The Impact of the Shanghai – Hong Kong Connect on the Market Liquidity and Price Divergence

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Abstract

The economic growth of China has seen an increase in its demand for capital, fueling its local stock markets. This paper exams a market liberalisation event between China and Hong Kong and its impact on: (1) market liquidity and (2) price differentials between cross-listed stocks across the two markets. On November 17, 2014, the Shanghai Stock Exchange and the Hong Kong Stock Exchange introduced the much anticipated, Shanghai-Hong Kong Connect, a bilateral investment channel between the two markets. The new channel brings with it accesses to new capital for domestic firms and trading expertise from new foreign participants. The Shanghai-Hong Kong Connect permits mutual market access for market participants, allowing investors in each market to trade in the other market using existing trading infrastructure. This study adopts a difference-in-difference methodology and finds that market liquidity as proxied by transaction costs, improves in both markets, for eligible stocks that are traded through the bilateral investment channel, post November 17, 2014. This result is consistent with literature, which identifies the benefits of open and enhanced market access. In addition, reported results identify that the pre-existing price premium between cross-listed China A-shares and Hong Kong H-shares, increases following the market design change. Contrary to expectations, this result is attributed to the incremental improvement in liquidity in China for cross-listed stocks vis-à-vis Hong Kong. Overall, results in this study demonstrate that the partial liberalisation of fund flow between the two markets had a positive impact on liquidity, in particular for China's largest equity market the Shanghai Stock Exchange.

Contents

1. Introduction

Equity market liberalisation enables foreign investors to participate in domestic stock markets, effectively allowing for the flow of investment capital across international borders. When governments open their capital markets, this signifies an important political shift in traditionally closed markets. Previous literature suggests that market liberalisation brings benefits in forms of a lower domestic cost of capital, higher economic growth and an increase in private investment (see Henry, 2000; Edison et al. 2002; Bekaert, Harvey and Lundblad 2005; Bekaert and Harvey 2000; Edison and Warnock 2003 and Levine and Zervos 1998).

Under the approval of the Securities and Futures Commission in Hong Kong and the China Securities Regulatory Commission in Beijing, the Shanghai–Hong Kong Stock Connect (SHHKConnect) is launched on November 17, 2014. The launch of the SHHKConnect, is effectively a market liberalisation event enacted by a bilateral investment channel between the two markets. With the SHHKConnect, investors in the Shanghai Stock Exchange (SSE) are able to purchase designated shares listed on the Stock Exchange of Hong Kong (SEHK). Conversely, any Hong Kong based investors (domestic Hong Kong investors or overseas investors that trades via a Hong Kong broker) is able to purchase designated shares listed on SSE.

The introduction of the SHHKConnect represents a substantial break from China's traditionally closed market position. Mainland China's stock markets have a long history of being closed to overseas retail and institutional investors[1]. The mutual-market access provided via the SHHKConnect will allow overseas investors, in particular retail investors, the opportunity to invest in China with fewer restrictions, and effectively opens China's financial market to the rest of the world. The SSE, by turnover is the second largest market (0.8 trillion USD) and in terms of market capitalisation is the 4th largest worldwide (4.7 trillion USD).[2] On the other hand, the SEHK as an open market has a turnover of 0.4 trillion USD (9th in the world), and a market capitalisation of 3.4 trillion USD (5th in the world). However, Chinese investors had very limited access to the SEHK due to restrictions in place pertaining to the flow of funds out of China to other markets, including Hong Kong. Considering the growing wealth of Chinese households and their limited investment opportunities[3], the introduction of the SHHKConnect is of significant interest to policy makers and market observes in that it is expected to attract a significant funds flow from the mainland China to Hong Kong market.

In addition to the capital flow with less restrictions between the two markets, the inception of this mutual market access is expected to also stimulate local investors' trading in the local market (Henry, 2000). Investors, foreign and domestic, may expect regulators in both markets to implement greater governance and oversight, as has traditionally been the case. For

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[1] Only Qualified Foreign Institutional Investors (QFII) and Renminbi QFII are permitted to invest in China's stock markets under programs launched in 2006 and 2011. However, even in these cases, QFII and RQFII are subject to trade restrictions and limited quotas. See Section 2.1for more details.

[2] Exchange data from the World Federation of Exchanges as of March 2015.

[3] Chinese households' portfolio has an average of 72% investment in real estate and only 6% in equities.

example, Bekaert, Harvey and Lundblad (2005) find that the introduction of foreign capital typically facilitates market reform to enhance investor protection, which encourages trade in the domestic market and information revelation. This may be particularly pertinent to Mainland China markets where retail investors account for approximately 85% of trade[4].

Distinct from previous literature concerning market liberalisation, which focuses on the changes in cost of capital and economic growth (Bekaert and Harvey, 2000; Quinn and Toyoda, 2008), this study contributes to the literature by examining its impact on two components of market quality: liquidity and price convergence. Liquidity is critically important to listed companies as it has a major bearing on a company's ability to raise capital. Amihud and Mendelson (1986), Brennan and Subramanyam (1996) and O'Hara (2003) show improvements in liquidity decreases the required return of investors and therefore the cost of capital for companies. In relation to price convergence, a number of studies have identified a price premium between China (ie A-shares) and Hong Kong (ie H-shares) cross-listed stocks. This result is surprising given A- and H-shares have almost identical underlying income streams. Economic agents should arbitrage away any price differential for such assets (Ross, 1976; Roll et al., 1980; Daniel et al., 2001)[5]. However, this literature has examined the issue in the presence of capital restrictions. This study will provide the first examination of changes in the price divergence between the two classes of shares, under the condition of partial ownership liberalisation. The pricing differences while expected to narrow, may not be fully explained due to continuing variations in rules related to trading and settlement, and liquidity levels across the two markets.

Two tests are carried out to address how liquidity and the price premium between SSE and SEHK change following the introduction of the SHHKConnect. First, we adopt a difference-in-differences methodology to test if the SHHKConnect had a significant effect on a number of liquidity proxies identified in the literature. Second, we adapt the model of Wang and Jiang (2004) to evaluate the price premium between cross-listed A- and H- shares. Using the data from the Market Quality Dashboard (MQD) provided by CMCRC, this paper finds that for stocks that are eligible to be traded through the SHHKConnect, they experience a significant decrease in trading costs following November 17, 2014. This is true for both exchanges. On the SSE, eligible stocks traded via the SHHKConnected experience a decrease in transaction costs by 1.04% and 3.94 % as measured by effective and quoted bid-ask spreads respectively. Meanwhile, on the SEHK, eligible SHHKConnected stocks experience reductions of 0.28% and 0.7% in effective and quoted bid-ask spreads, respectively. Despite the decrease in transaction costs, market depth, decreases for eligible securities traded via the SHHKConnect. On the SSE, market depth for such securities decreases by 14%, the decrease is 8.8% for such securities on the

[4] News reference for the proportion of retail investors in the SSE: http://www.reuters.com/article/2015/07/09/us-china-stocks-idUSKCN0PI04Q20150709

[5] Ross (1976) proposed arbitrage pricing theory (APT) for asset pricing. The APT is based on the assumption that there is no arbitrage profit at any market equilibrium. Roll et al. (1980) conduct empirical test on the APT. Their empirical evidence supports that expected returns can be affected by systematic arability alone, as it is suggested by APT. Daniel et al. (2001) proposed an asset pricing model reflects that misperceptions of firms' prospects, which results mispricing are arbitraged away by arbitrageurs.

SEHK. Given effective spreads incorporate both the depth and tightness elements of liquidity (Huang and Stoll, 2001), this study finds liquidity improved following the introduction of SHHKConnect, for eligible cross-traded stocks. In relation to tests of price convergence between A- and H-shares, on average, this study finds that the premium for A-shares increases by approximately 0.4% after the launch of the SHHKConnect. This result is attributed to larger liquidity improvement for cross-listed stocks on the SSE than it is for the SEHK. Both these results provide regulatory insights especially in light of new market connectivity agreements to be in operation between the Shenzhen Stock Exchange and the SEHK in early 2016.

The remainder of this study is constructed as follows: Section 2 provides institutional details on the SSE and SEHK markets in addition to details on the SHHKConnect. Section 3 reviews literature and develops testable hypothesis. Section 4 describes the data and methods. Results are reported and discussed in the following sections, while Section 8 concludes.

2. Institutional Details

In this section, we provide an account of the historical background and development of China's financial markets. Institutional details regarding the market structure of the SSE and SEHK are also included, followed by details regarding the SHHKConnect.

2.1. Background of China's Financial Markets

China has two exchanges that were established in 1990, namely, the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE). The two exchanges have experienced rapid growth for more than two-decades in terms of market capitalisation. At the beginning of 2003, the market capitalisations were CNY 2,829 billion (USD 455.5 billion) and CNY 1,424 billion (USD 229.3 billion) for the SSE and SZSE respectively. By the end of March 2015, their market capitalisations were CNY 29,221 billion (USD 4,705 billion) and CNY 18,480 billion (USD 2,975.8 billion)[6]. Figure 1 below depicts the growth in market capitalisation for the two Chinese markets. These two markets remain to be the primary exchanges in Mainland China, and they have been relatively closed to outsiders since their inception, compared to capital markets in other developed countries and regions.

[6] The figures are taken from World Federation of Exchanges, data is only available from 2003.

Figure 1 Market Capitalisation Growth in China

Prior to 1992, Chinese companies were permitted to only issue A-shares to the public. A-shares are ordinary shares that are denominated and traded in Chinese local currency, 'CNY'. A-shares were only available to Chinese domestic individuals and institutional investors, meaning that foreign investors did not have any access to China's capital markets. The debut of B-shares in February 1992 however, permitted foreign investors to invest in Chinese stocks for the very first time. B-shares are a special class of share, quoted and traded in foreign currencies. Before February 2001, only foreign institutional investors were permitted to trade B-shares. Starting from February 2001, domestic Chinese investors could also trade B shares through legal foreign currency accounts.[7] Typically, B-shares are traded in US dollars. Despite the same income streams attached to each class of shares, there has existed a large pricing differential between the two classes of shares, which has attracted the interest of academics (see for example Mei et al. (2005), Tan et al. (2008) and Chakravarty et al. (1998)). The general relevance of the discrepancy between A- and B-shares however has been reduced, as no new B-shares have been issued since 2001 and the turnover of B-shares is trivial compared to other classes of shares which have subsequently been issued.

Subsequent to China joining the World Trade Organization (WTO) in 2001, the Chinese government introduced the Qualified Foreign Institutional Investor (QFII) Scheme. The scheme, which came into operation on July 9, 2003,[8] enabled select foreign institutional investors to invest in China's stock markets directly. Foreign institutional investors, holding a QFII license however were only able to invest in China on a limited basis. Foreign investments under the scheme were strictly regulated in terms of quota, products, accounts and fund conversion eligible to be traded. The eligible products under the scheme included A-shares and listed funds. The

[7] An official document produced by the SEHK regarding the classes of stocks traded in the two markets: http://www.hkex.com.hk/eng/prod/secprod/eqty/documents/equities.pdf

[8] News reference regarding the launch of the QFII scheme: http://www.ft.com/intl/cms/s/0/1892dcf6-00b5-11de-8f6e-000077b07658.html#axzz3sS9seMfn

introduction of the scheme therefore eliminated the need for new issues of B-class shares. Data released by the Chinese State Administration of Foreign Exchange[9] shows that the aggregate QFII quota permitted is USD 72.1 billion, and as of 26 March 2015 there were 267 QFII accounts.

In addition to A- and B-shares, there is another class of shares that can be issued by Chinese companies, namely, H-shares. H-shares are listed on the SEHK however issued by companies that are incorporated in Mainland China. A widely held view is that Chinese firms benefit in being listed on the SEHK. For example, as the SEHK is a more open market than the SSE, a firm's international standing may be greatly improved by listing on the SEHK, and investors' confidence might be enhanced.[10] In addition, historically, compared to the Mainland China, the Hong Kong government allows greater freedom regarding capital flows in and out of its market, which is critical to the investment and capital raising activities of firms. The data obtained from China Securities Regulatory Commission (CSRC)[11] shows that by March 2015, there were 208 H-shares listed, among which, 69 companies are cross-listed in both SSE and SEHK. Figure 2 shows the value of Hang Seng China AH Premium Index, which tracks the price premium of cross-listed A- to H- shares on the China' stock markets and the SEHK, from January 2, 2013 to May 15, 2015. The figure suggests that from the late 2014, that is, after the SHHKConnect is launched, there is a large increase for A-share premium over the corresponding H-shares. This largely attracts academics' attentions and interests in the SHHKConnect, as theoretically, the prices of cross-listed stocks are expected to converge in the presence of the cross-markets investments. Studies related to cross-listed prices divergence are covered in the Section 3.3.

Figure 2 Hang Seng China AH Premium Index

9 The official site for the State Administration of Foreign Exchange: http://www.safe.gov.cn/

10 Fact sheet on the listing of H-shares produced by the SEHK: http://www.hkex.com.hk/eng/newsconsul/hkexnews/2013/documents/fact%20sheet_20th%20h%20shares.pdf

11 Market statistics released by the China Securities Regulatory Commission: http://www.csrc.gov.cn/pub/zjhpublic/G00306204/zqscyb/201504/t20150422_275368.htm

China has gradually opened its markets since its humble beginning and the Shanghai Hong Kong Connect is the most recent event in this expanding endeavor. Before discussing the SHHKConnect, the structures of the SSE and the HKSE are introduced, as these exchanges are the subjects of SHHKConnect.

2.2 Structure of the Shanghai Stock Exchange

Established in 1990, the Shanghai Stock Exchange (SSE) is considerably large in size and plays an important role in China's financial market. There are 1,021 companies listed on the SSE with a total market capitalisation of CNY 29.22 trillion (USD 4.71 trillion). The average turnover of the SSE is CNY 515.8 billion (USD 83.06 billion)[12] on any given trading day.

Equity trading on the SSE is conducted via an electronic order driven mechanism with two trading sessions. The morning session starts with an opening call auction, from 9:15 to 9:25, followed by a continuous trading session from 9:30 to 11:30. The market is shut for lunchtime and a continuous trading session recommences in the afternoon between 13:00 to 15:00.[13] Two types of orders are permitted: limit orders and market orders. During the continuous trading session, orders are sent through either the terminals at exchange members' firms or the terminals on the trading floor. The exchange maintains a fully lit order book, and dark trades are not allowed in the market.

From September 22, 2004 the SSE displayed the five top levels bid and ask quotes[14]. Orders are matched automatically through a centralized exchange trading system and are executed according to price and time priority. All trades are subject to stamp duty, equivalent to 0.1% of trading value. Although the stock settlement for A-shares is on T day, day trading is not available at the SSE. That means, for stocks that are bought on T day can only be sold on the next trading day. The money settlement for all A-shares is T+1. Moreover, short sale trades and on margin are only permitted from March 2010.

The board lot size at the SSE is 100 shares and odd lots must be sold in one order. The maximum size for a single order is 1 million shares, which is equivalent to 10,000 board lots. For A-shares, if a single order trades 3,000 board lots or CNY 2 million worth of shares, the orders can be submitted as a block trade. Expression orders for block trades are accepted from 9:30 to 11:30 in the morning and from 13:00 to 15:30 in the afternoon. Executions of block trades only take place during 15:00 to 15:30. For the analytical purpose of this paper, block trade data is not

12 (1) The number of listed stocks and the market capitalisation is calculated based on the market data on the 30th March, 2015. The figure includes market capitalisation for both A and B shares (2) The average daily turnover calculation including the turnover of both A and B shares, it is a raw figure taken from http://www.sse.com.cn/market/dealingdata/overview/stock/abshare/absharedealmonth_inde.shtml?YEAR=2015&prodType=9&sytle=1 (the markets statistics produced by the SSE). The figure is calculated using the total turnover in March 2015 divided by the number of trading days in the month. It is noticeable that the monthly turnover various considerably from 2014 to 2015. (3) the spot rate between CNY and USD is taken on the March 30th, 2015

13 http://english.sse.com.cn/tradmembership/trading/overview/

14 Due to the data limitation, we only examine market depth at the top of the book in this thesis.

included. Finally, the minimum price increment across all A-shares traded on the SSE is CNY 0.01.

There are several unique features of the SSE relative to other markets globally. First, daily price limits are in place, which set maximum and minimum price variations and second, the market has a separate trading board called Risk Alert Board. In December 1996, SSE introduced price fluctuation limits of plus or minus 10% relative to the previous closing price. The purpose of imposing the price limits is to avoid the market becoming too volatile or overheated from speculation (Suliman, 1998). For example, if the price increases by 10%, all subsequent purchases must be made at this price, sellers cannot achieve a higher price. The price limit however is not applicable on initial public offering firm days. Apart from normal stocks with a daily price limit of $\pm$10%, stocks listed on the Risk Alert Board are subject to price limits of $\pm$5%.

The Risk Alert Board, was launched on the January 1, 2013 with the intention to implement a delisting support system. Stocks listed on the Risk Alert Board bear significant risk of being or scheduled to be delisted; their trading information is displayed separately, and are identified as 'special treatment' stocks. The concept of special treatment was introduced in April 1998. The 'special treatment' stocks' trading tickers are preceded with the sign 'ST' or '*ST'. Three types of 'special treatment' stocks are assigned within 'ST': (1) stocks that have been resumed from suspension for listing; (2) stocks that have been relisted; and (3) stocks that have suffered from other significant risks. Stocks with the risks of being delisted are assigned with '*ST'. In this study, ST or *ST stocks are excluded in testing the market level performance of the SSE.

