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**DIRECT AND INDIRECT BARRIERS TO ARBITRAGE:
EVIDENCE FROM HONG KONG LISTED CHINA'S SHARES**

Master's Thesis in
Finance

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ABSTRACT

Arbitrage lies in the core of many finance theories. It eliminates any mispricing and brings prices to fundamental values, keeping markets efficient. In reality, however, there exist various barriers to arbitrage that deter potential arbitrageurs from correcting the relative mispricing in a timely manner. While the existence and consequences of some direct barriers, such as capital controls and short-sales restriction, are evident and straightforward, other barriers are less obvious and indirect in nature but with the same effect of discouraging arbitrage activity. This paper investigates the role of various direct and indirect barriers to arbitrage in the persistence of relative mispricing with a sample of shares listed both on Hong Kong Stock Exchange and one of China's stock exchanges.

Time-series and cross-company fluctuations in price difference of the sample of cross-listed shares are investigated. It is found that the reduction of direct barriers has a significantly negative impact on the aggregate level of pricing difference, and that direct and indirect barriers to arbitrage can explain collectively 54% of the cross-sectional variation in pricing difference. The estimates are significant even after controlling for firm size, listing year and performance. The findings in this paper provide an alternative explanation for China's foreign share discount, especially for the persistence of relative mispricing. This study also sheds lights on the pricing of noise trader risk argued in Lee, Shleifer & Thaler (1991) but proved otherwise in empirical studies. Specifically, the result confirms the notion that both idiosyncratic and systematic risk matter in arbitrageurs' positions, particularly when the markets under concern are relatively segmented.

KEYWORDS: Arbitrage, Capital Controls, Short sales constraint, Noise trader, Indirect barriers, Cross-listed Shares.

1. INTRODUCTION

1.1. Motivation and Research Question

The concept of arbitrage-free is at the core of our beliefs about finance theory. In particular, two assets with identical payoffs should share the same price. If this balance is violated for extended period of time, then two conditions must be met. First, there exist direct barriers that limit potential arbitrageurs from eliminating the relative mispricing, such as foreign ownership restrictions, high transaction costs, heavy taxes and short-sale constraints (e.g. Miller 1977; Figlewski 1981; Eun & Janakiramanan 1986; Errunza & Losq 1985; Hietala 1989; Bodurtha et al. 1995; Stulz & Wasserfallen 1995; Bris et al. 2007). It is well-documented that liberalization of markets with more artificial restrictions gives rise to a more consistent pricing among markets (e.g. Gultekin et al. 1989; Bonser-Neal et al. 1990; Mittoo 1992; Bailey, Chung & Kang 1999; Bekaert & Harvey 2000; Karolyi, Li & Liao 2009). Second, various indirect barriers to arbitrage, such as information asymmetry, noise trader risk and agency problems, are in effect that render arbitrage positions costly or risky and thus deter any arbitrage behavior (e.g. DeLong et al. 1990; Lee, Shleifer & Thaler 1991; Pontiff 1996; Shleifer & Vishny 1997; Pontiff 2006; Kondor 2009). This paper evaluate the impact of various direct and indirect barriers to arbitrage on the pricing difference with a sample of companies that issue shares both on Hong Kong Stock Exchange (HKSE) and on China's newly established stock markets.

Yet another motivation for this paper is to address the puzzle of China's foreign share discount from a different perspective. Similar to the more frequently investigated B-shares in China's stock market, the class of shares discussed in this paper, issued by Chinese companies and listed on HKSE, also serves as unrestricted foreign shares in the face of strict investment barriers in China. In a comprehensive examination of the impact of foreign investment restriction on asset pricings, Bailey, Chung and Kang (1999) note that

shares available to foreign investors exhibit price premiums over those shares restricted to domestic investors in all segmented markets except China. Various hypotheses have been put forward to explain this foreign share discount in China along with the more general foreign share premium. Fernald and Rogers (2002) attributes the premium of China's domestic shares to the lack of alternative investment opportunities for retail investors in China, which, coupled with high household savings rate, results in their willingness to accept a lower required rate of return, a higher price, than foreign investors. Mei, Scheinkman and Xiong (2003) analyze non-fundamental components in Chinese stock prices and argue that speculative trading is responsible for the high premium of A-share markets. Wang and Jiang (2004) add to the evidence of segmented markets and document that H-shares exhibit significant exposure to Hong Kong market factors and behave more like Hong Kong stocks than Chinese stocks even though they are issued by Chinese companies who base their business in China.

Direct barriers to arbitrage in this case are evident in that (1) different classes of shares are issued by the same company but not fungible. In other words, trading can take place within group of investors but not among groups; (2) short-sales are prohibited in China's stock market. The deregulation of B-share market in 2001, which allows domestic investors with required foreign currencies to invest in B-share market previously designated to foreign investors, provides a good example of what would happen when the first direct barrier is lifted. It is observed that this change of regulation results in a dramatic decline of B-share discount from 75% to 8% on average (Karolyi, Li & Liao 2009). However, the pricing difference remains and differs among companies, drawing us to explore the influence of various indirect barriers to arbitrage that deter arbitrageurs from eliminating relative mispricing even when they are no longer restricted to do so.

The two direct barriers are also present until recently in our case of Hong Kong listed China's shares, although Hong Kong stock market is a well-established market without any restrictions on foreign investment and short selling activity. First, China has strict capital

control and the A-share market is off-limit to foreign investors until 2002 upon introduction of the Qualified Foreign Institutional Investors (QFII) program which allows foreign institutional investors to participate in China's A-share market. Similarly, Chinese investors cannot invest overseas until 2006 with the launch of Qualified Domestic Institutional Investors (QDII) program that enables qualified domestic funds to invest in foreign financial markets. Besides, when China's B-share market is deregulated in 2001, the second direct barrier, restrictions on short-sales in A-share market, is still binding. With or without influence, the differential pricing between domestic A- and foreign B-shares is solved by Chinese investors' bidding up B-share prices instead of correcting the notorious overvaluation associated with A-shares. As a consequence, it is natural to argue that, the abolishment of short selling restriction may impact the relative pricing status between domestic and foreign shares in a way different from the resolution in B-share market.

1.2. Main Findings

Using a quasi-event study approach similar to that used in Nishiotis (2004), it is found that the removal or reduction of these two direct barriers to arbitrage has a significantly impact on the aggregate price difference of two share series concerned. The increased level of openness of China's stock market proxied by the increasing amount of capital flows appropriated under QFII program significantly reduce the seriousness of relative mispricing in two markets. Furthermore, the abolishment of short-sales restrictions realized in a multiple-step process act also has a negative and increasingly larger impact on the pricing differences.

Nonetheless, similar to the case of China's B-shares, the pricing gap remains and varies across firms even though direct barriers are lifted or significantly mitigated. As the next step, the impact of various indirect barriers to arbitrage identified by existing literature on the persistence of such pricing difference and its cross-sectional variation is investigated.

Using three proxies for indirect barrier to arbitrage - noise trader risk, volatility of the difference and concentration of ownership – it is documented that the long-term cross-sectional price difference is positively correlated with all three measures of indirect barriers, even after controlling for various firm characteristics. Particularly, the higher the idiosyncratic risk, the more volatile the price difference, and the less dispersed the shareholder base, the more severe the relative mispricing. The result also shows that the impact of various indirect barriers to arbitrage on the pricing in two markets is no less than that exerted by two direct barriers. Collectively, proxies for direct and indirect barriers in our study explain 54% of the cross-company variation in price difference of cross-listed shares. This result surpasses the highest cross-sectional explanatory power of 46% documented in Chan, Menkveld & Yang (2008) in their attempt to explain the price premium of domestic A-shares relative to foreign B-shares using various proxies for information asymmetry.

1.3. Contributions

The findings of this paper contribute, in different ways, to three lines of literature. The first and most straightforward one is that it provides an alternative explanation for China's foreign share discount, especially the persistence of the pricing difference. During the last decade, much attention has been gathered around this "anomaly" and efforts have been made to explore the time-varying price difference at the index level (Arquette et al. 2008; Seasholes & Liu 2011), comovement between A- and H-share prices (Peng, Miao & Chow 2007) and with the respective stock market (Wang & Jiang 2004), spillover effect of returns (Li, Yi & Su 2011; Qiao, Chiang & Wong 2008), the impact of listing H-shares on the price difference between A-and B-shares (Sun & Tong 2000) and the influence of B-share market's deregulation on the average price difference (Kayoli, Li & Liao 2009). At the firm level, links have been established between the price difference and (1) turnover (Mei, Scheinkman & Xiong 2003) which can be further broken down to trading volume (Chan, Menkveld & Yang 2008) and relative supply of shares (Chan & Kwok 2005); (2) market

capitalization (Mei, Scheinkman & Xiong; Chan & Kwok 2005); (3) state ownership (Fernald & Rogers 2002); and (4) information asymmetry (Chan, Menkveld & Yang 2008). This paper extends these studies by controlling for those well-established factors and investigating the cross-company variation in price difference in a more detailed way and from another perspective. The analyses performed in this paper are based on one single notion that arbitrage should eliminate any relative mispricing however it is formed in the first place. Following this idea, we identify various direct and indirect barriers to arbitrage evident in China's current stock market or suggested in recent literature on costly arbitrage and sustained anomalies (Lee, Shleifer & Thaler 1991; Pontiff 1996; Shleifer & Vishny 1997; Gemmill & Thomas 2002; Pontiff 2006; Kondor 2009) and then use them to explain the time-series and cross-sectional price difference of cross-listed A- and H-shares. Throughout the literature, the pricing discrepancy is most successfully attributed to trading behavior in two markets and the supply of shares in respective market. Little has pointed to recent liberalizations in China's stock market as ways mitigating the pricing inconsistency in two markets. Neither have they attributed the continued pricing discrepancy, especially after explicit restrictions on arbitrage have been removed or loosened, to any less-obvious barriers to arbitrage that put the seemingly noticeable money on the table without being exploited.

By examining the effect of relaxing two restrictions in China's financial market on the price difference of cross-listed shares, this paper also extends another strand of study, namely the economic benefits of emerging market's financial liberalizations. Empirical studies around the world show that market liberalizations in the form of overseas listing, formation of country funds and relaxation on equity capital controls and foreign investment cast significant influence on the financial market under such reforms. Using data from Japan's stock market, Gultekin et al. (1989) show that price of risk in U.S. and Japanese markets was different before, but not after, the major regime switch in December 1980 that virtually eliminated capital controls on Japanese equity markets. More recently, studies concerning emerging economies that liberalize their financial markets in the late 1980s and early 1990s, shepherded by Errunza and Miller (2000), Henry (2000) and Bekaert and Harvey (2000),

all point to a lowered cost of capital of the liberalizing stock market, lending support to the notion that liberalization allows for risk sharing between domestic and foreign agents. Particularly related to the present study is the effect of market liberalization on pricing consistency with more advanced markets. Since tests of market efficiency are frequently subject to Fama's (1976) joint hypothesis, asserting that the rejection of market efficiency may equally be due to a wrong asset pricing model or the inefficiency of the market, samples are hard to form to test the potential efficiency gains of various financial reforms. The group of cross-listed shares focused in this paper, for which identical pricing is demanded by Law of One Price which is further guaranteed by arbitrage, provides a good opportunity without being bonded by the common pitfall of joint hypothesis. By linking the two reforms to relative mispricing of cross-listed shares, we are the first, to the best of our knowledge, to formally test the validity of these reforms in China's stock market. The results show that increasing openness of China's stock market, as proxied by the increased amount of free capital flows, has been beneficial to a narrowing pricing gap with respect to the well-established Hong Kong stock market.

Last but not least, this paper extends the evidence of costly arbitrage in cases of sustained mispricing, of which idiosyncratic risk is of particular importance and encounters substantial controversy. Studies stemming from DeLong et al. (1990) consider noise trader sentiment as a systematic risk factor that causes the relative mispricing and also prevents arbitrageurs from forcing the price to theoretical values (Lee, Shleifer & Thaler 1991; Gemmill & Thomas 2002; Baker & Wurgler 2006). By acknowledging so they downplay the role of idiosyncratic risks since they are believed to be easily diversified away and thus should not be priced. In contrast, studies following Shleifer and Vishny (1997), which examine arbitrage behaviors in a more realistic context, argue that arbitrageurs are generally faced with limited resources and are not diversified. Thus, assets with high idiosyncratic risk will be intentionally avoided by rational arbitrageurs and thus subject to prolonged mispricing (Pontiff 1996; Wurgler & Zhuravskaya 2002; Ali et al. 2003; Mendenhall 2004; Pontiff 2006). This paper examines this problem in an emerging market flooded with retail investors and in a context of cross-listed shares. The results lend support

to Shleifer and Vishny' s (1997) model of limited-amount of not-diversified arbitrageurs and shows that idiosyncratic risk matters more in an arbitrageur's position, especially in an international arena where markets are not fully integrated.

