1968). Applying this theory in modeling stock price adjustment (Damodaran, 1993, and Koutmos, 1999), we write

\[ P_t - P_{t-1} = (1- \lambda)(P_t^{f} - P_{t-1}) + u_t \]  

\[ (4.1) \]

\[ \]

\[ 21 \] Dr. Thomas Chiang directed the formulation of this model.
where \( P_t \) and \( P_t^f \) in natural logarithms are the observed price and the unobserved fundamental price, respectively; \( u_t \) is a random error; \( \lambda \) is a constant fraction parameter.

Equation (4.1) states that if the current price \( P_{t-1} \) deviates from the equilibrium level of price \( P_t^f \), the subsequent price \( P_t \) will adjust in a fraction measured by \( (1 - \lambda) \). Thus, \( (1 - \lambda) \) measures the speed of adjustment. The problem is that \( P_t^f \) is usually unobservable.

To close the model, we need to specify the unobserved value \( P_t^f \). As suggested by Fama and French (1988), this component is assumed to follow a random walk process with a drift:

\[
P_t^f = \alpha + P_{t-1}^f + v_t
\]

(4.2)

where \( \alpha \) is the drift term and \( v_t \) is the error term. By combining equations (4.1) and (4.2), we derive an autoregressive process of order one as follows:

\[
r_t = \phi_0 + \phi_1 r_{t-1} + \varepsilon_t
\]

(4.3)

where \( r_t = P_t - P_{t-1} \), \( \phi_0 = \alpha (1 - \lambda) \), and \( \phi_1 = \lambda \), and \( \varepsilon_t = u_t - u_{t-1} + (1 - \lambda) v_t \). Equation (4.3) implies that the market adjustment is not frictionless, which is consistent with most findings in empirical studies of stock prices. In fact, the friction parameter, \( \lambda \), can be obtained by estimating the regression coefficient of \( \phi_1 \) contained in equation (4.3).

Notice that if adjustment costs are high or market friction is persistent due to government intervention or the like, the speed of adjustment can be nonlinear. For instance, if the fundamental price in (4.2) does not follow a random walk, but rather follows higher orders of an autoregressive process, the resulting return equation will entail longer lags. In general, it is more convenient to write (4.3) as:
\[ r_t = \phi_k(L^k)r_t + \varepsilon_t \]  \hspace{1cm} \text{(4.4)}

where \( L^k \) denotes the lagged operator in order of \( k \) such that \((L^k)_{r_t} = r_{t-k}\). The lag length in our context is often determined by empirical regularity.

In recent trading models, it has been observed that investors tend to incorporate cross-market information into their decision-making process. For instance, an investor in the Chinese stock market from (4.4) suggests that trading decisions can be traced out by observing the past price performance of A shares. However, the cross-market feedback trading rule (or contagion effect) advises that the past price performance in the B-shares market or the Hong Kong Hang Seng market can be equally informative. By incorporating the cross-market feedback rule into the model, equation (4.4) can be generally expressed as:

\[ r_t = \phi_k(L^k)r_t + \theta_k(L^k)r_t + \varepsilon_t \]  \hspace{1cm} \text{(4.5)}

where \( \phi_k(L^k) \) captures the autocorrelation, while \( \theta_k(L^k) \) measures the cross-correlation effect. More significantly, the performance of these two sets of coefficients can also help us to examine and identify the relative speeds of adjustment in a multi-market setting, which we shall tackle in the next section.

\[ \text{\textsuperscript{22}} \]

It should be noted that the representation of equation (4.4) is consistent with a number of empirical studies. For instance, Cutler et al. (1990) observe that traders that systematically follow the strategy of buying (selling) after prices rise and of selling (buying) after prices fall are considered positive (negative) feedback traders. These positive (negative) traders’ activity tends to reinforce (correct) price movements. As a result, the coefficients of autocorrelation coefficients produce different signs. (Cutler et al.,1990 and De Long, et al.,1990).
4.3 VAR Model for Paired A and B Shares

Along the lines of equation (4.5), we set up a vector autoregression (VAR) model that specifies a dynamic system containing Chinese A- and B-share returns. By estimating and comparing the lagged length and the cross-lagged coefficients, we can investigate the speed of adjustment (Chordia et. al. 2000). Specifically, we write:

\[
\begin{bmatrix}
    r_t^A \\
    r_t^B
\end{bmatrix} =
\begin{bmatrix}
    \alpha_0^A \\
    \alpha_0^B
\end{bmatrix} +
\begin{bmatrix}
    \sum_{k=1}^{K} a_k \\
    \sum_{k=1}^{K} b_k
\end{bmatrix}
\begin{bmatrix}
    r_{t-k}^A \\
    r_{t-k}^B
\end{bmatrix} +
\begin{bmatrix}
    \sum_{k=1}^{K} c_k \\
    \sum_{k=1}^{K} d_k
\end{bmatrix}
\begin{bmatrix}
    r_{t-k}^A \\
    r_{t-k}^B
\end{bmatrix} +
\begin{bmatrix}
    \epsilon_t^A \\
    \epsilon_t^B
\end{bmatrix}
\]

(4.6)

where \( r_t^A \) is the stock return for A shares at time \( t \); \( r_t^B \) is the stock return for B shares at time \( t \); \( k \) is the lagged length of returns; \( \sum_{k=1}^{K} x_k (x = a,b,c,d) \) is the sum of \( k (k = 1 \) to \( K) \) lagged coefficients for A- or B-share returns; \( \epsilon_t^i (i = A \) or \( B) \) is the error term with \( \epsilon_t^i \sim iid (0, \Sigma) \).

On the basis of the VAR model in (4.6), A shares are said to have a faster speed of adjustment than B shares if, and only if, the following conditions are met: (i) A and B returns are cross-autocorrelated; (ii) A-share lagged returns are able to predict B-share contemporaneous returns; (iii) the ability of A-share lagged returns to predict B-share contemporaneous returns is better than the ability of B-share lagged returns to predict A-share contemporaneous returns. Testing the above-mentioned three conditions is equivalent to testing the following three hypotheses.
The first hypothesis can be tested by examining the null hypothesis: \( \sum_{k=1}^{K} b_k = 0 \) and \( \sum_{k=1}^{K} c_k = 0 \) against the alternative hypothesis: \( \sum_{k=1}^{K} b_k \neq 0 \) and \( \sum_{k=1}^{K} c_k 
eq 0 \). If the null hypothesis is rejected, we concluded that A and B returns are cross-autocorrelated, and we proceed to examine the second hypothesis: whether A lagged returns are able to predict B contemporaneous returns or B lagged returns are able to predict A contemporaneous returns. If the sum of the coefficients \( \sum_{k=1}^{K} c_k \) for lagged A-share returns is positive, then A-lagged returns Granger causes B-contemporaneous returns. Likewise, if the sum of the coefficients \( \sum_{k=1}^{K} b_k \) for lagged B-share returns is positive, then B-lagged returns Granger cause A-contemporaneous returns. The third hypothesis can be examined by testing whether the sum of the coefficients for lagged A-share returns \( \sum_{k=1}^{K} c_k \) is greater than the sum of the coefficients for lagged B-share returns \( \sum_{k=1}^{K} b_k \). \(^{23}\)

4.4 Data and Summary Statistics

Observations of individual stock data for the Shanghai Stock Exchange and the Shenzhen Stock Exchange from the first date of listing through December 31, 2003, are collected. The Wednesday weekly data are used to avoid the “Monday effect” or “Friday effect.” The data consist of 746 Shanghai A-share firms (SHA), 54 Shanghai B-share firms (SHB), 489 Shenzhen A-share firms (SZA), and 57 Shenzhen B-share firms (SZB).

\(^{23}\) Since our goal is to examine the speed of adjustment, the specification is based on short-run dynamics. However, if our objective is to examine the causal relationship, long-run prices should be included into the model.
Among these firms, 44 firms are dual listing A and B shares on the Shanghai exchange and 43 firms dual listing on the Shenzhen exchange. The above data are provided by Shenying Wangguo Securities Co. and are obtained from the Shanghai and Shenzhen Stock Exchange official websites.

Owing to problems with missing data and internal inconsistency, we exclude observations for the first two years and employ observations from 1994 to 2003 in this study. The statistical analysis and estimations in this study are based on weekly (Wednesday) observations consisting of 87 cross-sectional firms spanning 1994 to 2003. Table 4.1 contains weekly summary statistics of all stocks listed in the Shanghai and Shenzhen stock exchanges. Table 4.2 reports the summary statistics for 87 dual listed A and B shares. The variables include Wednesday closing price, dividend yield, weekly raw trading volume (number of shares traded during the week), the turnover ratio (the ratio between and number of shares that changed hands during the period and the total number of shares outstanding at the end of the period), and market value (closing price multiplied by number of shares outstanding). The statistics show that A shares usually have a higher raw trading volume and turnover ratio before 2001. After 2001, these values decline. In general, B shares have higher dividend yields over the whole sample period. The data also indicate that the turnover ratio is extremely high for the A-share market. In 1998 and 1999, the weekly average turnover ratios for all A shares were 60 and 16, respectively.

< Insert Table 4.1 about here >

< Insert Table 4.2 about here >

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24 Shenying Wangguo Securities Co. is the largest investment bank in China.
4.5 VAR Estimates and Speed of Adjustment

The VAR model in system (4.6) is estimated by using weekly (Wednesday) stock returns calculated as the log difference of closing stock prices. Since our pre-tests based on AIC and SBC criteria indicate that the first-order lag is significant and appears to be robust, parsimonious principle suggests that only the first-order lag for stock return be included in the model specification\textsuperscript{25}.

The estimated results are reported in Table 4.3. The $t$-ratio suggests that the null hypotheses $b_1 = 0$ and $c_1 = 0$ are decisively rejected at the 1% level, confirming that A and B returns are cross-autocorrelated. As to the coefficient of $c_1$, the evidence indicates that the estimated value is positive and highly significant, suggesting that the null $c_1 = 0$ and $c_1 > 0$ is decisively rejected. This indicates that A lagged returns are able to predict B contemporaneous returns. Further examining the relative predictability as reflected in the relative size of $b_1$ and $c_1$, we see that the Wald test suggests that $b_1 < c_1$ is significant at the 1% level. Putting all the test results together, we can conclude that A shares have faster speed than their corresponding B shares.

This finding is consistent with the views of Kang, Liu, and Ni (2003), Wang, Burton and Power (2004), among others, documenting overreaction and overconfidence of A-share investors. Since A shares are dominated by individual investors who have very limited knowledge of stock investments, they act as noise traders, and their trading decisions are often based on rumors, sentiment, or herding behavior. On the contrary, B-share investors are mainly institutional investors from developed countries, and their investment behaviors are expected to be much more rational than those of their A-share

\textsuperscript{25} Since pre-tests show that models using one lag term, four lag term, and five lag terms produce similar results, one lag term is chosen based on parsimonious principle.
counterparts. The processing of information, formation of expectations, decision-making, and reaction of A- and B-share investors are reflected in the speed of adjustment of the asset-return series. Our evidence concludes that the speed of adjustment by investors in A shares is much faster than that of investors in B shares. Hu (1999) has documented that the Chinese stock market is a highly government-regulated emerging market. Many regulations and policy interventions in the A-share markets have made A-share investors deeply believe in the supportive role played by the government. As a result, A-share investors demonstrate overconfidence in making investment decisions (Mei, Scheinkman, and Xiong, 2004), and they have been reported as having much less risk aversion than B-share investors (Ma, 1996).

< Insert Table 4.3 about here >

4.6 Speed for Individual Firms

4.6.1 Dimson beta regression and speed proxy

Having observed that the paired A and B individual shares have different speeds of adjustment to common macro information, it is important to search out which factors explain the speed and the speed differential. Damodaran (1993) notes that there are differences among firms in the speed “with which prices incorporate information.” Lo and MacKinlay (1990) document that large firms lead small firms in returns. Chordia and Swaminathan (2000) indicate that trading volume plays a major role in explaining the speed of adjustment. However, no formal test has been conducted in relating the speed of price adjustment to firm characteristics. This research attempts to resolve this issue.
To identify the factors that may contribute to explaining the speed for individual stocks and the speed difference between A and B shares, we need to construct an individual stock speed proxy as denoted by “\( \text{DELAY}_i^\tau \)”. The proxy is derived from Dimson beta regressions first proposed by Dimson (1979) and later used by McQueen et al. (1996) and Chordia et. al. (2000) in analyzing price speed. Dimson (1979) develops an aggregated coefficient model to estimate unbiased beta in dealing with infrequent trading stocks. The Dimson beta regression model shows that the unbiased beta is the sum of the slope coefficients in a regression of stock returns on lead, lag, and contemporaneous market returns.