2.3 Structure of the Stock Exchange of Hong Kong

The Stock Exchange of Hong Kong (SEHK) is the only primary exchange in Hong Kong where securities can be listed. It is operated by the Stock Exchange and Hong Kong Futures Exchange Limited, a wholly-owned subsidiary of Hong Kong Exchanges and Clearing Ltd (HKEx). There are approximately 1800 stocks listed on the SEHK, among which, around 208 stocks are mainland-China domiciled companies.[15] Additionally, there are 69 cross-listed stocks on both the SSE and the SEHK. These stocks have been the subjects of several academic studies because they offer unique insight into the China's markets, which has historically been closed to overseas retail investors and partially to institutional investors. These studies are discussed further in the literature review in Section 3.3.

There are two trading sessions for equity trading at the SEHK. The Morning Session starts with the Pre-opening Session between 9:00 a.m. to 9:30 a.m., which is followed by continuous trading session from 9:30 a.m. to 12:00 a.m. The Afternoon Session starts from 1:00 p.m. to 4:00 p.m.

[15] Numbers of listed stocks is taken from http://www.csrc.gov.cn/pub/zjhpublic/G00306204/zqscyb/201504/t20150422_275368.htm as of March 30, 2015.

The SEHK is a pure order-driven market. After investors place orders with exchange members, their orders are routed to the Third Generation of Automatic Order Matching and Execution System at the exchange. The current version is AMS/3.8, which has a capacity of 150,000 orders per second. Orders are automatically matched and executed according to price and time priority. There are five types of acceptable orders: At-auction Orders, At-auction Limit Orders, Limit Orders, Enhanced Limit Orders and Special Limit Orders. The settlement for stocks and funds traded on the SEHK is T+2. In contrast to the Mainland China, SEHK allows for day trading, which investors can organise with their brokers. Short selling is also permitted in the SEHK.

Compared to the SSE, investors in SEHK are subject to greater trading costs. In addition to brokerage fees, trading costs at SEHK include a Transaction Levy (0.0027%), Trading Fee (0.005%), and Stamp Duty on Stock Transactions of (0.1%). Per transaction, buyers are also subject to the Transfer Deed Stamp of HK$5.00 and sellers are subject to the Transfer Fee of HK$2.50.

SEHK also has a different board lot size compared to the SSE. The size of a single board lot of a stock is determined by the issuer company. Orders with an odd lot (i.e. number of shares less than a board lot) are not accepted by the trading system. Odd-lot orders are traded on a special lot market. Commonly, trading prices are lower for stocks traded on the special lot market, compared to the same stocks traded on the board lot market.

Block trades are also facilitated at the exchange, yet unlike SSE, block trades are executed and reported during the normal trading hours on the SEHK. For the purpose of this paper, block trades are not included. There is no universal minimum price change across stocks on the SEHK. The minimum tick size varies depending on the share price of a stock, as set out in Table 1.

Table 1 Minimum Tick in Securities Exchange Hong Kong

Prices of Securities			*Minimum Spread*
From	0.01 to	0.25	0.001
Over	0.25 to	0.50	0.005
Over	0.50 to	10.00	0.010
Over	10.00 to	20.00	0.020
Over	20.00 to	100.00	0.050
Over	100.00 to	200.00	0.100
Over	200.00 to	500.00	0.200
Over	500.00 to	1,000.00	0.500
Over	1,000.00 to	2,000.00	1.000
Over	2,000.00 to	5,000.00	2.000
Over	5,000.00 to	9,995.00	5.000

Moreover, there are no maximum price movement limits imposed at the SEHK. However, starting from late 2016, the SEHK will introduce a Volatility Control Mechanism (VCM), which will be applicable to the constituents of the Hang Seng Index and the Hang Seng China Enterprises Index. The VCM will be triggered if a stock price changes ± 10% away from

the last traded price 5-min ago. The VCM will put in place a 5-min cooling-off period, during which trades can only take place within the ±10% price band.

Having documented the details of China's markets and their unique history, as well as the specific features of both the SSE and the SEHK, it is now possible to explore the particulars of the SHHKConnect in more detail.

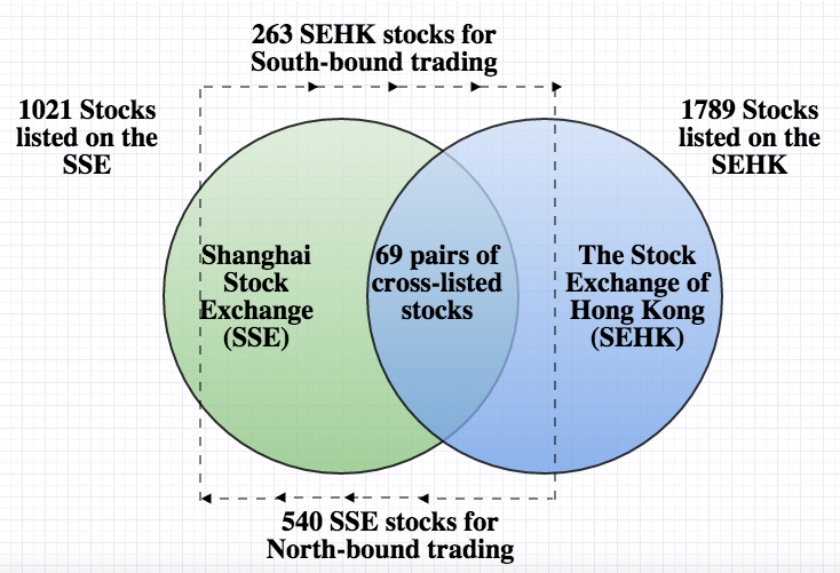
2.4. Shanghai-Hong Kong Connect (SHHKConnect)

The Shanghai – Hong Kong Connect (SHHKConnect) is launched and commenced operation on November 17, 2014. SHHKConnect creates mutual market access to trade designated stocks listed on either the SSE or the SEHK.

Figure 3 illustrates the trading mechanism of the SHHKConnect, the arrows highlight the directions of funds flow between the two markets. Among the 1,021 stocks that are listed on the SSE, investors in Hong Kong can invest in 540 of them, this is referred to as 'Northbound' trading. This sample of firms represents approximately 90% of the total market capitalisation of the SSE. On the other hand, mainland Chinese investors can invest in 263 SEHK-listed stocks, out of the possible 1,789 stocks that are listed on the SEHK. Otherwise known as 'Southbound trading', this represents approximately 80% of market capitalisation of the SEHK.

In general, the eligible SSE-listed stocks that can be traded under the SHHKConnect include all the constituents stocks of the SSE 180 Index and the SSE 380 Index, as well as A-shares that have corresponding H-shares cross-listed on the SEHK (but not included in the indices mentioned). The eligible SEHK-listed stocks to be traded under the SHHKConnect include all the constituents of Hang Seng Composite LargeCap Index and Hang Seng Composite MidCap Index, as well as all the H-shares that are not included in the indices mentioned above.

Figure 3 Shanghai Hong Kong Connect



Mainland Chinese investors, who have an aggregate amount of CNY 500,000 (i.e. USD 80,514) or more in their security and cash accounts with brokers, are eligible to invest in the SEHK through the SHHKConnect. SHHKConnect has provided mainland Chinese investors with greater and easier access to the Hong Kong stock market, whereas previously, mainland Chinese investors had limited ability to invest in the SEHK directly. They may have done so by opening a trading account with a Hong Kong – based broker; however mainland investors are subject to various constraints regarding funds flow in and out of China.

Although overseas institutional investors were able to invest in the SSE by acquiring QFII licenses and QFII quotas prior to the SHHKConnect, the program offers much greater freedom for international investors regarding their opportunity to invest in China. Moreover, SHHKConnect offers an unprecedented opportunity for international retail investors to access the historically closed Chinese capital market. Instead of purchasing ETF products that invest in Chinese securities, or investing in mutual funds via their brokers, investors can directly select and hold stocks listed on the SSE.

Under the SHHKConnect, the SSE and the SEHK establish two subsidiaries, namely, SSE Subsidiary and SEHK subsidiary, to act as a non-member trading participants of the other market. The function of the subsidiaries is to facilitate cross-boundary order-routing for exchange participants (EPs) of their home market. For example, the SEHK Subsidiary is established and located at the SSE as a local trading participant. The SEHK Subsidiary receives orders to trade stocks listed in China from EPs who are registered with the SEHK. It then routes the orders received to the trading system at the SSE for matching and execution. Similar arrangements are made by the SSE Subsidiary. For Hong Kong based investor trading SSE listed stocks, trading is labelled as Northbound Trading. In contrast, Southbound Trading is when Mainland Chinese investors trade stocks listed on the SEHK. The trading activities in both directions are limited to secondary market trading only, that is, investors cannot participate in IPOs cross markets.

Clearing and settlement under SHHKConnect is conducted by the China Securities Depository and Clearing Corporation Limited (ChinaClear) and the Hong Kong Securities Clearing Company Limited (HKSCC). ChinaClear and HKSCC established a clearing link whereby the two clearing houses act as a participant of each other. Under the SHHKConnect, in either direction, securities are traded in local currency but settled in CNY. For instance, for Southbound trades, Chinese investors will trade SEHK listed stocks in Hong Kong dollars. These trades will be settled with ChinaClear or its clearing participants in Chinese CNY. For the Northbound trades, HKSCC will settle such trades with its clearing participants and ChinaClear in CNY. This implies that all currency conversions are conducted outside of China, which strategically supports the Chinese government to internationalize the Chinese CNY. The stock and money settlements in both directions follow clearing and settlement cycles in the other market. That is, the Northbound trades are settled following settlement rules in the SSE, which is T day for stock settlement and T+1 for money settlement; visa versa for the Southbound trades.

During the period examined in this study, quotas is imposed for either trading direction (ie North- and South-bound). The trades are subject to a maximum cross-boundary investment quota, namely, Aggregate Quota, as well as the Daily Quota. The quotas aim to cap the amount of fund inflow and outflow into and out of Mainland China under Northbound and Southbound Trading, respectively. Purchasing activities through the SHHKConnect will be suspended when either quota is reached. Sell orders are always allowed regardless of quota level. The two exchanges distribute market data regarding respective trading quotas free of charge. The SSE updates the daily quota balance for Southbound Trading every 1 minute and SEHK updates the real-time daily quota balance for the Northbound Trading every 5 seconds.

In general, under the SHHKConnect, home rules apply to either direction of trading. For the Northbound Trading, Hong Kong based investors are subject to rules of the SSE and visa versa. However, there are some trading arrangements under SHHKConnect that are modified based on the original trading rules in the home market. The exceptions include acceptable order types, order submission time, permitted trade type and permitted trading strategy (uncovered short selling is not allowed for the Southbound Trading).To summarise, the SHHKConnect is a bilateral investment channel enabling institutional and retail investors to trade on both SSE and SEHK. It is the latest development in China's financial liberalisation and represents unique opportunities for investors, as well as for research.

3. Literature Review

This section outlines the relevant literature and formulates hypothesis to be tested in this study. Three strands of literature are reviewed, including first the theoretical and empirical evidence surrounding the impact of market liberalisation. The SHHKConnect as aforementioned, marks the next evolution in China opening its financial markets to the broader international investment community. Much of the market liberalisation literature focuses on the economy benefits of open markets. In this study, however, the focus is liquidity. The second strand reviews the theoretical and empirical literature on market liquidity. The review especially defines liquidity and the metrics that have been espoused by the literature in order to track liquidity variation and the events or factors which influences liquidity degradation or improvement. The final strand of literature reviews the empirical work, which examines the integration of markets in the presence of cross-listed stocks.

3.1 Equity Market Liberalisation

There is a rich body of literature examines market liberalisation as well as market integration. Several studies use the terms interchangeably, however, these are two distinct events. Bekaert and Harvey (2003) distinguish the difference between market integration and market liberalisation. They suggest that market or capital liberalisation relates to capital flows across markets. Whereas, market integration means that for two assets, which bear the same risk, will have same return regardless their domiciles. Further, Henry (2000) defines "stock market liberalisation [a]s a decision by a country's government to allow foreigners to purchase shares in that country's stock market." It is important to note that for the purpose of this section, we focus on market liberalisation.

The benefits of equity market liberalisation have been vastly modelled and examined in the literature. In this section, we categorise the literature into an examination the impact of market liberalisation on the firm, economy, and markets.

3.1.1 Impacts of Market Liberalisation on Firms

At the individual firm level, participation of foreign capital directly decreases the cost of equity and the equity risk premium by providing greater funding options (eg. Hubbard, 1997). In addition, Bekaert and Harvey (2000) suggest that improved risk sharing between domestic and foreign investors post-liberalisation reduces the cost of capital, consistent with empirical evidence reported by Iwata and Wu (2009) for several developing countries. Bekaert and Harvey (2000) also find that market liberalisation is accompanied by a small increase in stock return volatility.

Galindo et al. (2007) report affirmative evidence to support their proposition that capital allocative efficiency is positively correlated with financial liberalisation as more investment funds are distributed or available to firms with a higher marginal return to capital. Levin and Zervos (1998a) test if market liberalisation induces a permanent increase in stock growth rate. However, the paper does not find any significant relation between market liberalisation and permanent stock growth rate. Later, Henry (2000a) suggests that increasing market liberalisation results in temporary increase in the growth rate of stocks due to significant decreases in cost of capital.

3.1.2 Impacts of Market Liberalisation on Macro-economy

At a macro-economic level, Henry (2000b) studies the impact of capital liberalisation on the changes of private investment. By conducting an event study covering 11 developing countries, Henry (2006b) shows that developing countries experience significant but temporary growth in their private investment (that is, physical project investments) after opening up their stock markets.

Edison et al. (2002) and Bekaert, Harvey and Lundblad (2005) examine economic growth after capital liberalisation. By revisiting previous literature on capital account and stock market liberalisation, the former find there is mixed empirical evidence in long-run economic growth after countries allow foreigners to invest in local the market (both stock markets and physical investment). Edison et al. (2002) confirms liberalisation effects are most pronounced for developing countries in the East Asia. Bekaert, Harvey and Lundblad (2005) further show that equity market liberalisations lead to a 1% increase in real GDP across 50 countries, on average. Quinn and Toyoda (2008) draw similar conclusions for a larger sample set. Moreover, they find markets might also benefit from capital liberalisation due to improved market governances. Bekaert, Harvey and Lundblad (2005) also suggest that the introduction of foreign capital facilitates market reform aims at enhancing investor protection and corporate governance.

3.1.3 Impacts of Market Liberalisation on Stock Markets

Kwan and Reyes (1997) use market index data from the Taiwan Stock Market, to examine the impact of allowing direct participation of foreign investors in the local market. Examining the period 1988 to 1994, the paper finds that index returns are less volatile following

market liberalisation. Applying a GARCH model, the paper finds that after the market liberalisation, information flow is more efficient as old news has less impact on the current price change. Cajueiro, Gogas and Tabak (2009) also study market liberalisation on stock market efficiency. The market they examine is the Greek Stock Exchange. By testing the Hurst exponents (an indicator for autocorrelation) in end-of-day stock prices, the study finds that after the market liberalisation in the early 1990s, stocks' returns approximate a random walk, consistent with semi-strong form efficiency.

To date, the impact of market liberalisation on market liquidity has been limited. Levine and Zervos (1998), who examine the effect of capital liberalisation for 16 emerging markets, find that markets become more liquid after capital liberalisation events. They also find that markets tend to be more volatile after the liberalisation of international capital flows. However, in their paper, liquidity is measured as the ratio of trading turnover to a countries' GDP and market capitalisation. While this is one measure of market liquidity, this measure does not reflect the efficiency of the financial markets. The current study contributes to existing literature by examining market liquidity as it relates to market efficiency and transaction costs following market liberalisation.

3.1.4 Market Liberalisation in China

Existing literature that examines market liberalisation in China focuses on the Chinese economy reform during the late 20th century. The market liberalisation then involves "government initiatives to break the state monopoly in the market, free price controls, reduce entry barriers, and privatize state-owned enterprises (SOEs)" (Park, Li and Tse, 2006)

At a macro-economic level, Maurer-Fazio and Hughes (2002) study the impact of labour market liberalisation reform on the earnings gap between Chinese men and women. Their paper suggests that, overall wages are higher in liberalised sectors, yet, the gap between men and women's earnings becomes larger for those more liberalised sectors.

At an individual firm level, Park, Li and David (2006) study the impact of market liberalisation in China on individual firms' productivity and profitability. Using data that covers 23,577 firms from 1992 to 1996, they find that market liberalisation has a positive impact on Chinese firm performance. The paper suggests that market liberalisation leads to decentralisation of control to the local governments and privatisations of state-owned enterprises (SOEs). Therefore, government officials who run the local governments and managers who manage the SOEs have more incentives to improve their performances. It is because after market liberalisation, local governments' performances and enterprises' revenue are directly tied to individual performances of those government officials' and SOEs managers'.

3.2 Liquidity

The following subsection defines liquidity and the characteristics of a liquid market. The literature which is reviewed, focuses on the concept that a liquid market is one in which it is cheap to trade (Harris, 1990). Set out are the various transaction cost measures proposed in the literature, followed by a discussion of factors and events which influence market liquidity.