1.4. Structure of the Paper

The rest of the paper is organized as follows. Section II discusses the institutional background and some recent liberalization in China's A-share market. Section III constructs the theoretical framework of this study and presents some literature pertaining to the issues concerned. Section IV introduces the sample of cross-listed shares and dataset used in later empirical analyses. Section V formally tests whether various direct and indirect barriers to arbitrage can explain time-series and cross-firm fluctuations in the pricing difference. Section VI concludes.

2. INSTITUTIONAL BACKGROUND AND DATA

2.1. Multiple Equity Series

In the short history of Chinese stock markets, China is characterized by the coexistence of multiple stock classes. Every kind of shares emerges in a certain political and economic context and is closely linked to the development of the market itself and the economy as a whole. Three main types of equity shares issued by Chinese firms are A-shares, B-shares and H-shares. They were all formed in the 1990s following the establishments of Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE) in 1990 and 1991 respectively. In addition to the three most common classes of shares, there are also so-called N-shares, S-shares and L-shares, standing for the stock exchange where they are listed and traded, like N-shares for stocks listed in NYSE and S-shares for stocks listed in Singapore Stock Exchange. Here reviews in detail the denomination and background of the three main classes of shares, which are most relevant to the present study.

A-shares: They are the common shares listed and traded on Shanghai and Shenzhen Stock Exchanges, issued by Chinese companies and denominated in local currency, RMB. They exist since the formation of the two domestic stock markets. The purchasing and trading of A-shares are restricted to Chinese citizens only. Upon the introduction of QFII program in 2002, certain foreign institutional investors approved by the Chinese security authority CRSR are allowed to invest in the domestic A-share markets. The historical and current rules guiding investments by these foreign institutional investors are reviewed in the next part.

B-shares: They are shares issued by Chinese companies (many of them issue A-shares for domestic investors as well), listed on the same exchanges as A-shares, and eligible for foreign investor, individual or institutional alike. They are denominated in RMB, but traded

in foreign currencies (US dollar in Shanghai Stock Exchange and Hong Kong dollar in Shenzhen Stock Exchange). The idea of B-share market was formed by the authority in 1992 to attract foreign capitals through ways other than FDI and long-term borrowing. The first B-share was issued in the same year.

H-shares: They are issued by Chinese companies, listed and traded on the Hong Kong Stock Exchange. They are denominated in Hong Kong dollars, which are pegged to the U.S. dollars and are no different than other companies listed on HKSE. The first H-share IPO was conducted in June 1993, not long after the introduction of B-shares, as another way to raise foreign funds and to bond state owned large companies with more advanced listing environment.

As more companies successfully conducted their IPOs in HKSE, the authority began to pay attention to more remote foreign exchanges and list large national companies in U.S., London, and Singapore etc. These shares are termed then, out of habit, as N-shares, L-shares, and S-shares accordingly. Table 1 reviews the first time listings of Chinese firms in domestic B-share market and in distinct overseas stock markets.

Table 1. First IPOs in overseas markets (except for B-share)

This table reviews the first IPO in foreign stock markets and China's B-share market which is designated to foreign investors. Shares issued by Chinese companies but listed and traded in Hong Kong, New York, London, Singapore Stock Exchange are referred to H-shares, N-shares, L-shares and S-shares respectively.

Listing Venues	Time of IPO	Company	Sector
Shanghai (B-share)	February 1992	INESA Electron	Industry-Electronics
Hong Kong	June 1993	Tsingtao Brewery	Consumer-Beverages
New York	August 1994	HuaNeng Power Intl.	Utilities-Electric
London	March 1997	Datang Power Generation	Utilities -Electric
Singapore	May 1997	ZhongXin Pharmaceuticals	Consumer-Pharmaceuticals

Aside from the aforementioned ones, there is another series of shares that is very similar to H-shares, with the only difference being that the issuing firms of these shares are Chinese companies incorporated in Hong Kong and issuing firms of H-shares are Chinese companies incorporated in mainland China. These shares are called “Red Chips”. As of December 2012, Red chips and H-shares collectively constitute 57.4% of market capitalization on Hong Kong Stock Exchange (HKSE website).

Unlike other emerging markets that generally cross list their companies to foreign markets after or in the same pace with liberalization of domestic markets, China cross list their companies long before it relaxed capital inflow control through QFII program in 2002. As a result, it constitutes a unique case that all share series other than A-shares can be regarded as “unrestricted shares” in China under strict foreign ownership restrictions in the A-share market. However, empirical researches in this area mainly focus on the B-share market when it comes to China, ignoring the fact that those foreign listed shares are perfect substitutes for B-shares and are readily available to foreign investors who want to have a stake in the growth of Chinese companies, without leaving the regulatory environment of more developed financial markets. Sun and Tong (2000) document this effect by showing that when more H-shares and red chips are listed in Hong Kong, foreign investors move away from the B-share market and the B-share discount, relative to A-share price, becomes larger.

A more serious problem associated with the B-share market is its illiquidity, especially when more and more Chinese companies list their shares overseas, diminishing the B-share market's ability to attract capital in the international market. The capitalization and turnover were very low compared to that of the H-shares and Red chips and the authority ceased to accept IPO applications in the B-share market since October 2000. The deregulation of B-share market on February 2001 that allows Chinese residents with foreign currencies to trade B-shares, although mitigating the pricing discrepancy between A- and B- shares to a large extent as pointed out in several articles, fail to activate the

market and the market condition remain illiquid till now. Recently in December 2012, China International Marine Containers Corporation becomes the first to switch its B-shares on the Shenzhen Stock Exchange to H-shares on the Hong Kong Stock Exchange. Given the aforementioned reasons, this paper focuses on the pricing discrepancy between A-shares and their foreign listed counterparts, among which H-shares constitute the vast majority.

2.2. Recent Liberalizations on China's A-share Market

Hong Kong is a world city and an open market and it is stipulated in the Basic Law, Hong Kong's mini-constitution, that "No foreign exchange control policies shall be applied in the Hong Kong Special Administrative Region of China. The Hong Kong dollar shall be freely convertible," and "The Government of the Hong Kong Special Administrative Region shall safeguard the free flow of capital within, into and out of the Region." As a result, it is natural to argue that the pricing consistency of cross-listed shares lies in the liberalization of China's A-share market. While two kinds of direct barriers preventing arbitrage activities discussed when review the literature, inaccessibility of market and short-sale constraint, are all binding in Chinese stock market until recently, we elaborate in what follows the regulations removing or relaxing these barriers to arbitrage.

2.2.1. Relaxation of Capital Controls: A Primer on QFII Scheme

In order to open domestic stock market in an orderly manner, China introduced the QFII program in 2002. This practice has been adopted by a few emerging economies, such as Taiwan and Korea, during their opening-up process to protect them from excessive turbulence and speculative behavior (Ernest & Yuong, 2013).

On 1th December 2002, People's Bank of China (PBOC) and China Securities Regulatory Commission (CSRC) jointly issued the <*Interim Measures on the Administration of Securities Investments in China by Qualified Foreign Institutional Investors*> (Decree 12 of PBOC and CSRC), which officially initiated the pilot program in the QFII regime. This *Interim Measure* serves as temporary regulatory guideline in the early stage of this program. According to Decree 12, QFII are defined as overseas fund management institutions, insurance companies, securities companies and other assets management institutions which have been approved by CSRC and granted investment quota by the State Administration of Foreign Exchange (SAFE) to invest in China's A-share market. Several aspects are considered by the CSRC in qualifying QFIIs, such as financial stability, credit ratings, risk control mechanism, qualification of employees, corporate governance structure and internal control system. Generally, the CSRC tries to exclude potential speculators and attract more long-term foreign investment funds. Rules of important issues dictated in the Decree 12 are summarized in Table 2.

However, the CSRC and SAFE have been very strict on eligibility requirements for QFIIs and their investment quotas, leading to a relatively small aggregate size of QFIIs in China's securities markets. On 24 August 2006, the State Administration of Foreign Exchange (SAFE) along with CSRC, PBOC jointly released the <*Measures on the Administration of Securities Investments in China by Qualified Foreign Institutional Investors*>, replacing the *Interim Measures* to be the main regulatory guidance. On the same day, the CSRC released the <*Notice on the Issues related to the Implementation of the Measures on the Administration of Securities Investments in China by Qualified Foreign Institutional Investors*> to explain in more detail essential matters in the *Measures*. Compared with the old *Interim Measures*, the new *Measures* significantly lowered the threshold of QFII's investments and streamlined the application process.

The *Measures* was further revised on July 27, 2012, expressing the authorities' continued interest in opening of China's securities markets, especially by lowering the qualification

Table 2. Summary of QFII regulatory framework

This table reviews key requirements regarding the QFII qualification and regulatory procedures under this program. The table is revised and summarized from the <Interim Measures on the Administration of Securities Investments in China by Qualified Foreign Institutional Investors> (Decree 12 of PBOC and CSRC).

Aspects	Regulations
Quota Application	An application for a single QFII investment quota should be no less than an amount equivalent to USD 50 million for each time, and no more than an amount equivalent to USD 1 billion in total, except for sovereign wealth funds, central banks and monetary authorities.
Custody	QFII should mandate domestic commercial banks as custodians and domestic securities companies as brokers for their domestic securities trading.
Investment Accounts	With the approval of the investment quota by SAFE, the QFIIs can open a foreign exchange account for its own funds or for its client's funds for which it provides asset management services at its custodian bank. Then QFII should open RMB special deposit account related to its foreign exchange account, according to the quota approved by SAFE. Funds in the QFIIs' foreign exchange accounts and RMB account shall not be used for any purposes other than domestic securities investments.
Lock-up Period	For those QFIIs such as pension funds, insurance funds, mutual funds, charity funds, endowment funds, government and monetary authorities, and open-ended China funds* initiated and established by QFII, the lock-up period of the principal (during which QFIIs are forbidden from remitting the principal abroad) is 3 months; for other type of QFIIs, the lock-up period is 1 year. *Open-ended China funds refer to open-ended securities investment funds that are established abroad in public offerings, with over 70% of the funds invested in China.
Scope of Investment	QFII can invest, within quota, on the following RMB financial instruments: Shares listed in China's stock exchanges (excluding B-shares); Treasuries listed in China's stock exchanges; Convertible bonds and enterprise bonds listed in China's stock exchanges; Other financial instruments as approved by CSRC.
Ownership Restriction	Shares held by each QFII in one listed company should not exceed 10% of total outstanding shares of the company; Total shares held by all QFII in one listed company should not exceed 20% of total outstanding shares of the company.

requirements applicable to QFIIs, enlarging the scope of investments, and facilitating the investment activities by giving them greater investment latitude and improving convenience of account management. For example, the prior ownership restriction of all foreign investors in a single company is 20% as prescribed in Decree 12. This limit was relaxed on July 2012 to 30%. However, the ownership restriction of each foreign institution has not changed and remains as 10%. The increasing openness can also be observed from the changes of the total quota under the QFII program assigned by SAFE. Table 3 reviews the

three major adjustments of quota since the inauguration of the program and the number of qualified institutional investors by the time of each adjustment.

Table 3. Increase of total quota under QFII program and number of institutions

This table reviews the three major adjustments of total quota of foreign investment in China's A-share market under the QFII program since its inauguration and the number of qualified institutional investors by the time of each adjustment.

	Quota (in U.S. dollar)	No. of Institutions
Inception	\$ 1.7 billion	12
July 2005	\$ 10 billion	33
December 2007	\$ 30 billion	51
April 2012	\$ 80 billion	170

Source: SAFE website

It needs to mention that it is argued in this paper that QFIIs are potential arbitrageurs since they have both accesses to the two stock markets. The same is true for domestic institutional investors under QDII scheme which is introduced in 2006 and enables certain amount of free capital outflows. Besides, literature shows that outgoing Chinese funds have strong "home bias" towards Hong Kong stock market. However, due to data limitation, we are able to monitor investment behavior of foreign institutional investors but not of domestic outgoing institutional investors. Thus this question is left to further researches.