Applying a Dimson beta regression to every individual A- and B-share stock for each year from 1994 to 2003 allows us to construct an annual proxy “\( \text{DELAY}_i^\tau \)” for measuring the speed of adjustment for stock \( i \) in year \( \tau \), where \( \tau \) is an index for the year.\(^{26}\) The Dimson beta regression is given by:

\[
\begin{align*}
    r_i^\tau & = \alpha_i + \sum_{k=-5}^{5} \beta_k^i r_{i-k}^{m \tau} + u_i^\tau \\
\end{align*}
\]  

(4.7)

where \( r_i^\tau \) is the weekly return of stock \( i \) during year \( \tau \), \( i = \text{A or B} \), \( r_{i-k}^{m \tau} \) is the weekly return of the Shanghai Composite Index or Shenzhen Composite Index in year \( \tau \). \( \beta_k^i \) is the coefficient of stock \( i \) for market return at lag \( k \) if \( k > 0 \) (or lead \( k \) when \( k < 0 \)).

Equation (4.7) is assumed to follow one to five order leads and one to five order lags for market weekly return. \( \beta_0^i \) is the contemporaneous coefficient of stock \( i \) for market

\(^{26}\) That is, \( \tau = 1, 2, \ldots, 10 \) (\( \tau = 1994, 1995, \ldots, 2003 \) in our sample).
returns when \( k = 0 \), and \( \sum_{k=-5}^{-1} \beta_k^i \) is the sum of the coefficients of stock \( i \) for lead market returns from \( k = -5 \) to -1. \( \sum_{k=1}^{5} \beta_k^i \) is the sum of the coefficients of stock \( i \) for lag market returns from \( k = 1 \) to 5; \( u_t^i \) is an random error term.

Using the estimated coefficients from equation (4.7), we follow Chordia et al (2000) and construct a modified delayed ratio\(^{27}\) for each year using the sum of the absolute value of the lagged coefficients of stock \( i \), \( \sum_{k=1}^{5} |\beta_k^i| \), divided by the absolute value of the contemporaneous coefficient of stock \( i \) for market return, \( |\beta_0^i| \). That is,

\[
x_t^i = \frac{\sum_{k=1}^{5} |\beta_k^i|}{|\beta_0^i|},
\]

where \( x_t^i \) is an annual speed of adjustment ratio for stock \( i \) at year \( \tau \). Expressing this equation using logit transformation, we obtain \( DELAY_t^i \) as a measure for individual stock \( i \)'s speed of adjustment for year \( \tau \).

\(^{27}\) The \( DELAY_t^i \) variable in Chordia et al. (2000) is derived from speed ratio \( x_t^i = \sum_{k=1}^{5} \beta_k^i / \beta_0^i \). Note that the assumption used by Chordia et al. (2000) to construct “\( DELAY_t^i \)” is that individual stocks in reacting to contemporaneous market return have different magnitudes and move in the same direction (a detailed derivation of “\( DELAY_t^i \)” can be found in Chordia et al. (2000)). The same assumption is applied to the estimates of the lag returns. This may hold true for a portfolio of stocks in the long run where only systematic risk accounts. However, when we construct the proxy \( DELAY_t^i \) for individual stocks in a shorter time horizon, different individual stocks may have mixed reactions, displaying different magnitudes and signs on the estimated coefficients. For this reason, our speed ratio \( x_t^i \) is constructed based on the sum of the absolute values of lagged coefficients relative to the contemporaneous coefficient term.
\[
DELAY^i_t = \frac{1}{1 + e^{-x^i_t}}
\]  

(4.9)

The value of \(DELAY^i_t\) is in a range from 0 to 1 where a higher value of \(DELAY^i_t\) indicates a slower speed of adjustment.\(^{28}\)

Equation (4.7) is estimated separately for Shanghai and Shenzhen stocks using the Shanghai Composite Index and the Shenzhen Composite Index as the market price, where the Shanghai Composite Index and the Shenzhen Composite Index are value weighted indices including every stock on the Shanghai or Shenzhen market. The market return is calculated as the log difference between the market price and one-period lagged market price. Having defined these variables, we can construct the speed of adjustment ratio \(x^i_t\) and the annual \(DELAY^i_t\) for each A share and B share.

**4.6.2 Factors that explain the speed of adjustment for individual stocks**

In this section, we employed the pooled regression model to examine the speed of adjustment in relation to characteristics of firms trading on the Chinese A- and B-share markets. The analysis is carried out by testing the following hypotheses.

First, the *information flow hypothesis* states that speed is positively related to trading volume. Holden and Subrahmanyam (1992) and Foster and Viswanathan (1993) argue that stock prices reflect new information faster if those stocks have been purchased by an increasing number of informed investors. The study conducted by Brennan, Jegadeesh, and Swaminathan (1993) provides a supportive argument that firms followed by a large number of analysts show returns that adjust to information more rapidly. In this study,

\(^{28}\) McQueen (1996):“The logit transformation serves two purposes. First, in practice for some stocks, the sum of the current and lagged regression coefficients is very close to zero. Dividing by this small number yields extreme values that are moderated by the transformation. Second, the transformation yields values between 0 and 1...which gives the intuitively appealing interpretation of \(DELAY\) as the proportion of the response attributable to old news.”
we use trading volume to capture information flow. This notion is consistent with the view proposed by Bessembinder, Chan, and Seguin (1996) that trading volume on the stock market has been viewed as an instrument to reveal both public and private information flows. Following the information flow hypothesis, we anticipate that the speed measure $DELAY_i^\tau$ is negatively correlated with the amount of trading volume.

Second, the stock prominence hypothesis suggests that speed is positively related to a firm’s market value. Lo and MacKinlay (1990) argue that returns of large firms tend to lead those of small firms. This argument is consistent with the view stated by Merton (1987) that an investor includes a security in his portfolio only if he knows about that security. The larger the firm size, the more prominent the stock is. Thus, when a stock is known by more investors, it tends to increase the speed of adjustment. Under this stock-prominence hypothesis, we can argue that there is a positive relation between each stock’s speed and market value, suggesting a negative relation between $DELAY_i^\tau$ and market value. Market value in our context is measured by the product between the number of shares outstanding multiplied by the closing stock price. It is expressed in the log form.

Third, the dividend signaling hypothesis implies that speed is positively related to dividend yield. Since a stock with a higher dividend yield will send a signal to investors that the firm cares more about repaying investors, investors find that those firms’ announcements have more information content (Jennings and Starks, 1985). With better investor relations and smoother channels of information flow, investors find firm-related information more trustworthy; thus, there is a faster investor reaction. We expect a negative relation between $DELAY_i^\tau$ and dividend yield.
Fourth, the 2001 event hypothesis suggests that after the 2001 policy change that allowed domestic investors to purchase B shares, B-share speed should move in alignment with that of A shares. After February 2001, Chinese domestic investors, who are the main components of A shares, are allowed to purchase B shares if they have access to foreign exchanges; so the difference in investor characteristics between A and B shares after 2001 becomes smaller. This is also true for the speed difference. To investigate this policy effect, we include a post-event regime dummy variable in the test equation. The dummy variable is assigned a value of 0 before 2001 and a value of 1 after (and including) 2001. Since the 2001 policy change happened in February, one concern about our post-event regime dummy is that it does not capture any effect in January 2001. However, Karolyi and Li (2003) document that there was information leakage before February 2001; thus, using an event cutoff point of January 2001 should not pose a significant data problem.

Fifth, the A–B-share characteristic difference hypothesis states that A-share stock has a different speed than B-share stock owing to some constant unobserved component. Because the above-mentioned hypotheses cannot directly capture all the unobserved characteristic differences of A and B shares, such as investor behavior difference, management quality difference, A- and B-market structure difference, and so forth, we use a share-discrimination dummy variable to test this A–B-share characteristic difference and to examine whether there are market-specific characteristics of A or B markets that influence the speed. To set up the share-discrimination dummy variable, a value of 1 is assigned to A shares, and a value of 0 is assigned to B shares. We expect a
negative relation between $DELAY^i_\tau$ and the A-share dummy if A shares are, in general, responding to news faster, as reported in the earlier section.$^{29}$

Sixth, the protected industry hypothesis implies that stocks in “protected” industries have faster speed. The protected industry hypothesis is a specific hypothesis developed under the Chinese market environment. While moving from a traditional planning economy to a market-oriented economy, the business firms that are under the “protection” of the Chinese government (Shirai, 2002) are separated from other firms. The firms in these industries may have private information, so these stocks may have a superior information flow channel than investors in “non-protected” industries. The protected industry hypothesis can be examined by relating the speed of the “protected” industries vs. that of the “non-protected” industries. We can create an industry dummy with a value of 1 for the firms in protected industries, such as raw materials, utilities, or chemicals, and a value of 0 otherwise. If the protected industry hypothesis is true, we expect a negative coefficient for the protected industry dummy.

To test the above hypotheses, we regress $DELAY^i_\tau$ on investor and market characteristics and a set of dummy variables as follows:

$$
DELAY^i_\tau = \alpha_0 + \phi_1 TU^i_\tau + \phi_2 MV^i_\tau + \phi_3 DY^i_\tau + \phi_4 D_I + \phi_5 D_A + \phi_6 D_{IND} + w^i_\tau
$$

where $DELAY^i_\tau$ is a delay measure of speed for stock $i$ in year $\tau$. $TU^i_\tau$ is the turnover ratio for stock $i$ at year $\tau$, and coefficient $\phi_I$ tests the information flow hypothesis.

$^{29}$ A detailed examination of individual differences for specific firm effects may have to measure the fixed effects or random effects based on a panel data model (see Wooldridge, 2002, pp. 247-291), which is beyond the current research.
$MV_i^\tau$ is market value for stock $i$ at year $\tau$, and the coefficient $\phi_2$ tests the stock-prominence hypothesis. $DY_i^\tau$ is the dividend yield for stock $i$ at year $\tau$, and the coefficient $\phi_3$ tests the dividend yield hypothesis. All of the above variables are annual data from 1994 to 2003 for firm $i$, where $i=1,2,...,n$. $D_I$ is the post-event dummy variable and coefficient $\phi_4$ tests the 2001 event hypothesis. $D_A$ is the share-discrimination dummy variable and coefficient $\phi_5$ tests the A~B-share characteristic difference hypothesis. $D_{IND}$ is the “protected” industry dummy variable, and the coefficient $\phi_6$ tests the “protected” industry hypothesis.

4.6.3 Estimated results

A. Full sample estimation

The test results are reported in Table 4.4 Panel A. We shall comment on each independent variable. First, the estimated coefficient for trading volume, $\phi_1$, is negative and statistically significant, supporting the information flow hypothesis. This result is consistent with the results of the study by Chordia and Swaminathan (2000): high-volume stock returns lead low-volume stock returns. Second, the estimated coefficient for market value, $\phi_2$, is also negative and highly significant. This result agrees with our expectation that returns on large firms lead those of small firms. This finding is consistent with most studies prevailing in advanced markets (Lo and MacKinlay, 1990), in part because participants in Bshare markets are mainly foreign institutional investors, who know how to follow and trace news. Third, by checking the coefficient on dividend yield, the sign is anticipated, but insignificant. It seems to suggest that investors’ reaction to a dividend signal is rather diverse or weak, rendering the variance of the estimated coefficient
relatively large. Fourth, the estimated coefficient for the post-2001 period dummy, $D_I$, appears to show a negative sign and is statistically significant. This can be interpreted as a policy efficacy that has speeded up price adjustment for the post-2001 period. This finding matches well with the studies by Mei, Scheinkman, and Xiong (2004) and Karolyi and Li (2003), in which they find evidence that A-share premiums declined dramatically after the policy liberalization in 2001. Fifth, the estimated share-discrimination dummy coefficient, $\varphi_5$, is negative and statistically significant. This suggests that some unobserved heterogeneity, such as market frictions and the degree of risk aversion between A- and B-share investors, gives rise to a faster speed of adjustment in the A-share market. This is consistent with the stylized facts that A and B shares have different investor preferences and that different institutional constraints are imposed on A- and B-share investors. From Panel A, we also find that the protected industry dummy variable is not significant nor does it bear an anticipated sign, providing no significant explanatory power to predict the test equation. We shall drop this variable in subsequent estimations.