3.2.1 Definition of liquidity

Black (1971) describes a liquid market as one in which prices are always available and trade can take place immediately. Kyle (1985) defines three properties of a liquid market: tightness, depth, and resiliency. The tightness measures the difference between prices quoted by buyers and sellers; depth reflects the ability to absorb large order flow without moving market price; and resiliency measures how quickly prices bounce back from temporary random shocks. Liquidity plays an important role in financial markets as market liquidity affects asset pricing and security returns. Theoretical work by Amihud and Mendelson (1986) and the empirical evidence provided by Brennan and Subrahmanyam (1996) find that improvements in market liquidity reduce a firm's cost of capital. Improved market liquidity also bolsters investor confidence, which translates into a reduced cost of capital for listed companies and lowers transaction costs, in turn supporting higher net investment returns for individuals and corporations.

Harris (1990) suggests that in a perfect liquid market, any quantity of a particular security can be purchased or be converted into cash, instantaneously without cost. Similarly, Foucalt, Pagano and Roell (2013), define liquidity as "the degree to which an order can be executed within a short time frame at a price close to the security's consensus value" (p.3). They suggest that in an illiquid market, the purchase price (ask price) of a security will deviate considerably from the price at which the security could have been sold (bid price). Thus, transaction cost, or the difference between bid and ask quote prices has become a ubiquitous measure for the liquidity of markets in the market microstructure literature. By definition, transaction costs reflect the tightness of a market, the cheaper something is to trade the greater the likelihood it is liquid.

Early studies make attempts to decompose bid-ask spreads which measure the difference between bid and ask quote prices of buyers and sellers, respectively. The literature suggests that the bid-ask spread covers three costs of trading: order processing costs, inventory holding costs and adverse information costs. Demsetz (1968) argues that the order processing costs are waiting costs, which are incurred after a party submits an order and waits for the order to be traded. Stoll (1978) focuses on the inventory holding costs. Stoll's work suggests that inventory holding costs are incurred by dealers who supply immediacy to other traders, and consequently, they will move away from their desired portfolio by selling (buying) stocks to (from) other parties. Thus, inventory holding costs compensate dealers (liquidity providers) from deviating from their optimal portfolio[16]. Though not explicitly named or estimated, the idea of adverse selection is first raised in Bagehot (1971). The paper develops a model that assumes dealers trade with only two types of traders: informed traders and liquidity traders. The paper suggests that dealers make losses to informed traders, and can gain from trading with liquidity traders. Therefore, adverse selection cost is the loss incurred when trading with counterparties that have superior information. Copeland and Galai (1983) expand Bagehot's work and suggest that dealers will quote bid-ask spreads to maximize his profit so that the revenue they generate trading with

[16]Bagehot (1971) suggests the inventory holding costs are occurred as losses to insiders. Amihud and Mendelson (1980) study dealer's pricing policy based on dealer's inventory position. Ho and Stoll (1981) estimating the optimal bid and ask prices based on the inventory costs dealers are exposed to.

liquidity traders will cover the loss they trade with informed traders. Thus, a part of spread is the compensation for adverse selection costs.[17] Several metrics have been constructed in the literature to reflect one or all of these components.

3.2.2 Measures of Liquidity and Transaction Costs

Trade-based liquidity measures

In previous literature, trading activities have been used as supplementary measures for liquidity. These trading activities including volume (Kim and Verrecchia, 1994; Chordia, Roll and Subrahmanyam, 2001; Aitken and Comerton-Forde, 2003; Brogaard, 2010), turnover (Baker and Stein, 2004), trade count (Fleming, 2003; Baker and Stein, 2004) and trade size (Brogaard,2010; Fleming, 2003). Such studies use these trade-based measures to evaluate market liquidity as they suggest a market is more liquid if there are more trading activities in the market. However, this ignores an important characteristic of a liquid market, which is being able to trade with minimal or no cost, i.e. lower spreads. In addition, theoretical work by Kim and Verrecchia (1994) and the empirical tests during market crisis carried out by Aitken and Comerton-Forde (2003) find that volume, as an indicator of market activity produces contradictory result to the generally accepted views in the market. Aitken and Comerton-Forde (2003) also criticize trade-based liquidity measures as they only reflect market liquidity in the past and do not have indicative information regarding current and future liquidity, especially for small stocks.

Apart from the traditional trade-based liquidity measures such as turnover and trade count, there are several measures developed using trade data to evaluate market liquidity in the context of transaction costs. Roll (1984) proposes a transaction cost measure of liquidity using a covariance spread model. The model only uses transactions price data to estimate the bid-ask spread of firms. The model is developed under a set of assumptions relative to the order arrival process and the dynamics between prices and quotes. It assumes that there are only order processing cost in bid-ask spreads, and stock price change is isolated from trade flows or inventory adjustments. The absolute bid-ask spread estimated by Roll's model is $2\sqrt{-cov(\Delta p_{t+1}, \Delta p_t)}$, where Δp_{t+1} and Δp_t represent the price changes of trades. As is indicated by the formula, it suggests that the bid-ask spread will result in negative correlation in price changes. This measure is further tested by Stoll (2000), who suggests that spreads are underestimated using Roll's measure. Lesmond et al (1999) introduces a measure that uses the occurrence of zero returns, while Amihud (2002) measures stock illiquidity as a ratio of absolute daily return over the dollar-value trading volume on the day. The ratio aims to capture the stock price reaction to trading volume, or the price impact of order flow. This measure attempts to incorporate the concept of 'depth' as one of the characteristics of liquidity identified in Kyle (1985). A shortcoming of these measures, is however failure to have on hand quote information.

[17]Glosten and Milgrom (1985) develop a theoretical model and assume that adverse selection cost is the only component in the bid-ask spread. Their model aims to define the parameters of spreads, such as quality of insiders' information, arrival patterns of insiders etc. Easley and O'hara (1987) suggests that trade size will induce adverse selection problem. It is because that informed traders will prefer to trade larger amount of shares at a particular price.

In today's financial markets, this data is more readily available vis-à-vis the nascent market microstructure literature. Next reviewed are the quote based measures of liquidity.

Quote-based liquidity measures

Two traditional quote based measures of liquidity and transaction costs exist: depth and bid-ask spreads. A rich body of literature that centers around market liquidity most often examine spreads and depth as liquidity measures: Chung et al. (1999), Chordia, Roll and Subrahmanyam (2000), Goldstein and Kavajecz (2000), Chordia et al. (2002), Aitken and Comerton-Forde (2003), Frino et al. (2013), Baker and Stein (2004), Lee (2009), etc.

Market depth is a measure that captures the thickness of the market. It determines the ability and quantity participants can trade in the market in a short time. Most of the existing literature calculate depth as quoted depth at the best bid and ask quote. It is the aggregation of the available shares (or value of shares) recorded in the limit order book that can be bought (sold) at the prevailing lowest ask price (highest bid price). In the case where quoted depth at the best bid (ask) is significantly larger than the quoted depth at the best ask (bid), there is an order imbalance, which impacts trading price and market liquidity, e.g. Chordia et al. (2002). Several studies have also examined the depth of the limit order book beyond the best bid and ask (Bias et al 1995; Ahn et al 2001 and Irvine et al 2000) in order to model the supply and demand functions in markets, however most studies rely on the inside quotes.

Generally, the difference between the market lowest quote to sell (ask) and the market highest quote to buy (bid) order is the bid-ask spread. The spread is typically measured relative to the midpoint prices, to avoid bid-ask bounce, and is commonly referred to as the relative bid-ask spread. In addition, there are other variations of spreads which reflect the implicit components of trading costs. Effective spreads, for example measure the round trip of a transaction, it can be viewed as the gross revenue earned by a liquidity provider. It incorporates prices and quotes in order to reflect how much any trade consumes one side of the order book. Realised spreads, measures that part of transaction costs that is non-informational, it is the net profit for liquidity providers. The difference between effective spread and realised spread is the permanent impact on the prevailing price or adverse spread, it can be interpreted as the loss of a liquidity provider from trading with an informed counterparty.

Among the measures aforementioned, effective spreads best reflect both dimension of market liquidity, the depth and the bid-ask spreads. By incorporating trading price in the calculation, effective spread captures orders which 'eat' into the limit-order book by moving across quote levels or beyond the inside quote due to limited depth at prevailing prices in the market. A number of factors have been identified in the literature which affect liquidity. These are discussed in the following subsection.

3.2.3 Influential factors of liquidity

Market activities

Previous literature has identified several financial and economic elements that affect market liquidity. Demsetz (1968) suggests that spreads tend to increase proportionally with share

prices to equalize transaction cost for each dollar of security traded. The empirical statistics in the paper also shows that spreads are affected by the aggregate level of trading activity, which is measured by daily number of transactions in the paper. Demsetz (1968) finds that spreads decrease with higher transacting frequency in the market. Glosten and Milgrom (1985) also suggest a negative relation between spreads and trading frequency. Chordia, Roll and Subrahmanyam (2001) find that liquidity is influenced by market returns and volatility. In addition, they find that liquidity variations differ across bull and bear markets, that is, spreads increase significantly during downturns, and decrease marginally in bull markets. In addition, Chordia, Roll and Subrahmanyam (2001) identify market-wide factors that impact market liquidity. These factors include short- and long-term interest rates, default spreads, and indicator variables for holiday effects.

Order type and order imbalance

Cohen et al. (1981) build a theoretical model to study traders' choices between market orders or limit orders and their implications on market liquidity. The paper suggests that when spread is narrow, market orders will be submitted instead of limit orders to secure execution certainty. Consequently, some limit order will be cleared from the order book (i.e. market depth decreases) accompanied by larger spreads. This is a concept developed in their model called 'gravitational pull effect', which explains the phenomenon where there are many traders in the market, but still, the market spreads remains substantial. In addition, the paper concludes a positive relation between spreads and a security's thinness. However, it should be noted that the security's thinness is measured as the inverse of the order arrival rate and not depth. The 'gravitational pull' is also evident in Hasbrouck and Saar (2009), where they find fleeting orders[18] are part of traders' dynamic strategy to benefit from low cost of immediacy by switching to market orders when the prevailing spreads are tight. Similarly, Chung et al. (1999) conduct empirical test and find that on the NYSE, more investors submit market orders to hit the order book when spreads are tight, and they submit limit orders when spreads are wide. The papers aforementioned suggest that traders make choices between marketable or non-marketable orders by observing market prevailing spread. Meanwhile, such choices by traders will have impacts on the market spread. Chordia et al. (2002) study the relationship between order imbalance and market liquidity and find that there is a strong association between the changes in market liquidity and the absolute level of aggregated market order imbalance.

Investors' sentiment

Baker and Stein (2004) propose a theoretical model which helps to explain increases in liquidity. The paper suggests that the presence of irrational investors in the market will increase market liquidity. The model suggests that a class of irrational investors will underreact to the information revealed by order flows and push up liquidity in the form of lower quoted spreads, lower price impact or higher turnover. Consequently, the market is overvalued. Yet, there will be lower subsequent returns in both firm and overall market. The preliminary assumption for their model is that there are short-sale constrains, thus, when investors' sentiment becomes negative,

[18] Hasbrouck and Saar (2009) defines fleeing orders as "limit orders are cancelled within two seconds of submission".

the irrational investors are kept out of the market altogether as they cannot short sale, which may crash the market. The empirical work in their paper suggests that stock return, market liquidity (which is proxied by transaction costs), trading activity and investors' rationality are related to each other.

Information disclosure

Kim and Verrecchia (1994) develop a theoretical model, which confirms that greater information asymmetry induces higher spreads. Leuz and Verrechia (2000) undertake empirical analysis and find a positive relationship between liquidity and increased company disclosure. They study 14 German firms that commit to higher reporting standards and find market liquidity for those firms increases following the adoption of new standards. Heflin et al. (2005) also studies the relation between companies' disclosure policy and stock liquidity. Helfin et al. (2005) examine effective spreads and find a robust inverse relation between a companies' disclosure rating and effective spreads due to reduced information asymmetry. Frino et al. (2013) also study the impact of increasing corporate disclosure standards on the Italian market liquidity. By comparing companies that comply with IFRS from those which do not, they found that stocks liquidity improves regardless of trade sizes after adopting IFRS. Thus, their finding is consistent with earlier studies which conclude that better information disclosure will have a positive impact on stock liquidity.

Market structure and Trading Rules

The theoretical model constructed in Grossman and Miller (1988) suggests that specialist trading system can improve market liquidity when the trading volume is low. On the other hand, open outcry is preferred for securities that are actively traded. Studies including Neal (1992) and Mayhew (2002) compare trading costs between the aforementioned market structures in option markets and provide support consistent with findings by Grossman and Miller (1988). Huang and Stoll (1996) study market liquidity as proxied by trading costs (i.e. quoted spread, effective spread, realised spread and Roll's measure) under different dealer market and auction market structures. By calculating transaction costs for 175 NASDAQ (dealer-market) firms as well as their paired 175 NYSE (hybrid market) firms in 1991, the paper finds that the trading costs for the sampled stocks are twice as higher on the NASDAQ as their trading costs on the NYSE, suggesting that the trading costs are lower in auction markets. Later, Bessembinder and Kaufman (1997) examined the transaction costs on National Association of Securities Dealers (NASD) and NYSE in 1994. Different from the findings in Huang and Stoll (1996), Bessembinder and Kaufman (1997) find that the effective spread is only slightly smaller on the NYSE. However, they find that realised spreads, which measure the net profit for liquidity providers are much lower on the NYSE. They suggest that market makers in the dealer market can successfully cream-skim uninformed trades. Their finding suggests that trades executed on an auction market contain more information than trades executed in a dealer market.

Mayhew (2002) studies the differences in trading costs for securities that are listed on multiple markets (multiple-listed) and one single market (single-listed). The paper conducts empirical study on options traded on the Chicago Board Options Exchange market for the period from 1986 to 1997. The study finds that options that are multiple-listed will have smaller

quoted and effective spreads than options that are single-listed. However, as the trading volume increases, the difference in spreads between multiple- and single- listed options will be smaller.

In addition, previous literature finds that, like different market structures, different trading rules will have significant impact on market liquidity. Bessembinder (1999) revisits the comparison of trading costs on the NYSE and NASDAQ. He finds that in the wake of a reduction in tick sizes on NASDAQ, trading costs (measured by quoted spread and realised spread) are still higher on NASDAQ. Yet, the differences become smaller than they are in earlier years. Goldstein and Kavajecz (2000) also study the impact of changing minimum tick size on market liquidity. The paper finds that liquidity measure including spreads and market depth decline after NYSE reducing the minimum tick size. They suggest that traders who trade small orders are better off from the minimum tick size change, whereas, traders who desire to trade large quantity do not benefit from the change. Cumming et al. (2011) studies the impacts of the detailed trading rules on market liquidity. It uses month-end quoted bid-ask spread as one proxy for liquidity in the paper and finds that more detailed trading rules enhance market liquidity in the form of lower bid-ask spreads.

Stock markets nowadays are very different from how they were decades ago. They are now much more fragmented, and trading speed playing an important role in the modern stock markets. With the existence of multiple exchanges and different types of competing venues, such as alternative trading systems (ATS) and electronic communication networks (ECNS), stock markets are much more fragmented then before. It is especially true for relatively sophisticated capital markets, like the stock markets in the United States and European. O'Hara and Ye (2011) examine the impact of increasing market competition and fragmentation on market quality in the U.S. by studying the order flow fragmentation using data reported by the Trade Reporting Facilities (TRFs). The paper finds that in general, regardless of firm sizes, listed stocks are benefit from market fragmentation with narrower effective spreads, i.e. lower transaction costs and higher liquidity. Moreover, the paper finds that for large and already liquid stocks, with their order flows migrated from main exchange, their transaction costs further decrease and trading of such stocks becomes more liquid. Degryse, De Jong and Van Kervel (2014) suggest that market fragmentation improves liquidity, which is resulted from increasing competition among liquidity providers. Their finding is evident from lower market spread and larger market depth.

Transparency in markets has also been shown to influence market liquidity, both pre- (Boehmer, Saar and Yu 2005) and post-trade (Gemmil 1996) transparency. More recently the focus in the literature has shifted to the advent of dark pools. Empirical study by Buti, Rindi and Werner (2011) uses detailed dark pool trading activity data in the U.S. in 2009, they find that stocks with higher dark pool trading activities have lower transaction costs in the form of quoted spread and effective spread, yet, their tests on the transaction costs do not control for stock capitalisation or stock prices. Zhu (2013) builds a theoretical model, which studies trading in dark-pools and their impact on price discovery and liquidity. The model suggests that dark pool trading tends to attract uninformed orders, and leave informed traders trading on the exchange. Thus, it improves price discovery on the exchange. However, on market effective spreads will be wider with more uninformed order flow migrate to dark pools, i.e. market is less liquid. The empirical study by Degryse, De Jong and Van Kervel (2014) confirms that dark markets generally

attract uninformed order flows. Consequently, on market adverse selection costs increases and result in higher spreads and transaction costs.