Another link between two markets were established upon the introduction of RMB Qualified Foreign Institutional Investors (RQFII) program on December 2011, allowing Hong Kong subsidiaries of mainland brokerages and fund management firms to raise offshore RMB to invest in the mainland bond and A-share markets. The program is formulated in the context of increasing use of RMB as transaction currency in cross-border activities and as an attempt by the government to accelerate the backflow of offshore RMB funds (Wang, Gao & Chen 2013). However, since RQFII funds could invest in up to 20%

of their assets in index funds while the remaining 80% is restricted to fixed income products as of the end of our sample period, the impact on the issue we study is thus limited.

2.2.2. Abolishment of Short-Sale Constraints

The short sale ban long-standing in Chinese stock market has been lifted gradually during the past few years starting from March 2010 along with the introduction of margin trading. The removals of limit were not implemented universally among stocks. Rather, like the procedure adopted by Hong Kong Stock Exchange in the 1990s (see an introduction in Change, Cheng & Yu 2007), a greater amount of stocks were added to a list of stocks eligible for short at a time. The first announcement on March 2010, also served as a trial program, included the stocks that constitute SSE 50 Index, covering the largest 50 stocks listed on Shanghai Stock Exchange. They are mostly state-owned and very liquid. The subsequent major addition on November 2011 enlarged the scope of shortable shares to 180 component stocks of SSE 180 Index. The final adjustment on January 2013 increased the amount to 300 stocks traded either on Shanghai Stock Exchange or Shenzhen Stock Exchange. Table 4 reviews these adjustments and the content of changes.

In addition to the index constituent requirement, stocks must satisfy certain liquidity criteria to be included in the list. For example, according to the guidance released by CRCS, the floating market capitalization (not subject to non-tradable restrictions) is no less than 800 million RMB (\$129 million dollar); the number of shareholders is no less than 4000; daily turnover is not lower than that of the benchmark index by 15% during the past three months and daily dollar turnover is not less than 50 million RMB (\$8 million dollar) during the past three months.

Although the ban was lifted, from the supply side, the market for stock lending was still limited in that brokerages were not yet allowed to borrow stocks from long-term institutional investors. They could only lend out stocks for short selling activity from their

Table 4. Changes of stocks eligible for short-sales

This table reviews the adjustments of regulation toward short-sales and the content of changes. The short selling ban in China's stock market has been lifted gradually starting from March 2010. Like the procedure adopted by Hong Kong Stock Exchange in the 1990s, a greater amount of stocks are added to a list of stocks eligible to sell short at a time. The first announcement on March 2010, also serve as a trial program, include the stocks that constitute SSE 50 Index, covering the largest 50 stocks listed on Shanghai Stock Exchange. A subsequent major addition enlarges the scope to 180 component stocks of SSE 180 Index. The final adjustment on January 2013 increase the amount to 300 stocks traded either on Shanghai Stock Exchange or Shenzhen Stock Exchange.

Adjustment Date	Eligible Stocks for Short-Sales
March 2010	50 constituent stocks of SSE 50 Index
November 2011	180 constituent stocks of SSE 180 Index
*January 2013	300 stocks on SHSE and SZSE

*This major adjustment is beyond the sample period of this study and thus not counted in the empirical section.

own inventories. To solve this problem and further facilitate margin trading and short selling activity, an intermediary stock lending company, China Securities Finance Corporation (CSFC), was established in October 2011, indicating China's solution towards a central counterparty in stock lending marketplaces. It is allowed to borrow securities from institutions, including fund management companies and insurers, and to re-lend securities to brokerages. Shanghai Stock Exchange, Shenzhen Stock Exchange and China Securities Depository & Clearing Corporation maintain the majority ownership of this central intermediary. However, as the sample period ends in 2012, the CSFC only launched program concerning re-lending of money to brokerages to promote margin trading. On the short selling side, the supply of securities is still limited to the inventory of brokerages. As a result, in this initial stage, it is natural to have doubts toward the arbitrage potential of short sellers in the presence of large price differentials from their fundamental values. Nonetheless, our detailed data regarding short selling activity still document active trading behavior on many stocks included in our sample.

3. THEORETICAL FRAMEWORK AND LITERATURE

In this paper two main questions are essentially explored. First, whether and why the average pricing difference varies across time? Second, whether and why the pricing differences differ among firms. While theories have been put forward and empirical studies have been performed to answer these two questions, in the present study time-varying and cross-sectional variation of difference are related to various limits of arbitrage that make the difference last. Those barriers are either common to all firms during a certain period of time or exerting different impact on firms with distinct characteristics. Although the existence and consequences of some direct barriers, such as capital controls and short sales restriction, are evident and straightforward, other barriers are less obvious and indirect in nature but with the same effect of discouraging arbitrage activity. In 3.1 of this section the discussion is around the sources that might generate pricing differences in the first place. In 3.2 and 3.3 theoretical and empirical studies on the limits and costs of arbitrage are reviewed to isolate factors that might make pricing differences last.

3.1. Asset Pricing in Segmented Markets

Stulz (1981) defines capital market to be integrated internationally if assets of equal risk located in different countries yield equal expected returns on a currency-adjusted basis. Literature on international pricing under various cross-border investment barriers theorize that pricing of identical shares can differ due to differential demand and relative scarcity of certain type of shares (Eun & Janakiramanan 1986; Stulz & Wasserfallen 1995), differential risk perception of investors (Errunza & Losq 1985; Hietala 1989), information asymmetry (Bailey & Jagtiani 1994; Chan, Menkveld & Yanh 2008) and distinct market sentiments (Bodurtha et al. 1995). Empirical studies around the world echoes those hypotheses to varying degrees.

Eun and Janakiramanan (1986) and Hietala (1989) consider the situation where restrictions are imposed not on the overall accessibility of foreigners to investing in local market but on the fraction of ownership of local companies owned by foreign investors, which is common among newly emerging economies in the 1980s and present in current China's stock market. Eun and Janakiramanan (1986) argue that the pricing of foreign shares relative to domestic shares will alter depending on the binding nature of the percentage constraint. When the constraint is binding and thus the demand of these shares by foreigner exceeds the supply, foreigners would like to pay a price higher than what they would have paid without such restrictions. Likewise, when the demand of domestic investors is less than the supply, the securities will be sold at a discount among domestic investors. An important implication to the present study is that the relaxation of foreign ownership restrictions should be followed by a decrease in premium given by foreign investors as well as a decrease in discount requested by domestic investors, thus narrowing the pricing gap.

Hietala (1989) consider a slightly different case in which a restriction posed on domestic investors to invest overseas is also accounted for while at the same time foreign investors still face the percentage ownership constraint in local markets. This setting is based on the regulations in Finnish stock market in the 1980s and also resembles to the largest extent the current Chinese stock market. With a model consisting of two types of investors- domestic and foreign, and three kinds of shares- local shares restricted to domestic investors, local shares available to both types of investors, and foreign shares available only to foreign investors, he shows that each type of investors values every type of these shares differently. However, since the first and third kinds of shares are only available to respective investors, contradiction of pricing exists only on the second kind of shares, namely the unrestricted shares traded in local markets. The equilibrium market price for these shares hinges on the demand of the investor group for which the required risk premium is lower (valuation higher) and thus the stocks are overpriced from the viewpoint of the other investor group. Moreover, because there exists regulations against short selling for any type of investors, the seemingly overvaluation will not be adjusted to reflect the valuation of another group of investors. This result implies that if the short selling ban is removed from such a setting, a

universal price of unrestricted shares in local market should be observed even though the markets of two groups of investors are still segmented.

Stulz and Wasserfallen (1995) consider a possibility of voluntary restriction adopted by enterprises rather than that prescribed by the government. In the same spirit with Eun and Janakiramanan (1986), they argue that the demand from foreign investors is less price elastic than the demand from domestic investors due to deadweight cost. As a result, the domestic entrepreneurs like to pose a limit on foreign ownership so as to maximize firm values through price discrimination against foreign investors. Their study has the same empirical implication as Eun and Janakiramanan (1986) in that the cross-sectional premium of unrestricted shares will be negatively related with the supply of shares available to foreign investors. They test this hypothesis using unique data from Switzerland and document that an increase in the supply of unrestricted shares associated with the relaxation of restrictions decreases the price of unrestricted shares, driving the prices of two series of shares together.

Bodurtha et al. (1995) expand the investor sentiment framework established by Lee, Shleifer & Thaler (1991) in their investigation of closed-end fund puzzle to the study of closed-end country fund premiums and argue that the premium captures the differential sentiment between the U.S. and the country where the underlying shares stem. They provide evidence by documenting the comovement of the fund premiums with the U.S. market. Additionally, consistent with the finding of Bonser-Neal et al. (1990), they also provide evidence to the relative supply hypothesis by showing that fund premiums tend to be higher and more volatile for countries with more restrictive foreign ownership policies. However, in countries without such restrictions, they find that the country-specific risk is still evident.

There are also considerations from the perspective of information asymmetry in explaining

the cross-sectional variation of price premiums. Bailey and Jagtiani (1994) argue that it is easier for foreign investors to acquire information about large firms than about small firms, and that foreign investors are therefore willing to pay a higher premium to invest in large firms. They prove this hypothesis on the Thai stock market.

Empirically, Domowitz, Glen and Madhavan (1997) lend evidence from the Mexican stock market and confirm the explanatory power of relative share supply and firm size in the cross-sectional variation of unrestricted share premiums in Mexico. In a comprehensive examination, Bailey, Chung and Kang (1999) test various hypotheses using stock price data from 11 countries with percentage ownership restrictions in the period of 1988-1996 and find that premiums of unrestricted shares are positively correlated with (1) demand of foreign investors measured by international mutual fund flows, (2) market sentiment inherent in closed-end country fund premiums, (3) market liquidity, and (4) information transparency reflected in the number of press coverage, country credit rating and firm size.

Bailey (1994) is the first to exclusively look at the Chinese stock market in order to uncover the foreign share discount puzzle, even though the analysis is only based on limited observations both in time-series dimension and cross-sectionally. He attributes the premiums received by domestic investors to the lack of alternative investment channels and unattractive bank interest rates that push the required rate of equity return below the level that foreign investors would accept. Using a longer time frame, Fernald and Rogers (2002) arrive at similar conclusions that domestic investors' lack of alternative investment opportunities plays a major role in the observed lower return required by Chinese investors than that required by foreign investors. Furthermore, they explore the cross-sectional variation of discounts and find that foreigners pay a lower price, giving rise to a larger gap, for companies with higher national ownership.

Mei, Scheinkman and Xiong (2003) argue that there is a non-fundamental component in domestic A-share prices and that speculative trading of local investors is responsible for the

higher price of A-shares. Using a panel data approach, they confirm their analysis by showing that the turnover rate of A-shares can explain away 20% of the cross-sectional variation in premium of A-shares over B-shares. The finding regarding the decisive trading activity in domestic A-share market is also confirmed in Bailey, Chuang, and Kang (1999) in their cross-country analysis and highlighted in a sub-section dealing particularly with the Chinese discount with a sample of four Chinese companies. Wang and Jiang (2004) provide evidence for the market sentiment hypothesis and document that H-shares exhibit significant exposure to Hong Kong market factors and behave more like Hong Kong stocks than like Chinese stocks even though they are issued by Chinese companies with business based in China. Chan and Kwok (2005) confirm the relative supply hypothesis after highlighting the reverse setting in Chinese stock market in which A-shares are relatively scarce than unrestricted shares in the form of both B-shares and foreign-listed H-shares. They show that cross-sectional variation in the premium of A-shares is negatively related to the relative supply of A-shares and positively related to the relative supply of foreign shares (lower supply of foreign shares results in higher valuation for these companies, thus lowering premium of A-shares over the foreign shares for these companies).

Insufficient supply of A-shares, coupled with excessive demand from domestic investors due to the lack of alternatives, result in a higher turnover and speculative behavior, pushing up the price of A- shares. The theories provided in aforementioned studies seem to be interrelated in a larger picture. However, other hypotheses outside the supply and demand framework are also put forward and prove to be strongly explanatory. For example, Chan, Menkveld, and Yanh (2008) expand the information asymmetry hypothesis by constructing their two more proxies other than the usual size of firm and use them to examine the price difference of Chinese A-B- shares. They find that two proxies- price impact measure and adverse selection component of bid-ask spread- explain respectively 44% and 46% of the cross-sectional variation in B-share discounts.