B. Discriminate sample estimations

B1. Discriminate market characteristics

The statistics derived from the whole sample investigation provide an interesting message on general performance. However, in order to investigate a specific effect or time-period effect on performance, it is useful to discriminate the data to estimate the model accordingly. Since in the earlier sections we found that the speed of adjustment varies from A shares to B shares, we shall re-estimate the model by separating the data into A- and B-share series. In this model, the variable $D_{IND}$ is excluded from the
estimated equations, since the variable is either irrelevant or insignificant. The estimated results for A shares and B shares are presented in Panels B and C, respectively. By investigating the explanatory power and making a comparison with the full sample estimation in Panel A, several interesting points merit mention. First, the dividend yield variable appears to be statistically significant, suggesting that domestic investors do actively react to the dividend signal. On the other hand, foreign investors, who are the main traders in B shares, seem not to show an enthusiastic reaction to the dividend message. This leads to the next point: the evidence in Panel C indicates that when the speed of price adjustment is dominated by B-share investors, the market value coefficient is negative and statistically significant. This finding implies that B-share investors observe the behavior of prominent firms more closely, and their trading strategy appears to follow the actions of the prominent firms and react accordingly. Taking these two points together, it seems that for domestic investors, even though they appear to be frequent traders, their trading behavior has some direct or indirect link to firm fundamentals. This view is supported by the fact that the CRSC is tightening its monitoring of accounting manipulations owing to the apparent co-movement between stock price and some firm fundamentals (Shirai, 2002). Foreign investors, even though they may possess advanced knowledge and skills, may have less adequate information about sub-prominent firms compared to A-share investors for reasons such as a language barrier. As a result, B-share investors follow large firms more closely. Third, the estimated coefficient on $D_i$ is negative for B shares. This is consistent with the fact that following the removal of the restriction on purchasing B shares, some domestic investors participated in B-share investing, speeding up the price adjustment in the B-share market.
This implies that, in the long run, speed in the B-share market tends to align with that of the A-share market.

\textit{B2. Discriminate time periods}

Recognizing the significance of policy effects on market operations and price adjustment, in this section we re-estimate the model by dividing data into two separate periods: 1994-2000 and 2001-2003. The results are contained in Panels D and E of Table 4.4. Consistent with previous findings, the coefficient of the market value variable is negative and highly significant in both sub-periods. However, a special feature revealed in this sub-period study is that the estimated coefficient of $D_A$ in the policy-on regime showed a negative sign and is statistically significant, and then turned into a non-significant statistic in the policy-off period.\textsuperscript{30} This suggests that at least part of the unobserved A–B-share characteristic difference in price adjustment was removed after the government adopted a less restrictive policy in the financial markets. The evidence from both sub-sample studies concludes that both the A- and B-share markets have been dynamically moving together as reflected in the speed of price adjustment.

< Insert Table 4.4 about here >

\textbf{4.7 Concluding Remarks}

Although the dual-listed A and B shares in the Chinese markets have identical corporate and market fundamentals, our study finds that they have different speeds of adjustment to common information. A shares, which are available only to domestic investors, have a faster speed than that of foreign-investor-dominated B shares. This

\textsuperscript{30} Policy on refers to a regime that puts restrictions on purchasing B shares by domestic residents before February 2001, and policy off refers to the post-2001 period.
finding is consistent with the view that Chinese domestic investors are overconfident and overreact in the stock market. Analyzing the factors that may explain the difference in speed, we find evidence that stocks with higher information flows and more prominent status in the market adjust to information faster. There are also market-specific factors that explain the speed difference between A and B shares. Evidence shows that the unobserved component in the A-share market significantly enhances the speed of price adjustment.

Starting in February 2001, a new policy allows both domestic and foreign investors the opportunity to invest in B shares. Our evidence shows that the speed of B shares increases and that the speed difference between A and B shares has been moderate, suggesting that A and B markets begin to behave more similarly, removing some unobserved heterogeneity over time.
Chapter 5. The Summary

In the past two decades, the Chinese economy has marched from a central planning system to a market-oriented system. In this rapid transition and reform process, the indigenous economy and its cohesive traditional features mingle with a modern, efficient corporation system and generate diverse behaviors, which are reflected in market adjustments and business operations. In this complex background, issuing stock as an instrument to finance economic growth becomes the focal point of all fields of business and economic development. The significance of the stock market stems not only from its being the center of financial instruments but also from the economic advancement that the stock market shows in the process of financial liberalization. Thus, a study of the Chinese stock market in a transition stage will provide some unique empirical insight to guide other emerging markets in the process of modernization.

In addition, the coexistence of A and B shares, a special feature of the Chinese stock market, was originally designed to raise capital and at the same time insulate the market from being eroded by sophisticated foreign investors. Given apparent two-tier investor behavior, price differentials have been apparent in A- and B-share markets, and the differentials appear to be time-varying and persistent. This has provoked a series of studies to test the relationship between A-share and B-share prices. Further studies then attempt to resolve the price differential problem by investigating the issues surrounding liquidity, ownership, or demand elasticity. Built on this institutional setting and the state of empirical research, this dissertation studies several aspects of Chinese stock market behavior and is divided into three essays.
As stated earlier, A and B shares are issued for different purposes. A shares are the major financing vehicle for domestic SOEs (state-owned enterprises). B shares are issued mainly to attract foreign funds. With the coexistence of two classes of shares in the markets, in Chapter 2, we study the dynamic relationship between them by employing a dynamic multivariate GARCH model. We find that the conditional correlation coefficients between A- and B-share returns are time-varying, the dynamic correlation coefficient has increased in the recent sample period, and the variance of time-varying correlation coefficients has recently been reduced. Apparently, the phenomena are associated with a relaxation of government restrictions on the purchase of B shares by domestic residents. This indicates that the degree of segmentation has been moderated, the two classes of markets have tended to merge gradually, and the market integration process has been stabilized. Furthermore, the dynamic relationship between A shares and B shares is not independent of external shocks such as the Asian crisis.

A and B shares are held by different investors. A shares are held mainly by domestic Chinese investors. Before February 2001, B shares were held only by foreign investors and by both Chinese and foreign investors after that date. The different investor structure leads us to examine the investor behavior of the two classes of shares. In Chapter 3, we probe herding behavior in the Chinese stock market; in particular we examine whether herding-related behavior is different between A- and B-share markets. Our empirical results show that there is herding behavior in both Shanghai and Shenzhen A markets, but there is no supportive evidence for the existence of herding behavior in either of the B markets. We also find that herding behavior displays asymmetric effects in terms of whether the market goes up or down, trading volume is excessively high or excessively
low, and volatility is excessively high or excessively low. By constructing a herding index, we detect a positive relation between herding and volatility.

Owing to the heterogeneous characteristics of A- and B-share investors, the price dynamics may follow a partial adjustment process or may be governed by feedback traders. Essay three in Chapter 4 examines differences in the speed with which the prices of A and B shares adjust to information. Facing almost identical information and firm characteristics, A-share stocks adjust to common information faster than B-share stocks, indicating different information processes/assessments or different investor reactions exist between A and B markets. By further searching the characteristics of individual firms and market structure, we find evidence that stocks with higher information flows and/or with more prominent status adjust to information faster. The liberalization of policy in February 2001 that allowed B shares to be purchased by domestic investors is found to be attributable to the decline in the difference of speed adjustment between A- and B-share markets.

As mentioned in Chapter 1, the above research topics are limited within the first group of studies to general stock market behavior and momentum. But our interest in the Chinese stock market does not stop there. Many micro phenomena and panel studies are ready to be taken up. These research studies await the availability of more complete micro data, the advancement of corporate structure, and the transparency of accounting concepts and procedures. Topics include but are not limited to the privatization that the state-owned enterprises (SOEs) go through, the new phenomena and challenges faced by SOEs and other firms, and so forth. In sum, the transition of the Chinese market brings up many new issues and problems for researchers and practitioners to probe and to solve.
This dissertation pioneers only our research in this broad area, and we anticipate actively contributing to the related literature in the near future.
List of References

Chapter 1 References


Chapter 2 References


Chapter 3 References


Chapter 4 References


Table 1.1 Market Capitalization (including both A and B shares) from 1992 to 2003 (Data source: China Securities Regulatory Committee; IFS.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Market Capitalization (100,000,000 Yuan)</th>
<th>Market Capitalization (% of GDP)</th>
<th>GDP (100,000,000 Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>1048</td>
<td>4.1%</td>
<td>25864</td>
</tr>
<tr>
<td>1993</td>
<td>3541</td>
<td>10.3%</td>
<td>34501</td>
</tr>
<tr>
<td>1994</td>
<td>3691</td>
<td>7.9%</td>
<td>46691</td>
</tr>
<tr>
<td>1995</td>
<td>3474</td>
<td>5.9%</td>
<td>58511</td>
</tr>
<tr>
<td>1996</td>
<td>9842</td>
<td>14.4%</td>
<td>68330</td>
</tr>
<tr>
<td>1997</td>
<td>17529</td>
<td>23.4%</td>
<td>74894</td>
</tr>
<tr>
<td>1998</td>
<td>19506</td>
<td>24.7%</td>
<td>79003</td>
</tr>
<tr>
<td>1999</td>
<td>26471</td>
<td>32.0%</td>
<td>82673</td>
</tr>
<tr>
<td>2000</td>
<td>48091</td>
<td>53.8%</td>
<td>89357</td>
</tr>
<tr>
<td>2001</td>
<td>43522</td>
<td>44.7%</td>
<td>97314</td>
</tr>
<tr>
<td>2002</td>
<td>38329</td>
<td>36.4%</td>
<td>105172</td>
</tr>
<tr>
<td>2003</td>
<td>42458</td>
<td>36.3%</td>
<td>116898</td>
</tr>
</tbody>
</table>

Table 1.2 Number of Listed Companies (including both A and B shares) from 1992 to 2003 (Data source: China Securities Regulatory Committee.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Listed Companies (A and B shares)</th>
<th>Number of Listed Companies (A shares)</th>
<th>Number of Listed Companies (B shares)</th>
<th>Total Number of Investors (10,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>53</td>
<td>35</td>
<td>18</td>
<td>217</td>
</tr>
<tr>
<td>1993</td>
<td>182</td>
<td>141</td>
<td>41</td>
<td>778</td>
</tr>
<tr>
<td>1994</td>
<td>291</td>
<td>237</td>
<td>54</td>
<td>1059</td>
</tr>
<tr>
<td>1995</td>
<td>323</td>
<td>259</td>
<td>64</td>
<td>1242</td>
</tr>
<tr>
<td>1996</td>
<td>530</td>
<td>449</td>
<td>81</td>
<td>2307</td>
</tr>
<tr>
<td>1997</td>
<td>745</td>
<td>648</td>
<td>97</td>
<td>3333</td>
</tr>
<tr>
<td>1998</td>
<td>851</td>
<td>749</td>
<td>102</td>
<td>3911</td>
</tr>
<tr>
<td>1999</td>
<td>949</td>
<td>845</td>
<td>104</td>
<td>4482</td>
</tr>
<tr>
<td>2000</td>
<td>1088</td>
<td>978</td>
<td>110</td>
<td>5801</td>
</tr>
<tr>
<td>2001</td>
<td>1160</td>
<td>1050</td>
<td>110</td>
<td>6650</td>
</tr>
<tr>
<td>2002</td>
<td>1287</td>
<td>1274</td>
<td>110</td>
<td>6884</td>
</tr>
<tr>
<td>2003</td>
<td>1287</td>
<td>1274</td>
<td>110</td>
<td>7025</td>
</tr>
</tbody>
</table>
## Table 2.1 A Summary of Statistics of Stock Returns (1/1/1996-6/30/2003)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>LB(16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA</td>
<td>0.052</td>
<td>2.923</td>
<td>-0.305***</td>
<td>6.779***</td>
<td>69.986***</td>
</tr>
<tr>
<td>SHB</td>
<td>0.043</td>
<td>5.750</td>
<td>0.319***</td>
<td>4.482***</td>
<td>48.908***</td>
</tr>
<tr>
<td>SZA</td>
<td>0.061</td>
<td>3.622</td>
<td>-0.055</td>
<td>6.085***</td>
<td>46.909***</td>
</tr>
<tr>
<td>SZB</td>
<td>0.050</td>
<td>6.461</td>
<td>0.128**</td>
<td>5.820***</td>
<td>55.981***</td>
</tr>
<tr>
<td>US</td>
<td>0.030</td>
<td>1.296</td>
<td>-0.106**</td>
<td>3.365***</td>
<td>17.965</td>
</tr>
<tr>
<td>HK</td>
<td>-0.009</td>
<td>3.218</td>
<td>0.106**</td>
<td>9.170***</td>
<td>41.836***</td>
</tr>
</tbody>
</table>