In addition, market structure today has spurred the proliferation of new trading strategies and trades, so called algorithmic and high frequency traders. In the seminal paper Hendershott et al (2011) examine the introduction of AutoQuote on the NYSE to examine the influence new trading infrastructure which assists algorithmic traders. They find that algorithmic trading increased with each innovation and was accompanied by an improvement in market quality. Hendershott and Riordan (2013) study the impact of algorithmic trading (AT) on the supply and demand for market liquidity. They conduct empirical tests on 30 Deutscher Aktien Index stocks on the Deutsche Boerse for the first 13 trading days in 2008. They find that AT consumes market liquidity when prevailing bid-ask spread is tight and AT supplies liquidity when the market is less liquid (as measured by bid-ask spread). Hasbrouck and Saar (2013) categorise algorithmic trading into two groups: agency algorithms and proprietary algorithms. Similar to the finding in Hendershott and Riordan (2013), Carrion (2013) finds that HFTs provide liquidity by submitting limit orders when the market is less liquid and HFTs take liquidity when liquidity is plentiful in the market, where liquidity is proxied by effective spreads. Jarnecic and Snape (2014) find that passive order flows from HFT participants increase market depth, and HFT narrows bid-ask spread as traders are more likely to supply liquidity when the bid-ask spread is wider, which is consistent with the findings in previous literature. Yao and Ye (2014) compare the different impact of Non-HFT traders' and HFT traders' trading activities on market liquidity. They suggest that Non-HFT traders provide the best quotes, which narrows bid-ask spread more frequently for stocks with relative small tick size. And they supply more liquidity, which is measured by quoted depth for those stocks. On the other hand, HFT traders have comparative advantage in jumping the line for stocks with larger tick size. In which case, HFTs supply more liquidity and put downward pressure on best quoted spreads.

Furthermore, higher trading speed offered by more advanced market infrastructure itself also affects trading transactions in a market. Frino, Mollica and Webb (2014) find that the introduction of colocation in futures markets improved market liquidity as measured by an increase in depth and a reduction in bid-ask spreads, and Brogaard et al. (2015) confirm this result in equity markets. Conversely, Hasbrouck and Saar (2009) suggest as a byproduct of the development of technology and market infrastructure, the presence of fleeting orders[19] blurs the liquidity provision in the market place. It is because that market depth may not present true market liquidity due to the short duration of order submission and cancellation. Riordan and Storkenmaier (2012) examine the impact of market infrastructure upgrade on Xetra in 2007, the sole purpose of which is to reduce trading latency from 50 milliseconds to 10 milliseconds. By conducting tests for 110 stocks over 40 trading days, the paper finds that effective spreads decrease after the trading system upgrade, accommodated with much higher realised spreads and lower price impacts. That is, lower trading latency has positive impact on market liquidity and net profit for liquidity suppliers as adverse selection costs for liquidity suppliers drops in a more efficient trading system.

[19] Hasbrouck and Saar (2009) defines fleeing orders as "limit orders are cancelled within two seconds of submission".

Market co-movement

For individual stocks, their liquidity might be influenced by other stocks' liquidity in the market (Chordia, Roll& Subrahmanyam (2000), Huberman and Halka (2001) and Hasbrouck & Seppi (2001)). All three papers identify the existence of at least modest co-movements in stock liquidity in 1992, 1996 and 1994 respectively. Both the Huberman and Hasbrock studies find a relation between systematic liquidity and stocks return. Huberman and Halka (2001) finds that liquidity proxies are positively correlated with stock returns and Hasbrouck & Seppi (2001) finds that the commonality in order flows, which is proxied by dollar volume, explains two-thirds of the commonality in stock returns. Yet, there are large differences in the number of sampling stocks and Hasbrouck & Seppi (2001) uses different liquidity proxies from the other two papers. In addition, instead of regressing on daily average value over all the liquidity proxies, it computes proxies on 15-minute interval. The concept of commonality in liquidity is particularity important for cross-listed stocks.

3.3 Price Divergence in Cross-listed Stocks

De Jong et al. (2009) define dual-listed stocks as those where "two companies incorporated in different countries contractually agree to operate their businesses as if they were a single enterprise, while retaining their separate legal identity and existing stock exchange listings". On the other hand, studies suggest that cross-listed stocks represent one single company being listed in different stock markets (e.g. Domowitz et al. 1998, Chemmanur and Fulghieri 2006, Doidge et al. 2009).

Theoretically we expect assets which bear the same risk and income stream will be priced closely if not the same. This is because market participants will arbitrage away any advantageously different prices and bringing securities' prices close to their fundamental values and maintain market efficiency (Shleifer & Vishny, 1997). However, empirically we often observe price divergences arise between two similar or identical securities. The following subsections reviews literature that study price divergences in cross- or dual-listed stocks. Specifically this section focuses on a branch of literature which has identified a significant price differential and explores the various factors identified by the literature including the different liquidity of stocks, information asymmetry in the home and listing markets, divergence in market sentiment, different risk exposures in markets, and market microsturcture.

3.3.1 Price divergence caused by liquidity

For a company that is listed in different markets or issues different classes of shares, previous literature reports the price difference between corresponding shares stems from different liquidity provisions for each class of shares. Furthermore, such liquidity differences arise due to for example, ownership restrictions and investors demand for a certain class of stocks.

Bailey and Jagtiani (1994) and Domowitz et al. (1997) suggest that ownership restrictions impact the liquidity of different classes of shares, resulting in a price divergence between the two classes of shares. Baily and Jagtiani (1994) examine the price premium between stocks listed on the Alien Board and those listed on the Main Board in the Thailand Stock Exchange. There are

two boards in the Thailand market, namely, the Alien Board and the Main Board. The Alien Board is only accessible by foreign investors, whereas, the Main Board is open to both local Thai and foreign investors. Once the foreign ownership of a firm reaches a certain limit (generally 50%), foreign investors are required to submit their orders and trade on the Alien Board, whereas, local Thai investors continue trading on the Main Board. Examining monthly excess returns during January 1988 and December 1992, Baily and Jagtiani (1994) find that tighter foreign ownership limits results in a higher price premium on the Alien Board, moreover they show foreign investors are willing to pay more, for more liquid stocks.

Domowitz et al. (1997) analyses the Mexican stock price premium between A-Series shares (traded only by Mexican individuals) and B-Series shares (tradable by all investors), where both series of shares have the same voting rights and income streams. The study finds a significant price premium for B-Series shares over A-Series shares. The authors suggest that the price divergence arises from the different market liquidity between the two classes of shares. A-Series shares are much less liquid due to ownership restrictions and domestic control over those companies; shareholders in A-Series shares are reluctant to trade their shares, consequently, both supply and demand of A-Series shares are less than B-Series shares. Those findings support the finding in the previous paper, Eun and Janakiramanan (1986). The paper finds that in the presence of an international investment barrier, local investors pay more for local stocks as they bear ownership constraints and have limited investment opportunities.

Studies in China's stock markets also support the liquidity hypothesis. Chen and Xiong (2001) study price differences between common shares and restricted institutional shares (RIS). RIS can only be traded privately or through irregularly scheduled auctions which incur high illiquidity costs. The authors find that the prices of RIS are largely discounted compared to their corresponded common shares. Wang and Jiang (2004) and Lee (2009) exam the price difference between A- and H- shares, and both of their models include liquidity proxies. Wang and Jiang (2004) incorporate H-share trading volume relative to total shares outstanding while Lee (2009) includes depth to proxy liquidity. Both paper find a negative relation between the A-to-H share premium (return premium) and the liquidity of the H-share.

3.3.2 Price divergence caused by information asymmetry

Several paper model price differences across various classes of shares in response to information asymmetry amongst different groups of investors. In Bailey and Jagtiani (1994), they find that the price premium for stocks that can only be traded by foreigners is positively correlated to its trading activity as well as firm size. They suggest that larger firms provide richer public information, which attract foreign investors. Consequently, trading in such stock is more active. Karolyi and Li (2003) also document that information asymmetry is less severe in larger firms.

Extant literature has also shown information asymmetry as a cause for price divergences between Chinese A- and B-shares, or A- and H- shares. Chakravarty et al. (1998) document that the B-share price discount is negatively correlated with the number of news items reported to the market. It suggests that foreign investors bear higher information asymmetry risk compared to Chinese local investors. Chakravarty et al. (1998) suggest that the information barrier may stem

from language and different accounting standards. In further analysis and different tests, Rui et al. (2007) and Chan et al. (2008) provide consistent findings in support of the asymmetric information argument to help explain the A- and B-share price premium.

Wang and Jiang (2004) test the price difference between A- and H-shares, and unlike Chakravarty et al. (1998), the Granger-causality test results along with F-statistics in their paper do not show Granger-causes between returns of A- and H-share. Thus, they conclude that information barriers are not significant causes for the price divergence between the two stock classes.

3.3.3 Price divergence caused by differential risk exposures

The differential risk hypothesis, developed from asset pricing theory, suggests in light of a discounted cash flow model, given cross- or dual-listed stocks produce the same income and carry same rights, the reason for any price deviation is due to the discount factor, i.e. the risk exposure. Local market risks factors include local investor sentiment and trading behavior. Bodurtha et al. (1995), adopts a multifactor model which accommodates market segmentation and investor sentiment (demand). They find that the premiums on closed-end country funds do not move together with the premiums of domestic funds, instead, it is affected by local risk factors or country-specific sentiment. Similar findings are reported by Froot and Dabora (1995). Suh (2003) conduct similar study over U.S. ADRs, he also finds that the prices of ADRs co-move with U.S. market return and U.S. market sentiment. In the context of Chinese stock markets, market sentiment as reflected by herd trading has been shown to exist. Chiang et al. (2010) document herding behavior in the two Chinese stock markets in both up and down market. The herding information is not evident in the B-share market, which is dominated by institutional investors. In addition to local risk factors, if investors simply perceive that they bear more or less risks than other investors, it can cause price deviation between share classes, as documented by Chan and Kwok (2014)[20].

3.3.4 Price divergence caused by market microstructure

Ahn, Cao and Choe (1998) examine the impact of market structure changes in one market and its implications for cross-listed stocks. Specifically they study the impact of decimalization on the Toronto Stock Exchange (TSX) on market competition and market quality across the TSX and two U.S. markets. They take sample of 189 TSX-listed stocks, which are also cross-listed on the NYSE, American Stock Exchange (AMEX), or NASDAQ/National Market System (NMS). They find that the decimalization on the TSX resulted in a significant reduction in the quoted and effective spreads, and a reduction in quoted depth for the TSX-listed stocks. However, such reductions in transaction costs in the TSX do not have unified impact on the corresponding stocks that are listed on other markets. The effective spreads for TSX stocks that are cross-listed on Nasdaq decreases significantly, whereas, there is no significant impact on the

[20] Chan and Kwok (2014) suggest that the A-share premium reflects that international and local investors have different opinions regarding risk of underlying assets.

stocks' transaction costs, which are cross-listed on the NYSE and AMEX. Another important finding in the paper is that they do no observe order flow migration from the U.S. markets to the TSX even after the signification transaction reduction on the TSX. Sabherwal (2007) finds that trading is more active on the market with lower spreads and greater depths for cross-listed stocks. The paper takes sample of 126 Canadian firms that are cross-listed on TSX and on either NYSE or Nasdaq. It finds that the trading volume share in the U.S. is negatively related to the relative spread in the U.S. compare to it is in Canada. That is, for a cross-listed stock, if its transaction is cheaper in the U.S. compare to it is in Canada, its trading volume share in the U.S. will be larger. Grossmann, Ozuna and Simpson (2007) examine the price premium of 74 American depository receipts (ADR), which are cross-listed from nine countries. The sample period is from 1996 to 2003. Testing with a fixed-effects panel data model, the paper investigates investors' sentiment differences, dividend payments, and transaction costs on ADR premium. Their finding support the mispricing explanations related to costly arbitrage. They find that the higher the transaction costs (measured by bid-ask spread) in the U.S. market, the higher is the premiums. However, their finding is contradict with differential market sentiment hypothesis as they find that ADR premium is lower when there is more optimistic U.S. investors.

3.4 Hypotheses Development

In this section, a set of testable hypotheses are developed in view of the extant research reviewed.

3.4.1 Impact of SHHKConnect on market liquidity

SHHKConnect creates a mutual investment channel between the SSE and the SEHK. It effectively removes the ownership restrictions in the SSE and affects stocks that are listed on the SEHK in being more accessible for mainland Chinese investors. Thus, by allowing investors in the two markets to invest in designated stocks in another market, the SHHKConnect partially liberalises the two stock markets, this is especially true for the SSE.

Hubbard (1997), Bekaert and Harvey (2000) and Iwata and Wu (2009) suggest that market liberalisation events improve risk sharing between local and foreign investors. Moreover, market liberalisation promotes more efficient capital allocation as suggested in Galinda et al. (2007). In addition, empirical studies Kwan and Reyes (1997) and Cajueiro, Gogas and Tabak (2009) report affirmative evidence that market liberalisation has positive impact on stock market efficiency.

Given liquidity is a major component and measure of a markets efficiency the following hypothesis are tested:

H1. The introduction of SHHKConnect decreases spreads for SHHKConnected stocks

H2. The introduction of SHHKConnect increases depth for SHHKConnected stocks

3.4.2 Impact of SHHKConnect on price divergence between cross-listed A- and H-shares

Studies suggest many reasons which result in price divergence between cross-listed stocks. Bailey and Jagtiani (1994) and Domowitz et al. (1997) suggest that different liquidity provisions and different degree of stock ownership restrictions between classes of stocks will result in price divergences even if the stocks produce same income streams. In the case of SHHKConnect, as the two hypotheses proposed in the Section 3.4.1 above, in this study, the liquidity for cross-listed H-shares are expect to be improved[21] after the SHHKConnect, thus, the A- and H-share price divergence is expected to be narrower under liquidity hypothesis. Moreover, as Chinese investors are now able to purchase shares in HK more freely via the SHHKConnect, they are more likely to substitute A- and H-shares thus the premium should reduce. Thus, the following hypothesis is tested:

H3. The A- to H-share premium will be narrower after the introduction of SHHKConnect

This paper will contribute to literature that centers on market liberalisation and liquidity in two areas. Firstly, almost all the examinations on market liberalisations events focus on the overall markets' performance as the focus has been opening up a particular stock market. Whereas in the event of SHHKConnect, it effectively removes investment constrains for designated shares. In other words, it is an event of partial market liberalisation. The paper also contributes to literature that studies A- and H-share premiums as the SHHKConnect creates a unique experiment that enables one to revisit the price divergences by testing liquidity changes in partially liberalised markets.

4. Data and Market Descriptive Statistics

4.1 Data

The data used in this study is obtained from the Market Quality Dashboard (MQD) database developed and managed by CMCRC. The data includes end-of-day security level metrics, which are calculated from source data maintained by SIRCA and distributed via the Thomson Reuters Tick History (TRTH) database. The TRTH data includes the best level bid and ask quotes, and trading statistics for each trade and quote message in the two markets. The trading statistics include trading price, trading volume and trading value. For each trade and quote, TRTH provides a time stamp up to millisecond. Table 2 describes each of the metrics obtained from the Market Quality Dashboard, and the metrics are examined in the subsequent sections.

Table 2 Metric Description and Estimation Procedure

Variable	Description	Calculation

[21] Cross-listed A- and H-stocks are eligible for trading under SHHKConnect. Refer Section 2.4 for details.

Quoted depth in dollar value ($Depth) $Var[1]$	For each security, end-of-day quoted depth in dollar value is the aggregate value of the time-weighted best bid and ask value throughout a day. This variable measures the thickness of the supply and demand of a security, at certain price.	$QuotedBid_{s,d} = \sum_{i=1}^{i} BidPrice_{i,s,d} \times BidVolume_{i,s,d} \times TW_{i,s,d}$ $QuotedAsk_{s,d} = \sum_{i=1}^{i} AskPrice_{i,s,d} \times AskVolume_{i,s,d} \times TW_{i,s,d}$
Quoted depth by volume $Var[2]$	For each security, end-of-day quoted depth by volume is the aggregate volume of the time-weighted best bid and ask volume throughout a day.	$\$Depth_{s,d} = QuotedBid_{s,d} + QuotedAsk_{s,d}$ $QuotedBid\_by\_volume_{s,d} = \sum_{i=1}^{i} BidVolume_{i,s,d} \times TW_{i,s,d}$ $QuotedAsk\_by\_volume_{s,d} = \sum_{i=1}^{i} AskVolume_{i,s,d} \times TW_{i,s,d}$ $QuotedDepth\_by\_volume_{s,d} = QuotedBid\_by\_volume_{s,d} + QuotedAsk\_by\_volume_{s,d}$ $TW_{i,s,d}$: is the time-weight of a quote
Effective Spread $Var[3]$	Effective spread compares the execution price to the prevailing midpoint before the trade. Modified upon the classification of trading direction in Lee and Ready (1991)[22], trading direction ($D_{i,s,d}$) can take a value as: If $P_{i,s,d} > Mid_{i,s,d}$ then $D_{i,s,d} = 1$; if $P_{i,s,d} < Mid_{i,s,d}$ then $D_{i,s,d} = -1$; if $P_{i,s,d} = Mid_{i,s,d}$ and $P_{i,s,d} > P_{i-1,s,d}$ then $D_{i,s,d} = 1$; if $P_{i,s,d} = Mid_{i,s,d}$ and $P_{i,s,d} < P_{i-1,s,d}$ then $D_{i,s,d} = -1$.	$effective\ spread_{s,d} = \sum_{i=1}^{i} 200 \times \frac{D_{i,s,d} \times (P_{i,s,d} - Mid_{i,s,d})}{Mid_{i,s,d}} \times W_{i,s,d}$ $D_{i,s,d}$: indicates trading direction; $VW_{i,s,d}$: is the value weigh of the transaction over the total turnover of that security on the day; $Mid_{i,s,d}$: is the prevailing midpoint before the trade; $P_{i,s,d}$: *is the trade price.*
Quoted Spread(perc) $Var[4]$	Quoted Spread is calculated as the time-weighted percentage of the prevailing bid-ask spread over the midpoint.	$quoted\ spread_{s,d} = \sum_{i=1}^{i} \frac{Bid_{i,s,d} - Ask_{i,s,d}}{Mid_{i,s,d}} \times TW_{i,s,d}$
Trade size in dollar value (Trade size$)/ Trade size in volume $Var[5]/[6]$	This variable measures average value or volume of each trade; it is calculated on a daily basis.	$Trade\ Size\$_{s,d} = \frac{Total\ turnover_{s,d}}{Number\ of\ trades_{s,d}}$ $Trade\ Size\ Vol_{s,d} = \frac{Volume_{s,d}}{Number\ of\ trades_{s,d}}$
Trade Count $Var[7]$	Trade Count measures the total number of trades that occur for a security on a particular day	

i: stands for a quote or trade;s: stands for security;

[22] Trading direction ($D_{i,s,d}$) is assigned as 1 for buyer-initiated trade, -1 for seller-initiated trade, otherwise, the trading direction takes value of 0. Following the extant literature (see Lee & Ready (1991) and Ellis Michaley and'Hara (2000): if $P_{i,s,d} <= Ask_{i,s,d}$ and $P_{i,s,d} > Mid_{i,s,d}$ then $D_{i,s,d} = 1$; if $P_{i,s,d} >= Bid_{i,s,d}$ and $P_{i,s,d} < Mid_{i,s,d}$ then $D_{i,s,d} = -1$; in any other cases, $D_{i,s,d} = 0$.

d: stands for date

In order to evaluate the impact of the SHHK Connect, a one-year event sample window is identified, six months pre- and post- the launch of the SHHKConnect. Specifically from 19 May 2014 to the 15 May 2015.