A major event in China's B-share market is captured in a variety of studies as a "(partial) resolution" of the Chinese discount puzzle. In 2001, China's security authority allowed domestic investors with required foreign currencies to invest in the B-share market that is previously restricted to foreign investors. It is observed that this change of regulation resulted in a dramatic decline of B-share discount from 75% to 8% on average (Karolyi, Li & Liao 2009). Using a cross-sectional quasi event study regression, Karolyi, Li and Liao (2009) find that small cap companies and companies with positive past-return momentum are mostly concentrated by domestic investors in bidding up the price of B-shares (largest price changes). Alternative variables such as differential risk exposure (local market beta of A-shares and world market beta of B-shares), liquidity and trading volume lose explanatory power in modeling the extent of price changes around the event.

In conclusion, in this part a few alternative hypotheses proposed and tested seeking to explain the discount of foreign shares in Chinese stock market as opposite to common premiums witnessed among countries with similar segmented settings are reviewed and evaluated. Among them many are proved to be significant in either cross-sectional or time series analysis of the price difference. Furthermore, the foreign discount in Chinese stock market is found to be not inconsistent with mainstream hypotheses proposed to model the common foreign premiums. At last, we see that arbitrage behaviors by domestic investors in the B-share market solve the unequal pricing problem to a large extent, although it is done by bidding up the price of B-shares rather than correcting the commonly perceived over-valuation associated with A- shares. In the following part, the role of arbitrage in driving prices of identical assets together and the cost or limit of arbitrage associated with large pricing differences during sustained period of time are discussed in more detail.

3.2. Direct Barriers to Arbitrage

Regardless of premiums witnessed in other markets or discounts observed in Chinese stock market, and whatever the sources that drive away the prices of identical assets in the first place, since the assets traded in different markets are identical after all, we would expect the relative mispricing to disappear and the two series of price to converge or become substantially close to each other whenever arbitrage is possible.

Traditional arbitrage behavior involves buying the relatively undervalued and selling the relatively overvalued at the same time. Impediments to this kind of arbitrage activity can take many forms, two of which that are more evident and of more concern in our study are inaccessibility of markets and short selling restrictions in either market. These are the direct barriers that deter any potential arbitrageurs from correcting the relative mispricing. The persistence of pricing difference in the case of restricted/unrestricted shares is comparatively understandable in this regard since trading can take place within groups of investors but not among groups. This is generally prescribed by regulators posing such investment restrictions right from the formation of the markets designated to different groups of investors. Since supply cannot be shared and demand differs, there is no wonder any relative mispricing resulted from different condition of supply and demand will sustain. The deregulation of Chinese B-share market discussed in Karolyi, Li and Liao (2009) provides a good example of what would happen when one group of investor is granted access to the market previously dominated by another group of investors. The problem of different valuations is immediately solved by the more optimistic investors taking over the market.

The situation is the same in the case of closed-end country funds when the countries where underlying shares come from have foreign investment controls in effect on local markets. In investigating the effect of investment barriers on the pricing of closed-end country funds, Bonser-Neal et al. (1990) argue that, consistent with the relative supply hypothesis proposed by Eun and Janakiramanan (1986), binding restrictions on cross-border investment will raise the price of a fund relative to its net asset value (NAV) by

approximately the amount the marginal foreign investor is willing to pay to avoid these restriction. Through regression analysis they establish a relation between announcements of changes in foreign investment restrictions and changes in country fund premiums in France, Japan, Korea and Mexico. Bodurtha, Kim and Lee (1995) also show that premiums of closed-end country fund tend to be higher and more volatile for countries with more restrictive foreign ownership policies, proving the bonding effect of direct barriers to arbitrage.

Another evident barrier of arbitrage is restrictions on short selling in either of the markets concerned. In Hietala (1989)'s model of three markets and two kinds of investors, both domestic and foreign investors have access to the second market. He argues that the final price level in that market is determined by the group of investors with lower required rate of return, thus higher valuation. Since short selling is precluded, the other group of investors with more moderate opinion cannot correct the valuation to reflect their views. When the pricing level of the second market is compared with that of first and third market, the groups of investors who cherish the bullish opinion and who are more bearish is clear. Actually, even in one domestic market, there may exist distinct kinds of investors with polar-different perceptions, leading to varying valuation of identical assets. This is the view held by many researchers arguing against the restrictions on short sales. For example, Miller (1977) theorize that when short sales constraint is in effect, asset prices tend to reflect a more optimistic valuation than the average opinion held among potential investors. Similarly, Figlewski (1981) show that when short selling restrictions are bonding that effectively prevent informed investors with unfavorable information from selling short, excess demand exists that result in a higher equilibrium price than in the case when short selling is allowed.

Empirically, Jones and Lamont (2002) use data in U.S. during 1926-1933 when a central stock lending market exists and the loaning data is readily available and find that stocks that are costly to short have higher valuations and low subsequent returns. More recently,

use information regarding short selling regulation from 46 stock markets around the world, Bris et al (2007) provide weak evidence that short selling facilitates efficient price discovery. Furthermore, they document that lifting of short sale restrictions is associated with increased negative skewness in market returns. However, they find that enabling short selling has no significant impact on the frequency of large declines in price, suggesting that short selling activities are responsible for *more* negative returns but not *larger* negative returns.

Chang, Cheng, and Yu (2007) adopt an event study approach and examine the “inclusion” effect of stocks added to the list of designated stocks eligible for short established and revised periodically by the Hong Kong Stock Exchange. They find that short sale constraints tend to cause stock overvaluation and that the overvaluation effect is more dramatic for individual stocks with wider dispersion of opinions measured by volatility of daily stock returns. They also document higher volatility and less positive skewness of individual stocks after allowed for selling short.

Relative overvaluation of stocks may be better identified through examination of pricing of identical shares in two markets, one with short selling restrictions and one without. However, sample of real cases may be difficult to find and test. Foreign-listed emerging countries shares are good candidates but those cross-listed shares, mostly in the form of ADRs in the U.S., are generally observed to be traded at parity with underlying ones due to the fungibility of ADRs inherent in the program itself (Gagnon & Karolyi 2010). The large sample of firms focused in this study that list their shares both in Chinese stock market with short selling restriction and Hong Kong stock market with relatively fewer constraints provides an ideal vehicle to perform such a test.

3.3. Indirect Barriers to Arbitrage

Even in the absence of those direct barriers, arbitrage can still turn out to be costly, difficult, or associated with substantial risks, as opposite to the commonly perceived “risk-free” arbitrage. These kinds of barriers to arbitrage can be regarded as indirect barriers. In investigation of the domestic closed-end fund discount, Lee, Shleifer and Thaler (1991) point out the difficulty involved in arbitrage strategies aiming at eliminating those pricing differences. First, the exact replication of the portfolio may be difficult due to frequent changes of component stocks and comparatively infrequent disclosure (quarterly or semiannually). Second, investors’ cost may not be covered since holding the portfolio can only obtain a portion of dividends while shorting needs to pay out the full amount of dividends. This, added by Pontiff (1996) that the (saving) interest received from shorting the stocks may be much less than that (borrowing) paid out in a long position realized by margin trading, makes potential profits to shrink due to additional cost associated with short sales. Third, which is studied in more detail in Shleifer and Vishny (1997) as well as Kondor (2009), is the uncertainty involved in eliminating the relative mispricing, such as noise trader risk that drive prices further away from their fundamental values in sustained period of time and the resulting infinite horizon needed to correct the pricing.

While the first consideration is unique to closed-end funds, the last two limitations are common to all situations including the relative mispricing of cross-listed shares. Moreover, unlike the direct barriers to arbitrage that are bonding to all securities in a market, the extent of indirect barriers may vary across firms. So it is rational to hypothesize that the extent of mispricing is correlated with varying cost of arbitrage across firms. This is hypothesis is explicitly tested in, among others, Pontiff (1996) and Gemmill and Thomas (2002) with cross-sectional models. Even though Bodurtha, Kim and Lee (1995) do not perform such an analysis, they confirm this view by showing that country funds have larger premiums and discounts than domestic closed-end funds, mainly due to increased cost associated with international arbitrage and greater uncertainty.

Using absolute value instead of the real value of the discount or premium as the dependent variable, Pontiff (1996) show that the market value and NAV are more likely to diverge, in the form of either a premium or a discount, for funds (1) with underlying portfolios that are hard to replicate, (2) that pay out smaller dividends, (3) with lower market value, and (4) for all funds when interest rates are high. Taking particular interest in the noise trader risk implied by Lee, Shleifer and Thaler (1991), Gemmill and Thomas (2002) model the discounts of closed-end funds from U.K. and control for other factors such as size and dividend yield used in Pontiff (1996). While they document that in time-series dimension noise trader sentiment, as proxied by retail investor flows, results in fluctuations in the discount, they find mixed evidence regarding the cross-sectional explanatory power of noise trader risk. The rest of their results are largely consistent with the findings of Pontiff (1996). For example, age and size of the fund are proved to be significant in explaining the discount with age of funds positively correlated with discount and market value of the underlying portfolio negatively associated, meaning that newer and larger funds have less severe pricing discrepancies. Dividend yield and transaction cost variable have inconsistent results of significance test in models with or without the noise trader risk proxy but the signs are in line with predictions.

To sum up, in this part we explore the reasons why pricing difference of identical assets traded in different markets are not eliminated in disregard the sources contributing to them in the first place. Specifically, various barriers of arbitrage are discussed and studies concerning their impact are briefly reviewed. Generally, whatever the reason that gives rise to the pricing difference, the lack of arbitrage mechanism in some markets and costly arbitrage in others enables them to persist. In the following section we test the effect of both direct and indirect barriers suggested in literature on the time-varying and cross-sectional fluctuation of price difference using our sample of cross-listed shares.

4. SAMPLE AND DATA

The sample used in this study is initially formed based on Hang Seng China A-H Premium Index which is published in 2006 by Hang Seng Index Corporation and contains the largest 53 cross-listed companies in terms of their market capitalization in Hong Kong stock market. This index is revised by leaving out 5 companies whose H-shares are either relatively illiquid (less frequent volume data) or traded less than 1 Hong Kong Dollar (\$0.13USD) on average. It leaves us with 47 companies that list shares in both markets. The list of 47 companies in our sample and their tickers in two markets are provided in the Appendix.

The tracking history is also extended back to the year of 2000. Thus, for those cross listings conducted before 2000 the sample starts from 2000, and for those companies that cross-list their shares after 2000, the sample starts from the first trading day of the cross listing for that particular company. As a tradition, a large portion of companies first lists their stocks in Hong Kong and then go back to China as the stock markets develop.

Data used in this study come from multiple sources. Data of stock prices and trading volume are obtained from Yahoo Finance. Company-specific information and financial data are gathered from several sources including Bloomberg, CNINFO, and company annual reports. Our data concerning the stock holding history of foreign institutional investors and short selling activity are mainly obtained from Shenzhen Genius Finance, a whole subsidiary of China Finance Online, and cross-checked in areas of confusion with a variety of Chinese finance websites including JRJ, Hexun Stock and Sohu Stock that provide sporadic or partial information on these issues. Table 5 presents a summary of some time-invariant characteristics of the sample companies. All information is updated till the end of 2012.

Table 5. Characteristics of sample companies

This table reviews a number of time-invariant characteristics of the sample companies, including industry, place of Initial Public Offering (IPO), time of IPO, whether shares in China are listed on Shanghai Stock Exchange (SHSE) or Shenzhen Stock Exchange (SZSE), and the number of companies in the sample that are constituent stocks of major indexes in two markets. Particularly, SSE 50 and SSE 180 are two major indexes of SHSE and cover the largest and most liquid 50 and 180 stocks on SHSE respectively. CSI 300 covers the largest and most liquid 300 stocks listed either on SHSE or SZSE. Hang Seng Index is the barometer of Hong Kong stock market and includes the largest 50 stocks listed on HKSE. All information is updated till the end of 2012.