| Panel B. Pre-Policy Change Period (1/1/1996 – 2/28/2001) |      |          |          |          |        |
| SHA            | 0.096| 3.395    | -0.572***| 5.941*** | 69.902***|
| SHB            | 0.047| 6.063    | 0.299*** | 4.222*** | 44.183***|
| SZA            | 0.117| 4.305    | -0.249***| 5.171*** | 42.166***|
| SZB            | 0.041| 7.121    | 0.022    | 5.807*** | 40.003***|

| SHA            | -0.044| 1.902   | 0.960*** | 9.053*** | 14.567  |
| SHB            | 0.036| 5.148    | 0.383*** | 4.990*** | 25.040* |
| SZA            | -0.058| 2.125   | 0.919*** | 8.268*** | 14.052  |
| SZB            | 0.076| 5.052    | 0.520*** | 4.733*** | 70.467***|

There are 1,995 observations for each series in the entire sample period. The number of observations before and after the policy change period are 1347 and 608, respectively. SHA is Shanghai A-share market; SHB is Shanghai B-share market; SZA is Shenzhen A-share market; SZB is Shenzhen B-share market; U.S. is S&P500 index; HK is Hang Seng index. Stock return is calculated as the first difference of the natural log of stock indices times 100. LB(16) refers to Ljung Box statistics with a 16-day lag. The ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.
Table 2.2 Simple Correlation Matrix of Stock Returns Before and After Policy Change (March 1, 2001 as the break point)

<table>
<thead>
<tr>
<th></th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entire Period (1/1/1996 – 6/30/2003)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB</td>
<td>0.4689</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZA</td>
<td>0.8580</td>
<td>0.4474</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SZB</td>
<td>0.4894</td>
<td>0.7156</td>
<td>0.4689</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Policy Change Period (1/1/1996 – 2/28/2001)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB</td>
<td>0.4113</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZA</td>
<td>0.8331</td>
<td>0.3928</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SZB</td>
<td>0.4449</td>
<td>0.6640</td>
<td>0.4205</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-Policy Change Period (3/1/2001 – 6/30/2003)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB</td>
<td>0.6662</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZA</td>
<td>0.9649</td>
<td>0.6514</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SZB</td>
<td>0.6533</td>
<td>0.8671</td>
<td>0.6622</td>
<td>1</td>
</tr>
</tbody>
</table>

SHA is Shanghai A-share market; SHB is Shanghai B-share market; SZA is Shenzhen A-share market; SZB is Shenzhen B-share market.
<table>
<thead>
<tr>
<th>Return</th>
<th>Variance Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\delta$</td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
</tr>
<tr>
<td>SHA</td>
<td>-0.0163</td>
</tr>
<tr>
<td></td>
<td>(-0.663)</td>
</tr>
<tr>
<td>SHB</td>
<td>-0.0533</td>
</tr>
<tr>
<td></td>
<td>(-1.648)*</td>
</tr>
<tr>
<td>SZA</td>
<td>-0.0365</td>
</tr>
<tr>
<td>SZB</td>
<td>-0.0378</td>
</tr>
<tr>
<td></td>
<td>(-1.015)</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
</tr>
<tr>
<td>SHA</td>
<td>-0.0175</td>
</tr>
<tr>
<td></td>
<td>(-0.715)</td>
</tr>
<tr>
<td>SHB</td>
<td>-0.0518</td>
</tr>
<tr>
<td>SZA</td>
<td>-0.0401</td>
</tr>
<tr>
<td></td>
<td>(-1.708)*</td>
</tr>
<tr>
<td>SZB</td>
<td>-0.0375</td>
</tr>
<tr>
<td></td>
<td>(-1.266)</td>
</tr>
</tbody>
</table>
Table 2.3 (Continued)

<table>
<thead>
<tr>
<th>Return</th>
<th>Variance Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\delta$</td>
<td>$\gamma_{11}$</td>
</tr>
<tr>
<td>SHA</td>
<td>0.0053</td>
</tr>
<tr>
<td></td>
<td>(0.228)</td>
</tr>
<tr>
<td>SHB</td>
<td>0.0151</td>
</tr>
<tr>
<td></td>
<td>(0.403)</td>
</tr>
<tr>
<td>SZA</td>
<td>0.0423</td>
</tr>
<tr>
<td>SZB</td>
<td>0.0374</td>
</tr>
<tr>
<td></td>
<td>(0.865)</td>
</tr>
</tbody>
</table>

SHA is Shanghai A-share market; SHB is Shanghai B-share market; SZA is Shenzhen A-share market; SZB is Shenzhen B-share market. Stock return is calculated as the first difference of the natural log of stock indices times 100. Change of trading volume is the first difference of the natural log of trading volume. Unexpected volume is the first difference of the natural log between trading volume and expected trading volume (60 business days' moving average).

Model 1: Mean equation:

$$
\begin{bmatrix}
R_{i,t} \\
R_{j,t}
\end{bmatrix} =
\begin{bmatrix}
\gamma_{11} & 0 \\
0 & \gamma_{22}
\end{bmatrix}
\begin{bmatrix}
R_{i,t-1} \\
R_{j,t-1}
\end{bmatrix} +
\begin{bmatrix}
\varepsilon_{i,t} \\
\varepsilon_{j,t}
\end{bmatrix}
$$

where $\varepsilon_i | I_{t-1} = [\varepsilon_{i,t}, \varepsilon_{j,t}]' \sim N(0, H_t)$, $i =$ A-share, $j =$ B-share.

Variance equation:
\[ h_{i,t} = c_i + a_i h_{i,t-1} + b_i \varepsilon_{i,t-1}^2, \text{ where } i = \text{A} \]
\[ h_{j,t} = c_j + a_j h_{j,t-1} + b_j \varepsilon_{j,t-1}^2, \text{ where } j = \text{B} \]
\[ h_{\tilde{i},t} = \rho_{\tilde{i},t} \sqrt{h_{i,t}} \sqrt{h_{j,t}} \]
\[ \rho_{\tilde{i},t} = q_{\tilde{i},t} / \sqrt{q_{i,t}q_{j,t}} \]

Model 2: Mean equation:
\[
\begin{bmatrix}
R_{i,t} \\
R_{j,t}
\end{bmatrix} = \begin{bmatrix}
\gamma_{11} & 0 \\
0 & \gamma_{22}
\end{bmatrix} \begin{bmatrix}
R_{i,t-1} \\
R_{j,t-1}
\end{bmatrix} + \begin{bmatrix}
\varphi_{11} & 0 \\
0 & \varphi_{22}
\end{bmatrix} \begin{bmatrix}
\Delta V_{i,t} \\
\Delta V_{j,t}
\end{bmatrix} + \begin{bmatrix}
\varepsilon_{i,t} \\
\varepsilon_{j,t}
\end{bmatrix}
\]

where \( \varepsilon_t | I_{t-1} = [\varepsilon_{i,t} \quad \varepsilon_{j,t}]' \sim N(0, H_t), \ i = \text{A}, j = \text{B} \)

Variance equation is the same as that of Model 1.

Model 3: Mean equation:
\[
\begin{bmatrix}
R_{i,t} \\
R_{j,t}
\end{bmatrix} = \begin{bmatrix}
\gamma_{11} & 0 \\
0 & \gamma_{22}
\end{bmatrix} \begin{bmatrix}
R_{i,t-1} \\
R_{j,t-1}
\end{bmatrix} + \begin{bmatrix}
\varphi_{11} & 0 \\
0 & \varphi_{22}
\end{bmatrix} \begin{bmatrix}
U V_{i,t} \\
U V_{j,t}
\end{bmatrix} + \begin{bmatrix}
\varepsilon_{i,t} \\
\varepsilon_{j,t}
\end{bmatrix}
\]

where \( \varepsilon_t | I_{t-1} = [\varepsilon_{i,t} \quad \varepsilon_{j,t}]' \sim N(0, H_t), \ i = \text{A}, j = \text{B} \)

Variance equation is the same as that of Model 1.

The t-statistics are in parentheses. The ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels with critical values of 2.58, 1.96, and 1.65, respectively.

The estimates of the mean-reverting process for the conditional covariance, \( q_{AB,t} \), are based on:

\[ q_{AB,t} = \bar{q}_{AB}(1 - \alpha - \beta) + \alpha q_{AB,t-1} + \beta \eta_{A,t-1} \eta_{B,t-1} \]

The results are (1) Model 1 Shanghai market: \( \alpha = 0.043 \) (264.279), \( \beta = 0.957 \) (7124.877); (2) Model 1 Shenzhen market: \( \alpha = 0.045 \) (6.138), \( \beta = 0.955 \) (129.277); (3) Model 2 Shanghai market: \( \alpha = 0.058 \) (317.018), \( \beta = 0.942 \) (4932.707); (4) Model 2 Shenzhen market: \( \alpha = 0.044 \) (5.472), \( \beta = 0.956 \) (117.546); (5) Model 3 Shanghai market: \( \alpha = 0.042 \) (3.147), \( \beta = 0.958 \) (70.446); (6) Model 3 Shenzhen market: \( \alpha = 0.045 \) (6.238), \( \beta = 0.955 \) (132.959).

The persistence measure of the variance is calculated as the summation of the coefficients in the variance equations \( (\alpha + \beta) \).
### Table 2.4 Summary Statistics for Correlation Coefficients for Three DCC Models

<table>
<thead>
<tr>
<th>Model Description</th>
<th>Mean</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant Correlation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_{AB}$ (SH)</td>
<td>0.4689</td>
<td></td>
</tr>
<tr>
<td>$\rho_{AB}$ (SZ)</td>
<td>0.4474</td>
<td></td>
</tr>
<tr>
<td><strong>Time-varying Correlation (Model 1)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_{AB}$ (SH)</td>
<td>0.5305</td>
<td>0.0724</td>
</tr>
<tr>
<td>$\rho_{AB}$ (SZ)</td>
<td>0.4988</td>
<td>0.0727</td>
</tr>
<tr>
<td><strong>Time-varying Correlation (Model 2)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_{AB}$ (SH)</td>
<td>0.5232</td>
<td>0.0772</td>
</tr>
<tr>
<td>$\rho_{AB}$ (SZ)</td>
<td>0.4865</td>
<td>0.0727</td>
</tr>
<tr>
<td><strong>Time-varying Correlation (Model 3)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_{AB}$ (SH)</td>
<td>0.5268</td>
<td>0.0727</td>
</tr>
<tr>
<td>$\rho_{AB}$ (SZ)</td>
<td>0.4924</td>
<td>0.0734</td>
</tr>
</tbody>
</table>
Table 2.5 Effects of Crisis and Policy Change on Dynamic Correlation of Chinese Stock Returns