It is important to recall that the SHHKConnect does not liberalise trading for all listed stocks on the both exchanges. Consequently, three security groups are created to isolate the impact of the SHHKConnect for specific stock groups that are expected to be affected. For both stock exchanges, we create the following three security groups:

1. *SHHKConnected stocks*: this security group includes stocks that are eligible to be traded through SHHKConnect. For such Northbound trading, that is, Hong Kong-based investors trading stocks listed in SSE, there are 540 SSE-listed stocks that are eligible to be traded through SHHKConnect. For the Southbound trading, 263 SEHK-listed stocks can be traded through SHHKConnect.
2. *Non-Connected stocks*: the second group consists of stocks that are not eligible to be traded through SHHKConnect. There are 481 and 1,526 stocks that fall into this group, in the SSE and SEHK respectively.
3. *The Cross-listed stocks*: this security group includes the 69 pairs of cross-listed stocks that are listed on both the SSE and SEHK. All cross-listed stocks are eligible for trading through SHHKConnect but have had a pre-existing arrangement for cross-listing since before SHHKConnect event.

Both the SSE and SEHK review and adjust stock eligibility for trading through SHHKConnect on a frequent basis. For example on the first day there were 541 SSE-listed stocks are connected, as of March 30, 2015 the number is 543. In the SEHK, on the first day there were 269 SEHK-listed stocks are connected, as of March 9, 2015 the number is 285[23]. In this study, for consistency, included in the sample are those stocks that were eligible for trading via SHHKConnect throughout the entire sample period examined. Any additional stocks that became eligible after November 17, 2014 are excluded from the sample. Similarly, if a stock is disqualified as an eligible stock during the sample period, it is removed from the sample pool. Similar rules apply to the cross-listed stocks group. If a stock is delisted from either exchange during the sample period, it is not included in the subsequent analysis.

Data for all trading days in the respective markets is examined[24]. For SSE, there are 243 trading days during the sample period, and 242 trading days for the SEHK. Additional filter rules, based on the trading frequency in each stock are also applied. Specifically, firstly, to avoid

[23] The date for two markets to adjust the eligible stocks to be traded through SHHKConnect is not synchronised.

[24] The two regions, the Mainland China and Hong Kong, have different holiday schedules due to their unique history. For instance, Good Friday (during our sample period, it is April 3, 2015) is a public holiday in Hong Kong, whereas in China, it is a normal trading day. Another example is the Dragon Boat Festival (during our sample period, it is on the June 22, 2015). Both regions celebrate the festival, but in the Mainland China, it is a national holiday, whereas in Hong Kong, it is a normal trading day.

bias from small sample size, stocks that have less than 20 trades on any particular trading day are excluded. Secondly, stocks that trade less than 80% of the trading days throughout the entire sample period are also excluded. Thirdly, extreme outlier observations according to filter rules set out in *Appendix 1* are removed. In the final sample, there are 170,026 stock-day observations for stock that are traded on the SSE and 194,414 stock-day observations for stocks that are traded on the SEHK.

To examine the price premium between cross-listed A- and H- shares, we only include data for the days when both markets are open for trading. In addition, because there is no price limit in the SEHK, an H-share may experience heightened volatility than the corresponding A-share on a particular day, biasing any comparison. Thus, following Lee (2009), we exclude stock days when a company's share price hit the ±10% limits on the SSE. In the final sample, there are 14,657 paired stock day observations.

4.2 Market descriptive statistics

Table 3 and Table 4 report descriptive statistics for the SSE and the SEHK markets respectively. The descriptive statistics include market capitalisation and levels of daily trading activities for each of the markets and by category of stock grouping as aforementioned.

Panel A in Table 3 shows that there are 1,021 firms listed on the SSE during the sample period. Their market capitalisation is around CNY 28.8 billion (USD 4.7 billion) on average, which confirms that the typical SSE securities are large. Panel B reports the average market capitalisation for the 540 SSE-listed SHHKConnected stocks is around CNY 46.8 billion (USD 7.5 billion), approximately 5 times the average market capitalisation of the 481 Non-Connected stocks in the market (CNY 8.6 billion, i.e. USD 1.4 billion). The total average daily turnover for the SSE-listed SHHKConnected stocks is CNY 270.05 billion (USD 43.48 billion), which is more than double of the daily quota for the Northbound trading[25]. The average daily return for SHHKConnect stocks during the sample period is 0.36%, with a standard deviation of 2.85%. Compared to the Non-Connected stocks, which on average return 0.45% daily (standard deviation of 2.92%), stocks that are designated to be traded under the SHHKConnect in the SSE appear be larger in size and marginally less volatile. In addition, the daily trading activity figures including: daily trade volume, value and trade count show that the SHHKConnected stocks are much more frequently traded vis-à-vis other stocks. This is expected since most of SHHKConnected stocks are index constituent stocks.

Table 3 Summary Statistics Shanghai Stock Exchange Listed Stocks

			Aggregated Trading Activity		
	Market Cap. (mil)	*Daily Return (%)*	*Daily Trade Volume*	*Daily Trade Value*	*Daily Trade Count.*
Panel A: *Shanghai Market (Number of Securities: 1021)*					
Mean	28,803	0.39	32,311,951	351,659,621	12,788
Median	9,117	0.27	10,688,993	114,228,499	5,527
Std Dev	99,022	2.88	95,308,164	1,040,035,163	28,743

[25] The daily quota for the Northbound trading is CNY130 billion (USD 20.93 billion).

Panel B: *Connect Stocks (Number of Connected Securities: 540)*					
Mean	46,769	0.36	45,411,915	500,083,672	17,444
Median	16,327	0.24	15,379,237	174,144,634	7,823
Std Dev	133,109	2.85	117,969,190	1,286,498,648	35,183
Panel C: *Non-Connect Stocks (Number of Non-Connected Securities: 481)*					
Mean	8,633	0.45	10,231,547	101,486,181	4,940
Median	5,389	0.33	6,208,682	59,884,137	3,145
Std Dev	13,030	2.92	12,672,797	124,374,724	5,844

** Market Capitalisation is calculated based on the share prices on the March 30th, 2015;*
All the Market cap and daily trade value are converted to CNY using spot rate on the March 30th, 2015;
Market level daily return percentage is calculated using value-weighted average
All variables are averaged over the number of stocks in each stock group

Table 4 shows the descriptive statistics for the SEKH, for comparison purposes, the figures are converted into CNY from HKD. Panel A shows that there are 1,789 firms listed in the SEHK, with an average market capitalisation of around CNY 12.6 billion (USD 2.03 billion). Compare to the SSE, there are around 700 more stocks listed on the SEHK. However, the average market capitalisation of the SSE-listed stocks is almost 4 times the market capitalisation on the SEHK. This is predominately a result of the large state-owned Chinese enterprises listed on the SSE. For example, almost all the market capitalisations for the 'Big Four' banks are over CNY 1 trillion (USD 161 billion).

Table 4 Summary Statistics Stock Exchange of Hong Kong Listed Stocks

			Aggregated Trading Activity		
	Market Cap. (mil)	*Daily Return (%)*	*Daily Trade Volume*	*Daily Trade Value*	*Daily Trade Count.*
Panel A: *Hong Kong Market (Number of Securities listed: 1,789)*					
Mean	12,609	0.23	10,557,459	27,712,985	563
Median	1,353	0.00	1,434,000	1,495,124	76
Std Dev	69,413	4.18	94,223,071	147,187,405	1,496
Panel B: *Connect Stocks (Number of Connected Securities: 263)*					
Mean	62,400	0.14	18,244,074	134,903,104	2,258
Median	20,206	0.00	5,320,000	38,852,806	1,444
Std Dev	160,850	2.37	54,127,764	335,946,289	2,838
Panel C: *Non-Connect Stocks (Number of Non-Connected Securities: 1526)*					
Mean	4,028	0.25	9,026,791	6,367,767	226
Median	983	0.00	1,000,000	840,225	45
Std Dev	17,410	4.48	100,241,583	27,578,746	626

** Market capitalisation is calculated based on the share prices on the March 30th, 2015;*
All the Market cap and daily trade value are converted to CNY using spot rate on the March 30th, 2015;
Market level daily return percentage is calculated using value-weighted average
All variables are averaged over the number of stocks in each stock group

Panels B and C in Table 4 report market summary statistics for the SHHKConnected and Non-Connected stocks listed on the SEHK, respectively. Again, the average market capitalisation for eligible SHHKConnect stocks is larger than it is for the Non-Connected stocks

in the SEHK. The difference however, is even larger vis-à-vis SSE: the average market capitalisation for 263 SEHK-listed SHHKConnected stocks is CNY 62.4 billion (USD 10.05 billion), it is almost as 15 times as it is for the 1,526 Non-Connected stocks (CNY4 billion, i.e. USD 0.644 billion) in the market. The average daily return of SHHKConnected stocks is 0.14%, with a standard deviation of 2.37%. Comparing with Non-Connected stocks, which on average return 0.25% daily with a standard deviation of 4.48%, stocks that are designated to be traded under the SHHKConnect are immensely larger in size and less volatile on the SEHK. In addition, the daily trading activity figures including: daily trade volume, value and trade count show that the SHHKConnected stocks are much more frequently traded, which is expected as most of the SHHKConnected stocks are index constituents. Among the trading activity figures, the average daily turnover for SEHK-listed SHHKConnected stocks is CNY 35.48 billion (USD 5.71 billion), which is around a third of the daily quota for the Southbound trading[26].

Comparing the SHHKConnected stocks in both markets, the average market capitalisation is larger for the SEHK than it is for the SSE. Yet, the trading activities show that SSE-listed SHHKConnect stocks are traded much more frequently. The average trade count is more than 17 million per day in the SSE, whereas in the SEHK, the figure is only 2.3 million. The daily trade value in the SSE is CNY 500.01 billion (USD 80.15 billion), it is more than 3 times larger compare to the SEHK-listed SHHKConnected stock, which is CNY 134.9 billion (USD 21.72 billion). One highlight in the data shows that among the SHHKConnected stocks, SSE-listed stocks offer significantly higher average return of 0.36% (0.14% for SEHK-listed stocks), meanwhile, the return volatility of the SHHKConnected stocks in the two markets are of similar level (2.85% in the SSE versus 2.37% in the SEHK).

Table 5 reports descriptive data for the 69 pairs of cross-listed A- and H- shares between the SSE and SEHK. Although paired A- and H- shares are issued by the same companies and receive identical cash flows, the average market capitalisation varies substantially between the stocks listed in the SSE and the SEHK, consistent with Lee (2009) and the reported Hang Seng China AH Premium Index.[27] The average market capitalisation for A-shares is approximately CNY 184 billion (USD 29.6 billion), whereas, it is CNY 57 billion (USD 9.2 billion) for cross-listed H-shares. The difference between the two is more than 3 times. Table 5 reports the average returns of cross-listed A-shares are much higher on average than it is for the cross-listed H-shares, yet, the two classes of shares have similar risk. Cross-listed A-shares are much more frequently traded than their corresponding H-shares. There are large differences between average daily trading volume, turnover and trade count between the cross-listed stocks on the two exchanges. The daily trade volume for cross-listed A-shares is 121 billion shares, which is around 5 times more than the daily trade volume of cross-listed H-shares, which is 18 billion shares. Nevertheless, the average daily trade value of A-shares is CNY 1.2 trillion (USD 193 billion). It is around 8 times more than the daily trade value of H-shares (CNY 135 billion, i.e. USD 21.7 billion).

[26] The daily quota for the Southbound trading is CNY105 billion (USD 16.91 billion)
[27] Hang Seng China AH Premium Index: http://www.hsi.com.hk/HSI-Net/HSI-Net

Table 5 Summary Statistics for Cross-Listed Stocks

			Aggregated Trading Activity		
	Market Cap. (mil)	*Daily Return (%)*	*Daily Trade Volume*	*Daily Trade Value*	*Daily Trade Count.)*
Panel A: SSE-Listed Stocks					
Mean	183,782	0.40	121,127,241	1,212,249,752	37,130
Median	61,912	0.22	37,630,903	290,818,598	13,296
Std Dev	329,569	2.80	238,093,120	2,744,485,049	65,053
Panel B: SEHK-Listed Stocks					
Mean	57,411	0.14	18,244,074	134,903,104	2,258
Median	12,140	0.00	5,320,000	38,852,806	1,444
Std Dev	161,650	2.37	54,127,764	335,946,289	2,838

** Market capitalisation is calculated based on the share prices on the March 30th, 2015;*
All the Market cap and daily trade value are converted to CNY using spot rate on the March 30th, 2015;
Market level daily return percentage is calculated using value-weighted average
All variables are averaged over the number of stocks in each stock group

5. Methodology

Set out below is the methodology applied to evaluate hypotheses [1], [2] and [3] identified in Section 3.4.

5.1 Liquidity hypothesis

The liquidity proxies used in this study are quoted bid-ask spreads, effective spreads and quoted depth as identified by the literature examining changes in market liquidity. It should be noted that due to data limitation, the quoted depth examined in this thesis is of the top-level prices, that is, we only test quoted depth at the best prices. First, univariate tests are conducted pre- and post-November 17, 2014 across the various categories of securities (i.e. Overall Market, SHHKConnected, Non-connected and Cross-listed) traded on the SSE and SEHK. In addition to liquidity metrics, variables which the literature has identified as factors which influence market liquidity are also examined. The most common and consistent explanatory variables for liquidity examined in previous research are volatility, volume, trade size and trade frequency. The theory underpinning these variables is well developed in Stoll (1978) and Copeland and Galai (1983). Both volatility and trading activity reflect some dimensions of risk faced by liquidity providers. Price volatility measures the risk to liquidity providers per unit of time (e.g. offering to buy stock at a price level of $10 when price volatility causes the price to fall to $9). Hence, the higher the price volatility, the greater the compensation sought by liquidity providers. Trading activity reflects the length of time the inventory provider is exposed to this risk (e.g. the amount of time that the limit order is expected to be 'alive'). Hence the lower the trading activity, the longer a limit order will be 'alive'.

Turning to the multivariate analysis, the SHHKConnect creates a unique opportunity to exam the liquidity change by employing the difference-in-differences methodology. The difference-in-differences method attempts to capture the impact of the event (i.e. the introduction of SHHKConnect) by distinguishing the changes for connected stocks from the

changes of the stocks excluded from bilateral investment channel, providing a cleaner assessment of its impact.