Total: 47 companies					
Industry		IPO venue		IPO year	
Basic Materials	6	Hong Kong	37	1993-1996	11
Communications	1	China	2	1997-2000	17
Consumer	9	Simultaneously		2001-2005	13
Energy	6	(within 1 month)	8	2006-2012	6
Financial	9				
Industrial	12				
Utilities	3				
Domestic Listing Venue		Index Constitution - China		Index Constitution - HK	
Shanghai	44	SSE 50	14	Hang Seng Index	11
Shenzhen	3	SSE 180	27		
		CSI 300	30		

As can be seen from the table, the vast majority of companies in our sample first list their shares in HKSE and a large portion of companies do so in the five years after the handover of sovereign right in 1997. The common behavior of Chinese firms' going public in Hong Kong is consistent with the investor recognition and bonding hypothesis proposed by literature. The initial public offering of many national firms is part of the governments' reform to privatize its enterprises in the early 1990s. Since domestic stock exchanges were merely open at that time, HKSE seemed to be the best choice to bring home large companies to the international stage and learn from experiences of advanced exchanges at the same time. While many other firms choose to list in more remote stock exchanges like NYSE and LSE, HKSE was the most popular overseas listing venue probably due to its proximity both in geography and in language and culture. Some of them cross-list in one of the domestic exchanges one year or so apart; the others do so in later years, especially in the 2000s when domestic stock markets grow and evolve.

About 29% and 23% of the sample companies are included in the largest cap index in domestic and Hong Kong stock market respectively. Moreover, over half of the sample companies are components of SSE180 Index which captures the largest and most liquid stocks in domestic A-share markets. These stocks are also among the first portion of stocks that are allowed by the authority to be eligible for short selling activity.

5. EMPIRICAL EVIDENCE

5.1. Direct Barriers and Time-Varying Price Differences

5.1.1. Time-Varying Price Difference

As a first step, it is helpful to sketch the size of the phenomenon we will study. Equal weighted average prices for both A- and H- shares are compiled to observe the price differential collectively along the time. Figure 1 shows the price behavior of two portfolios during the whole sample period from January 2000 to December 2012. Also plotted is China's GDP growth rate on a quarterly basis.

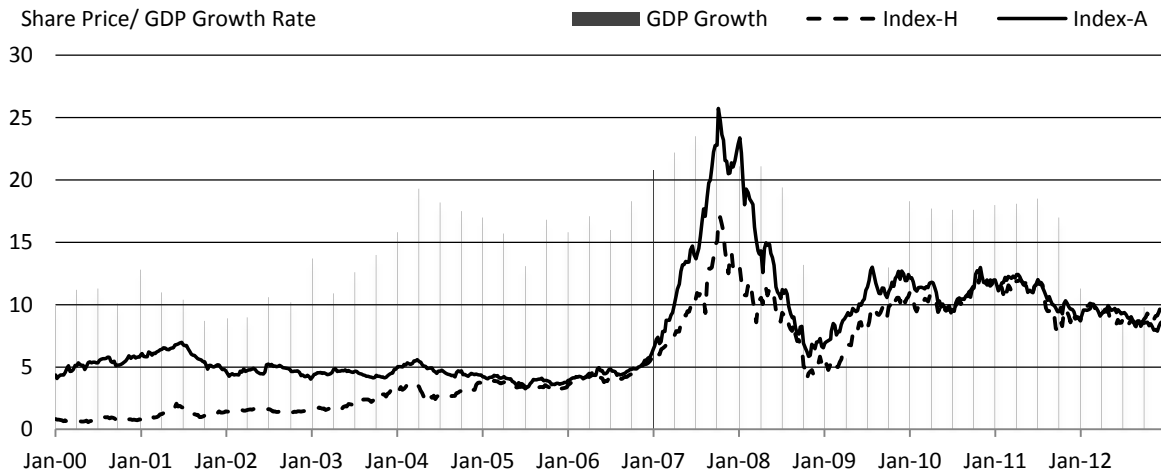


Figure 1. A- H- share prices of cross-listed companies

This figure shows index level time-varying pricing discrepancy of two share series. Equal-weighted average prices for both A- and H-shares are calculated on a weekly basis from January 2000 to December 2012. Also plotted is China's GDP growth rate measured on a quarterly basis.

It can be seen from the graph that during the sample period from 2000 to 2012, prices of A- and H-shares largely move together. The general trends are almost the same and are

consistent with the growth of the country's economy as a whole. It is noticeable that every time the GDP growth rate of China peak in the neighborhood, so does the price of both A- and H- shares. The huge expansion of China's stock market in 2007 is not groundless in hindsight since it coincides with the greatest momentum on the growth of the economy. Furthermore, the general uptrend starting from the beginning of 2009 is in line with the new round of fiscal policy implemented by the Chinese government to mitigate the impact of global financial crisis and boost domestic economy. The general co-movement of two series of shares implies that they are largely sensitive to the same series of factors. After all they are issued by the same Chinese company that bases its business in China.

Three periods of large deviation from law of one price can be identified: the years before 2005, the 2007 China's stock market surge, and the upper half of 2009. However, in the period before the year of 2005, H-shares are constantly increasing in price, shrinking the gap with A-share prices. This can be attributed to, and verified in later part of the study, the gradual loosening of capital control in China's stock market. The second large deviation happens during the market expansion of 2007 when Shanghai stock market is ranked as one of the best performers in the world. The price of A- and H-shares diverges drastically in this period with A-shares showing greater momentum. The third occasion in the upper part of 2009 is probably resulted from the implementation of powerful fiscal policy in mainland China to boost economy, which may raise investor confidence in a more significant way than in Hong Kong.

5.1.2. Model Specification

In this part, the effect of two reforms in China's stock market on the aggregate pricing difference in two markets is formally tested. Bonser-Neal et al. (1990) use an event study to examine the announcement effect of relaxation on investment restrictions on the premium of country funds relative to their NAVs. In the same spirit, we adopt a quasi-event study

approach and estimate the following model to examine the effect of loosening two direct barriers discussed in our study on the pricing difference of cross-listed shares.

$$(1) \quad Diff_t = \beta_0 + \sum_{i=1}^k \beta_i D_{i,t} + \varepsilon_t$$

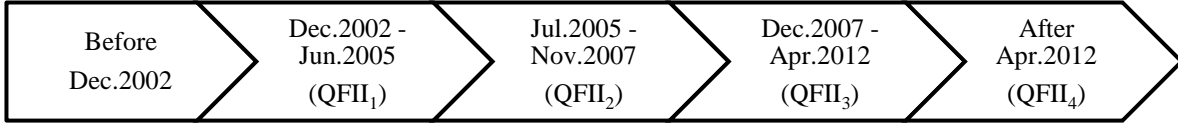
where $Diff_t$ is the log difference of prices for cross-listed shares at time t , averaged across sample companies, namely, $Diff_t = \ln P_{A,t} - \ln P_{H,t} = \ln P_{A,t}/P_{H,t}$; $D_{i,t}$ are dummy variables representing different stages of relevant reforms.

5.1.3. Relaxation of Direct Barriers

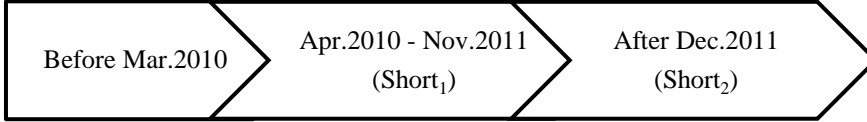
As reviewed in the second section, the process of loosening capital inflow in Chinese stock market can be divided into five periods based on changes of the amount of quota approved under QFII program for foreign investment (see Table 3). Thus, four dummy variables are used to isolate each period as illustrated in Panel A of Figure 2.

Similarly, the removal of restrictions on short sales can be regarded as a two-step process with the first step serving as a pilot program by allowing the largest 50 stocks in the market to be sold short. The following enlargement of the scope includes the constituent stocks of SSE 180 Index (see Table 4). Accordingly the whole sample period can be divided into three periods and two dummies are used to account for increasing intensity of the reform. Panel B of Figure 2 shows this process.

Panel A: Relaxation on foreign investment restriction



Panel B: Removal of short selling restriction

**Figure 2.** Timetable for relaxation of direct barriers

This figure fits multi-stages of respective reforms that remove or reduce direct barriers to arbitrage into a quasi-event study regression model with n dummy variables representing $n+1$ different stages in each case. The separation of stages is based on details shown in Table 3 and Table 4.

Thus model (1) can be further specified based on stages of respective reforms as follow:

$$(2) \quad Diff_t = \beta_0 + \beta_1 QFII_1 + \beta_2 QFII_2 + \beta_3 QFII_3 + \beta_4 QFII_4 + \varepsilon_t$$

$$(3) \quad Diff_t = \beta_0 + \beta_1 Short_1 + \beta_2 Short_2 + \varepsilon_t$$

Regressions are estimated using OLS and the Newey-West (1987) correction for heteroskedasticity and serial correlation. Murray (2005) suggest that, with quarterly data, if any shock will dissipate within two years, at least a lag of 8 should be accounted. Accordingly, with weekly data, a maximum lag of 52 week is considered given the observation in the previous part that it normally takes one year or so for prices of two series to converge again. Smaller order of auto-correlation only makes the t-statistics more significant.

The results are shown in Table 6. The estimates in Panel A are consistent with the finding of Bonser-Neal et al. (1990) regarding closed-end country funds that loosening capital control

Table 6. Impact of direct barriers on prices of cross-listed shares

The table reports the result from regressions of the two time-series models:

$$Diff_t = \beta_0 + \beta_1 QFII_1 + \beta_2 QFII_2 + \beta_3 QFII_3 + \beta_4 QFII_4 + \varepsilon_t$$

$$Diff_t = \beta_0 + \beta_1 Short_1 + \beta_2 Short_2 + \varepsilon_t$$

where $Diff_t$ is the log price difference of two share series at time t , averaged across sample companies; $\sum_{i=1}^4 QFII_i$ are dummy variables representing four different stages of the QFII program and one period before introduction of the program; $\sum_{i=1}^2 Short_i$ represent two stages inherent in the removal of short-sales restriction and one period when such restriction is in effect. Estimates are controlled for heteroskedasticity and auto-correlation using Newey-West (1987) standard error with 52 lags. ** represents significance at 5% level.

	Intercept	β_1	β_2	β_3	β_4	R-Squared
Panel A: Relaxation on foreign investment restriction						
	1.57 (9.13)**	-0.88 (-3.87)**	-1.37 (-7.56)**	-1.41 (-7.81)**	-1.57 (-9.01)**	86.38%
Panel B: Removal of short selling restriction						
	0.68 (3.65)**	-0.64 (-3.46)**	-0.68 (-3.63)**			18.58%

reduces the pricing difference of the fund and its underlying portfolio. The intercept stands for the period when no foreign investments are allowed in China's A-share market and shows that A-shares are on average traded at a premium than their H-share counterparts. The increase in magnitude of the negative coefficient of QFII dummies demonstrates that the price discrepancy of shares cross-listed in Hong Kong and China decreases with the quota of foreign investment under QFII program in Chinese stock market. The model explains away more than 80 percent of the time varying difference of prices of A-H-shares.

Panel B demonstrates the impact of loosening short selling restrictions on the price gap between A-H- shares. The results response to Mei, Scheinkman & Xiong (2003)' argument about overvalued A-shares and speculation behavior in the A-share market that approval of short selling activity reduces the priced difference of two series of shares. In more general way, short sales are indispensable in efficient pricing function of a market and inherent in

most asset pricing models, thus fewer artificial restrictions of this kind would improve the pricing efficiency of market concerned, reducing pricing discrepancies when compared with a more advanced market.

5.2. Indirect Barriers and Cross-Sectional Variation of Price Differences

In this part the cross-sectional variation of pricing differences among firms is focused and the relation between the variation and various direct and indirect barriers to arbitrage proposed in literature is explored.

5.2.1. Variations in Difference across Companies

Although relaxation of direct barriers to arbitrage gradually and significantly reduce the pricing difference in two markets along the time, from a company level the average level of difference and the speed of convergence given certain shocks differs a lot. Figure 3 gives a comparison between three cross-listed firms in our sample.

Three companies in Figure 3 represent three main types of price behavior of cross-listed shares in the sample. The first one shows that shares in Hong Kong stock market were traded at discount until the last three years starting from the beginning of 2010 when H-share prices rise above that of A-shares in China's market. The second one gives an example of a company with a higher-valued H-share price all along the time during which the company is cross-listed on two exchanges, even though the premium of H-shares over A-shares varies through time and closes to zero in many occasions. The third one represent a complete opposite case in which A-shares prices are always higher than their H-share counterparts in the cross-listing history of the company.