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\rho_{AB,t}(SH)$</td>
<td>$\rho_{AB,t}(SZ)$</td>
<td>$\rho_{AB,t}(SH)$</td>
</tr>
<tr>
<td><strong>Panel A: Mean Equation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.0150</td>
<td>0.0096</td>
<td>0.0482</td>
</tr>
<tr>
<td></td>
<td>(11.950)***</td>
<td>(5.128)***</td>
<td>(31.120)***</td>
</tr>
<tr>
<td>$\rho_{AB,t-1}$</td>
<td>0.9765</td>
<td>0.9862</td>
<td>0.9301</td>
</tr>
<tr>
<td></td>
<td>(359.382)***</td>
<td>(300.257)***</td>
<td>(326.708)***</td>
</tr>
<tr>
<td>$DM_1$</td>
<td>-0.0001</td>
<td>-0.0003</td>
<td>-0.0079</td>
</tr>
<tr>
<td></td>
<td>(-0.035)</td>
<td>(-0.069)</td>
<td>(-1.403)</td>
</tr>
<tr>
<td>$DM_2$</td>
<td>-0.0109</td>
<td>-0.0032</td>
<td>-0.0433</td>
</tr>
<tr>
<td></td>
<td>(-6.534)***</td>
<td>(-1.423)</td>
<td>(-17.280)***</td>
</tr>
<tr>
<td>$DM_3$</td>
<td>0.0055</td>
<td>0.0016</td>
<td>0.0150</td>
</tr>
<tr>
<td></td>
<td>(4.147)***</td>
<td>(0.905)</td>
<td>(12.090)***</td>
</tr>
</tbody>
</table>
Table 2.5 (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho_{AB,t}^{(SH)} )</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
<tr>
<td>( \rho_{AB,t}^{(SZ)} )</td>
<td>(25.365)**</td>
<td>(16.889)**</td>
<td>(14.064)**</td>
</tr>
<tr>
<td>( e_{t-1}^{2} )</td>
<td>0.3137</td>
<td>0.2093</td>
<td>0.6992</td>
</tr>
<tr>
<td>( \sigma_{\rho,t-1}^{2} )</td>
<td>(19.360)**</td>
<td>(15.230)**</td>
<td>(21.185)**</td>
</tr>
<tr>
<td>( DM_{1} )</td>
<td>0.0002</td>
<td>0.0001</td>
<td>0.0009</td>
</tr>
<tr>
<td>( DM_{2} )</td>
<td>(6.352)**</td>
<td>(1.639)*</td>
<td>(8.798)**</td>
</tr>
<tr>
<td>( DM_{3} )</td>
<td>(2.563)**</td>
<td>(-0.693)</td>
<td>(6.110)**</td>
</tr>
<tr>
<td>( F\text{-stat} )</td>
<td>11503.42***</td>
<td>6439.018***</td>
<td>10426***</td>
</tr>
</tbody>
</table>

Panel B: Variance Equation

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
<tr>
<td>( (25.365)** )</td>
<td>(14.064)**</td>
<td>(18.966)**</td>
<td>(24.244)**</td>
</tr>
<tr>
<td>( (19.360)** )</td>
<td>(15.230)**</td>
<td>(21.185)**</td>
<td>(19.067)**</td>
</tr>
<tr>
<td>( (61.740)** )</td>
<td>(61.087)**</td>
<td>(34.868)**</td>
<td>(67.472)**</td>
</tr>
<tr>
<td>( (6.352)** )</td>
<td>(1.639)*</td>
<td>(8.798)**</td>
<td>(5.859)**</td>
</tr>
<tr>
<td>( (2.563)** )</td>
<td>(6.110)**</td>
<td>(-2.321)**</td>
<td>(0.769)</td>
</tr>
<tr>
<td>( F\text{-stat} )</td>
<td>11072.00***</td>
<td>10426***</td>
<td>10653.51***</td>
</tr>
</tbody>
</table>

Estimates are based on mean equations: \( \rho_{AB,t} = g_0 + g_1 \rho_{AB,t-1} + \sum_{i=1}^{3} \delta_i DM_{s,i,t} + \epsilon_t \). Variance equation: \( \sigma_{\rho,t}^{2} = c + a_1 \sigma_{\rho,t-1}^{2} + b_1 \epsilon_{t-1}^{2} + \sum_{i=1}^{3} d_i DM_{s,i,t} \). The \( \rho_{AB,t} \) is the correlation coefficient between the A-share stock return and B-share stock return from GARCH-DCC models (Model 1, Model 2, and Model 3). \( DM_{s,i,t} \) (s =1, 2 and 3) are dummy variables: \( DM_{1} \) is for the first phase of the Asian crisis (7/2/1997–11/17/1997); \( DM_{2} \) is for the second phase of the Asian crisis (11/18/1997–12/31/1998); \( DM_{3} \) is for the post-policy-change period when domestic investors were allowed to purchase B-shares (3/1/2001–6/30/2003). ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Numbers in parentheses are Z-statistics.
**Table 2.6 Dynamic Correlation of Chinese Stock Returns and Risk**

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\rho_{AB,t}(SH))</td>
<td>0.5736</td>
<td>0.5724</td>
<td>0.5601</td>
</tr>
<tr>
<td>(\rho_{AB,t}(SZ))</td>
<td>0.5578</td>
<td>0.5720</td>
<td>0.5690</td>
</tr>
<tr>
<td>Constant</td>
<td>(49.082)***</td>
<td>(48.008)***</td>
<td>(46.336)***</td>
</tr>
<tr>
<td>(p_{A,t}^{HL}(SH))</td>
<td>-0.0435</td>
<td>0.1332</td>
<td>-0.0278</td>
</tr>
<tr>
<td></td>
<td>(-0.092)</td>
<td>(0.273)</td>
<td>(-0.059)</td>
</tr>
<tr>
<td>(p_{B,t}^{HL}(SH))</td>
<td>-1.6079</td>
<td>-1.4954</td>
<td>-1.7005</td>
</tr>
<tr>
<td></td>
<td>(-5.174)***</td>
<td>(-4.652)***</td>
<td>(-5.464)***</td>
</tr>
<tr>
<td>(p_{A,t}^{HL}(SZ))</td>
<td>-1.1454</td>
<td>-1.1045</td>
<td>-1.1199</td>
</tr>
<tr>
<td></td>
<td>(-2.707)***</td>
<td>(-2.608)***</td>
<td>(-2.637)***</td>
</tr>
<tr>
<td>(p_{B,t}^{HL}(SZ))</td>
<td>-1.4861</td>
<td>-1.4406</td>
<td>-1.5926</td>
</tr>
<tr>
<td></td>
<td>(-5.325)***</td>
<td>(-5.157)***</td>
<td>(-5.685)***</td>
</tr>
</tbody>
</table>

Estimates are based on the following equation:
\[
\rho_{AB,t} = V_0 + V_1 (p_{A,t}^{HL}) + V_2 (p_{B,t}^{HL}) + \epsilon_t.
\]
Here \(\rho_{AB,t}\) is the correlation coefficient series between A-share stock returns and B-share stock returns generated from GARCH-DCC models (Model 1, Model 2, and Model 3 for the Shanghai and Shenzhen markets as defined in Table 3). Additionally, \(p_{A,t}^{HL} = \ln P_{A,t}^H - \ln P_{A,t}^L\) and \(p_{B,t}^{HL} = \ln P_{B,t}^H - \ln P_{B,t}^L\) are the differences between the natural log of the highest price and lowest price during a particular day for the A-share and B-share indices. The t-statistics are reported in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.
Table 3.1 Descriptive Statistics

<table>
<thead>
<tr>
<th>Panel A: Statistics for Stock Return $R_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
</tr>
<tr>
<td>Observation Number</td>
</tr>
<tr>
<td>Minimum (%)</td>
</tr>
<tr>
<td>Maximum (%)</td>
</tr>
<tr>
<td>Mean (%)</td>
</tr>
<tr>
<td>S.D. (%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Statistics for $CSAD_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
</tr>
<tr>
<td>Observation Number</td>
</tr>
<tr>
<td>Minimum (%)</td>
</tr>
<tr>
<td>Maximum (%)</td>
</tr>
<tr>
<td>Mean (%)</td>
</tr>
<tr>
<td>S.D. (%)</td>
</tr>
</tbody>
</table>

Descriptive statistics of weekly stock Return ($R_t$) and cross-sectional absolute deviations ($CSAD_t$) for Shenzhen A (SZA), Shenzhen B (SZB), Shanghai A (SHA) and Shanghai B (SHB) stock markets from 7/12/1994 to 12/31/2003. Where $R_sza$ is stock return for Shenzhen A composite index, $R_szb$ is stock return for Shenzhen B composite index, $R_sha$ is stock return for Shanghai A composite index, $R_shb$ is stock return for Shanghai B composite index, $CSAD_t$ is the cross-sectional absolute deviation of returns over the sample period.
Table 3.2 Detecting Herding Behavior in Four Chinese Stock Markets: Regression Results of Weekly Cross-Sectional Absolute Deviation

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>$\alpha$</th>
<th>$\gamma_1$</th>
<th>$\gamma_2$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (486)</td>
<td>0.0008</td>
<td>0.3093</td>
<td>-0.1168</td>
<td>0.5833</td>
<td>340.45***</td>
</tr>
<tr>
<td></td>
<td>(1.25)</td>
<td>(26.05)***</td>
<td>(-1.95)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZB (486)</td>
<td>-0.0006</td>
<td>0.2899</td>
<td>0.1154</td>
<td>0.7661</td>
<td>795.05***</td>
</tr>
<tr>
<td></td>
<td>(-1.34)</td>
<td>(37.79)***</td>
<td>(2.75)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA (486)</td>
<td>0.0006</td>
<td>0.2857</td>
<td>-0.0775</td>
<td>0.7346</td>
<td>672.29***</td>
</tr>
<tr>
<td></td>
<td>(1.66)*</td>
<td>(34.57)***</td>
<td>(-1.91)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB (486)</td>
<td>-0.0006</td>
<td>0.2833</td>
<td>0.12098</td>
<td>0.8332</td>
<td>1212.35***</td>
</tr>
<tr>
<td></td>
<td>(-1.87)*</td>
<td>(47.53)***</td>
<td>(2.57)**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports the following regression results for Shenzhen A and B, and Shanghai A and B stock markets:

$$\text{CSAD}_t = \alpha + \gamma_1 (R_{m,t}) + \gamma_2 (R_{m,t})^2 + \varepsilon_t$$

where $R_{m,t}$ is the stock market return on week $t$. The stock index ($m$) includes four value-weighted composite indexes: Shenzhen A composite index (SZA), Shenzhen B composite index (SZB), Shanghai A composite index (SHA), and Shanghai B composite index (SHB). $(R_{m,t})^2$ is the squared value of the term.