The three liquidity models estimated are as follows:

$$Effective\ spread_{i,t} = \beta_0 + \beta_1 \ln Volume_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 InverPrice_{i,t} + \beta_4 D_{connect} + \beta_5 D_{nov2014} + \beta_6 D_{connect} * D_{nov2014} + \beta_7 FE_i + \beta_8 FE_t + \varepsilon_{i,t} \quad Eq[1]$$

$$Qtd\ spread_{i,t} = \beta_0 + \beta_1 \ln Volume_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 InverPrice_{i,t} + \beta_4 D_{connect} + \beta_5 D_{nov2014} + \beta_6 D_{connect} * D_{nov2014} + \beta_7 FE_i + \beta_8 FE_t + \varepsilon_{i,t} \quad Eq[2]$$

$$lnDepth_{i,t} = \beta_0 + \beta_1 lnVolume_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 InverPrice_{i,t} + \beta_4 D_{connect} + \beta_5 D_{nov2014} + \beta_6 D_{connect} * D_{nov2014} + \beta_7 FE_i + \beta_8 FE_t + \varepsilon_{i,t} \quad Eq[3]$$

where $\ln Volume$ is the natural logarithm of the total number of shares traded of a security in a day. $lnDepth$ is the natural logarithm taken over the total number of quoted volume at the best levels. $Volatility$ is calculated using a value-weighted intraday return measure. $InverPrice$ is the inverse of the close price of a stock, added to our model to control for the price variation across stocks, as per McInish and Wood (1992). $D_{connect}$, $D_{nov2014}$ and $D_{connect} * D_{nov2014}$ are the three dummy variables used in the difference-in-differences methodology. $D_{connect}$ is a dummy variable that tries to capture the differences in the treatment group and the control group. The treatment group is the group of stocks eligible for trading through SHHKConnect (ie. SHHKConnected stocks). The control group includes all the Non-connected stocks. If a stock is a SHHKConnected stock, $D_{connect}$ is equal to 1, otherwise it is equal to 0. $D_{nov2014}$ is a time period dummy that indicates the time when a stock-date is observed. If the stock-date is observed after SHHKConnect is launched, $D_{nov2014}$ takes value of 1, otherwise it equals to 0. $D_{connect} * D_{nov2014}$ is the interaction term. This term is our key interest for the model. $D_{connect} * D_{nov2014}$ equals to 1 for observations in the treatment group (SHHKConnected stocks), for the post- SHHKConnect period. FE_i and FE_t are added to control for the stock and time fixed effects, given the panel data examined. The coefficients of interest to examine the impact of the SHHKConnect on liquidity are:

$H_0: \beta_6 \neq 0$, the introduction of SHHKConnect improves market liquidity for the SHHKConnected stocks

$H_1: \beta_6 = 0$, the introduction of SHHKConnect does not improve market liquidity for the SHHKConnected stocks

5.2 Price Premium Hypothesis

To evaluate the impact of the introduction of the SHHKConnect on the price premium between cross-listed A- and H-shares, the model applied is based on a framework established in the prior literature examining the premium. Wang and Jiang (2004) use a multi-factor model as is the case in Boduratha et al. (1995) and Froot and Dabora (1999). The model estimated is:

$$Ah\_ratio_{i,t}$$
$$= \alpha_0 + \alpha_1 \text{Ah\_ratio}_{i,t-1} + \alpha_2 SSEIndex_t + \alpha_3 SEHKIndex_t + \alpha_4 \frac{HVol_{i,t}}{Hshare_{i,t}} + \alpha_5 \Delta Qtd_{i,t} + \alpha_6 VolaRatio_{i,t}$$
$$+ \alpha_7 Xrate_{i,t} + \alpha_8 D_{nov2014} + \varepsilon_{i,t} \qquad Eq[4]$$

where Ah_ratio is calculated as, $\frac{A-share's\ Price_{i,t}}{H-share's\ Price_{i,t}}$. This modification is derived from the methodology used to calculate the Hang Seng China AH Premium Index,[28] compiled and maintained by Hang Seng Indexes Company Ltd. Following Wang and Jiang (2004), in order to control for possible autocorrelation in the price ratio between A- and H-shares, the model above includes a first-order autoregressive term of A-/H- share price ratio, $\text{Ah\_ratio}_{i,t-1}$. SSEIndex_t and SEHKIndex_t are the inter-day returns of the market indices of the two exchanges, namely the A-Share Index and Hang Seng Index, respectively. These are included as control factors for overall market performance.

Previous studies have noted that price differences between effectively identical shares on two markets may result from variations in liquidity and the ability of investors to trade desired volumes. Chen et al. (2001) studies the price differences between A- and B-shares and finds that the A-share price premium over B-shares is primarily caused by the illiquidity in the B-share market. Longstaff (2001) argues that securities' prices will be substantially discounted where investors cannot trade the desired amount of stock. Considering the likely relevance of liquidity for the price of A- and H-shares, a liquidity proxy for H-shares is added to the model for this study, following Wang and Jiang (2004). $\frac{HVol_{i,t}}{Hshare_{i,t}}$ is a volume-based liquidity proxy. It is calculated as daily H-share trading volume divided by the total number of free-floated H-shares. As the proxy aims to show the velocity, i.e. how quickly the H-shares are changing hands, it is reasonable to use the total number of free-floating shares in the denominator since some portion of issued H-shares are not available to the market, for instance, due to state ownership. This practice is consistent with the calculation of Hang Seng China AH Premium Index, reported daily by the Hang Seng Indexes Company Limited (Hang Seng Indexes)[29]. $\Delta Qtd_{i,t}$ is a liquidity proxy in the form of transaction costs. It is the difference between the time-weighted quoted spreads by percentage of A- and H-shares. $VolaRatio$ is calculated as the intra-day volatility of an A-share over the intra-day volatility of its corresponding H-share, i.e. $\frac{\delta_A^2}{\delta_H^2}$. This variable measures the relative risk level of corresponding stocks, its purpose is to test the differential risk hypothesis (Eun and Janakiramanan, 1986; Sun and Tong, 2000; Chan and Kwok, 2014) $Xrate$

[28] Refer to http://www.hsi.com.hk/HSI-Net/HSI-Net for detailed methodology for the calculation of the Hang Seng China AH Premium Index

[29] The company calculates and manages the Hang Seng Family of Indexes, among which, Hang Seng Index is recognized as barometer for the SEHK. Most empirical paper that use index to evaluate SEHK performance would use Hang Seng Index (Wang and Jiang, 2004; Lee, 2009; Chan and Kwok, 2014). The Hang Seng China AH Premium Index was first released on the July 9, 2007 (information found from the official website). To my knowledge, it is the only one index that tracks the price premium between the two markets.

is the exchange rate between the Chinese CNY and the Hong Kong dollar. $D_{nov2014}$ is a time period dummy, it takes value of 1 if the date of the observation is on or after the SHHKConnect date (17 November 2014), otherwise it equals to 0. This dummy variable is our primary interest when testing the impact of SHHKConnect on the change of A/H share premiums.

The hypothesis of the price premium test is:

H_0: $\alpha_8 < 0$, the A- to H- share price premium will be narrower after the introduction of SHHKConnect

H_1 : $\alpha_8 \geq 0$, the A- to H- share price premium will not be narrower after the introduction of SHHKConnect

6. Empirical Results

6.1 Univariate analysis

Table 6 and Table 7 present summary statistics pre- and post- the launch of the SHHKConnect for a number of liquidity proxies and control variables for the SSE and the SEHK markets, respectively.

Panel A in Table 6 reports statistics for the universe of SSE stocks pre- and post-November 17, 2014. Firstly, SSE listed stocks are more actively traded after the launch of SHHKConnect. The market's average daily volume increases by more than 180% and average daily trade count increases more than 200%. The increased trading is also accompanied by a 0.13% increase in market volatility. This is consistent with a large number of studies that document positive relationships between volume and volatility.[30] In contrast, the average trade size by number of shares decreases post the SHHKConnect launch. Secondly, proxies for transaction costs, namely, effective spread and quoted spread decrease by 0.77% and 3.76% on average after the event respectively. Thirdly, the market depth by dollar value almost doubled after the SHHKConnect. However, the market depth by volume decreases.

[30] Karpoff (1987) cites a large number of studies, which document positive relation between price changes and trading volume.

Table 6 Univariate Test for the Shanghai Stock Exchange

Liquidity measures and proxies for pre- and post- SHHKConnect of *the Shanghai Stock Exchange (SSE)*. Sampling period from 19th May, 2014 to 15th May, 2015. *Quoted depth in dollar value ($Depth)* measures the aggregate value of its time-weighted best bid and ask throughout a day; *Quoted depth by volume (Depth by Vol)* is the aggregate bid and ask volume of time-weighted at the best bid and ask; *Effective Spread* is calculated as the value weighted (price-midpoint)*direction/midpoint; *Quoted Spread (Qtd Spread (perc))* is calculated as time-weighted percentage of prevailing bid-ask spread over the midpoint; ** indicates the significance at the 5% level.

	$Depth		*Depth by Vol*		*Effective Spread*		*Qtd Spread (perc)*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Panel A: Overall Market								
Mean	1,890,633	3,371,699	424,157	368,548	0.2021	0.1944	0.1624	0.1248
Standard Deviation	12,240,713	33,426,112	2,636,060	3,203,708	0.0955	0.0835	0.0829	0.0516
Difference	1,481,066**		-55,609**		-0.0077**		-0.0376**	
	(12.05)		(-3.91)		(-17.61)		(-112.77)	
Panel B: SHHKConnected Stocks								
Mean	2,416,731	4,520,375	565,774	493,973	0.19	0.1796	0.1543	0.1149
Standard Deviation	14,364,206	40,299,694	3,141,564	3,857,125	0.0953	0.0719	0.0890	0.0511
Difference	2,103,644**		-71,801**		-0.0104**		-0.0394**	
	(11.74)		(-3.48)		(-20.77)		(-92.67)	
Panel C: Non- Connected stocks								
Mean	764,097	929,864	120,912	101,921	0.2281	0.2259	0.1798	0.1457
Standard Deviation	5,196,392	5,594,294	748,414	593,088	0.0905	0.0967	0.0644	0.0461
Difference	165,767**		-18,991**		-0.0022**		-0.0341**	
	(3.85)		(-3.27)		(-2.74)		(-70.56)	
Panel D: Cross-listed stocks								
Mean	6,426,281	13,162,213	2,066,383	1,717,970	0.2423	0.1978	0.2181	0.1402
Standard Deviation	16,908,196	78,719,696	6,408,299	7,391,061	0.1292	0.0825	0.1287	0.0720
Difference	6,735,932**		-348,413**		-0.0445**		-0.0779**	
	(7.20)		(-3.10)		(-25.33)		(-46.11)	

Table 6 (Continued)

Liquidity measures and proxies for pre- and post- SHHKConnect of the Shanghai Stock Exchange (SSE). Sampling period from 19th May, 2014 to 15th May, 2015. Trade size in dollar value (Trade Size$) is the average value of each trade on a day; Trade size by volume (Trade Size Vol) is the average trading volume of each trade on a day; Trade Count measures the total numbers of trades occur for a security on a particular day. **indicates the significance at the 5% level.

	Volatility		*Volume*		*Trade Size$*		*Trade Size Vol*		*Trade Count*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Panel A: Overall Market										
Mean	0.0026	0.0039	18,519,762	52,763,352	19,511	25,212	2,437	2,107	6,873	20,727
Standard Deviation	0.0014	0.0020	37,704,886	136,850,000	7,314	10,396	1,381	990	8,983	39,856
Difference	0.0013**		34,243,590**		5,701**		-330**		13,854**	
	(154.26)		(69.81)		(130.37)		(-56.56)		(98.10)	
Panel B: SHHKConnected Stocks										
Mean	0.0025	0.0040	23,140,607	71,071,349	20,509	27,051	2,453	2,103	8,382	27,397
Standard Deviation	0.0014	0.0021	44,345,935	162,460,000	7,880	11,248	1,542	1,088	10,158	46,662
Difference	0.0015**		47,930,742**		6,542**		-350**		19,015**	
	(141.89)		(67.93)		(114.23)		(-44.72)		(94.99)	
Panel C: Non- Connected stocks										
Mean	0.0029	0.0038	8,625,123	13,844,560	17,374	21,302	2,404	2,115	3,643	6,549
Standard Deviation	0.0015	0.0019	10,547,606	14,502,127	5,328	6,809	947	738	4,150	6,415
Difference	0.0009**		5,219,437**		3,928**		-289**		2,906**	
	(65.66)		(48.05)		(74.96)		(-39.61)		(62.45)	
Panel D: Cross-listed stocks										
Mean	0.0022	0.0043	43,342,154	208,430,000	20,564	27,839	3,677	2,895	10,734	64,583
Standard Deviation	0.0014	0.0024	71,340,350	316,990,000	10,567	15,625	2,342	1,728	12,561	80,670
Difference	0.0021**		165,087,846**		7,276**		-782**		53,850**	
	(65.66)		(43.71)		(33.36)		(-23.25)		(56.71)	

Panels B and C in Table 6 report for the SHHKConnected stocks and the Non-Connected stocks listed on the SSE respectively. Both panels show that the changes after the SHHKConnect launch for the two stock groups are align with the market-wide changes but with different magnitudes. Across all the liquidity proxies and variables reported, the SSE–listed SHHKConnected stocks have significantly larger changes after the SHHKConnect launch. In the respect of trading activities, SHHKConnected A-shares' average volume increases by more than 200% (versus 60% for Non-Connected stocks), and average daily trade count increases by 203% (versus 80% for Non-Connected stocks). The transaction costs of the SHHKConnected stocks in the Panel B decrease more than the Non-Connected stocks, which is reported in Panel C, in terms of both effective (-1.04% versus -0.22%) and quoted spreads (-3.94% versus -3.4%). Regarding changes in depth, on average, SHHKConnected stocks' depth, by value, doubled but decreased in terms of volume. For Non-Connected stocks, the dollar value depth increases a smaller amount compared to SHHKConnected stocks; depth, by share number, decreases by around 3 times less, vis-à-vis the decrease of the SHHKConnected stocks.

The Panel D reports the changes for the cross-listed A-shares on the SSE. It highlights that this group of stocks experiences the most significant changes among the three stock groups across all the proxies and variables: on average, their trading volume increases by almost 400%, trade count increases 5 times and volatility increases by 0.21%. The transaction costs of cross-listed A-shares decreases by 4.5% (versus 1.04% for SHHKConnected stocks) and 7.8% (versus 4% for SHHKConnected stocks) in the form of effective spread and quoted spread respectively. The depth in dollar value also doubled for cross-listed A-shares after the SHHKConnect, and their depth by volume decreases significantly by around 17% (versus 13% for the SHHKConnected stocks).

Table 7 shows the market performance change of the three stock groups after the SHHKConnect in the SEHK. In the Panel A, it shows that, overall, the scale of the changes in the SEHK is relatively smaller than those observed for the SSE. Firstly, in terms of trading activity, there is a moderate increase in trading volume of approximately 37% and moderate increase in the average trade count, by approximately 40%. Unlike what happens in the SSE, where average trade size by value increases and trade size by volume decreases, both variables increase in the SEHK post November 2014. The average dollar value of each trade increase by 3.6% and the number of shares transacted in each trade increases by 2%. The volatility of the market also increased marginally, 0.06%. Secondly, it is interesting to observe that the market-wide proxies for liquidity, i.e. the transaction costs, move in opposite direction in the two exchanges pre- and post-SHHKConnect. In the SSE, as discussed before, transaction costs decrease after the SHHKConnect. However, in the SEHK, average trading costs in forms of effective spread and quoted spread increase by around 6% and 4% respectively after November 17, 2014. Thirdly, the average market depth for SEHK decreases. It should be noted that compared to the average market depth in the SSE, the stocks in SEHK always have higher depth in terms of volume quoted depth. It is more than 3 times higher in the SEHK pre-SHHKConnect, and the difference narrowed by around 25% post-SHHKConnect. Before November 17, 2014 the average value quoted value in the two markets are similar. However, as in the SEHK, the figure doubled after SHHKConnect is launched, whereas, it decreases in SEHK, consequently, the depth by value in the SEHK is 100% less than it is in the SEHK after November 17, 2014.

Panel B and C in the Table 7 show that similar to the performance of individual stock groups in the SSE, SHHKConnected stocks appear to have larger adjustment after the event than those Non-Connected stocks in the SEHK. Average trading volume increases by 54% for the SHHKConnected stocks (versus 28% for Non-Connected stocks), and the trade count increases by around for 40% (versus 26% for the Non-Connected stock). It should be noted that although SHHKConnected stocks experience more significant market activities changes, the change in volatility between the two stock groups is similar. The volatility increases by a very small magnitude of around 0.05% for both stock groups. Meanwhile, the changes in the trade sizes for SHHKConnected stocks are similar to what was reported for the SSE –the trade size by value increases, yet, trades size by volume decreases (but the test result is insignificant). Whereas for the Non-Connected stocks, they have both trade size measures increase, which also aligns with the market-wide change on the SEHK.

The most significant difference in the changes of the two stock groups (i.e. the SSHKConnected stocks and the Non-Connected stocks) relate to transaction costs. For the SHHKConnected stocks, effective spread and quoted spread decreased (the test result is insignificant for effective spreads) post-event, whereas, both trading costs proxies increase for the Non-Connected stocks. This highlights the impact of the market connection on liquidity as the reductions are only observed for stocks eligible for trading under the SHHKConnect. Between the SHHKConnected stocks that are listed on the SSE and SEHK, SSE-listed SHHKConnected stocks have largest reduction in trading costs. On average, there is a 1.04% reduction in effective spreads for the SSE-listed SHHKConnected stock, yet, for SEHK-listed SHHKConnected stockst, the reduction is only 0.28%. Likewise the average quoted spread

decreased by 3.9% for SSE-listed SHHKConnected stocks, whereas the reduction is 0.7% in the SEHK.