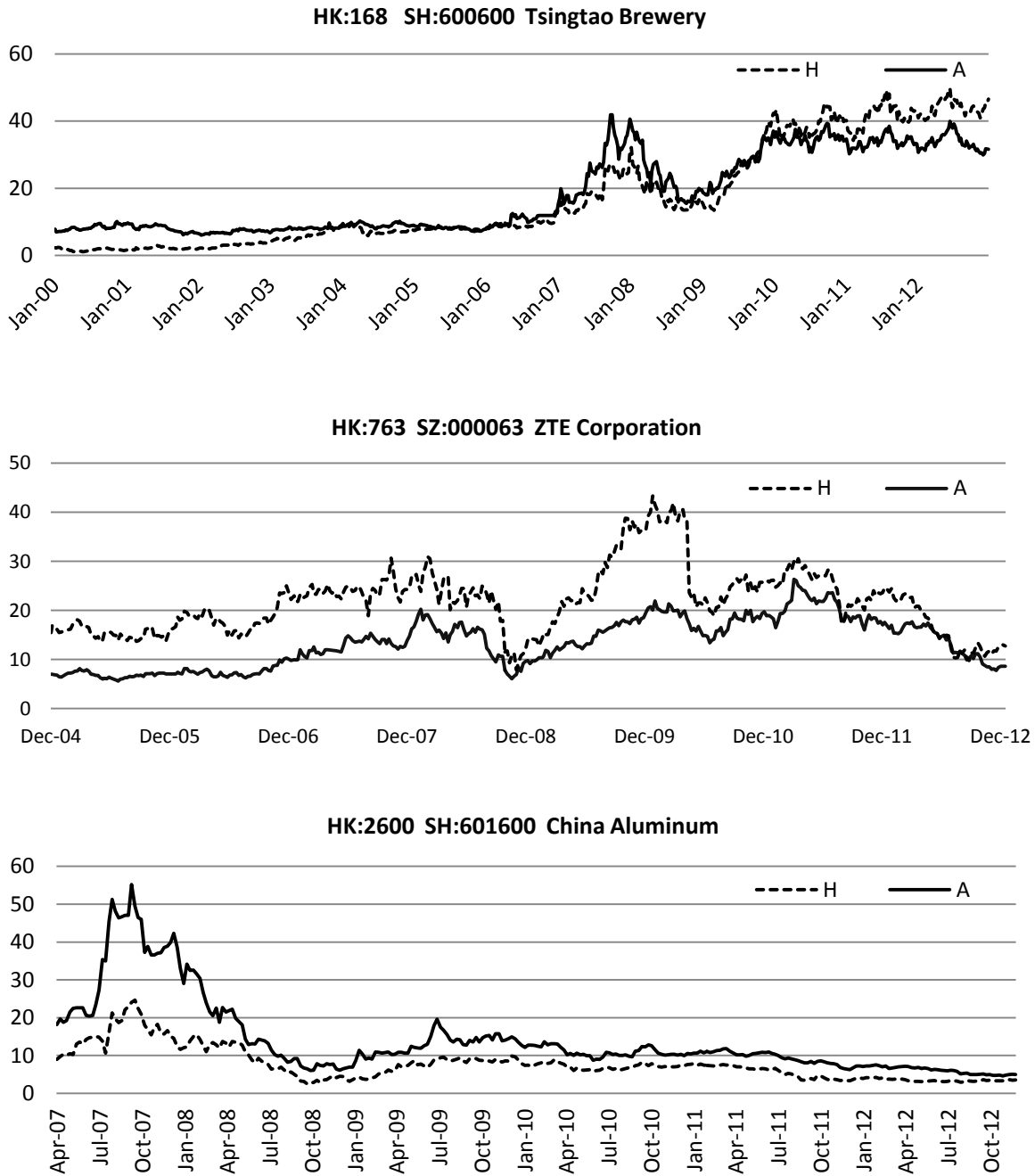


Figure 3. Variation in difference across firms

This figure provides three typical examples of price behavior of cross-listed A-and H-shares in the sample in their respective cross-listing history. The first one represents the vast majority of sample companies for which A-shares were traded at a higher price than H-shares until the situation was reversed during the past few years. The second one is representative on the company that enjoys a higher H-share price ever since the cross-listing. The final one shows the opposite case.

Due to the large discrepancy among firms and in order to unveil more patterns across firms in their price behavior of cross-listed shares, we screen through the dates when the shares are cross-listing and note down the first cross-over time of the prices of two share series for each company. It is found that among 47 sample companies, there are 35 companies whose A- H- share prices have crossed at least once since the cross-listing and as of the end of 2012. The cross-over days clustered around the middle of 2006, 2008 and 2012, similar to the finding of aggregate time-series analysis in the previous section. To the rest 12 companies whose two share prices never crossed, 5 of them have had a difference of less than 10% in history (it's already close given the general large difference in China's case). For the remaining 7 pairs, the pricing differential narrowed sometime in the cross-listing history but had never gotten that close, let alone cross over. For them, the H-shares in Hong Kong are always traded at a discount over A-shares in China. We notice that there is at least one quality shared by those uncrossed shares: they are either very cheap (H-share price is less than 2 HK Dollar or \$0.26 USD), or their prices were declining monotonously over the sample period.

A few other patterns also come to attention. First, there is a collective "coming home" for China's national banks and some other large-cap corporations from Hong Kong Stock Exchange to Shanghai Stock Exchange during 2006-2008. They were initially listed in HKSE in the early 2000s and cross-listed in SHSE following the expansion of domestic stock markets. The two series of prices intersected, normally within one year, after they were cross-listed in home stock exchanges. Second, there are a few companies which performed their IPOs in both markets at the same time after 2005, normally a few dates apart. Their issuing prices differed slightly but converged shortly, and never drifted apart very far.

In order to formally investigate the role of various indirect barriers to arbitrage in the cross-section variation of price difference among firms, a number of indirect barriers suggested in literature and their proxies in the context of cross-listed shares are discussed. Factors

regarding trading activity and firm characteristics are also considered to control for their potential effect.

5.2.2. Proxies for Indirect Barriers and Control Variables

The two direct barriers discussed in previous part also have their implications in the cross-sectional analysis since the removal of short selling bans and investment by foreign institutions do not affect all companies in the sample. With the unique dataset, those companies that have real short selling transaction history as well as those actually invested by foreign institutions can be identified. This matters since the list of shortable shares published by China's security authority may differ from the shares that actually have a lending market in the early stage of development. Therefore, two dummies for direct barriers are both evaluated based on real transaction data. Three indirect barriers investigated and discussed in more detail in what follows are noise trader risk, volatility of price differences and concentration of ownership.

A. Noise trader risk

DeLong et al. (1990) consider the market as a contest between rational arbitrageurs and sentiment-driven noise traders. They argue that arbitrageurs are likely to be risk averse and to have short horizons so that the willingness to take positions against noise trader is limited. Lee, Shleifer & Thaler (1991) derive an implication from the study of DeLong et al. (1990) that forms the theoretical framework of their study of closed-end fund discounts. They claim that levels of and changes in discounts should be highly correlated across funds. This is due to the observation that closed-end funds are largely held by individual investors who, according to them, form the base of noise traders. Thus, fluctuation of closed-end fund discount should reflect changes in individual investor sentiment which is also present in small capitalization stocks. They confirm their argument by documenting that the

discounts on closed-end funds narrow when small stocks do well, suggesting that the discounts are smaller when individual investors' sentiment is high.

Parallel with previous studies in term of time-series observations, Gemmill and Thosmas (2002) provide further support by theorizing that the existence of a discount is a rational phenomenon in closed-end funds and by showing that noise-trader sentiment, as proxied by retail-investor flows, leads to time-series fluctuations in the discount. As a matter of fact, the time-varying discounts of closed-end fund prices are often cited as proxy for retail investor sentiment (see e.g. Baker & Wurgler 2006).

However, unlike the unanimous opinion obtained in time-series analysis, cross-company empirical studies have a hard time proving this idea. In a cross-sectional analysis with averaged observations over a long period, Gemmill and Thosmas (2002) reject the hypothesis that noise trader risk is a priced factor that causes the discount. They find that higher exposure to sentiment is associated with lower discount. Specifically, they use the individual fund sensitivity to the value-weighted average discount as a proxy for systematic sentiment factor and interpret that higher loading of sentiment factor reveals higher noise trader risk so that if it is a systematic risk priced in the discount, higher beta should result in a higher discount. The empirical result of a negative sign to this factor found in their regression model therefore rejects the hypothesis and renders the noise trader risk a puzzle.

This discrepancy may result from their measure of noise trader risk and interpretation of the result. As a matter of consistency, in the paper this measure continues to serve as the proxy for noise trader risk. In the context of cross-listed shares it is calculated as follows:

$$(4) \quad Diff_{i,t} = \alpha_i + \beta_i \overline{Diff}_t + \varepsilon_i \quad (i=1, 2, \dots, 47)$$

where $Diff_{i,t}$ is the log price difference between A- and H-shares in time t for company i ; \overline{Diff}_t is the mean price difference in time t averaged across 47 sample companies. For each company the regression is run over the sub-sample period during April 2010-December 2012 and the beta obtained from the regression is thus the proxy for systematic noise factor to be used in later cross-section analysis. In other words, the noise trader risk is measured by the individual share sensitivity to the averaged share difference across sample firms.

The interpretation of this variable needs some caution. Theoretically, as suggested in Lee, Shleifer & Thaler (1991), greater exposure to this priced risk factor, which is captured by a larger beta, should be followed with larger pricing differences since idiosyncratic risks can be diversified away and thus are not counted. This points to a positive sign of this variable in a cross-sectional analysis. However, in our context of internationally cross-listed shares, a negative sign with regard to the beta is expected. Here are the reasons. First, two series of shares in our sample are listed and traded in two different stock markets, thus may reflect market- or country-related sentiment as described in Bodurtha et al. (1995). A fluctuation more correlated with average changes can be interpreted as ease of arbitrage if hedging of arbitrage position is considered. On the contrary, lower association with the average level may indicate that the companies' shares incorporate the sentiments of two markets differently than other pairs and further suggest unobservable artificial manipulation of prices in either market. Second, we argue that in the real world, contrary to textbook predictions, idiosyncratic risks associated with arbitrageurs' positions matter more than systematic risks. This is due to the consideration that arbitrage activities between two markets are more complex and involves more risks than simple portfolio investment. Multiple short and long positions are required so that it is normally not possible to take enough arbitrage position so as to diversify away idiosyncratic risks.

Indeed, the argument expounded here that hedging outweighs diversification can find its origin in a variety of theoretical studies. In their study of agency problems of professional arbitrageurs, Shleifer and Vishny (1997) point out that "To specialized arbitrageurs, both

systematic and idiosyncratic risk matters. In fact, idiosyncratic volatility probably matters more, since it cannot be hedged and arbitrageurs are not diversified. ” They continue saying that “In reality, arbitrage resources are heavily concentrated in hands of few investors that are highly specialized in trading a few assets, and are far from diversified. As a result, these investors care about total risk, and not just systematic risk.” Following them, the importance of idiosyncratic risks in arbitrageurs’ position has been strengthened in some other studies addressing the relation between costly arbitrage and well-established market anomalies, such as index addition effect (Wurgler & Zhuravskaya 2002), book-to-market ratios (Ali et al. 2003), post-earnings announcement drift (Mendenhall 2004) and accrual and asset growth anomalies (Li & Sullivan 2010). However, despite the widespread acknowledgement, they fail to examine, due to the lack of generosity of the sample and the uniqueness of the anomaly they address, the extent to which idiosyncratic risks prevents arbitrageurs from forcing the price to theoretical values.

In fact, without extract implication to the ease of arbitrage, the importance of idiosyncratic risk has been highlighted in a world of segmented market and costly information, prevailing in the 1980s before emerging economies began to liberalize their markets. With particular emphasis on segmented markets, Merton (1987) suggests that idiosyncratic risk raises expected returns when security markets are segmented and investors must incur a fixed cost to become informed and participate in each market. These assumptions fit the research question in this study of shares listed on both an open and well-established stock market and the relatively new and segmented China’s stock market.

Due to the aforementioned reasons, the beta from model (4), which measures the systematic loading of this factor should has a negative impact on the price difference so that a smaller systematic factor indicates a larger idiosyncratic noise trader risk which, although can be diversified away theoretically, cannot be hedged easily in the real world.