The sample period is from 7/12/1994 to 12/31/2003. There are 486 observations in each market. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.3 Detecting Herding Behavior in Four Chinese Stock Markets: Regression Results of Weekly Cross-Sectional Absolute Deviation When Market Goes Up or Down

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>( \alpha )</th>
<th>( \gamma_{1}^{\text{UP}} )</th>
<th>( \gamma_{2}^{\text{UP}} )</th>
<th>Adjusted ( R^{2} )</th>
<th>( F_{1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (249)</td>
<td>0.0007</td>
<td>0.4410</td>
<td>-0.8615</td>
<td>0.4647</td>
<td>106.80***</td>
</tr>
<tr>
<td>SZB (241)</td>
<td>-0.0012</td>
<td>0.4253</td>
<td>-0.5781</td>
<td>0.7686</td>
<td>395.31***</td>
</tr>
<tr>
<td>SHA (253)</td>
<td>-0.0001</td>
<td>0.4142</td>
<td>-0.6443</td>
<td>0.6839</td>
<td>270.46***</td>
</tr>
<tr>
<td>SHB (230)</td>
<td>-0.0017</td>
<td>0.2773</td>
<td>-0.2142</td>
<td>0.3566</td>
<td>62.91***</td>
</tr>
</tbody>
</table>

Panel A: Regression results for Model 3.7A when market goes up \((R_{m,t} > 0)\)

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>( \alpha )</th>
<th>( \gamma_{1}^{\text{DOWN}} )</th>
<th>( \gamma_{2}^{\text{DOWN}} )</th>
<th>Adjusted ( R^{2} )</th>
<th>( F_{2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (237)</td>
<td>0.0008</td>
<td>-0.4526</td>
<td>0.7993</td>
<td>0.4182</td>
<td>84.12***</td>
</tr>
<tr>
<td>SZB (245)</td>
<td>-0.0028</td>
<td>-0.3173</td>
<td>0.5529</td>
<td>0.4693</td>
<td>107.02***</td>
</tr>
<tr>
<td>SHA (233)</td>
<td>-0.0007</td>
<td>-0.3703</td>
<td>0.9498</td>
<td>0.5574</td>
<td>144.82***</td>
</tr>
<tr>
<td>SHB (256)</td>
<td>-0.0022</td>
<td>-0.2754</td>
<td>0.2784</td>
<td>0.6061</td>
<td>194.64***</td>
</tr>
</tbody>
</table>

Panel B: Regression results for Model 3.7B when market goes down \((R_{m,t} < 0)\)

This table reports the two regressions results for Shenzhen A and B, Shanghai A and B stock markets:

\[
\text{CSAD}_{t}^{\text{UP}} = \alpha + \gamma_{1}^{\text{UP}} R_{m,t}^{\text{UP}} + \gamma_{2}^{\text{UP}} (R_{m,t}^{\text{UP}})^2 + \epsilon_{t}, \text{ if } R_{m,t} > 0 \tag{3.7A}
\]

\[
\text{CSAD}_{t}^{\text{DOWN}} = \alpha + \gamma_{1}^{\text{DOWN}} R_{m,t}^{\text{DOWN}} + \gamma_{2}^{\text{DOWN}} (R_{m,t}^{\text{DOWN}})^2 + \epsilon_{t}, \text{ if } R_{m,t} < 0 \tag{3.7B}
\]

where \( R_{m,t}^{\text{UP}} (R_{m,t}^{\text{DOWN}}) \) is the stock market return of on week \( t \) when the market is up (down). The stock index \((m)\) includes four value-weighted composite indexes: Shenzhen A composite index (SZA), Shenzhen B composite index(SZB), Shanghai A composite index(SHA), and Shanghai B composite index(SHB). \((R_{m,t}^{\text{UP}})^2 (R_{m,t}^{\text{DOWN}})^2\) is the squared value of the term. Panel A reports regression results for Model 3.7A when the market goes up and Panel B reports regression results for Model 3.7B when the market goes down. The sample period is from 7/12/1994 to 12/31/2003. There are 486 observations in each regression. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.4 Herding Behavior Regression Results of Weekly Cross-Sectional Absolute Deviation: Excessively High Trading Volume vs. Excessively Low Trading Volume

Panel A: Regression results for Model 3.8A when trading volume is excessively high

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>( \alpha )</th>
<th>( \gamma_{UP}^1 )</th>
<th>( \gamma_{UP}^2 )</th>
<th>Adjusted ( R^2 )</th>
<th>( F_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (82)</td>
<td>0.0008</td>
<td>0.4578</td>
<td>-1.3761</td>
<td>0.7120</td>
<td>97.64***</td>
</tr>
<tr>
<td>(0.59)</td>
<td>(11.53)***</td>
<td>(-4.07)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZB (68)</td>
<td>0.0003</td>
<td>0.2947</td>
<td>0.0170</td>
<td>0.8985</td>
<td>315.42***</td>
</tr>
<tr>
<td>(0.27)</td>
<td>(23.25)***</td>
<td>(0.22)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA (81)</td>
<td>0.0005</td>
<td>0.4418</td>
<td>-0.5466</td>
<td>0.7991</td>
<td>160.08***</td>
</tr>
<tr>
<td>(0.45)</td>
<td>(17.83)***</td>
<td>(-4.57)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB (72)</td>
<td>-0.0001</td>
<td>0.2628</td>
<td>0.1332</td>
<td>0.8749</td>
<td>739.01***</td>
</tr>
<tr>
<td>(-0.15)</td>
<td>(35.89)***</td>
<td>(2.52)**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: Regression results for Model 3.8B when trading volume is excessively low

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>( \alpha )</th>
<th>( \gamma_{DOWN}^1 )</th>
<th>( \gamma_{DOWN}^2 )</th>
<th>Adjusted ( R^2 )</th>
<th>( F_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (56)</td>
<td>-0.0008</td>
<td>0.3865</td>
<td>2.5070</td>
<td>0.6834</td>
<td>60.35***</td>
</tr>
<tr>
<td>(-0.90)</td>
<td>(10.10)***</td>
<td>(4.09)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZB (32)</td>
<td>0.0002</td>
<td>0.3182</td>
<td>-0.4816</td>
<td>0.8916</td>
<td>128.52***</td>
</tr>
<tr>
<td>(0.25)</td>
<td>(15.64)***</td>
<td>(-1.36)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA (54)</td>
<td>-0.0006</td>
<td>0.3267</td>
<td>1.1880</td>
<td>0.8724</td>
<td>182.16***</td>
</tr>
<tr>
<td>(-1.04)</td>
<td>(16.50)***</td>
<td>(8.80)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB (48)</td>
<td>-0.0005</td>
<td>0.2470</td>
<td>0.3626</td>
<td>0.8320</td>
<td>117.35***</td>
</tr>
<tr>
<td>(-1.05)</td>
<td>(15.29)***</td>
<td>(1.68)*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports the two regressions results for Shenzhen A and B, Shanghai A and B stock markets:

\[
CSAD_{t}^{V-HIGH} = \alpha + \gamma_{1}^{V-HIGH} R_{m,t}^{V-HIGH} + \gamma_{2}^{V-HIGH} (R_{m,t}^{V-HIGH})^2 + \varepsilon_t, \text{ if } V_t > (V_{Mean} + V_{1.s.d.}) \quad (3.8A)
\]

\[
CSAD_{t}^{V-LOW} = \alpha + \gamma_{1}^{V-LOW} R_{m,t}^{V-LOW} + \gamma_{2}^{V-LOW} (R_{m,t}^{V-LOW})^2 + \varepsilon_t, \text{ if } V_t < (V_{Mean} - V_{1.s.d.}) \quad (3.8B)
\]

where \( V_t \) is the trading volume for market \( m \) at time \( t \). Trading volume \( V_t \) is regarded as being in an excessively high state \((V-HIGH)\) if it exceeds the mean trading volume plus one standard deviation of trading volume in the past 26 weeks. Trading volume \( V_t \) is regarded as being in an excessively low state \((V-LOW)\) if it is lower than the mean trading volume minus one standard deviation of trading volume in the past 26 weeks. The stock index \( m \) includes four value-weighted composite indexes of Shenzhen A composite index (SZA), Shenzhen B composite index (SZB), Shanghai A composite index (SHA) and Shanghai B composite index (SHB). Panel A reports regression results for Model 3.8A when trading volume is excessively high and Panel B reports regression results for Model 3.8B when trading volume is excessively low. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.5 Herding Behavior Regression Results of Weekly Cross-Sectional Absolute Deviation: Excessively High Volatility vs. Excessively Low Volatility

Panel A: Regression results for Model 3.9A when volatility is excessively high: $\hat{\sigma}^2_t > (\hat{\sigma}^2_{\text{Mean}} + \hat{\sigma}^2_{\text{1.s.d.}})$

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>$\alpha$</th>
<th>$\gamma^\text{UP}_1$</th>
<th>$\gamma^\text{UP}_2$</th>
<th>Adjusted $R^2$</th>
<th>$F_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (104)</td>
<td>0.0014</td>
<td>0.3061</td>
<td>-0.3554</td>
<td>0.7457</td>
<td>152.04***</td>
</tr>
<tr>
<td></td>
<td>(1.14)</td>
<td>(16.30)**</td>
<td>(-2.87)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZB (100)</td>
<td>0.0023</td>
<td>0.2534</td>
<td>0.0956</td>
<td>0.7940</td>
<td>191.77***</td>
</tr>
<tr>
<td></td>
<td>(1.56)</td>
<td>(18.12)**</td>
<td>(1.51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA (110)</td>
<td>0.0008</td>
<td>0.3030</td>
<td>-0.1611</td>
<td>0.8282</td>
<td>263.70***</td>
</tr>
<tr>
<td></td>
<td>(1.35)</td>
<td>(22.96)**</td>
<td>(-1.93)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB (100)</td>
<td>0.0001</td>
<td>0.2486</td>
<td>0.1058</td>
<td>0.8499</td>
<td>281.30***</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(22.54)**</td>
<td>(1.42)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: Regression results for Model 3.9B when volatility is excessively low: $\hat{\sigma}^2_t < (\hat{\sigma}^2_{\text{Mean}} - \hat{\sigma}^2_{\text{1.s.d.}})$

<table>
<thead>
<tr>
<th>Market (number of observations)</th>
<th>$\alpha$</th>
<th>$\gamma^\text{DOWN}_1$</th>
<th>$\gamma^\text{DOWN}_2$</th>
<th>Adjusted $R^2$</th>
<th>$F_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZA (134)</td>
<td>-0.0021</td>
<td>0.5678</td>
<td>4.4456</td>
<td>0.6656</td>
<td>133.36***</td>
</tr>
<tr>
<td></td>
<td>(-1.97)</td>
<td>(16.10)**</td>
<td>(6.67)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZB (117)</td>
<td>-0.0005</td>
<td>0.3086</td>
<td>0.4308</td>
<td>0.8880</td>
<td>461.07***</td>
</tr>
<tr>
<td></td>
<td>(-1.19)</td>
<td>(29.51)**</td>
<td>(3.81)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHA (124)</td>
<td>-0.0005</td>
<td>0.4710</td>
<td>1.1054</td>
<td>0.7615</td>
<td>197.39***</td>
</tr>
<tr>
<td></td>
<td>(-0.74)</td>
<td>(19.37)**</td>
<td>(2.58)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHB (108)</td>
<td>-0.0005</td>
<td>0.3282</td>
<td>0.2055</td>
<td>0.7487</td>
<td>160.37***</td>
</tr>
<tr>
<td></td>
<td>(-0.81)</td>
<td>(13.51)**</td>
<td>(0.59)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports the two regressions results for Shenzhen A and B, Shanghai A and B stock markets:

\[
\begin{align*}
\sigma^2_{t,\text{HIGH}}^2 &= \alpha + \gamma_1 \sigma_{m,t} + \gamma_2 (\sigma_{m,t}^2)^2 + \epsilon_t, \text{ if } \hat{\sigma}^2_t > (\hat{\sigma}^2_{\text{Mean}} + \hat{\sigma}^2_{\text{1.s.d.}}) \tag{3.9A} \\
\sigma^2_{t,\text{LOW}}^2 &= \alpha + \gamma_1 \sigma_{m,t} + \gamma_2 (\sigma_{m,t}^2)^2 + \epsilon_t, \text{ if } \hat{\sigma}^2_t < (\hat{\sigma}^2_{\text{Mean}} - \hat{\sigma}^2_{\text{1.s.d.}}) \tag{3.9B}
\end{align*}
\]

where volatility, $\sigma^2_{m,t}$ is the stock return variance for the rolling period (26 weeks) for market $m$ ending at week $t$. Return volatility is defined as being in an excessively high state if it exceeds the mean volatility plus one standard deviation of volatility in the past 26 weeks. Return volatility $\hat{\sigma}^2_t$ is regarded as being in an excessively low state if it is lower than the mean volatility minus one standard deviation of volatility in the past 26 weeks. The stock index ($m$) includes four value-weighted composite indexes of Shenzhen A composite index (SZA), Shenzhen B composite index (SZB), Shanghai A composite index (SHA) and Shanghai B composite index (SHB). Panel A reports regression results for Model 3.9A when volatility is excessively high and Panel B reports regression results for Model 3.9B when volatility is excessively low. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.6 Herding Behavior across A and B markets