Regarding the changes in market depth volume, for SEHK-listed SHHKConnected stocks it has always been higher than it is for the SSE-listed SHHKConnected stocks over the sample period. Conversely, depth by value, it is higher for the SSE-listed SHHKConnected stocks after November 17, 2014. For both depth- related variables, there is a large reduction for the SEHK-listed SHHKConnected stocks. Their market depth by volume decreases by more than 30% (versus 12% decrease for the SSE-listed SHHKConnected stocks), and market depth by value decreases by 17% (for the same stock group, it is an increase in the SSE). The Non-Connected stocks in the SEHK also experiences lower depth after SHHKConnect is launched, yet, the reductions in depth are much more moderate compares to the SHHKConnected stocks in the market.

The Panel D in the Table 7 reports the changes for the cross-listed H-shares on the SEHK. Similar to the cross-listed A-shares on the SSE, the univariate result highlights that this group of stocks experiences the most significant changes among the three SEHK-based stock groups across all the proxies and variables. It has the largest increase in trading activities, 64% increase in volume, 77% increase in trade count and 0.08% increase in price volatility. It is noted that different from non-connected stocks and market-wide changes, where trade size by volume decreases after the SHHKConnect is launched, trade size by volume decreases for the cross-listed H-shares by 4.5%. The transaction costs for this stock group decrease by 2.7% and 3.3% for effective spread and quoted spread respectively. Thus, compare to the cross-listed A-shares, there are less transaction cost reductions in the cross-listed H-shares after November 17, 2014. As for market depth, it should be highlighted that cross-listed H-shares always have much lower market depth than cross-listed A-shares[31]. The market depth difference between the two classes of cross-listed stocks is magnified after the SHHKConnect is launched. For instance, the quoted number of shares for cross-listed A-shares is around 38% higher than the cross-listed H-shares before November 17, 2014. However, the difference is approximately 100% higher after SHHKConnect is launched.

[31] Recall for the previous discussions about market depth comparison between the SSE and SEHK, for any stock groups (i.e. SHHKConnected stocks and Non-connected stocks) and for the overall market, in most cases the SEHK has much higher market depth than SSE (except for the post-event market depth by value results).

Table 7 Univariate Test for the Stock Exchange of Hong Kong

Liquidity measures and proxies for pre- and post- SHHKConnect of the Stock Exchange of Hong Kong (SEHK). Sampling period from 19th May, 2014 to 15th May, 2015. Quoted depth in dollar value ($Depth) measures the aggregate value of its time-weighted best bid and ask throughout a day; Quoted depth by volume (Depth by Vol) is the aggregate bid and ask volume of time-weighted at the best bid and ask; Effective Spread is calculated as the value weighted (price-midpoint)*direction/midpoint; Quoted Spread (Qtd Spread (perc)) is calculated as time-weighted percentage of prevailing bid-ask spread over the midpoint; ** indicates the significance at the 5% level.

	$Depth		*Depth by Vol*		*Effective Spread*		*Qtd Spread (perc)*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Panel A: Overall Market								
Mean	1,885,782	1,629,713	1,375,468	1,090,733	0.7673	0.8283	0.7507	0.7903
Standard Deviation	8,113,850	5,069,454	9,981,161	5,568,467	0.6679	0.7494	0.6175	0.6674
Difference	-256,069**		-284,735**		0.0610**		0.0396**	
	(-8.34)		(-7.77)		(18.95)		(13.72)	
Panel B: SHHKConnected Stocks								
Mean	4,184,984	3,468,124	1,296,555	906,067	0.2959	0.2931	0.2937	0.2867
Standard Deviation	13,914,350	8,332,788	9,320,362	6,393,722	0.2362	0.2353	0.2299	0.2261
Difference	-716,860**		-390,488**		-0.0028		-0.0070**	
	(-7.75)		(-6.06)		(-1.46)		(-3.82)	
Panel C: Non- Connected stocks								
Mean	817,656	783,773	1,412,128	1,175,707	0.9863	1.0745	0.9624	1.0220
Standard Deviation	1,697,168	1,817,764	10,273,558	5,142,271	0.6901	0.776	0.6261	0.6756
Difference	-33,883**		-236,421**		0.0882**		0.0596**	
	(-3.51)		(-5.30)		(21.91)		(16.68)	
Panel D: Cross-listed stocks								
Mean	7,243,744	5,157,078	1,493,817	856,628	0.3167	0.2897	0.3104	0.2778
Standard Deviation	21,048,357	11,891,977	5,316,795	2,507,709	0.2298	0.2318	0.2007	0.1935
Difference	-2,086,666**		-637,189**		-0.0270**		-0.0326**	
	(-7.49)		(-9.41)		(-7.17)		(-10.13)	

Table 7 (Continued)

Liquidity measures and proxies for pre- and post- SHHKConnect of the Stock Exchange of Hong Kong (SEHK). Sampling period from 19th May, 2014 to 15th May, 2015. Trade size in dollar value (Trade Size$) is the average value of each trade on a day; Trade size by volume (Trade Size Vol) is the average trading volume of each trade on a day; Trade Count measures the total numbers of trades occur for a security on a particular day. ** indicates the significance at the 5% level.

	Volatility		*Volume*		*Trade Size$*		*Trade Size Vol*		*Trade Count*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Panel A: Overall Market										
Mean	0.0032	0.0038	13,383,269	18,298,873	36,557	37,860	30,509	31,159	892	1,232
Standard Deviation	0.0024	0.0027	42,534,180	66,955,420	32,347	33,504	60,837	60,139	1,447	2,285
Difference	0.0006**		4,915,604**		1,303**		649.80**		340**	
	(51.8)		(19.32)		(8.73)		(2.37)		(39.22)	
Panel B: SHHKConnected Stocks										
Mean	0.0020	0.0026	14,369,531	22,137,497	48,539	51,897	6,611	6,504	1,894	2,732
Standard Deviation	0.0011	0.0015	38,143,576	64,844,275	41,758	42,944	10,857	9,545	1,992	3,337
Difference	0.0005**		7,767,966**		3,358**		-107.10		838**	
	(50.25)		(18.09)		(9.83)		(-1.3)		(37.79)	
Panel C: Non-Connected stocks										
Mean	0.0037	0.0043	12,925,088	16,532,541	30,991	31,402	41,611	42,504	427	542
Standard Deviation	0.0027	0.0029	44,419,351	67,832,353	24,993	25,653	70,549	69,503	735	996
Difference	0.0006**		3,607,453**		411**		892.60**		115**	
	(40.73)		(11.48)		(2.96)		(2.32)		(24.03)	
Panel D: Cross-listed stocks										
Mean	0.0022	0.0030	27,315,719	44,865,593	52,626	61,167	8,662	8,276	2,364	4,202
Standard Deviation	0.0010	0.0015	59,812,359	92,168,810	43,313	45,018	8,585	7,088	2,143	4,403
Difference	0.0008**		17,549,874**		8,541**		-386.00**		1,838**	
	(35.49)		(13.82)		(11.85)		(-3.01)		(32.45)	

Table 8 shows the change in the price premium and the daily return between corresponding cross-listed A- and H- shares. The table shows that, prior to the SHHKConnect, A-shares traded at a premium of around 23% to their corresponding H-shares on average. A-shares also experience higher returns then their corresponding H-shares counterparts on the SEHK, approximately 1.37%. After the SHHKConnect, the differences further magnified. The average price ratio changes from 1.23 to 1.71, which indicates that A-shares are traded at a higher premium over their corresponding H-shares after SHHKConnect is launched. The daily return premium increased significantly from 1.4% to 22.7% for cross-listed A-shares over H-shares. On the whole, the changes of larger price divergence and excess return are not anticipated under the trading mechanism of the SHHKConnect.

Table 8 Univariate Test for A and H-Share Price Premium

69 pairs of cross-listed stocks are tested for the testing period between the 19th May, 2014 and 15th May, 2015. Ah_ratio stands for the ratio of close prices of one stock to another, which is the close price of A-share over the close price of corresponding H-share, i.e. A-share's price/H-share's price; Daily Return (%) is calculated as (Close price/Previous Close price-1)*100%. ** indicates the significance at the 5% level.

	Ah_ratio		Daily Return (%)	
	Pre	Post	Pre	Post
Mean	1.2260	1.7073	0.0137	0.2272
Standard Deviation	0.3863	0.5860	1.9806	3.2798
Differences	0.4813**		0.2135**	
	58.15		4.71	

6.2 Results for Liquidity Test – the SSE

Panel A in Table 9 reports multivariate results of liquidity tests for the three liquidity proxies on the SSE. The result shows that effective spread and the quoted spread in the SSE are negatively related to volume and stock price, and positively related to volatility. These relations are consistent with the findings in the theoretical models in Stoll (1978), Bagehot (1971) and Copeland and Galai (1988). The estimation result for quoted depth in the SSE is positively related to trading volume and negatively related to price volatility. The former is consistent with the general consensus in literature, which documents the positive relation between trading volume and depth. The negative relation between depth and volatility reconfirms the theoretical and empirical findings of Stoll (1978) and Amihud and Mendelson (1989). The result also shows a negative relationship between depth and price, as expected as the proxy used for market depth is the logarithm of number of shares quoted, the higher the stock price, the less number of shares investors can trade[32].

[32] Brunnermeier and Pedersen (2009) discussed about funding constraints for margin trading, and the paper also mentions that the higher the stock price, the lower the investors' ability to quote in the market.

In the test results for effective spread, Panel A of Table 9, the coefficient estimation for $\mathrm{D_{connect}}$ indicates that overall, SHHKConnected stocks have insignificantly different effective spreads relative to other stocks. However, the estimated coefficient for the second dummy variable $\mathrm{D_{nov2014}}$ is negative and significant, this suggest that after the SHHKConnect, the overall market's effective spread has declined. Although SHHKConnect does not have direct impact on Non-connected stocks, the negative and significant estimation of $\mathrm{D_{nov2014}}$ can be supported by the idea raised by Chordia et al. (2000), that is market liquidity is correlated across stocks in a market. The variable of primary interest to evaluate hypothesis [1] and [2] in the Section 3.1.4, however is $\mathrm{D_{connect} * D_{nov2014}}$. The significant negative value of the estimated coefficient for this interaction term indicates that for those SHHKConnected stocks, effective spreads declined after SHHKConnect was launched. After the SHHKConnect, holding everything else constant, it costs 1.3 basis points less to trade those eligible stocks under SHHKConnect.

Results for quoted spread reported in the Panel A, shows that across the entire sampling period, the treatment group of SHHKConnected stocks have on average higher bid-ask spreads than the Non-Connected stocks in the SSE the $D_{connect}$ estimation is 0.00543. The estimation for $D_{nov2014}$ is insignificant, which imply that the market-wide quoted spread does not change significantly pre- and post- the event. Our key variable of interest, the interaction variable $D_{connect} * D_{nov2014}$, is negative and significant. This indicates that after SHHKConnect is launched, the bid-ask spread of stocks eligible to trade under the SHHKConnect has decreased by 0.063 basis points on average.

Table 9 Liquidity Test Results

The estimated regression is as follow:

$$Liquidity\ Proxies_{i,t} = \beta_0 + \beta_1 \ln Volume_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 InverPrice_{i,t} + \beta_4 D_{connect} + \beta_5 D_{nov2014} + \beta_6 D_{connect} * D_{nov2014} + \beta_7 FE_i + \beta_8 FE_t + \varepsilon_{i,t}$$

For the liquidity proxies, $Effective\ Spread$, $Qtd\ spread$ and $lnDepth$ are used. For each security –day, its $Effective\ Spread$ is aggregated by value weight effective spread of each trade, which is calculated by comparing the execution price to the previous prevailing midpoint before the trade; $Qtd\ spread$ is calculated as time-weighted percentage of prevailing bid-ask spread over the midpoint; $lnDepth$ is the logarithm taken over the quoted depth by volume, which is the aggregate volume of its time-weighted best bid and ask throughout a day; $\ln Volume$ is the logarithm taken over daily volume; $Volatility$ is calculated using value-weighted intraday volatility. $InverPrice$ is the inversion of the close price of a stock. $D_{connect}$ is a dummy variable, which indicates a stock's eligibility to trade under SHHKConnect. It equals to 1 if a stock can be traded under SHHKConnect, otherwise, it equals to 0; $D_{nov2014}$ is a time period dummy, it equals to 1 if a sample is observed after November 17th, 2014, otherwise, it equals to 0; $D_{connect} * D_{nov2014}$ is a interaction variable, it equals to 1 if a sample observed is of a Connected stock after SHHKConnect date, it equals to 0 otherwise. ** indicates the significance at the 5% level.

	Intercept	lnVolume	$Volatility$	$InverPrice$	$D_{connect}$	$D_{nov2014}$	$D_{connect} * D_{nov2014}$	*R- square*
Panel A: Liquidity Test - the Shanghai Stock Exchange								
$Effective\ Spread$	0.04070**	-0.00214**	19.52221**	0.99613**	0.00923	-0.00782**	-0.01301**	0.62946
	(6.12)	(-6.59)	(159.06)	(178.19)	(1.85)	(-2.61)	(-22.54)	
$Qtd\ spread$	0.18339**	-0.01126**	6.49108**	0.94577**	0.00543**	-0.00079	-0.00063**	0.93856
	(84.76)	(-106.5)	(162.59)	(520.11)	(3.34)	(-0.81)	(-3.34)	
$lnDepth$	2.54685**	0.46203**	-45.22948**	8.17939**	-0.01111	0.04294	-0.13967**	0.86889
	(41.86)	(155.39)	(-40.29)	(159.96)	(-0.24)	(1.57)	(-26.45)	
Panel B: Liquidity Test - the Stock Exchange of Hong Kong								
$Effective\ Spread$	3.57917**	-0.11536**	69.86412**	0.06030**	-1.16248**	-0.02422	-0.06661**	0.73360
	(108.9)	(-96.74)	(139.34)	(76.95)	(-33.73)	(-1.33)	(-18.51)	
$Qtd\ spread$	3.99110**	-0.15071**	57.20474**	0.06324**	-0.96935**	-0.02225	-0.03717**	0.80948
	(158.61)	(-165.07)	(148.96)	(105.41)	(-36.73)	(-1.59)	(-13.49)	
$lnDepth$	7.46482**	0.41636**	-90.67331**	0.08629**	0.47673**	-0.09794**	-0.08820**	0.90212
	(159.13)	(244.63)	(-126.7)	(77.15)	(9.69)	(-3.76)	(-17.17)	

The result of the variable $lnDepth$ in the Panel A provides addition insight relating to market depth over and above the univariate results. The estimation for the first two dummies variables, i.e. $\mathrm{D_{connect}}$ and $\mathrm{D_{connect}}$are insignificant. This suggests that, considering the entire sample period, the market depth for SHHKConnected stocks is not significantly different from that for the Non-Connected stocks. Moreover, the market depth does not change significantly pre- and post- SHHKConnect. However, the estimation for the key variable $\mathrm{D_{connect}} * \mathrm{D_{nov2014}}$ suggests that in the SSE, after SHHKConnect is launched, stocks that can be traded through the market connect experience lower depth, with a up to 13.97% decrease compared to the previous levels.

On the whole, the SSE-listed SHHKConnected stocks' liquidity is improved after the launch of the SHHKConnect in the form of lower trading costs. Thus, we accept hypothesis [1] in the Section 3.4.1 and conclude that the introduction of SHHKConnect decreases spreads for SHHKConnected stocks in the SSE. On the other hand, market liquidity decreases for SSE-listed stocks that are eligible for trading under the SHHKConnect. Therefore, we reject hypothesis [3] proposed in the Section 3.4.1 and fail to conclude that the introduction of SHHKConnect increases depth for SHHKConnected stocks in the SSE.

6.3 Results for Liquidity Test – the SEHK

Panel B in Table 9 shows the liquidity test's results for three liquidity proxies of the Stock Exchange of Hong Kong. The result shows that effective spread and the quoted spread in the SEHK are negatively related to volume and stock price, and positively related to volatility, consistent with results for the SSE and previous literature.

In the test results for effective spreads in the Panel B, the estimations of $D_{connect}$ is negative and significant, it indicates that SHHKConnected stocks have lower effective spreads than the Non-Connected. The estimation for the second dummy variable $\mathrm{D_{nov2014}}$ suggests that after SHHKConnect is launched, it means that the market level trading costs does not change significantly. On the other hand, the test result for $\mathrm{D_{connect}} * \mathrm{D_{nov2014}}$ is negative and significant. It suggests that for SEHK-listed SHHKConnected stocks after the SHHKConnect date, their effective spread has decreased by 6.67 basis points and the change is significant. In other words, the transaction costs for those SHHKConnected stocks have decreased after SHHKConnect is launched. By comparing the coefficient estimations between $D_{nov2014}$ (negative but insignificant) and $D_{connect} * D_{nov2014}$ (-0.06661), it indicates that the reduction in quoted spread only occurs for those SHHKConnected stocks.

In the test results for quoted spreads in the Panel B, the negative and significant coefficient of the first dummy variable, i.e. $D_{connect}$, suggests that it is cheaper to trade SHHKConnected stocks in the SEHK. The estimation for $\mathrm{D_{nov2014}}$ in the regression suggest that the market level bid-ask spread does not change significantly after SHHKConnect is launched at 95% confidence level. However, the third dummy variable $\mathrm{D_{connect}} * \mathrm{D_{nov2014}}$ has a negative and significant estimation. It suggests that the quoted spread for SHHKConnected stocks in Hong Kong has decreased under the SHHKConnect. Holding everything else constant, on average, the quoted spread for SHHKConnected stocks is 3.7 basis points less after

SHHKConnected is launched and this change is significant. By comparing the coefficient estimations between $D_{nov2014}$ (negative but insignificant) and $D_{connect} * D_{nov2014}$ (-0.03717), it indicates that the reduction in quoted spread only occurs for those SHHKConnected stocks.