B. Volatility of price differences

Aside from the relatively controversial noise trader risk, two more proxies for indirect barriers to arbitrage are investigated. The first one is closely related to the noise trader risk. Pontiff (1996) posits that the risk of arbitrage position is the volatility of the difference between two related assets. If the volatility is low and the correlation between the returns on two series is high, then the arbitrageur is better hedged without being exposed to much fundamental risk. Thus, the volatility of price difference is another proxy for unhedged risk and the “out-of-range” risk discussed in Shleifer and Vishny (1997). They stress that the risk of further diverging from fundamental values associated with temporary mispriced assets can drive a performance-based arbitrageur out of money and thus results in the persistence of mispricing for these assets. As a result, the volatility of price difference should be positively related to the average price difference.

Moreover, in Pontiff’s (1996) study of closed-end fund discounts, a measure for costly arbitrage is identified and strengthened in his later work trying to debunk the noise trader risk puzzle and auguring toward the deterministic role of idiosyncratic risk (see Pontiff 2006). The proxy he uses for this variable is obtained at the following steps. First, model (4) is run for each sample fund and the residual is saved. Then annualized standard deviations of the residuals are calculated for each fund. The result, in his case of closed-end funds, is termed as log NAV residual standard deviation and used as the proxy for idiosyncratic risk. This differs from our measure whereas idiosyncratic risk is captured by the inverse relation with the systematic loading beta. When we use their measure as an alternative to ours, we find insignificant result. More interestingly, we document a near perfect correlation ($\rho > 0.9$) of this variable to the second proxies of arbitrage barrier used in our study, the volatility of the price difference itself. However, it does not correlate much with our measure of idiosyncratic risk. As a result, by incorporating the volatility of price difference in our model, we are able to evaluate their measure to the same effect. Besides, this volatility is

also referred to, in Gemmill and Thosmas's (2002) study of closed-end funds, as replication risks.

C. Concentration of Ownership

The extent of ownership concentration is measured by the percent of shares held by the ten largest shareholders in either China's A-share market or foreign markets. The rationale for this factor to deter arbitrage is straightforward. The more concentrated the shareholder base, the less likely for newly arbitrageurs to strike an impact on the price of shares. Thus the proxy for ownership concentration should be positively associated with the magnitude of relative mispricing.

D. Control Variables

In order to isolate the impact of various barriers on the long-term price difference, we control for a number of factors, some of which are proved to be significant in predicting the relative mispricing in related empirical studies.

i. Trading activity

The first controlling factor is the volume ratio representing trading behavior in respective market. In a survey of literature regarding price-volume relation in financial markets, Karpoff (1987) conclude that volume is positively related to the magnitude of price change. In studying the role of trading volume in price momentum, Lee and Swaminathan (2000) show that past trading volume predicts both the magnitude and persistence of price momentum. Dennis and Strickland (2002) document that there is abnormally high turnover associated with two percent share returns. Statman, Thorley & Vorkink (2006) relate turnover to investor overconfidence and find that share turnover is positively related to

lagged returns for many months. Trading and potential speculation also play an important role in the argument of Mei, Scheinkman and Xiong (2003) trying to explain the price discount of foreign B-shares relative to A-shares. Therefore, we include the ratio of A-share trading volume over H-share volume averaged across the sample period in our model to control for this effect. Theoretically, a positive sign is expected since the more intense the trading in A-share market relative to H-share market, the more likely that A-shares are overvalued relative to their H-share counterparts.

ii. Firm Attributes

The second set of control variables are those related to various firm characteristics including size, performance, listing year in Hong Kong stock market and dividend paying history. Baker and Wurgler (2006) suggest that, other than the frequently cited small cap stocks, young stocks, unprofitable stocks, non-dividend paying stocks and extreme growth stocks are both more subject to subjective valuation and more costly to arbitrage. We want to see whether these attributes carry explanatory power for the cross-sectional variation of price difference in our sample of cross-listed shares. One potential contradiction lies in the sign of listing years, since it is observed in preliminary analysis that recently cross-listed firms have a smaller initial pricing difference and small range of disparity after the cross-listing. Besides, in the case of closed-end funds, Gemmill and Thomas (2002) document a positive relation between the age of funds and the average discount of funds relative to their NAV, indicating that the older the fund the larger the pricing discrepancy. All variables analyzed in this part and their predicted effects on the pricing difference of cross-listed shares are summarized in Table 7.

Table 7. Measures of direct and indirect barriers to arbitrage

This table summarizes all the variables discussed previously and used in following regression analysis, grouped according to variables representing direct and indirect barriers to arbitrage, variable controlling for trading activity and variables controlling for firm attributes. The right hand side column indicates the sign of each variable's predicted effect on price difference of A- and H- shares, based on the discussion above.

Empirical Measure	Predicted effect on price differences
Barriers to arbitrage	
Direct barriers	
Shortability in China's stock market	-
QFII investment	-
Indirect barriers	
Noise trader risk (Systematic noise factor)	+ (-)
Volatility of price difference	+
Concentration of ownership	+
Trading activity	
Relative volume ratio between two markets	+
Firm characteristics	
Size of firm	-
Listing year on Hong Kong Stock Exchange	/
Firm Performance	-
Dividend	-

5.2.3. Summary Statistics of Explanatory Variables

Table 8 provides a summary of all continuous explanatory variables that are employed as independent variables in later cross-sectional regressions. Since the latest removal of direct barrier, the relaxation of short selling activity, is not realized until March 2010, the data in this cross-sectional analysis starts from the first week of April 2010 and ends in the last week of year 2012. All weekly and yearly data are averaged over three years and by doing so we intend to explain price difference of cross-listed shares across firms in the long-run, rather than short-term variation.

Table 8. Descriptive statistics: cross-sectional regression

This table presents descriptive statistics of dependent variables for the population of 47 cross-listed companies, averaged across the sub-sample period from April 2010 to December 2012. *Noise* and *Volatility* are calculated using weekly data during the sub-sample period; *List* has a single value being the number of years listing on HKSE; *VolRatio* is first calculated on a weekly basis, then averaged across the sample period. The remaining variables, *Owner*, $\log(\text{Size})$ and *ROE*, are averaged from yearly observations. Panel A reports summary statistics; Panel B presents the correlation matrix.

Panel A. Summary Statistics					
	Numbers of Observations	Mean	Standard Deviation	Minimum	Maximum
<i>Proxies of Indirect Barriers</i>					
<i>Noise</i>	47	1.064	0.605	0.342	4.034
<i>Volatility</i>	47	1.027	0.392	0.426	2.445
<i>Owner</i>	47	0.806	0.131	0.379	0.981
<i>Control Variables</i>					
<i>VolRatio</i>	47	2.093	2.193	0.102	9.424
$\log(\text{Size})$	47	4.482	1.582	1.519	8.159
<i>List</i>	47	13.127	4.739	5	20
<i>ROE</i>	47	1.703	3.309	-11.64	6.28

Panel B. Correlation Matrix of Variables									
	<i>Short</i>	<i>QFII</i>	<i>Noise</i>	<i>Volatility</i>	<i>Owner</i>	<i>VolRatio</i>	$\log(\text{Size})$	<i>List</i>	<i>ROE</i>
<i>Short</i>	1								
<i>QFII</i>	0.09	1							
<i>Noise</i>	0.29	0.12	1						
<i>Volatility</i>	0.05	0.04	0.51	1					
<i>Owner</i>	0.12	-0.04	-0.07	-0.07	1				
<i>VolRatio</i>	-0.34	-0.09	-0.22	0.06	-0.58	1			
$\log(\text{Size})$	0.53	0.17	0.21	-0.17	0.46	-0.62	1		
<i>List</i>	-0.65	-0.11	-0.37	0.14	-0.16	0.45	-0.66	1	
<i>ROE</i>	0.22	-0.04	-0.03	-0.29	0.08	-0.15	0.37	-0.23	1

The first part of Panel A in Table 8 shows the statistics of the most concerned explanatory variables. The first variable, *Noise*, is the systematic noise factor calculated by regressing individual log difference on equal-weighted log difference of sample companies. The sample statistics show that the factor loading is averaged around one with a minimum of less than 0.5 and a maximum of more than 4. *Volatility* captures the second indirect barriers to arbitrage and is measured by the standard deviation of weekly log price difference of two share series. The third proxy for indirect barrier is *Owner* which

measures the percentage of ownership by the ten largest shareholders. It varies from less than 40% to more than 98% and averages at 80%, indicating that the ownership of the sample companies is relatively concentrated that on average 80% of the companies' shares is held by the ten largest shareholders.

The second part of Panel A reports the result for other independent variables, one, *VolRatio*, controls for trading activities in two markets and three others account for firm characteristics. *VolRatio* is the ratio of trading volume in two markets. Time series of weekly volume ratio is firstly calculated and then averaged through time for individual company. A value of one indicates that the average weekly volume in China's A-share market equals that in Hong Kong. A value larger than one suggests relatively more intense trading behavior in China and vice versa. The result shows that it varies drastically among sample firms with a maximum ratio of 9.4 and a minimum ratio of 0.1. On average, the weekly trading volume of our sample firms in China is two times that in Hong Kong's stock market. *Size* controls for the size effect documented in many related empirical studies and is proxied in this study by the total number of shares issued by a company. It is relatively stable during our sub-sample period and suits our intention to examine the long-run relationship between firm size and average price difference. *List* measures the number of years that the companies' shares are listed in Hong Kong stock market. It shows that companies in our sample have a shortest listing history of 5 years and a longest history of 20 years.

Panel B reports the correlation matrix among firm-level variables, revealing some mild correlation between factors. For example, dummy variable representing shortability in China's stock market is positively correlated with size of the firm, which is understandable given the fact that the shares eligible for short selling in the early stage of development are largely lag-cap stocks on the market constituting major indexes. Listing years's negative correlation with shortability and size is also comprehensive in that many mega-cap companies like national banks and petroleum producers perform their IPO in the late 2000s,

and are also among the first group of companies that are allowed to be sold short. Furthermore, the third proxy for indirect barrier, ownership concentration, is negative correlated with measure of trading activity but positive associated with size of the firm, suggesting that small cap companies have a less concentrated ownership, and that the more dispersed the shareholder base the more intense the trading in China's A-share market, which echoes institutions' preference for large-cap stocks and the fact that China's stock market is more flooded with retail investors comparing to Hong Kong's stock market.

5.2.4. Model and Estimation

In the same spirit with Pontiff (1996) and Gemmill and Thomas (2002), we estimate a cross-sectional regression of the form

$$(5) \quad Diff_i = \alpha + \beta_1 Short_i + \beta_2 QFII_i + \beta_3 Noise_i + \beta_4 Volatility_i + \beta_5 Owner_i + \beta_6 VolRatio_i + \beta_7 \log(Size_i) + \beta_8 List_i + \beta_9 ROE_i + \beta_{10} Dividend_i + \varepsilon_i$$

where $Diff_i$ is the log difference between A-share price and H-share price for company i ; $Short_i$ is a dummy variable indicating the shortability of company i 's shares in China's stock market; $QFII_i$ is the dummy variable that equals to one if the company's shares in China's A-share market are at least once traded by foreign institutional investors. The value of both dummy variables is assigned based on real transaction and holding history of domestic short sellers or foreign investors. $Dividend_i$ is a dummy variable that equals to one if the company has a dividend paying history over the sample period. The rest of the independent variables are consistent with the settings laid out in the previous part.

Estimated coefficients with full set of variables are given in column 1 of Table 9. The results indicate that one direct barrier, shortability, all three proxies for indirect barriers, a

Table 9. Cross-sectional analysis

The following table reports result of multiple specifications of the regression model:

$$Diff_i = \alpha + \beta_1 Short_i + \beta_2 QFII_i + \beta_3 Noise_i + \beta_4 Volatility_i + \beta_5 Owner_i + VolRatio_i + \beta_7 \log(Size_i) + \beta_8 List_i + \beta_9 ROE_i + \beta_{10} Dividend_i + \varepsilon_i,$$

where $Noise_i$ is the individual sensitivity to average price difference; $Volatility_i$ is the standard deviation of weekly price difference; $Owner_i$ is the percentage ownership held by the ten largest shareholders of the company; $VolRatio_i$ is the ratio of trading volume in A-share market relative to that in H-share market. $Size_i$ is proxied by the total shares outstanding; $List_i$ is the year of listing in Hong Kong stock market; ROE_i is return on equity; $Dividend_i$ is a dummy variable that equals to one when the company has a dividend paying history over the sample period. The subscript i denotes company. T-values are shown in parentheses. ** represents significance at 5% level, and * represents significance at 10% level.