<table>
<thead>
<tr>
<th>Model</th>
<th>$\alpha$</th>
<th>$\gamma_1$</th>
<th>$\gamma_2$</th>
<th>$\gamma_3$</th>
<th>$R^2$</th>
<th>$F_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.10A</td>
<td>0.0002</td>
<td>0.3122</td>
<td>-0.1437</td>
<td>0.1782</td>
<td>0.5912</td>
<td>234.78***</td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(26.47)***</td>
<td>(-2.40)**</td>
<td>(3.21)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.10B</td>
<td>-0.0009</td>
<td>0.2918</td>
<td>0.0971</td>
<td>0.1286</td>
<td>0.7697</td>
<td>541.30***</td>
</tr>
<tr>
<td></td>
<td>(-1.91)*</td>
<td>(38.20)***</td>
<td>(2.30)**</td>
<td>(2.94)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.10C</td>
<td>0.0004</td>
<td>0.2866</td>
<td>-0.0909</td>
<td>0.1052</td>
<td>0.7361</td>
<td>451.84***</td>
</tr>
<tr>
<td></td>
<td>(0.88)</td>
<td>(34.71)***</td>
<td>(-2.22)**</td>
<td>(1.91)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.10D</td>
<td>-0.0007</td>
<td>0.2832</td>
<td>0.1147</td>
<td>0.0274</td>
<td>0.8331</td>
<td>808.03***</td>
</tr>
<tr>
<td></td>
<td>(-1.99)**</td>
<td>(47.49)***</td>
<td>(2.41)**</td>
<td>(0.86)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports regression results of the following four models.

\[
CSAD_{SZA,t} = \alpha + \gamma_1 (R_{SZA,t}) + \gamma_2 (R_{SZA,t})^2 + \gamma_3 (R_{SZB,t})^2 + \epsilon_t \quad (3.10A)
\]

\[
CSAD_{SZB,t} = \alpha + \gamma_1 (R_{SZB,t}) + \gamma_2 (R_{SZB,t})^2 + \gamma_3 (R_{SZA,t})^2 + \epsilon_t \quad (3.10B)
\]

\[
CSAD_{SHA,t} = \alpha + \gamma_1 (R_{SHA,t}) + \gamma_2 (R_{SHA,t})^2 + \gamma_3 (R_{SHB,t})^2 + \epsilon_t \quad (3.10C)
\]

\[
CSAD_{SHB,t} = \alpha + \gamma_1 (R_{SHB,t}) + \gamma_2 (R_{SHB,t})^2 + \gamma_3 (R_{SHA,t})^2 + \epsilon_t \quad (3.10D)
\]

Model 3.10A is to detect whether Shenzhen A-market is herding on Shenzhen B-market. Model 3.10B is to detect whether Shenzhen B-market is herding on Shenzhen A-market. Model 3.10C is to detect whether Shanghai A-market is herding on Shanghai B-market. Model 3.10D is to detect whether Shanghai B-market is herding on Shanghai A-market. The sample period is from 7/12/1994 to 12/31/2003. There are 486 observations in each regression. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.7 Herding Behavior across Shanghai and Shenzhen Markets

<table>
<thead>
<tr>
<th>Model</th>
<th>$\alpha$</th>
<th>$\gamma_1$</th>
<th>$\gamma_2$</th>
<th>$\gamma_3$</th>
<th>Adjusted $R^2$</th>
<th>$F_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.11A</td>
<td>0.0007</td>
<td>0.3071</td>
<td>-0.1830</td>
<td>0.0891</td>
<td>0.5832</td>
<td>227.18***</td>
</tr>
<tr>
<td></td>
<td>(1.19)</td>
<td>(25.38)***</td>
<td>(-1.96)**</td>
<td>(0.92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.11B</td>
<td>0.0005</td>
<td>0.2924</td>
<td>-0.2552</td>
<td>0.2108</td>
<td>0.7410</td>
<td>463.55***</td>
</tr>
<tr>
<td></td>
<td>(1.30)</td>
<td>(34.90)***</td>
<td>(-4.01)***</td>
<td>(3.59)***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports regression results of the following two models:

$$\text{CSAD}_{SZA,t} = \alpha + \gamma_1 \left( R_{SZA,t} \right) + \gamma_2 \left( R_{SZA,t} \right)^2 + \gamma_3 \left( R_{SHA,t} \right)^2 + \varepsilon_t \quad (3.11A)$$

$$\text{CSAD}_{SHA,t} = \alpha + \gamma_1 \left( R_{SHA,t} \right) + \gamma_2 \left( R_{SHA,t} \right)^2 + \gamma_3 \left( R_{SZA,t} \right)^2 + \varepsilon_t \quad (3.11B)$$

Model 3.11A is to detect whether Shenzhen A-market is herding on Shanghai A-market. Model 3.11B is to detect whether Shanghai A-market is herding on Shenzhen A-market. The sample period is from 7/12/1994 to 12/31/2003. There are 486 observations in each regression. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
### Table 3.8 Correlation among Herd Index, Volume, and Volatility

<table>
<thead>
<tr>
<th></th>
<th>Herdindex_sza</th>
<th>Volatility_sza</th>
<th>Volume_sza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herdindex_sza</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility_sza</td>
<td>0.0954</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0482)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume_sza</td>
<td>-0.0355</td>
<td>0.1699</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0.4629)</td>
<td>(0.0004)***</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Herdindex_sha</th>
<th>Volatility_sha</th>
<th>Volume_sha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herdindex_sha</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility_sha</td>
<td>0.1291</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0074)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume_sha</td>
<td>0.0006</td>
<td>-0.2885</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0.9890)</td>
<td>(&lt;.0001)***</td>
<td></td>
</tr>
</tbody>
</table>

This table reports Pearson Correlation Coefficients among herding index, volume and volatility for Shenzhen A and Shanghai A markets respectively. Herding index of SZA and SHA is the series of coefficients \( \gamma_2 \) from the following half-year rolling regression:

\[
CSAD_t = \alpha + \gamma_1 (R_{m,t}) + \gamma_2 (R_{m,t})^2 + \epsilon_t,
\]

where \( m \) is equal to SZA and SHA respectively. Volatility is the stock return variance for the same rolling period (half year). Volume is the trading volume (number of shares change hands) for the rolling period. The sample period is from 7/12/1994 to 12/31/2003. The Prob > |r| under H0: Rho=0 are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 3.9 Relation among Herd Index, Volume, and Volatility

<table>
<thead>
<tr>
<th>Model</th>
<th>$\alpha$</th>
<th>$\phi_1$</th>
<th>$\phi_2$</th>
<th>Adjusted $R^2$</th>
<th>$F_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_{t,SZA}$</td>
<td>0.0447</td>
<td>92.3644</td>
<td>-0.16351</td>
<td>0.01</td>
<td>2.55**</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(2.19)**</td>
<td>(-1.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.6075</td>
<td>81.5950</td>
<td></td>
<td>0.01</td>
<td>3.96**</td>
</tr>
<tr>
<td></td>
<td>(-5.58)**</td>
<td>(1.99)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$H_{t,SHA}$</td>
<td>-1.5123</td>
<td>150.6618</td>
<td>0.1792</td>
<td>0.02</td>
<td>4.07***</td>
</tr>
<tr>
<td></td>
<td>(-2.39)**</td>
<td>(3.00)***</td>
<td>(1.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.7441</td>
<td>137.7251</td>
<td></td>
<td>0.02</td>
<td>7.88***</td>
</tr>
<tr>
<td></td>
<td>(-7.80)***</td>
<td>(2.81)***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table reports regression results of the following models:

$$H_{t,SZA} = \phi_0 + \phi_1 \sigma^2_t, SZA + \phi_2 V_{t,SZA} + \epsilon_t$$

$$H_{t,SHA} = \phi_0 + \phi_1 \sigma^2_t, SHA + \phi_2 V_{t,SHA} + \epsilon_t$$

where $V_t$ is trading volume, $\sigma^2_t$ is return volatility. Herding index of SZA and SHA is the series of coefficients $\gamma_2$ from the following half-year rolling regression:

$$CSAD_t = \alpha + \gamma_1 (R_{m,t}) + \gamma_2 (R_{m,t})^2 + \epsilon_t$$

where $m$ is equal to SZA and SHA respectively. Volatility is the stock return variance for the same rolling period (half year). Volume is the trading volume (number of shares change hands) for the rolling period. The sample period is from 7/12/1994 to 12/31/2003. T-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level.
Table 4.1 Summary Statistics for Listed Stocks in Chinese Markets

<table>
<thead>
<tr>
<th>Year</th>
<th>Raw Trading Volume (Thousand)</th>
<th>Stock Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SHA</td>
<td>SHB</td>
</tr>
<tr>
<td>1994</td>
<td>19356</td>
<td>2662</td>
</tr>
<tr>
<td>1995</td>
<td>11437</td>
<td>1960</td>
</tr>
<tr>
<td>1996</td>
<td>18207</td>
<td>2661</td>
</tr>
<tr>
<td>1997</td>
<td>12309</td>
<td>3067</td>
</tr>
<tr>
<td>1998</td>
<td>8707</td>
<td>2005</td>
</tr>
<tr>
<td>1999</td>
<td>8787</td>
<td>3095</td>
</tr>
<tr>
<td>2000</td>
<td>12008</td>
<td>5283</td>
</tr>
<tr>
<td>2001</td>
<td>180615</td>
<td>14949</td>
</tr>
<tr>
<td>2002</td>
<td>10750</td>
<td>3270</td>
</tr>
<tr>
<td>2003</td>
<td>9244</td>
<td>2454</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Market Value ( Million)</th>
<th>Dividend Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SHA</td>
<td>SHB</td>
</tr>
<tr>
<td>1994</td>
<td>912</td>
<td>295</td>
</tr>
<tr>
<td>1995</td>
<td>1002</td>
<td>218</td>
</tr>
<tr>
<td>1996</td>
<td>1061</td>
<td>206</td>
</tr>
<tr>
<td>1997</td>
<td>1646</td>
<td>384</td>
</tr>
<tr>
<td>1998</td>
<td>1994</td>
<td>234</td>
</tr>
<tr>
<td>1999</td>
<td>2496</td>
<td>236</td>
</tr>
<tr>
<td>2000</td>
<td>3718</td>
<td>387</td>
</tr>
<tr>
<td>2001</td>
<td>4499</td>
<td>1114</td>
</tr>
<tr>
<td>2002</td>
<td>3878</td>
<td>1038</td>
</tr>
<tr>
<td>2003</td>
<td>3747</td>
<td>846</td>
</tr>
</tbody>
</table>
Table 4.1 (Continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>167</td>
<td>32</td>
<td>112</td>
<td>22</td>
<td>0.21</td>
<td>0.03</td>
<td>0.13</td>
<td>0.01</td>
</tr>
<tr>
<td>1995</td>
<td>182</td>
<td>34</td>
<td>121</td>
<td>30</td>
<td>0.10</td>
<td>0.02</td>
<td>0.11</td>
<td>0.27</td>
</tr>
<tr>
<td>1996</td>
<td>282</td>
<td>40</td>
<td>213</td>
<td>41</td>
<td>0.15</td>
<td>0.03</td>
<td>0.25</td>
<td>0.06</td>
</tr>
<tr>
<td>1997</td>
<td>369</td>
<td>48</td>
<td>336</td>
<td>49</td>
<td>0.09</td>
<td>0.03</td>
<td>0.18</td>
<td>0.02</td>
</tr>
<tr>
<td>1998</td>
<td>422</td>
<td>50</td>
<td>389</td>
<td>52</td>
<td>60.81</td>
<td>0.01</td>
<td>32.62</td>
<td>0.01</td>
</tr>
<tr>
<td>1999</td>
<td>468</td>
<td>52</td>
<td>441</td>
<td>52</td>
<td>16.90</td>
<td>0.02</td>
<td>9.91</td>
<td>0.02</td>
</tr>
<tr>
<td>2000</td>
<td>553</td>
<td>53</td>
<td>486</td>
<td>57</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>2001</td>
<td>633</td>
<td>53</td>
<td>487</td>
<td>57</td>
<td>1.23</td>
<td>0.09</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>2002</td>
<td>746</td>
<td>54</td>
<td>489</td>
<td>57</td>
<td>0.07</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>2003</td>
<td>746</td>
<td>54</td>
<td>489</td>
<td>57</td>
<td>0.03</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
</tr>
</tbody>
</table>