In the test results for quoted depth in the Panel B, the estimation for $\mathrm{D_{connect}}$ suggests that the market depth for the treatment group (SHHKConnected stocks) is thicker than for the control group (Non-connected stocks). The estimation for the time period dummy variable $\mathrm{D_{nov2014}}$ is negative and significant. It shows that the overall market depth becomes thinner after SHHKConnect date. Results relating to the key variable of interest, $\mathrm{D_{connect} * D_{nov2014}}$, suggests that after SHHKConnect, market depth for SHHKConnected stocks decreased by 8.82%.

By looking at the results in Panel A and Panel B together, it is found that after the SHHKConnect date, for the stocks that are eligible for trading under the SHHKConnect, their transaction costs decreased as measured in the form of effective and quoted spreads. Therefore, we accept the hypothesis [1] in the Section 3.4.1, that the introduction of SHHKConnect decreases spreads for SHHKConnected stocks in the SEHK. In addition, the market depth becomes thinner after the SHHKConnect date for the SHHKConnected stocks in the SEHK. Thus, we reject the hypothesis [2] proposed in the Section 3.4.1 and fail to conclude that the introduction of SHHKConnect increases depth for SHHKConnected stocks in the SEHK. Although contradictory conclusions might be drawn from decreased trading costs and decreased market depth, Frino et al. (2012) and others suggests that effective spread should be used as it is a better proxy for liquidity. Effective spreads offer a more accurate evaluation for market liquidity when there are aggressive orders that trade through the order book.

6.4 Price - premium Test

Having documented the results relating to the liquidity tests on both the SSE and HK, this section will focus on tests of the price-premium between A- and H-shares, Table 10 reports coefficient estimates of Equation 4.

Table 10 Price-Premium Test Result

$\mathrm{Ah\_ratio_{t-1}}$ is the A/H price ratio from the last trading day; SSEIndex and SEHKIndex are the inter-day return of Shanghai A-Share Index and Hang Seng Index, respectively; HVol/Hshare is calculated as daily H-share trading volume divided by the total number of free-floated H-shares; ΔQtd is the difference between the time-weighted quoted spreads by percentage of A- and H-shares. VolaRatio is calculated as the intra-day volatility of an A-share over the intra-day volatility of its corresponding H-share;Xrate is the exchange rate between the Chinese CNY and the Hong Kong dollar; $\mathrm{D_{nov2014}}$ is a time period dummy, it equals to 1 if a sample is observed after November 17th, 2014, otherwise, it equals to 0; ** indicates the significance at the 5% level.

R-square	0.98269	
Mean	1.45622	
Parameter	**Estimate**	**T-Stats**
Intercept	-0.01232	(-0.14)
$\mathrm{Ah\_ratio_{t-1}}$	0.98064**	(658.89)
SSEIndex	1.51575**	(55.27)

$SEHKIndex$	-1.84050**	(-26.41)
$HVol/Hshare$	-0.00098**	(-5.16)
ΔQtd	-0.03967**	(-11.23)
$VolaRatio$	0.01378**	(14.52)
$Xrate$	0.01328	(0.19)
$D_{nov2014}$	0.00397**	(2.64)

The results show that the price premium between the two classes of shares is positively correlated to market performance of the SSE and the price premium is negatively correlated to the market index of the SEHK. The correlations between the price premium and market indices are significant at a 5% level. The negative coefficient of the liquidity proxy for H-shares reconfirms the findings in Chen et al. (2001), Longstaff (2001) and Wang and Jiang (2004). The inverse correlation shows that the price premium of A-shares over H-shares narrows when liquidity of H-shares increases. Furthermore, the coefficient of the difference between quoted spreads of A- and H-shares is negative and the estimation is significant at a 5% level. The estimation is expected as the average of ΔQtd is negative and the negative coefficient suggests that, when the difference between the quoted spread of A- and H-shares becomes larger (i.e. change towards zero), the price premium of A- to H- shares will become smaller. That is, holding everything else constant, the price premium of A- to H- shares will decrease (increase) by around 4% for one percentage point increase (decrease) in A-shares (H-shares) in quoted spread. Stock illiquidity will result in higher required returns and lower stock prices. Thus, the larger the difference of the illiquidity proxy between A- and H-shares, the lower the price difference between these classes of shares.

$VolaRatio$ is a proxy to test the differential risk hypothesis, its positive and significant coefficient supports the differential risk hypothesis in Brennan and Subramanyam (1996) and Eun and Janakiramanan (1986). Reflecting the findings in Wang and Jiang (2004), the test results for the exchange rate change suggests that the exchange rate change does not play a significant role in the price divergence of A- and H-shares. The reason for this might be that the exchange rate between the two currencies, Chinese CNY and Hong Kong Dollar, is relatively stable overtime due to the currency policies of both regions. Therefore, exchange rate may not be a powerful variable to explain the price difference between A- and H-shares. Lastly, as the main purpose of this study is to address the price premium of A-share to H-share, the model aims to test $D_{nov2014}$. The estimation for this variable is positive and significant at a 5% level. This suggests that after SHHKConnect, the price premium increases by 0.40%. Thus, the hypothesis [3] is rejected[33]. Interestingly, results suggest that after SHHKConnect, free trading of the two classes of shares does not close the price gap between them.

7. Robustness Tests

7.1 Robustness Test – Liquidity Test

A robustness test is carried out to re-test the impact of the SHHKConnect on market liquidity. The test re-visits the liquidity test model as specified in Section 4, and a different

[33] The hypothesis [3]: The introduction of SHHK Connect decreases the liquidity premium.

sample period is examined. For this robustness test, the sample period selected is 3-month pre- and post- SHHKConnect.

Table 11 reports the result for the robustness tests. For both markets, the key variable of interest, which is the interaction dummy variable, $\mathbf{D_{connect} * D_{nov2014}}$ in the test regression for all three liquidity proxies are negative and significant at 5% level. This test result is consistent with the test results output from the sample data using 6-month pre- and post- SHHKConnect. Thus, it can be concluded that after SHHKConnect, the trading costs in the form of quoted and effective spread of those eligible stocks that can be traded through SHHKConnect have decreased.

7.2 Robustness Test – Price-premium Test

A robustness test is carried out to re-test the impact of the SHHKConnect on price premium between A- and H-shares. Instead of testing on the price-premium model specified in Section 4, a test is conducted on the liquidity hypothesis test model that is modified based on the model tested in the Lee (2009). Lee (2009) incorporates further liquidity proxies to test the A- and H- price premium. The hypothesis he proposed is that the price premium between A- and H- shares is due to the SSE being more liquid than the SEHK. The control variables he used including relative difference daily trade count, average trade size (by value), quoted spread and market depth (by value). The test model we use is modified based on Lee's model in certain ways: 1) for some variables (e.g. trade size and market depth), the model in this study uses volume based data instead of value based data to avoid the impact that SSE-listed stocks have experienced large price change during the sample period. 2) In order to test the impact of the SHHKConnect, there is a time period dummy added in the test regression, i.e. $D_{nov2014}$. The test result is reported in Table 12.

The liquidity hypothesis test model in this robustness test is modified by adding a period dummy variable of $\mathbf{D_{nov2014}}$ to indicate the change of the premium after SHHKConnect. The test results is consistent with the test results output using the factor model. Both tests find that the A- to H-share price premium has increased after SHHKConnect.

Table 11 Robustness Tests - Liquidity Tests

The estimated regression is as follow:
$Liquidity\ Proxies_{i,t} = \beta_0 + \beta_1 \ln Volume_{i,t} + \beta_2 Volatility_{i,t} + \beta_3 InverPrice_{i,t} + \beta_4 D_{connect} + \beta_5 D_{nov2014} + \beta_6 D_{connect} * D_{nov2014} + \beta_7 FE_i + \beta_8 FE_t + \varepsilon_{i,t}$
For the liquidity proxies, $Effective\ Spread$, $Qtd\ spread$ and $lnDepth$ are used. For each security –day, its $Effective\ Spread$ is aggregated by value weight effective spread of each trade, which is calculated by comparing the execution price to the previous prevailing midpoint before the trade; $Qtd\ spread$ is calculated as time-weighted percentage of prevailing bid-ask spread over the midpoint; $lnDepth$ is the logarithm taken over the quoted depth by volume, which is the aggregate volume of its time-weighted best bid and ask throughout a day; $\ln Volume$ is the logarithm taken over daily volume; $Volatility$ is calculated using value-weighted intraday volatility. $InverPrice$ is the inversion of the close price of a stock. $D_{connect}$ is a dummy variable, which indicates a stock's eligibility to trade under SHHKConnect. It equals to 1 if a stock can be traded under SHHKConnect, otherwise, it equals to 0; $D_{nov2014}$ is a time period dummy, it equals to 1 if a sample is observed after November 17th, 2014, otherwise, it equals to 0; $D_{connect} * D_{nov2014}$ is a interaction variable, it equals to 1 if a sample observed is of a Connected stock after SHHKConnect date, it equals to 0 otherwise. ** indicates the significance at the 5% level.

	Intercept	$\ln Volume$	$Volatility$	$InverPrice$	$D_{connect}$	$D_{nov2014}$	$D_{connect} * D_{nov2014}$	*R- square*
Panel A: Liquidity Test - the Shanghai Stock Exchange								
$Effective\ Spread$	-0.07679**	0.00455**	17.47801**	1.08744**	0.01902**	0.00585**	-0.01319**	0.62222
	(-7.7)	(8.82)	(95.75)	(95.57)	(2.76)	(2)	(-16.41)	
$Qtd\ spread$	0.13570**	-0.00858**	5.61935**	0.99120**	0.00750**	-0.00416**	-0.00097**	0.92809
	(42.54)	(-52.05)	(96.28)	(272.46)	(3.4)	(-4.44)	(-3.79)	
$lnDepth$	1.91656**	0.47973**	-51.11943**	10.11830**	0.16110**	0.42608**	-0.08084**	0.88246
	(22.02)	(106.71)	(-32.1)	(101.93)	(2.68)	(16.66)	(-11.53)	
Panel B: Liquidity Test - the Stock Exchange of Hong Kong								
$Effective\ Spread$	3.19733**	-0.09900**	70.92048**	0.06341**	-1.05735**	0.07593**	-0.10201**	0.74592
	(70.05)	(-55.43)	(95.96)	(45.37)	(-21.86)	(4.09)	(-20.25)	
$Qtd\ spread$	3.78467**	-0.14182**	56.57983**	0.06643**	-0.91412**	0.03749**	-0.08245**	0.82989
	(112.42)	(-107.66)	(103.8)	(64.44)	(-25.62)	(2.74)	(-22.19)	
$lnDepth$	7.62767**	0.40762**	-90.19160**	0.08101**	0.50497**	0.03838	-0.03662**	0.91359
	(125.1)	(170.86)	(-91.35)	(43.39)	(7.81)	(1.55)	(-5.44)	

Table 12 Robustness Test – Price premium test

Ah_ratio_{t-1} is the A/H price ratio from the last trading day; Δdepth is the ratio of total depth of A-share divided by the total depth of its corresponding H-share; Δqtd_abs is A-shares' quoted spread(abs) minus its corresponding H-share's quoted spread(abs); Δtrade_count is total trade count of A-share divided by the total trade count of its corresponding H-share; Δvol_size_v is the difference of average trade size in number of shares between A-share and its corresponding H-share; $D_{nov2014}$ is a time period dummy, it equals to 1 if a sample is observed after November 17, 2014, otherwise, it equals to 0; ** indicates the significance at the 5% level.		
R-square	0.97734	
Mean	1.45619	
Parameter	**Estimate**	**T-Stats**
$Intercept$	0.02501**	(11.29)
Ah_ratio_{t-1}	0.97405**	(645.99)
$\Delta depth$	0.00034**	(7.12)
Δqtd_abs	0.24127**	(5.63)
$\Delta trade\_count$	0.00039**	(11.47)
Δvol_size_v	0.00000	(0.9)
$D_{nov2014}$	0.01754**	(11.42)

8. Conclusion

The launch of the SHHKConnect liberalised the SSE to international retail and institutional investors, permitting enhanced capital flows between the capital markets of mainland China and Hong Kong. This event provides a unique and natural experiment to examine the impact of partial capital liberalisation and market connection in China on market liquidity and price divergence. More importantly, the study of this event will shed light on the possible impact of subsequent market connect between China's next largest listing market, the Shenzhen Stock Exchange and the SEHK.

Based on previous literature, the current thesis develops and tests three hypothesis: [1] Does the introduction of SHHKConnect decrease transaction costs for SHHKConnected stock [2] Does the introduction of SHHKConnect increase market depth for SHHKConnected stocks [3] Does the A- to H-share premium for cross-listed stocks in China and Hong Kong, respectively, narrow following the mitigation of capital flow restriction with the introduction of SHHKConnect. Given the introduction of SHHKConnect is limited to a select number of securities, adopted is a difference-in-difference methodology to establish and disentangle the impact of the introduction of SHHKConnect from the extraneous variables. The three stock groups created: SHHKConnected stocks, Non-Connected stocks and Cross-listed stocks. SHHKConnected stocks are eligible for trading under the SHHKConnect, whereas, Non-Connected stocks are not to be traded under the SHHKConnect. Cross-listed stocks are cross-listed A- and H- shares. Refer to the Section 5 for details.

The results find, as anticipated by many market commentators prior to the official inception of the program, trading activities increase in both markets after the launch on November 17, 2014. This is especially true for stocks that are eligible to be traded under the SHHKConnect, i.e. the SHHKConnected stocks. The univariate test results in this thesis show that the overall market liquidity improves as effective bid-ask spreads or price impact decreased

for the SSE, but the overall market's liquidity does not change significantly for the SEHK. The market depth decreases in both markets for SHHKConnected stocks after November 17, 2014 and the change is larger on the SSE-listed.

After controlling for the known determinants of market liquidity, i.e. volume, price and volatility, the multivariate tests report significant evidence for Hypothesis 1. On both the SSE and the SEHK, transaction costs, in the form of effective spread, decrease for securities that are eligible for trading through the SHHKConnect. However, Hypothesis 2 is rejected as both markets' depth decrease significantly. While this finding could be interpreted as a reduction in market liquidity, given findings of a decrease in effective spreads which reflect both price and depth dimension of liquidity, this thesis concludes that the SHHKConnect, has a positive impact on market liquidity. The tests' results above are supported by robustness tests conducted.

In the test of price convergence/divergence for cross-listed stocks (i.e. Hypothesis 3), results reported in Table 10 show that despite Chinese investors now being permitted to purchase H-shares in Hong Kong at cheaper prices than buying corresponding A-shares in China, the premium of A-shares over H-shares increases. The robustness test for A- and H-share premium confirms such the finding aforementioned. This result to some extent is affected by the improved liquidity for cross-listed A-shares. The liquidity of A-shares increases more than the cross-listed H-shares, which is suggested by effective spread and quoted spread decrease more for cross-listed A-shares. While reported results find a decrease in trade size post-SHHKConnect, we are not able to distinguish order flows from retail investors and confirm their participation in the markets. It will be an interesting topic for future research to study the impact of trading by retail investors on market liquidity.

A number of other possible avenues for future research also exist. Firstly, as the eligibility for stocks to be traded through the SHHKConnect is adjusted with the adjustment of index constituents, the liquidity changes for individual stocks that are removed or added into the SHHKConnect can be studied with sufficient sample period[34]. Secondly, as trading through the SHHKConnect is subject to an Aggregate Quota and a Daily Quota, a study might be carried out on this special market design regarding the changes of market liquidity when either quota is reached. Lastly, different from previous literature that study price discovery between cross-listed stocks in traditional market settings, the SHHKConnect creates a unique opportunity for studying the price discovery between cross-listed stocks when stock trading on one stock is suspended due to active trading that is when the quota limits are reached in either market.

[34] The sampling period in this paper is up to 6 month after the launch of the SHHKConnect, a longer sampling period is required with sufficient sample stocks to test such liquidity changes.

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Appendix 1 – Additional Data Filtering Rules

In the tables below, they contain additional filtering rules applied to filter out extreme input variables.

For the stocks traded on the SSE:

Variable	*Direction*	*Value*	*Mean*	*Standard Deviation*
Volatility	>	0.0240	0.0033	0.0019
Qtd spread (perc)	>	1.0000	0.1439	0.0718
Effective spread	>	2.2000	0.1984	0.0918
Depth Vol	>	200,000,000.00	402,171.78	3,209,841.74
Depth$	>	4,000,000,000.00	2,672,886.52	28,490,995.72

For the stocks traded on the SEHK:

Variable	Direction	value	Mean	Standard Deviation
Volatility	>	0.0400	0.0035	0.0026
Qtd spread (perc)	>	10.0000	0.7722	0.6561
Trade Count	>	50,000.00	1,064.17	1,938.02
Effective Spread	>	11.7000	1.1915	1.8514
Invert Price	>	65.00	1.13	2.56
Depth$	>	300,000,000.00	1,773,140.93	7,186,293.79
Trade Size Vol	>	2,000,000.00	31,157.85	64,480.70