Independent Variables	Dependent Variable		
	1	2	3
Constant	-0.28 (-0.64)	-0.40 (-1.12)	0.09 (0.30)
Short	-0.31 (-3.11)**	-0.33 (-3.46)**	-0.35 (-3.65)**
QFII	0.05 (0.63)		0.03 (0.34)
Noise factor	-0.32 (-3.86)**	-0.32 (-3.98)**	-0.36 (-4.13)**
Volatility	0.43 (3.55)**	0.43 (3.69)**	0.53 (4.07)**
Ownership	1.13 (3.17)**	1.03 (3.17)**	0.19 (0.58)
Volume Ratio	0.09 (3.96)**	0.09 (4.39)**	
Log of size	-0.03 (-0.84)		
Listing year	-0.02 (-2.00)**	-0.02 (-1.85)*	
ROE	-0.03 (-2.17)**	-0.03 (-2.97)**	
Dividend	-0.05 (-0.44)		
R-Squared	74.76%	73.99%	54.28%
Adj.R-Squared	67.75%	69.2%	48.70%
F-test	10.67	15.78	9.73

factor capturing trading behavior and two firm attribute are significant in explaining the cross-sectional variation in long-term pricing difference. Specifically, firms that are eligible

to short in China's stock market, with less idiosyncratic noise trader risk, less volatile price differences, more dispersed shareholder base, longer listing history and higher firm performance have a relatively less severe problem of relative mispricing between two markets.

Given the dependent variable as $\ln(P_A/P_H)$, the coefficient of *Short* indicates that the group of companies that are allowed to sell short in China's A-share market enjoy a 25% lower price ratio than the rest of sample companies. This amount may mitigate the relative overvaluation associated with A-shares and even lower the A-share prices below their H-share counterparts, especially during the last year of sample period when Hong Kong stock market exhibit aggressive increase while China's stock market remains relatively sluggish. The magnitude of coefficients shows that three indirect barriers to arbitrage make a larger difference on the pricing consistency than those direct barriers, confirming the influence of indirect barriers in deterring arbitrage behavior and correcting relative mispricing even in the absence of any direct barriers. Furthermore, the significantly negative sign of noise factor solves the puzzle mentioned in Gemmill and Thomas (2002) and confirms the notion suggested in Merton (1987) and Shleifer and Vishny (1997) that idiosyncratic risk matters more in arbitrageurs' taking of positions, especially when the markets under consideration are segmented.

The significant coefficient of trading activity echoes previous studies in China's foreign share discount as well as mainstream literature about volume's influence on share prices. Specifically, one unit increase of the average volume ratio leads to 9% higher A-share prices relative to H-shares, suggesting that those that are heavily traded in China's A-share market are more likely to be over-valued and thus have a higher pricing gap with their H-share counterparts in Hong Kong stock market.

Two proxies for firm attributes, listing year and ROE, are significant in predicting the average price difference. The impact is respectively 2% and 3%. In particular, one year

longer of the company's listing history on Hong Kong Stock Exchange is coupled with 2% smaller pricing gap between A- and H-shares. Likewise, higher firm performance as captured by ROE is associated with a 3% lower pricing difference on average. These results confirm Baker and Wurgler's (2006) argument that younger stock and unpredictable stocks are more difficult to value and also tend to be avoided by arbitrageurs. Moreover, although insignificant, the coefficient of size and dividend all have expected signs, confirming Baker and Wurgler's (2006) prediction toward small cap and non-dividend paying companies.

The results after leaving out those insignificant variables are presented in column 2. Most of the remaining factors become more significant except for listing year, which turns insignificant probably due to its negative correlation with the removed size of the firm, as depicted in the correlation analysis. The same is true for concentration of ownership in column 3 after excluding all controlling variables and keeping only proxies for arbitrage barriers. It may become insignificant due to its mildly negative association with one of the control variables, the volume ratio. Collectively, results in column 3 show that direct and indirect barriers to arbitrage explain 54% of the cross-sectional fluctuation of pricing differences. This exceeds the largest explaining power of 46% found in empirical study by Chan, Menkveld and Yang (2008) with proxies for information asymmetry in China's stock market.

The estimates of QFII dummy representing those companies invested by foreign investors do not have expected sign in either model. The coefficient of QFII being positive indicates that, given the same level of other variables, companies whose shares are traded by foreign institutions in China have a larger pricing discrepancy with their H-share counterparts in Hong Kong, undermining the role of capital flow and foreign investment in aligning the pricing of identical assets. However, when we regress log price difference on QFII dummy exclusively, the estimate becomes negative even though still not significant. This may due to, although rather weakly as pointed out in the correlation analysis, its positive correlation with the dummy for shortability, for the large cap stocks that are allowed to sell short may

also be the target of foreign institutional investors, or with other proxies for indirect barriers, suggesting that foreign institutions actively seek exposure to shares with higher systematic noise factor and/or more volatile prices difference between A- and H-shares.

6. CONCLUSIONS

This paper investigates China's foreign share discount relative to the price of shares restricted only to domestic investors. It is argued that whatever the reason that gives rise to the pricing difference, the lack of arbitrage mechanism in some markets and costly arbitrage in others enables them to persist. Textbook arbitrage behavior involves buying the relatively undervalued and selling the relatively overvalued simultaneously. Limits to this kind of arbitrage activity can take many forms, two of which that are more critical in our case of shares listed in two markets are inaccessibility to markets and short selling restrictions in either market.

The effect of relaxation on these two direct barriers on relative asset pricing is examined with a sample of shares listed both on Hong Kong stock market, an open and advanced stock market, and one of China's stock markets shortly established in the early 1990s. It is found that large pricing differences documented in previous studies decrease with the openness of China's market proxied by the amount of capital flows approved by the authority. Moreover, the lifting of short sales restriction also contributes to the narrowing gap of share prices in two markets.

Given the fact that the price gap still exists and differs across firms, we further this analysis by relating various indirect barriers suggested in recent studies on arbitrage behavior to the cross-sectional fluctuation in price difference. We want to see whether these indirect barriers deter rational arbitrage and prolong relative mispricing and whether they can explain the cross-firm variation of long-term price gaps. Three proxies for indirect barriers to arbitrage are constructed based on previous studies, which are noise trader risk, volatility of differences and ownership concentration. In a cross-sectional regression, we document that these proxies of indirect barriers along with those two direct barriers collectively explain 54% of the long-term different levels of pricing discrepancy across firms. Specifically, shares that are shortable in China's stock market and that have less

idiosyncratic risk, less volatile price difference and dispersed shareholder base have a narrower gap of pricing difference in the long run. The result also shows that three indirect barriers to arbitrage make a larger difference on the pricing consistency than those direct barriers.

The finding of this paper provides an alternative explanation for the China's foreign share discount, especially the cross-sectional variation among firms. The analysis highlights a few attributes of price behavior, representing various indirect barriers to arbitrage, that make the speed of restoration to Law of One Price varies across firms. Compared with empirical studies in the late 1990s and early 2000s, the recent alleviation of two direct barriers, relaxation of restriction on capital flows and short selling activity, allows us to isolate and explore the role of indirect barriers in the persistence of pricing differences.

Moreover, the examination of relation between time-varying pricing difference and the amount of free capital flows in China's stock market contributes to the study of emerging market liberalizations. The unique setting of cross-listing focused in this study provides opportunity to test any efficiency gains associated with China's recent liberalizing reforms without biased by Fama's (1976) joint hypothesis issue. The result shows that two regime switches in China's stock market all are contributive to the narrowing pricing gap between it and the more advanced Hong Kong stock market, suggesting that various artificial constraints imposed by the authority successfully segment the markets and the removal or mitigation of them significantly improve the pricing consistency of the market with international financial markets.

Finally, this paper extends and contributes to the literature of arbitrage and its interplay with various anomalies. The findings suggest that both idiosyncratic and systematic risks matter in arbitrageurs' attempt to eliminate those seemingly obvious anomalies. Specifically, shares associated with higher idiosyncratic risks are more likely to have a larger and sustained pricing difference in our case of cross-listed companies. This finding

confirms Shleifer and Vishny's (1997) model of not fully diversified arbitrageurs with limited resources and thus vetoes conventional models of many diversified, all-powerful arbitrageurs such as that suggested by DeLong et al. (1990).

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APPENDIX. Cross-listed companies in the sample

Ticker		Company	Listing Date	
H-share	A-share		H-share	A-share
168	600600	Tsingtao Brewery Co. Ltd.	15/07/1993	27/08/1993
177	600377	Jiangsu Expressway Co. Ltd.	27/06/1997	16/01/2001
300	600806	Shenji Group Kunming Machine Tool Co. Ltd.	07/12/1993	03/01/1994
317	600685	Guangzhou Shipyard International Co. Ltd.	06/08/1993	28/10/1993
323	600808	Ma'anshan Iron&Steel Co. Ltd	03/11/1993	06/01/1994
338	600688	Sinopec Shanghai Petrochemical Co. Ltd.	26/07/1993	08/11/1993
347	000898	Angang Steel Company Limited	24/07/1997	25/12/1997
358	600362	Jiangxi Copper Co. Ltd.	12/06/1997	11/01/2002
386	600028	China Petroleum&Chemical Co. Ltd.	19/10/2000	08/08/2001
390	601390	China Railway Group Ltd.	07/12/2007	03/12/2007
525	601333	Guangshen Railway Co. Ltd.	14/05/1996	22/12/2006
548	600548	Shenzhen Expressway Co., Ltd.	12/03/1997	25/12/2001
588	601588	Beijing North Star Co. Ltd.	14/05/1997	16/10/2006
670	600115	China Eastern Airlines Co. Ltd.	05/02/1997	05/11/1997
719	000756	Shandong Xinhua Pharmaceutical Co. Ltd.	31/12/1996	06/08/1997
753	601111	Air China Ltd.	15/12/2004	18/08/2006
763	000063	ZTE Corp.	09/12/2004	18/11/1997
857	601857	PetroChina Co. Ltd	07/04/2000	05/11/2007
874	600332	Guangzhou Pharmaceutical Co. Ltd.	30/10/1997	06/02/2001
902	600011	Huaneng Power International.Inc	21/01/1998	06/12/2001
914	600585	Anhui Conch Cement Co. Ltd	21/10/1997	07/02/2002
939	601939	China Construction Bank Co. Ltd.	27/10/2005	25/09/2007
991	601991	Datang International Power Generation Co. Ltd.	21/03/1997	20/12/2006
995	600012	Anhui Expressway Co. Ltd.	13/11/1996	07/01/2003
998	601998	China CITIC Bank Co. Ltd.	27/04/2007	27/04/2007
1053	601005	Chongqing Iron and Steel Co. Ltd.	17/10/1997	28/02/2007
1055	600029	China Southern Airlines Co. Ltd.	31/07/1997	25/07/2003
1065	600874	Tianjin Capital Environmental Protection Group Co. Ltd.	17/05/1994	30/06/1995
1071	600027	Huadian Power International Co. Ltd.	30/06/1999	03/02/2005
1072	600875	Dongfang Electronic Co. Ltd.	06/06/1994	10/10/1995
1088	601088	China Shenhua Energy Co. Ltd.	15/06/2005	09/10/2007
1138	600026	China Shipping Development Co. Ltd.	11/11/1994	23/05/2002
1171	600188	Yanzhou Coal Mining Co. Ltd.	01/04/1998	01/07/1998
1186	601186	China Railway Construction Co. Ltd.	13/03/2008	10/03/2008
1398	601398	Industrial and Commercial Bank of China Ltd.	27/10/2006	27/10/2006
1898	601898	China Coal Energy Co. Ltd.	19/12/2006	01/02/2008
1919	601919	China COSCO Holdings Co. Ltd.	30/06/2005	26/06/2007
2318	601318	Ping'An Insurance Co. Ltd.	24/06/2004	01/03/2007
2600	601600	Aluminum Co. of China Ltd.	11/03/2004	30/04/2007
2628	601628	China Life Insurance Co. Ltd.	12/12/2001	30/04/2007
2727	601727	Shanghai Electronic Group Co. Ltd.	28/04/2005	05/12/2008
2866	601866	China Shipping Container Lines Co. Ltd.	18/12/2003	09/01/2007
2883	601808	China Oilfield Services Ltd.	16/06/2004	12/12/2007
2899	601899	Zijing Mining Group Co. Ltd.	20/11/2002	28/09/2007

3328	601328	Bank of Communications Co. Ltd	23/06/2005	15/05/2007
3968	600036	China Merchants Bank Co. Ltd	22/09/2006	09/04/2002
3988	601988	Bank of China Ltd.	01/06/2006	05/07/2006