This table provides weekly (Wednesday) statistics for all stocks listed in China from 1994 to 2003. “SHA” and “SHB” are A- and B-shares listed on Shanghai Stock Exchange respectively; “SZA” and “SZB” are A- and B-shares listed on Shenzhen Stock Exchange, respectively. The “Raw Trading Volume” measured in thousand is the numbers of shares changed hands each week. “Market value” in thousand is the closed price multiply by numbers of shares outstanding. “Turnover” is the ratio between trading shares and the number of shares outstanding. “Price” is closed price. “Dividend yield” is the annual dividend divided by closed price. “Price” and “Market Value” for SHA and SZA are in RMB Yuan; for SHB, in U.S. dollars, and for SZB, in HK dollars.
Table 4.2 Summary Statistics for Dual-Listed A and B Shares

<table>
<thead>
<tr>
<th>Year</th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
<th>SZB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>14275</td>
<td>2678</td>
<td>11620</td>
<td>462</td>
<td>4.18</td>
<td>0.34</td>
<td>4.00</td>
<td>2.57</td>
</tr>
<tr>
<td>1995</td>
<td>7119</td>
<td>2035</td>
<td>9668</td>
<td>25216</td>
<td>4.13</td>
<td>0.25</td>
<td>3.25</td>
<td>1.89</td>
</tr>
<tr>
<td>1996</td>
<td>17048</td>
<td>2693</td>
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<table>
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<th>SZA</th>
<th>SZB</th>
<th>SHA</th>
<th>SHB</th>
<th>SZA</th>
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<td>9.12</td>
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Table 4.2 (Continued)

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<th>SHA</th>
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<td>28</td>
<td>30</td>
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<td>0.27</td>
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<tr>
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<td>37</td>
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<td>0.05</td>
</tr>
<tr>
<td>1997</td>
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<td>41</td>
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<td>49</td>
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<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
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<tr>
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<td>0.03</td>
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<td>2001</td>
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<td>44</td>
<td>43</td>
<td>57</td>
<td>0.02</td>
<td>0.09</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>2002</td>
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<td>0.02</td>
</tr>
<tr>
<td>2003</td>
<td>44</td>
<td>44</td>
<td>43</td>
<td>57</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
</tr>
</tbody>
</table>

This table provides weekly (Wednesday) statistics for dual listed A- and B-shares from 1994 to 2003. “SHA” and “SHB” are A- and B-shares listed on Shanghai Stock Exchange respectively; “SZA” and “SZB” are A- and B-shares listed on Shenzhen Stock Exchange, respectively. The “Raw Trading Volume” measured in thousand is the numbers of shares changed hands each week. “Market value” in thousand is the closed price multiply by numbers of shares outstanding. “Turnover” is the ratio between trading shares and the number of shares outstanding. “Price” is closed price. “Dividend yield” is the annual dividend divided by closed price. “Price” and “Market Value” for SHA and SZA are in RMB Yuan; for SHB, in U.S. dollars, and for SZB, in HK dollars.
Table 4.3 Vector Autoregression Results for Paired A and B Shares

\[
\begin{bmatrix}
\alpha_0^A \\
\alpha_0^B \\
\end{bmatrix}
\begin{bmatrix}
a_l & b_l \\
c_l & d_l \\
\end{bmatrix}
\]

\begin{align*}
\text{F-ratio} \\
0.0005 & 0.0146 & 0.0483 \\
(1.47) & (2.55)^** & (0.21)^*** (69.97)^*** \\
0.0012 & 0.0668 & 0.0396 \\
(2.86)^*** & (9.63)^*** & (6.92)^*** (100.24)^*** \\
\end{align*}

Joint Wald Test for \(H_0(3) = 6.73 \, ^{***}\)

The following VAR model is estimated using weekly dual listed paired Chinese A- and B-shares stock data from 1994 to 2003.

\[
\begin{bmatrix}
r_t^A \\
r_t^B \\
\end{bmatrix} = \begin{bmatrix}
\alpha_0^A \\
\alpha_0^B \\
\end{bmatrix} + \begin{bmatrix}
\sum_{k=1}^K a_k \\
\sum_{k=1}^K c_k \\
\end{bmatrix} \cdot \begin{bmatrix}
r_{t-k}^A \\
r_{t-k}^B \\
\end{bmatrix} + \begin{bmatrix}
\varepsilon_t^A \\
\varepsilon_t^B \\
\end{bmatrix}
\]

There are totally 34378 observations. This model takes one-period lag for both A- and B-shares.

\(r_t^A\) is stock return for A-share portfolio at time \(t\), \(r_t^B\) is stock return for B-share portfolio at time \(t\), \(r_{t-k}^A\) is \(k\)th lagged return of A-share portfolio, \(r_{t-k}^B\) is \(k\)th lagged return for B-share portfolio. Stock returns are calculated as the log-difference of closed stock prices, \(\sum_{k=1}^K x_k \) \((x = a,b,c,d)\) is the sum of the \(k\) \((k = 1 \text{ to } K)\) lagged coefficients for A or B portfolio return. \(\varepsilon_t^i \) \((i = A \text{ or } B)\) is the error term where \(\varepsilon_t^i \sim iid (0, \sum)\). The test equations are designed to examine the speed of adjustment to information for A-shares vs. their corresponding B-shares on the dual listed stocks. The hypotheses are:

Hypothesis (1): \(H_0(1): b_1 = 0 \text{ and } c_1 = 0; H_1(1): b_1 \neq 0 \text{ and } c_1 \neq 0;\)

Hypothesis (2): \(H_0(2): c_1 = 0; H_1(2): c_1 > 0;\)

Hypothesis (3): \(H_0(3): b_1 = c_1; H_1(3): b_1 < c_1\)

\(t\)-statistics are reported in parentheses. * indicates a 10% significance level; ** indicates a 5% significance level; *** indicates a 1% significance level. F is to test joint significance of xxx. Joint Wald Test is to test hypothesis 3.
Table 4.4 Estimates of Speed of Adjustment for Dual-Listed A and B Shares

Panel A: All dual listed A- and B-shares from 1994 to 2003

<table>
<thead>
<tr>
<th>Intercept</th>
<th>TU</th>
<th>MV</th>
<th>DY</th>
<th>DI</th>
<th>DA</th>
<th>DIND</th>
<th>F-stat.</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7932</td>
<td>-0.0111</td>
<td>-0.0153</td>
<td>-0.0045</td>
<td>-0.0378</td>
<td>-0.0178</td>
<td>0.0125</td>
<td>0.1266</td>
<td></td>
</tr>
<tr>
<td>(18.37)***</td>
<td>(-3.33)***</td>
<td>(-4.39)***</td>
<td>(-1.22)</td>
<td>(-3.85)**</td>
<td>(-2.39)**</td>
<td>(0.94)</td>
<td>(25.40)***</td>
<td>0.1266</td>
</tr>
</tbody>
</table>

Sample separated by A- and B-share in Panel B and C

Panel B: Dual listed A-shares from 1994 to 2003

<table>
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<tr>
<th>Intercept</th>
<th>TU</th>
<th>MV</th>
<th>DY</th>
<th>DI</th>
<th>DA</th>
<th>DIND</th>
<th>F-stat.</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5517</td>
<td>0.0008</td>
<td>0.0022</td>
<td>-0.0081</td>
<td>0.0036</td>
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<td>(2.43)**</td>
<td>0.0144</td>
</tr>
<tr>
<td>(11.74)***</td>
<td>(0.2)</td>
<td>(0.61)</td>
<td>(-2.99)**</td>
<td>0.48</td>
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Panel C: Dual listed B-shares from 1994 to 2003

<table>
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<th>DY</th>
<th>DI</th>
<th>DA</th>
<th>DIND</th>
<th>F-stat.</th>
<th>R²</th>
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<tr>
<td>(14.64)***</td>
<td>(-1.21)</td>
<td>(-4.94)***</td>
<td>(-1.18)</td>
<td>(-2.56)**</td>
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Sample separated by pre-/post- policy time period in Panel D and E

Panel D: Dual listed A- and B-shares from 1994 to 2000.

<table>
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<tr>
<th>Intercept</th>
<th>TU</th>
<th>MV</th>
<th>DY</th>
<th>DI</th>
<th>DA</th>
<th>DIND</th>
<th>F-stat.</th>
<th>R²</th>
</tr>
</thead>
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<tr>
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<tr>
<td>(16.47)***</td>
<td>(-1.26)</td>
<td>(-2.77)***</td>
<td>(-1.32)</td>
<td>(-4.7)***</td>
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</table>

Panel E: Dual listed A- and B-shares from 2001 to 2003.

<table>
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<th>TU</th>
<th>MV</th>
<th>DY</th>
<th>DI</th>
<th>DA</th>
<th>DIND</th>
<th>F-stat.</th>
<th>R²</th>
</tr>
</thead>
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<tr>
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<tr>
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</table>
Table 4.4 (Continued)

The estimated regression is $DELAY_{it}^i = \alpha_0 + \varphi_1 TU_{it}^i + \varphi_2 MV_{it}^i + \varphi_3 DY_{it}^i + \varphi_4 D_I + \varphi_5 D_A + \varphi_6 D_{IND} + w_i^t$.

Total number of observations is 1338, covering weekly A- and B-stock data from 1994 to 2003. $TU_{it}^i$ is the turnover ratio for stock $i$ at year $\tau$, $MV_{it}^i$ is the market value for stock $i$, $DY_{it}^i$ is the dividend yield. $D_I$ is an indicator variable with a value of 1 the post- (and including) 2001 period. $D_A$ is a dummy variable with value 1 for A-shares and value 0 for B-shares. $D_{IND}$ is the “protected” industry dummy variable with a value of 1 if the firm is in raw materials, utilities or chemicals industry, and a value of 0, otherwise. $DELAY_{it}^i$ is constructed by regressing each weekly Shanghai A- and B-share return on Shanghai Composite Index return and each Shenzhen A- and B-share return on Shenzhen Composite Index return using Dimson Beta Regression with one to five lead and five lagged weeks: $r_i^t = \alpha_i + \sum_{k=-5}^{0} \beta_k^i m_{i-k} + u_i^t$. The speed of adjustment ratio $x_i^t = \sum_{k=-5}^{0} \beta_k^i \left| \beta_k^i \right|$ is calculated for each stock for year $\tau$. $DELAY_{it}^i = \frac{1}{1 + e^{-x_i^t}}$ is the logit transformation of the adjustment ratio. Panel A is estimated based on whole period sample for both A- and B-share stocks. Panel B and C report statistics using the same regression as in Panel A for the same sample period. However, the estimates are made by separating A- and B-share data for the dual listed stocks. Panel D reports the estimates based on A- and B-shares. However, the estimations are conducted by separating two sub-periods: 1994 - 2000 in Panel D, 2001-2003 in Panel E. The $t$-statistics are reported in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.
Figure 1.1 Market Capitalization for Selected Countries, 2000 (Graph source: Indian Securities Market – A Review, National Stock Exchange of India Ltd, 2001; Shirai (2002)).

Figure 1.2 Shanghai Market A- and B-Share Stock Prices in Log Scale (1994.1.1 - 2003.6.30)
Figure 1.3 Shenzhen Market A- and B-Share Stock Prices in Log Scale (1994.1.1 - 2003.6.30)

Figure 2.1.1 Shanghai Market A and B Share Stock Prices (1994.1.1 - 2003.6.30)
Figure 2.1.2 Shenzhen Market A and B Share Stock Prices (1994.1.1 - 2003.6.30)
Figure 2.2 Shanghai and Shenzhen A- and B-Share, S&P500, Hang Seng Index Stock Returns (1996.1.1 - 2003.6.30)
Figure 2.3 Two-Year Rolling Correlation Coefficient for A and B Shares (1996.1.1 – 2003.6.30)
Figure 2.4.1 Time-Varying Correlation Coefficient for A and B Shares – Model 1 (1996.1.1 - 2003.6.30)
Figure 2.4.2 Time-Varying Correlation Coefficient for A and B Shares -- Model 2 (1996.1.1 - 2003.6.30)
Figure 2.4.3 Time-Varying Correlation Coefficient for A and B Shares -- Model 3 (1996.1.1 - 2003.6.30)
Vita

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M.S.  Finance, Drexel University  2001
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Instructor  Financial Management  Fall 2003
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Dr.Edward Nelling, Dr. Jacqueline Garner and Dr. Wei-ling Song.  2001 - Present
Technology TA  MBA Online Courses  2000 - 2001

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Research/Teaching Assistantship, PhD program, Drexel University  2001 – 2004
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